# NATIONAL WETLANDS MANAGEMENT FRAMEWORK FOR RWANDA

**Final Report, December 2020**

**By the Centre of Excellence in Biodiversity and Natural Resource Management**

**University of Rwanda**

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# EXECUTIVE SUMMARY

This National Wetland Management Framework for the country of Rwanda has been developed as part of a larger project undertaken for the Rwanda Environment Management Authority (REMA).The purpose of a National Wetland Management Framework is to provide a national approach to the management of the country's wetlands.

Wetlands are dominant features of the Rwandan landscape, and are vitally important for biodiversity, people and the economy. Rwanda has already taken the significant step of recognizing the importance of wetlands and the need to manage them proactively. This National Wetlands Management Framework forms the next step in focusing efforts towards maximizing the benefits of wetlands for the country into the future.

For the purposes of this project and this National Wetland Management Framework, the concept of Wetland Management is understood to include the tasks of inventory, protection, rehabilitation and monitoring, as well as setting policy, guidance on sustainable use and management framework, as outlined in the Ramsar guidelines for wetland policy.

The report reviews the current knowledge about the state of wetland management in Rwanda in order to identify and prioritise the prevalent issues and concerns regarding wetland management in the country. This current state forms the baseline from which the framework can be developed, and against which the future implementation of the framework can be measured.

This was carried out according to the approved methodology by gathering together and reviewing the available information. This review was supplemented by identifying and consulting with government officials, local experts and stakeholders, as well as by undertaking field visits. Additionally, a workshop was held to engage with stakeholders. Based on the above information, the current issues and concerns related to wetlands and wetland management in Rwanda were identified.

It was found that Rwanda has made significant progress on developing a comprehensive national wetland inventory since 2003, when the previous National Environmental Policy was enacted, and 2004, when the National Land Policy was enacted, which was later revised in 2019. This is to be commended, since very few other countries worldwide have yet achieved this. A comprehensive spatial analysis of the extent of coverage, locations and boundaries of wetlands across the country has been established and has been communicated in legislation and through public engagement on the ground. The total number of wetlands for the 2017 updated and gazetted list is 935, with a total area of 176 337 ha. Lakes account for a further approximately 120 000 ha. All calculations reported in the remainder of this situational analysis are based on the area in hectares reported in the 2017 gazetted list. It is understood that the wetland characteristics attribute information is based on the 2008 inventory (REMA, 2009).

Current characteristics used to classify wetlands in Rwanda include – wetland soil type, wetland vegetation, hydrology and climate zone.

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 standardised assessment of the condition of Rwanda wetlands.
Current legislation categorises 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.

**Wetlands with the status of "total protection"**

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).

Of the wetlands designated for total protection, 46 056 ha (96% of the wetlands under total protection and 46% of all wetlands) were mapped as natural vegetation, and 1 964 ha (4% of total protection) were mapped as cultivated. Wetlands under "total protection" fall within Akagera and Nyungwe National Parks, as well as the Rugezi wetland (Ramsar site) and the lake dams.

**"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. It should be noted that a new law on environment and a new law on water resources were gazetted together with the law N°55/2018 of 13/08/2018 and in its article 39 provides that a zone developer, operator and user must comply with laws determining modalities for protection, conservation and promotion of environment.

**"Non-protected wetlands with status of use without 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.

Issues in wetland management were found to be largely related to the increase in use of wetlands for agriculture. Considerable focus is needed to understand the relationship between wetland function and ecosystem provisioning and conversion to agriculture, particularly in identifying the limit to which each wetland can be altered/converted before it is destroyed and can no longer provide services. Recommendations were made to enhance the sustainable agricultural use of wetlands relating to cultivation methods, crop selection, cropping systems, and alternatives to rice in prioritised catchments. The mining of peat, sand and clay also impact on wetlands, as does pollution from high sediment loads in rivers; microbial pollution and water-borne pathogens; hotspots of salinization; nutrient enhancement and eutrophication; acidity and alkalinity; solid waste and litter; dissolved oxygen, BOD/COD and organic pollution; agrochemicals and toxic substances; heavy metals; and invasive alien plants.

The vision is to have wetlands that can continue to provision ecosystem services that support Rwanda's sustainable development, climate resilience, and biodiversity conservation over the long term. A set of goals and objectives were developed in consultation with stakeholders in the country during a two-day stakeholder workshop in October 2017 with 59 participants. Based on this stakeholder workshop, the following vision for the country is proposed: **Sustainable and productive wetlands for the socio-economic welfare of Rwanda.** This vision, along with the goals and objectives listed below, is the basis for the Implementation Framework put forward for feedback from stakeholders, and will be revised and refined based on their feedback.

Three themes emerged from the 2017 workshop: 1) People-sustainable/wise-use; cultivation, health, goods; 2) Economy-commercial production/income generation, wise use; 3) Biodiversity-rehabilitation, conservation, biodiversity, Ramsar, ecosystem function. Three goals and a number of objectives dealing with wetland rehabilitation, sustainable use, and protection were also developed from this workshop, which are described later in this report.

The National Wetland Management Framework proposed in this report incorporates the vision, goals and objectives determined through the stakeholder engagement process, and the information provided from the catchment characterisation.

The actions needed to ensure that the vision and goals of the Wetland Management Framework are achieved were combined with responsibilities and an indication of the time scale involved to form the implementation framework. As mentioned previously, this Implementation Framework is put forward as a basis for feedback from stakeholders, and will be revised and refined based on their feedback.

The management of Rwanda's wetlands is the responsibility of all users, not only that of the mandated government institutions. Once the final framework is available, implementation of the recommendation actions contained in it will contribute towards the sustainable management and use of the country's wetlands. The review and updating of this framework in five to ten years is recommended.

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# ABBREVIATIONS AND ACRONYMS

| | | |
|---|---|---|
| BOD | : | Biochemical Oxygen Demand |
| CIP | : | Crop Intensification Program |
| COD | : | Chemical Oxygen Demand |
| EbA | : | Ecosystem based Adaptation |
| EDPRS | : | Economic Development and Poverty Reduction Strategy |
| EIA | : | Environmental Impact Assessment |
| GIS | : | Geographical Information System |
| GoR | : | Government of Rwanda |
| IMCE | : | Integrated Management of Critical Ecosystems |
| IWRM | : | Integrated Water Resources Management |
| LULC | : | Land Use / Land Cover |
| LVEMP | : | Lake Victoria Environmental Management Project |
| LWH-RSSP | : | Land Husbandry and Water Harvesting -Rural Sector Support Project 3 |
| masl | : | Metre above sea level |
| M&E | : | Monitoring and Evaluation |
| MINAGRI | : | Ministry of Agriculture and Animal Resources |
| MINALOC | : | Ministry of Local Government |
| MINILAF | : | Ministry of Land Affairs |
| MININFRA | : | Ministry of Infrastructure |
| MINIRENA | : | Ministry of Natural Resources |
| MIS | : | Management Information System |
| MoE | : | Ministry of Environment |
| NAKU | : | Nile Akagera Upper Catchment |
| NBSAP | : | National Biodiversity Strategy and Action Plan |
| NGO | : | Non-Governmental Organization |
| NIRDA | : | National Industrial Research and Development Agency |
| NMUK | : | Nile Mukungwa Catchment |
| NISR | : | National Institute of Statistics of Rwanda |
| NNYL | : | Nile Nyabarongo Lowe Catchment |
| NNYU | : | Nile Nyabarongo Upper Catchment |
| NST1 | : | National Strategy for Transformation 1 (2017-2024) |
| NWCC | : | National Water Consultative Commission |
| NWRMP | : | National Water Resources Master Plan |
| RAB | : | Rwanda Agricultural Board |
| RDB | : | Rwanda Development Board |
| RSB | : | Rwanda Standards Board |
| REMA | : | Rwanda Environment Management Authority |
| RLMUA | : | Rwanda Land Management and Use Authority |

| | | |
|---|---|---|
| RMA | : | Rwanda Meteorological Agency |
| RWFA | : | Rwanda Water and Forestry Authority |
| RWB | : | Rwanda Water Resources Board |
| SDGs | : | Sustainable Development Goals |
| SOM: | : | Soil Organic Matter |
| UR | : | University of Rwanda |

# GLOSSARY OF TERMS

| | |
|---|---|
| **Buffer** | A zone of vegetated land designed and managed so that sediment and pollutant transport carried from source areas via diffuse surface runoff is reduced to acceptable levels (Macfarlane & Bredin, 2017). Buffer zones may reduce impacts on aquatic ecosystems from adjacent land uses, may contribute to channel bank stabilisation and may provide habitat for a range of semi-aquatic and terrestrial species that make use of aquatic ecosystems for water, food or shelter. |
| **Catchment** | The area of land that contributes water to a particular river. Includes the natural resources, people and land use activities on the area of land. |
| **Climate Change** | A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.1 See also Climate variability and Detection and attribution (IPCC, 2012). |
| **Ecological character** | Ecological character is the combination of the ecosystem components, processes and benefits/services that characterise the wetland at a given point in time[1]. |
| **Ecological flow** | the quantity and quality of the water flow required to sustain the aquatic ecosystem and the human and animal lives depending upon it; |
| **Ecosystem** | Complex of living communities (including human communities) and non-living environment (ecosystem components) interacting (through ecological processes) as a functional unit which provides *inter alia* a variety of benefits to people (ecosystem services (RAMSAR Convention Secretariat, 2010) |
| **Ecosystem approach** | A strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Thus, the application of the ecosystem approach will help to reach a balance of the three objectives of the Convention: conservation; sustainable use; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources[1]. |
| **Ecosystem services** | Ecosystem services are provisioning, regulating and cultural services that directly affect people and supporting services that are needed to maintain these other services[1] |
| **Erosion** | The action of water or wind, gravity, chemical reactions and human disturbance such as tillage (Lal, 2001) to remove earth materials from one location and transport it to another. Soil erosion starts with detachment through raindrop impact, shearing force of wind or water, or dissolution of cementing agents through chemical reactions (Lal, 2001). Sheet erosion is the transport of sediment by overland flow, with rill erosion occurring as concentrated flow paths (Cantón et al., 2011). Gully erosion occurs as a certain threshold is reached and flow paths become deeper channels (Cantón et al., 2011). The rate of soil erosion is determined by soil erodibility, climatic erosivity, terrain and ground cover (Lal, 2001). |
| **Hydrogeomorphic unit** | The form/shape, position in the landscape and the way water moves into, through and out of the wetland is termed the Hydrogeomorphic (HGM) unit (Brinson, 1993). |
| **Hydrophytic vegetation** | Wetland plants, or "water-loving' plants. |
| **Rehabilitation** | (of wetland) Rehabilitation is the process of assisting in the recovery of a wetland that has been degraded or in maintaining the health of a wetland that is in the process of degrading (Kotze et al., 2008). Wetland rehabilitation should first reinstate hydrology, then move to reinstate self-sustaining processes and develop interventions specific to goals. |

| | |
|---|---|
| **Riparian** | The portion of land directly adjacent to the active channel of a river. Plant habitats and communities along river margins and banks are called riparian vegetation. |
| **Runoff** | That part of precipitation that does not evaporate and is not transpired, but flows through the ground or over the ground surface and returns to bodies of water. See Hydrological cycle (IPCC, 2012). |
| **Marshland** | Marshlands are defined as wetlands frequently or continually inundated with water, characterized by emergent soft-stemmed vegetation adapted to saturated soil conditions. There are many different kinds of marshes, ranging from the prairie potholes to the Everglades, coastal to inland, freshwater to saltwater. All types receive most of their water from surface water, and many marshes are also fed by groundwater. Nutrients are plentiful and the pH is usually neutral leading to an abundance of plant and animal life (EPA, 2020). In the current law on environment of Rwanda dated 2019, it is clear that wetlands includes marshlands/swamps, lowlands and shores. |
| **Sedimentation** | (see erosion) Once loosened soil is picked up by either wind or water it is termed “sediment”. In terms of soil erosion sediments entrained by the flow of water may be transported by rolling or sliding along the floor of a river (bedload) or by suspension in the moving fluid (suspension) before being deposited (Gordon et al., 2004). A catchment may be considered to be made up of a patchwork of sediment source zones (source of sediment) and sink zones (sediment deposition areas), with sediment spending most time in storage (Fryirs et al., 2013). Management of sedimentation therefore needs to be at the catchment scale in order to effectively manage the episodic pattern of sources and sinks through the catchment (Fryirs et al., 2013). |
| **Wetland** | ’As defined by the Convention, wetlands include 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). |

# CHAPTER 1 INTRODUCTION

## 1.1 Background and context

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.

However, these ecosystems are at risk and the most prevalent threat is unsustainable use of wetland and catchment systems by adjacent communities, leading to degradation and a reduction in the capacity of these systems to provide ecosystem services and contribute to climate resiliency. This has led to the vulnerability of many communities in Rwanda to the adverse effects of climate change.

Climate change is negatively affecting communities, livelihoods and the environment in Rwanda. The changes include unreliable rainfall events both in timing and amount, resulting in flooding events in the central and north-western highlands, and droughts in the eastern and southern lowlands. These changes are having significant effects on critical sectors in Rwanda's economy and development, including agriculture and water. This has subsequently led to decreased agricultural production due to soil erosion, reduced soil moisture and water availability, crop damage from flooding, landslides, and droughts; and decreased quality and quantity of water as a result of flooding and droughts.

To address these problems, Rwanda is implementing a pilot project of LDCF II (Building resilience of communities living in degraded forests, savannahs and wetlands of Rwanda through an Ecosystem-based Adaptation (EbA) approach). The project is funded by Global Environment Facility (GEF) through United Nations Environment Programme (UNEP) under the climate change adaptation GEF focal area for a duration of four years. The main objective of the project is to increase capacity of Rwandan authorities and local communities to adapt to climate change by implementing Ecosystem based Adaptation (EbA) interventions in degraded forests, savannahs and wetland ecosystems.

The project is being implemented for restoration of Nyiramuhondi watershed in Ngororero District; Murago wetland and Lake Cyohoha North in Bugesera District; Kibare lakeshores in Kayonza District and Nyandungu wetland in Gasabo and Kicukiro Districts; and Lake Ruhondo in Musanze District.

It is in that context that the LDCF II/REMA Project requested to conduct a study to develop a wetland and catchment management framework that will be used for upscaling of wetland ecosystems restoration activities under the LDCF II Project. This wetland management framework will collate current knowledge on status and health of wetland ecosystems in Rwanda with particular focus on Nile-Akagera upper, Nile-Nyabarongo lower and Nile-Nyabarongo upper catchments including Nyiramuhondi watershed.

The purpose of a National Wetland Management Framework is to provide a national approach to the management of the country's wetlands. Wetlands are dominant features of the Rwandan landscape, and are vitally important for biodiversity, people and the economy. These three aspects are equally important and are desired by all stakeholders. They need to be managed because they are essentially in conflict with each other. If any one of them dominates, the other two aspects will be negatively affected. Rwanda has already taken the significant step of recognizing the importance of wetlands and the need to manage them proactively. This National Wetlands Management Framework forms the next step in focusing efforts towards maximizing the benefits of wetlands for the country into the future.

For the purposes of this project and this National Wetland Management Framework, the concept of Wetland Management is understood to include the tasks of inventory, protection, rehabilitation and monitoring, as well as setting policy, guidance on sustainable use and management frameworks, as outlined in the Ramsar guidelines for wetland policy.

## 1.2 Scope of work

The study gathered existing knowledge on status and health of wetland and catchment ecosystems in Rwanda with particular focus on Nile-Akagera upper (NAKU), Nile-Nyabarongo lower (NNYL) and Nile-Nyabarongo upper (NNYU) catchments including Nyiramuhondi watershed. The study will also provide the following:

- Develop systematic mapping and monitoring tools to identify basin management needs and track progress towards addressing them.
- Develop an understanding of the drivers of wetland and catchment degradation
- Prepare a range of plans based on the results of the analyses and in response to climate threats, in collaboration with appropriate government agencies.
- Analysis of drivers of wetland and catchment degradation focused on agricultural activities; eutrophication and pollution; infrastructure development; wetland overharvesting/ overexploitation; emergent invasive species; loss of indigenous species (fauna and flora); alteration of biogeochemical cycles; as well as other key drivers that may emerge during the study.

The project is divided into two tasks. Task one has three components (Wetland management strategic plan, Water quality management, and Integrated catchment management plans), and Task two deals with building capacity to implement the plans and framework.

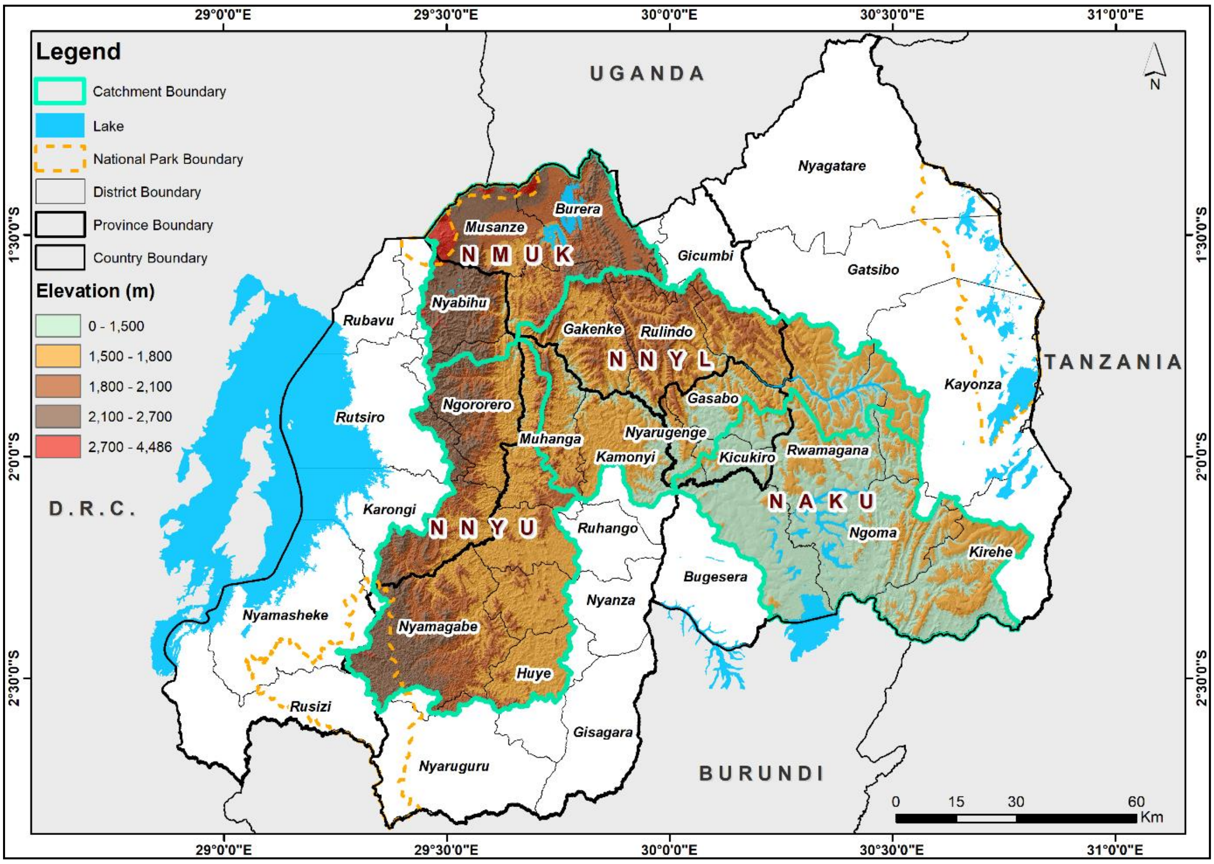



**FIGURE 1-1 Location of the four Catchments in the study area**

## 1.3 Methodology of wetland management framework

The steps followed in developing the wetland management framework are outlined in Figure 1-2, and described in the text that follows.


**FIGURE 1-2 STEPS IN THE DEVELOPMENT OF THE WETLAND MANAGEMENT FRAMEWORK.**

**Step 1: Determine the current state of wetland management nationally**

The aim of this step is to understand the current state of wetland management in Rwanda in order to identify and prioritise the current issues and concerns regarding wetland management in the country. This current state forms the baseline from which the framework can be developed, and against which future implementation of the framework can be measured

This was carried out according to the approved methodology by gathering together and reviewing the available information. This review was supplemented by identifying and consulting with government officials, local experts and stakeholders, as well as by undertaking field visits. Additionally, a stakeholder workshop was held in 2017 and other focus group discussions, use of questionnaires and interviews were conducted in 2020. Based on the collected information, the current issues and concerns related to wetlands and wetland management in Rwanda were identified.

**Step 2: Formulate a vision and goals**

This involves determining the long term desired state of the wetlands in the country (the vision), as well as the goals (preliminary objectives) and principles that would cause this to be achieved. These need to be developed in consultation with stakeholders in the catchment.

A first stakeholder workshop was held on 10 and 11 October 2017 in Kigali during which a subset of stakeholders were invited to identify and prioritise current issues regarding wetland management, and also to develop a vision and goals for the national management of wetlands. A summary of this workshop is provided in Appendix A.

**Step 3: Develop a national wetland management framework**

Specific actions that will result in the vision and goals for wetland management being achieved were determined. This includes objectives and outcomes related to categorization, sustainable use, protection, rehabilitation and monitoring.

The National Wetland Management Framework proposed in this report incorporates the vision, goals and objectives determined through the stakeholder engagement process, and the information provided from the catchment characterisation.

## 1.4 Structure of wetland management framework

A description of the current state of wetland management in Rwanda is contained in Chapter 2. The chapter describes the main characteristics of the country's wetlands and identifies the challenges that should be addressed through the Wetland Management Framework. In addition Chapter 3 provide detailed field observations replies to questionnaires in four catchments: NAKU, NNYL, NNYU and NMUK.

Chapter 6 of the Report sets out the Wetland Management Framework. The chapter presents the vision, goals and objectives, as well as the proposed strategic measures that are required to achieve them. In addition, chapter 6 contains the proposed institutional arrangements for the implementation of the Catchment Management Framework. Finally, chapter 7 provide guidelines for wetlands rehabilitation and planning for the sustainable of the country's wetlands.

# CHAPTER 2 SITUATIONAL ANALYSIS OF WETLANDS IN RWANDA

## 2.1 Wetland definition

### 2.1.1 Ramsar wetland definition

Rwanda is a signatory to the Ramsar Convention on Wetlands, which defines wetlands as:

> "wetlands include 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).

Ramsar splits the above all-encompassing group into marine, inland and man-made wetlands (Ramsar, 2008), but does not provide definitions for these. Manmade wetlands include reservoirs and waste water treatment ponds (Ramsar, 2010). Given that Rwanda is a land-locked country, only inland and man-made wetland categories are applicable. Within the inland wetland group, Ramsar suggests a further refinement into flowing water (rivers, streams and springs), lakes and marshes[1] (Ramsar, 2008), and again, does not provide definitions for these.

### 2.1.2 Current wetland definitions for Rwanda

Within Rwanda, wetlands are currently interchangeably referred to as "marshlands", "swamps" and "wetlands" across environmental policies and laws (Table 2-1).

**TABLE 2-1 WETLAND DEFINITIONS ACROSS LAWS, POLICIES AND GUIDELINES IN RWANDA**

| Law/Policy/Guideline | Term | Wetland definition |
|---|---|---|
| National Environment and Climate Change Policy (2019) | Wetland | Not defined |
| Land Policy 2004 | Marshland | Not defined within the policy document |
| Land Policy (2019) | Wetland, marshland, swamp | Not defined |
| Law No 48/2018 of 13/08/2018 on Environment | Wetland (ahantu hahehereye) | Wetland is defined as areas consisting of marsh, fen, peat land or water, whether 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 (6) meters |
| | Swamp (Igishanga) | Swamp is defined as a plain area between hills or mountains with water and biodiversity where Papyrus, Carex or other plant species grow |
| | Plain land (ikibaya) | Plain land: a flat area with little water and less biodiversity; |

[1]Considered to be a synonym for wetland.

| Law/Policy/Guideline | Term | Wetland definition |
|---|---|---|
| | Shores | Shores: a wetland that is dominated by herbaceous rather than woody or plant species often found at the edges of lakes and streams where they form a transition between the aquatic and terrestrial ecosystems; |
| | Valley | Valley: an area between two hills or mountains characterised by a source of water above the ground or underground |
| Law No 49/2018 of 13/08/2018 determining the use and management of water resources in Rwanda | Wetland | Wetland is defined as area of marsh or water, whether natural or artificial, permanent or temporary, with water that is stagnant or flowing. |
| Law No 43/2013 governing land in Rwanda | Swamp | A plain area between hills or mountains with water and biodiversity, and where papyrus or carex or plants of their species grow. |
| Prime Minister's Order No 006/03 of 30/01/2017 drawing up a list of swamp lands, their characteristics and boundaries and determining modalities of their use, development and management | Swamp land | A flat area between mountains with much stagnant water and biodiversity, with papyrus, cypress or other vegetation of the same family |
| Guidelines for EIA for Wetland Management in Rwanda, 2009 | Wetland | Areas that are seasonally or permanently flooded with characteristic soils, inhabited by flora and fauna adapted to living in water logged conditions. These include seasonally flooded grassland, swamp forest, permanently flooded papyrus and grass swamp and upland bog. |

In the current law on environment dated 2019, particularly referring to the definitions in Kinyarwanda, it is clear that wetlands includes marshlands/swamps, lowlands, shores, but not clearly valleys.

### 2.1.3 Aquatic ecosystems in Rwanda

In keeping with the broad Ramsar groupings, aquatic ecosystems in Rwanda can be grouped into rivers, lakes and wetlands (Table 2-2).

**TABLE 2-2 AQUATIC ECOSYSTEM BROAD GROUPS AND DEFINITIONS**

| Ramsar category | Definition |
|---|---|
| **Aquatic ecosystems** | |
| River | Flowing water concentrated within a natural channel, with distinct bed and banks |
| Lake | Relatively large body of slow-moving or standing open water that occupies an inland basin |
| Wetland | Intermittently or periodically waterlogged, has a predominance of hydric soils and is inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions (Mitsch and Gosselink, 2004) |

Most operational definitions of wetlands, used around the world, refer to the continuous presence of near-surface or surface saturation, such that it influences the soil morphology and the type of flora present in such conditions. It is proposed that the term "wetlands" should be used and considered as indicated in the environmental law (2018) and as summarized in the table below Table 2-2. All three terms for wetlands that are commonly used in Rwanda ("marshlands", "swamps" and "wetlands") fit within the definition of a wetland, but they may encompass certain additional characteristics, such as the presence of peat soils associated with peatlands, or the presence of trees associated with swamps (Table 2-3**)**.

**TABLE 2-3 WETLAND SYNONYMS**

<table>
<tr><th rowspan="7">Wetland</th><th colspan="2">Kinyarwanda</th><th>English</th><th>French</th><th>Characteristics</th></tr>
<tr><td rowspan="6">Ahantu hahehereye</td><td rowspan="3">igishanga</td><td>Peatland</td><td>tourbière</td><td>peat soils dominate</td></tr>
<tr><td>swamp</td><td>marecage</td><td>trees are present</td></tr>
<tr><td>marshland</td><td>marais</td><td>herbaceous (grasses and sedges)</td></tr>
<tr><td>Shores</td><td>Inkuka</td><td>Bords</td><td>Herbaceous, transition between aquatic and terrestrial ecosystems</td></tr>
<tr><td>Plain land</td><td>Ikibaya</td><td>Plaine</td><td>Little water and less biodiversity</td></tr>
</table>

### 2.1.4 Findings and Recommendations

In general, the Law on Environment serves as the reference law document for wetlands terminology, but there is a need to develop definitions that are more comprehensive. All findings and recommendations are indicated in Table 2-4.

**TABLE 2-4 WETLAND TERMINOLOGY: FINDINGS AND RECOMMENDATIONS**

| FINDINGS | RECOMMENDATIONS |
|---|---|
| The new law on environment (Law No 48/2018) gives a more inclusive definition of wetland. | All laws, policies and guidelines shall refer to the law on environment to avoid any confusion between different terminologies. Confusion could be eliminated by using the single Kinyarwanda term, ubutaka buhehereye which may include not only "Igishanga", swamp/wetland/peatland, but also plain land (ikibaya) as it is stated in the law. Or simply, "Ibishanga n'ibibaya". |
| Translations between English, French and Kinyarwanda are not always consistent within legal documentation. | The description used to define 'ibishanga' should also be written so that translations between English, French and Kinyarwanda are consistent. |
| There is a lack of definitions for activities related to wetlands within legal documentation. | Definitions should be provided for each use, for each wetland classification, for protected and unprotected wetlands, and for terms used within use agreements. |

Briefly, the definition given in the Rwandan Environmental law is similar to that of RAMSAR. However, for the purpose of these guidelines, the RAMSAR definition is recommended since it also include artificial wetlands (man-made), like wastewater treatment ponds and reservoirs. In any case, the most important is the interpretation of wetland and as it is recommended in the table above, wetlands should be read as any of the following: swamp, marsh, peatland, flood plain and oxbow lake.

## 2.2 Policy and legislation situation

The enabling environment provides the framework for the management of wetlands in Rwanda. The enabling environment comprises the 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.

This section outlines this enabling environment and identifies the issues arising within this component of wetland management. The components of the enabling environment are presented in chronological order.

### 2.2.1 Overarching Legislation

#### 2.2.1.1 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.

#### 2.2.1.2 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 2020 (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 2020 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 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 2020, 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.

#### 2.2.1.3 Economic Development and Poverty Reduction Strategy 2 (EDPRS II), Sustainable Development Goals 2030 (SDGs), Vision 2020 and the National Strategy for Transformation I (NSTI)

In EDPRS II, which was set for the period 2013-2018 as an extension of EDPRS I, the GoR envisaged to increase productivity and enhance food security. The target was to develop 100,000 ha for irrigation and 65% of the area to be irrigated area was supposed to be in the marshlands, while 35% was hillside irrigation. Both irrigation schemes could affect water quantity and quality of the wetlands as well as provision of ecosystem goods and services of wetlands. In addition to this EDPRS II target of 100,000 ha for irrigation, the Ministry of Agriculture and animal resources (MINAGRI) planned to develop an additional 60,000 ha, comprising of two-thirds in the marshlands and one-third on hillsides.

In Vision 2020, the GoR expects to transform the country into a middle-income nation by 2020. Vision 2020 recognises that depletion of biodiversity, degradation of ecosystems such as swamps and wetlands and pollution of waterways are threats to the environment. Thus, the management of natural resources, environment and climatic changes were highlighted among the priorities of Vision 2020.

With NST I, the GoR program for the period 2017-2024, published in September 2017, this document indicates that the country intends to accelerate economic growth and development founded on the private sector, knowledge and Rwanda's natural resources. In NSTI, the GoR also envisage to increase the surface of irrigated area from 48.508 ha for 2017 to 102.284 in 2024 and the priority will be given to wetlands where small scale irrigation schemes will be developed. This will go together with best management of irrigation infrastructure by building the capacity of water-users association. This will be in parallel to the promotion of mechanised farm operations and land consolidation. The development of NST I was based to some national strategic documents such as EDPRS II, Rwanda Vision 2020, Vision 2050 and other international strategic guidelines such East African Community (EAC) Vision 2050, African Union Vision 2063 and SDGs 2030.

Rwanda has domesticated the Sustainable Development Goals (SGSs) in the existing national development plans. SDGs goals related to wetland management and planning are SDG 6 (for clean water and sanitation), SDG13 (to combat climate change and its impacts) and SDG 15 (to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss).

#### 2.2.1.4 National Biodiversity Strategy and Action Plan (NBSAP) and Rwanda Biodiversity Policy (2011)

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.

### 2.2.2 Policies and strategies

#### 2.2.2.1 National Environmental Policy (2019)

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:

i. *Develop a master plan and implementation strategies for wetland management in Rwanda.*
ii. *Identify all polluted wetlands and develop a decontamination plan including the use of environmentally-sound technologies (*Phytoremediation*) for pollution prevention, control and remediation.*
iii. *Promote and intensify wetland protection, and restoration and rehabilitation of degraded wetlands.*
iv. *Strengthen collaborative and participatory management of wetland resources.*

v. *Strengthen existing wetland research and encourage conservation and restoration of ecosystems critically threatened by climate change.*
vi. *Ensure the protection of wetlands, riverbanks, hilltops and slopes from unsustainable practices to prevent soil erosion and environmental degradation.*
vii. *Ensure that developmental activities within wetlands or in the buffer of wetlands conform to EIA process and procedures (Republic of Rwanda, 2019).*

#### 2.2.2.2 National Land Policy (2019)

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 was 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).

#### 2.2.2.3 Agriculture policy (2018)

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).

#### 2.2.2.4 Forestry policy (2018)

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)

#### 2.2.2.5 Integrated Water Resource Management (IWRM) Policy (2011)

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 urbanisation, 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).

#### 2.2.2.6 Biodiversity Policy (2011)

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:

1. Support the principle that domestic consumption and environmental needs will enjoy priority use of water;
2. 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;
3. Determine the impact of aquaculture species and management practices on biodiversity, and develop appropriate guidelines for aquaculture developments;
4. 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;
5. 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).

#### 2.2.2.7 Energy Policy 2015 Ministry of Infrastructure, 2015)

The vision and mission of the energy policy stipulates that the GoR has to ensure the sustainability of energy exploration, extraction, supply, and consumption so as to prevent damage to the environment and habitats. As biomass energy is extracted in some wetlands, this policy indicates that exploitation of biomass and production of renewable energy (mainly hydroelectricity) should reduce negative impacts of harvesting to the environment and to the Rwandan habitats. Furthermore, the law governing human habitation in Rwanda also considers the preservation and protection of then environment while constructing houses and buildings in Rwanda (Republic of Rwanda, 2011).

#### 2.2.2.8 National urbanization policy (MININFRA 2015)

Under local development and poverty reduction of the fourth policy piller "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).

#### 2.2.2.9 Green Growth and Climate Resilience Strategy (GGCRS)

The strategy recommend 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).

#### 2.2.2.10 National industrial policy (MINICOM, 2011)

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).

#### 2.2.2.11 Rwanda Nationally Determined Contributions (NDCs)

Rwanda as a party to the United Nations Framework Convention on Climate Change (UNFCCC) submitted its Intended Nationally Determined Contributions (INDCs) well ahead of the 21$^{st}$ session of conference of parties (COP 21) held in Paris, December 2015. After adoption in the COP 21, these INDCs were no longer intentions, but became a 2030-horizon commitment (NDCs) towards limiting the global warming to below 2$^{o}$C by 2100 (Republic of Rwanda, 2015). Rwanda has also recently submitted its updated NDC in May 2020. Rwanda, being vulnerable to climate change, have both actions for mitigation and adaptations. In case of wetland management, updated NDCs provides with interventions that are directly or indirectly contribute towards wetland management and sustainable use, as follows (Republic of Rwanda, 2020):

- Develop a National Water Security through water conservation practices, wetlands restoration, water storage and efficient water use;
- Develop water resource models, water quality testing, and improved hydro-related information systems;
- Develop and implement a catchment management plan for all Level 1 catchments;
- Develop sustainable land management practices (soil erosion control; landscape management);
- Expand irrigation and improve water management.

### 2.2.3 Laws

#### 2.2.3.1 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.
- 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.
- Article 42stipulates 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.
- 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).

#### 2.2.3.2 Rwanda Water Law Nº 49/2018 of 13/08/2018 Determining the use and management of water resources in Rwanda

The general principles of this law 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:

(a) prevention of pollution with priority to source;

(b) 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;

(c) integrated management of water resources within catchment, taking into account the interests of all water users, land and other natural resources and related ecosystems;

(d) participation, according to which all interested stakeholders, including water users through their representatives, are entitled to participate in water resources management and planning;

(e) "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;

(f) 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).

#### 2.2.3.3 Law Governing Land in Rwanda N° 43/2013

Similar to the Environment Law N° 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. "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).

#### 2.2.3.4 Law Governing Biodiversity in Rwanda N° 70/2013

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).

### 2.2.4 Orders

#### 2.2.4.1 Ministerial Order No. 005/16.01 of 15/07/2010 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).

#### 2.2.4.2 Prime Minister's Order No. 006/03

Most recently, the Prime Minister's Order No. 006/03 of 30 January 2017 presents a list of swamp lands, their characteristics and boundaries and determining modalities of their use, development and management; as per the requirements of the Law Governing Land in Rwanda N° 43/2013. Furthermore, the order also 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.

### 2.2.5 Findings and Recommendations

The summary of statues contributing to the enabling environment for wetland management in Rwanda is provided in Table 2-5.

**TABLE 2-5 SUMMARYOF POLICIES, LAWS AND ORDERS PROVIDING THE EXISTING MANAGEMENT FRAMEWORK FOR WETLANDS**

| Policies | Law | Orders |
|---|---|---|
| • **Land Policy 2019**<br>• **National Environment and Climate Change Policy 2019**<br>• **National Policy for Water Resources Management 2011**<br>• **Biodiversity Policy 2011** | • Law Governing Land in Rwanda No 43/2013<br>• Environmental Law No 48/2018 of 13/08/2018<br>• Water Law No 49/2018 of 13/08/2018<br>• Law Governing Biodiversity in Rwanda No 70/2013 | • Prime Minister's Order No.006/03 of 30/01/2017 drawing up a list of swamp lands, their characteristics and boundaries and determining modalities of their use, development and management<br>• Ministerial order No. 005/16.01 of 15/07/2010 determining the list of prohibited plains to constructions<br>• Rwanda National Land Use Planning Guidelines (RLMUA, 2017) |

Findings and recommendations from analysis of these frameworks are provided in

Table 2-6 below:

**TABLE 2-6 LEGISLATION: FINDINGS AND RECOMMENDATIONS**

| FINDINGS | RECOMMENDATIONS |
|---|---|
| The enabling environment supporting wetland management, utilization and protection is extensive. The challenge arises that the mandates for implementing these policies and laws are not vested with one institution. Similarly, there is no single policy that encompasses the sustainable utilization, management and protection of wetlands, and therefore the enabling environment providing for the management of wetlands remains fragmented and not integrated. | The GoR should allocate the responsibility of governing the use, development and protection of wetlands to one institution, who in turn should be responsible to review all legislation relating to wetland management in order to compile integrated wetland legislation. |
| The statutes mainly set out objectives of protection or conservation and management of wetlands. There is little elaboration on the sustainable utilisation of wetlands, and setting thresholds for utilisation. Ramsar recognises the | Wetland legislation should include specific categories for wetlands which specifies the type of developments and extent to which such developments may take place within wetland areas. It should also identify wetland areas which |

| FINDINGS | RECOMMENDATIONS |
|---|---|
| contributing role of wetlands to food security in developing countries, as well as other economic contributions such as water, mining and tourism, provision of raw material for wicker (basket work) As such conservation of wetlands is not necessarily synonymous with complete exclusion. | are excluded from development options and should be protected. |
| The overarching policies, while not in conflict, do not provide a coordinated approach to wetland management, for example the different terminology used for wetlands, for management plans, etc. There is duplication in provisions across policies.<br>Only some of the policies and laws include a definition of a wetland (including humid zone, marsh, or swamp). However, this definition is not uniform across all the policies and Laws, resulting that some statutes may not be applicable to some wetland areas due to a shortfall in the definition. | As mentioned above, wetland related legislation should be reviewed to include holistic and integrated management principles for wetlands, including the definition of different types of wetlands to be standardised across legislation. |
| As highlighted in Section 2.2.3.1 above, although the Law sets out clear implementation objectives, these are not adhered to in practice.<br>Similarly, in terms of the Land Policy 2019, wetlands classified as protected wetlands are fully protected in terms of the law including proposed Ramsar sites, yet some sites are currently being cultivated and developed e.g. Gashora-Mugesera-Rweru Wetland complex, which is a proposed Ramsar wetland. This demonstrates challenges both in the EIA authorisation process, as well as in the regulation of protected wetland areas. | Monitoring and regulation of these provisions should be strengthened. |

## 2.3 Institutional status quo

There are several institutional organisations involved in the management of wetlands in Rwanda which are grouped into Ministries and Authorities, where the Authorities are the implementing Authorities of the Ministry. A critical challenge to wetland management in Rwanda is the uncoordinated and unclear assignment of roles and responsibilities to institutions. There is no one institution tasked with wetland management.

### 2.3.1 Ministries

#### 2.3.1.1 Ministry of Environment

Ministry of Environment (MoE) is the primary governing body for wetland management and in charge of their identification and mapping, developing management policies and classifying which wetlands can be used for which purposes, as per the Prime Minister's Order 006/03 of 30/01/2017. Wetland-related tasks are handled across the authorities within the MoE.

In a review of environmental policy in support of wetland protection and sustainable use across Rwanda, Heermans and Ikirezi (2015) reflect that institutional responsibilities for managing wetlands are not clearly stipulated in existing policies. This has recently been addressed in Ministerial Order No 006/03 of 30/01/2017, which identifies that the Authority in charge of the management of unprotected swamp lands is the Ministry in charge of land, currently Ministry of Environment. The Ministerial Order No 006/03 states the following:

- Article 7: The Ministry in charge of land has the overall management of unprotected swamp lands and prescribes the use of each swamp land.
- Article 8: The competent authority (Ministry in charge of Land) in respect of a specific unprotected swamp land has the responsibility to plan for its development according to the prescribed use and such plan would be approved by the Minister in charge of land.
- Article 9: Use of unprotected swamp land is the responsibility of a competent authority in accordance with its prescribed use and development plan.
- Article 20: The Minister of Natural Resources and the Minister of Agriculture and Animal Resources are entrusted with the implementation of this Order.

The Order does not specify who the Authority in charge of protected wetlands is. It is understood that protected wetlands fall under the Department of Conservation at Rwanda Development Board.

#### 2.3.1.2 Ministry of Agriculture and Animal Resources (MINAGRI)

The Ministry of Agriculture and Animal Resources (MINAGRI) also has sustainable management of natural resources, especially water and soil, as one of its ten strategic priorities. MINAGRI is tasked to initiate, develop and manage suitable programs of transformation and modernization of agriculture and livestock, to ensure food security, and to contribute to the national economy. Agricultural activities contribute as the predominate use for utilization of wetlands. Ministerial Order 006/03 of 30/01/2017 also tasks the MINAGRI with the implementation of drawing up a list of swamp lands, their characteristics and boundaries and determining modalities of their use, development and management.

While existing policies do not require approval for agricultural development in wetlands from MINAGRI, current practices do coordinate agricultural proposal reviews and approvals between MoE and MINAGRI (Heermans and Ikirezi, 2015). In practice, the MoE coordinates with MINAGRI to review and approve proposals for agricultural uses in wetlands; however, formal requirements for this coordination only exist within Ministerial Order Nº001/11.30 of 23/11/2011outlining procedures for approving irrigation projects (Republic of Rwanda, 2011). For larger agricultural projects, MINAGRI and MoE coordinate proposal reviews and project approvals, although it is unclear what the regulatory requirements for coordination are, or what the project size must be to initiate interagency coordination (Heermans and Ikirezi, 2015). Furthermore, this interagency does not include RDB, resulting in cultivation of wetlands that are categorized for protection.

#### 2.3.1.3 Ministry for Local Government (MINALOC)

The Ministry for Local Government is indirectly involved in wetland management through works carried out at District and Sector levels.

#### 2.3.1.4 Other

While not specific to wetland management, a significant future-impacting activity on wetlands in Rwanda, outside of the agriculture sector, is the planned generation of electricity from peat wetlands, under the Ministry of Infrastructure (MININFRA) and the Energy Division. Construction was completed in early 2017 for the country's first peat-fired power plant in Gishoma in the Rusizi District, with the potential to contribute 15 MW to the national electricity grid and plans are underway for several more plants. While peat diversifies the country's domestic energy supply, it is not environmentally sustainable, highlighting the difficult challenge of reconciling the GoR's goals for environmental protection with the goals for development.

### 2.3.2 Authorities

#### 2.3.2.1 Rwanda Environment Management Authority (REMA)

The Environmental Policy of 2003 entrusted the implementation of the policy to the Rwanda Environment Management Authority (REMA).This institution is responsible for executing the following duties:

(a) to coordinate various activities undertaken by environmental protection institutions for the protection of environment, and promote the integration of environmental issues in the developmental policies, projects and programmes with the aim of ensuring appropriate management and rational use of environmental resources on the basis of sustainable production for the improved well-being of the people of Rwanda;

(b) to coordinate the implementation of Government policies and decisions taken by the Board of Governors, and ensure the integration of environmental issues in national planning, and in relevant departments and institutions within the Government;

(c) to advise the Government on legislations and other measures relating to environmental management or the implementation of relevant international conventions, treaties and agreements in the field of environmental management as and when necessary;

(d) to make proposals to the Government in the field of environmental policies and strategies;

REMA as an institution was established by the Law No. 63/2013 OF 27/08/2013 ("the Law"). Article 3 of the Law states that REMA is the authority in charge of supervising, monitoring and ensuring that issues related to environmental management are integrated in all national development programs. REMA is only tasked with the coordinating, monitoring and supervising of activities; it is not tasked with the daily management and monitoring of the environment, including wetlands. Despite wetlands being a critical contributor to the economy and environment of Rwanda, the policy framework is uncoordinated, and within the REMA organization structure there is no provision for a person/section/unit dedicated to the coordination of the plethora of policy, law and orders providing for wetland protection, management and utilization, or the daily wetland management and utilization (Refer to Figure 2-1**)**. It is recommended that a dedicated section be incorporated into the REMA structure to provide for the coordination of wetland management at statute and ground level.

#### 2.3.2.2 Rwanda Land Management and -Use Authority (RLMUA)

The Rwanda Land Management and -Use Authority (RLMUA) was created by Law Nº05/2017 of 03/02/2017 after the Rwanda Natural Resources Authority (RNRA) was dissolved into separate Authorities. RLMUA is responsible for establishing and implementing an efficient system of land administration, use and management that secures land ownership in the country. In particular the Mission of RLMUA is:

1. to implement national policies, laws, strategies, regulations and Government resolutions related to the management and use of land; which includes swamps;
2. to provide advice to the Government, monitor and coordinate the implementation of strategies related to the management and use of land;
3. to promote activities relating to investment and value addition in the activities related to the use and exploitation of land resources in Rwanda;
4. to register land, issue and keep land authentic deeds and any other information relating to land of Rwanda; and
5. to supervise all land-related matters and represent the State for supervision and monitoring of land management and use; For example: Prime Minister's Order No006/03 of 30/01/2017 drawing up a list of swamp lands, their characteristics and boundaries and determining modalities of their use, development and management.

RLMUA plays a crucial role in the management of wetlands through the management of land which could be defined as swamps. Through MoE, RLMUA is tasked with the management of unprotected swamp lands.

#### 2.3.2.3 Rwanda Development Board (RDB)

The Rwanda Development Board (RDB) was established by bringing together all the government agencies responsible for the entire investor experience under one roof. This includes key agencies responsible for business registration, investment promotion, environmental clearances, privatization and specialist agencies which support the priority sectors of ICT and tourism as well as SMEs and human capacity development in the private sector. The Conservation Division of the Rwanda Development Board has the task of maintaining, enhancing and sustaining the ecological integrity, health and productivity of Rwanda's ecosystems. RDB was delegated by REMA to review and approve environmental impact assessment while monitoring and audit remained with REMA. The Ministerial order No 001/2019 of 15/04/2019 establishes the list of works, activities and projects that have to undertake an EIA assessment prior to obtaining authorisation for implementation. The order gives also the instructions, requirements and procedures to conduct environmental impact assessment. In particular the Land Policy (2004) stated that wetlands meant for agriculture should not be cultivated except after adequate planning and environmental impact assessment (EIA) while the new land policy (2019) is silent on environmental assessment of agricultural activities within wetlands. The screening of EIAs of projects is carried out by RDB. Furthermore, the policy classifies wetland utilisation into three categories:

1. Use without specific conditions,
2. Use under specific conditions (after EIA & EMP), and
3. Fully protected wetlands.

In turn, the Ministerial Order No 006/03 of 30/01/2017, identifies that the Authority in charge of the management of unprotected swamp lands is the Ministry in charge of land. It is thus understood that the Authority in charge of protected swamp lands is the Department of Conservation, in RDB.

The Tourism Department of the Rwanda Development Board relies significantly on the conservation of natural heritage and can also provide motivation for strengthened conservation. As part of a national tourism plan, priority wetlands of the country provide key tourism sites. The transformation of wetlands for energy or agriculture development is thus in opposition to such a plan.

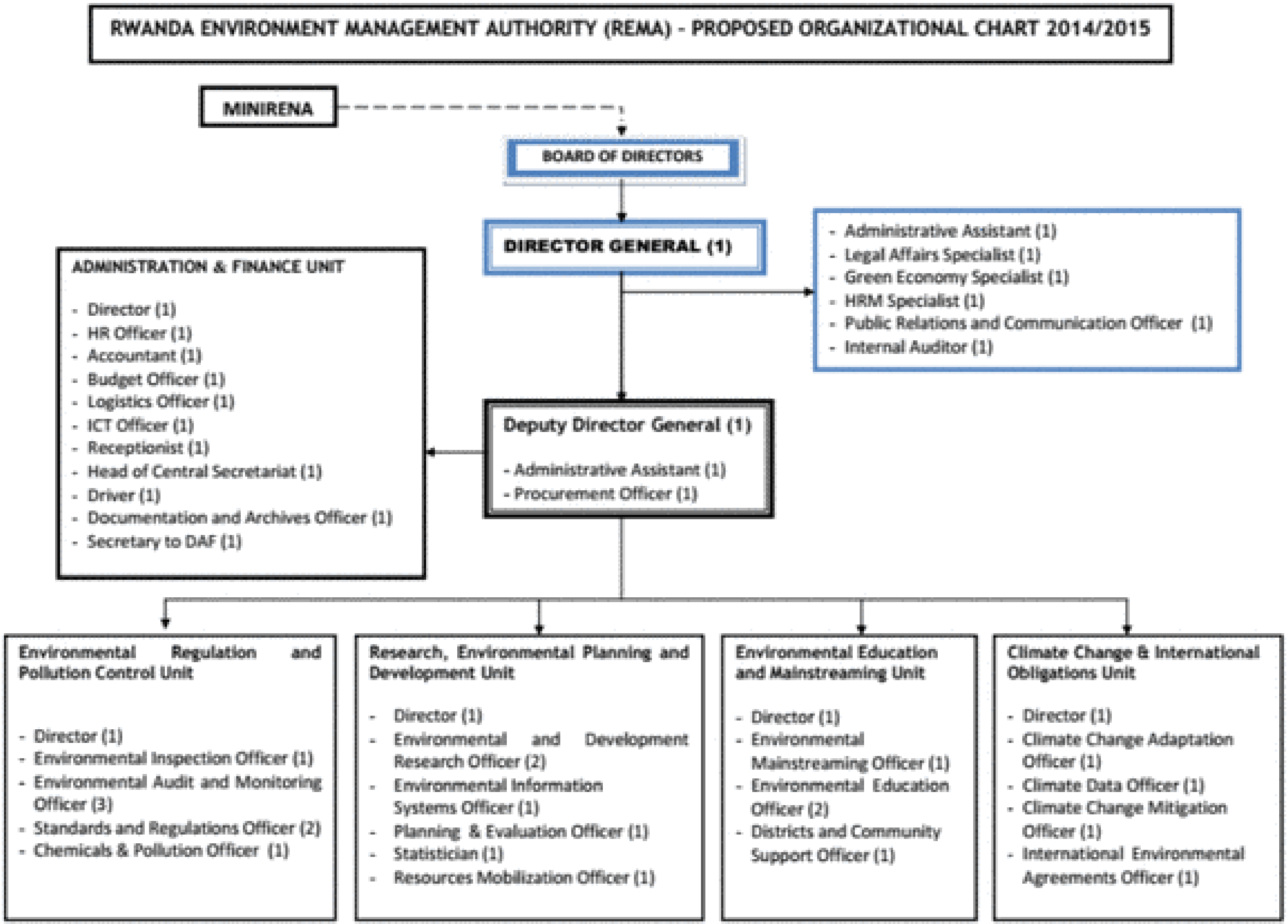



**FIGURE 2-1 ORGANOGRAM OF REMA STRUCTURE (SOURCE: REMA, 2017)**

#### 2.3.2.4 Rwanda agricultural board (RAB)

The Rwanda Agricultural Board (RAB) was established by Law N°38/2010 OF 25/11/2010. RAB has the general mission of championing the agriculture sector development into a knowledge based; technology driven and market oriented industry, using modern methods in cultivation, livestock farming, fisheries and forestry as well as soil and water management within the food, wood and energy production and processing industries.

Although not specifically tasked with functions of wetland management, the work and research of RAB should contribute to sustainable utilisation of the wetlands.

#### 2.3.2.5 Rwanda water resources board (RWB)

The Rwanda Water and Forestry Authority RWFA which was established in 2017 as a requirement of Law No. 06/2017 of 03/02/2017., was recently split into two institutions, namely Rwanda Water Resources Board and Rwanda Forestry Authority (RFA), respectively established by law No 71/2019 of 29/01/2020 and law No 72/2019 of 29/01/2020.

Rwanda Water Resources Board (RWB) deals with implementation of policies, laws, strategies and government decisions regarding management of water resources. The Water Law, No 49/2018 of 13/08/2018 in its article 4 makes provision for wetlands among other natural waters (permanent streams and rivers, lakes, wetlands, springs and aquifers.

#### 2.3.2.6 Rwanda forestry authority (RFA)

Rwanda Forestry Authority was established in 2019 by the law No 72/2019 of 29/01/2020 with the mission to ensure growth of forest resources their management and protection for sustainable development purpose. RFA may advise on tree species to be planted, sustainable use of forest, and in the erosion control for landscape restoration and protection that requires tree planting (Republic of Rwanda, 2020).

#### 2.3.2.7 Rwanda energy group Ltd (REG)

There are many reforms and restructuring of the entity in charge of energy production in Rwanda. The production and supply of energy in Rwanda is the responsibility of the Rwanda Energy Group Ltd (REG). REG was created in 2014, by the prime ministerial order Nº 87/03 of 16/08/2014 determining modalities for the transfer of responsibilities, movable and immovable property and liabilities of the Energy, Water and Sanitation Authority (EWSA) to Rwanda Energy Group (REG) and Water and Sanitation Corporation (WASAC) (Republic of Rwanda, 2014). REG has two subsidiaries, i.e. the Energy Development Corporation Ltd (EDCL) and the Energy Utility Corporation Ltd (EUCL). Before the establishment of EWSA, all activities related to energy development, including energy exploration studies, construction of hydropower plants, peat, biogas, methane gas, other types of renewable energies in Rwanda such as geothermal, wind and solar were undertaken by the Ministry of Infrastructure (MININFRA). Currently these activities are controlled by EDCL (under REG). Thus, as many hydropower plants, peat to power plants use water resources from the wetlands (such as Rugezi wetland, Akagera wetland, Gisagara Peat to power plants, Gishoma Peat to Power Plant, geothermal exploration in the plain of Bugarama). It is very important to involve EDCL as the activities related to wetlands management and planning in Rwanda, do affect or are affected by poor management of the wetlands.

### 2.3.3 Decentralised Environmental Protection

#### 2.3.3.1 Districts

Each Districts within Rwanda, with advice from specific committees, have a responsibility for the protection of the environment. They implement decentralized environmental protection and management activities, and develop District Development Plans. In Rwanda, wetland management is not yet fully transferred to certain Districts (Heermans and Ikirezi, 2015), which is illustrated in the country's organizational structure in Figure 2-2. The structure makes provision for a Natural Resources Management department within a district. However, this department is only represented by 3 representatives, neither of which are relating specifically to wetland management. These are the following:

- Director in charge of Water & Environmental Management (1 representative)
- Expert in charge of Forestry (1 representative)

- Expert in charge of Mining (1 representative)

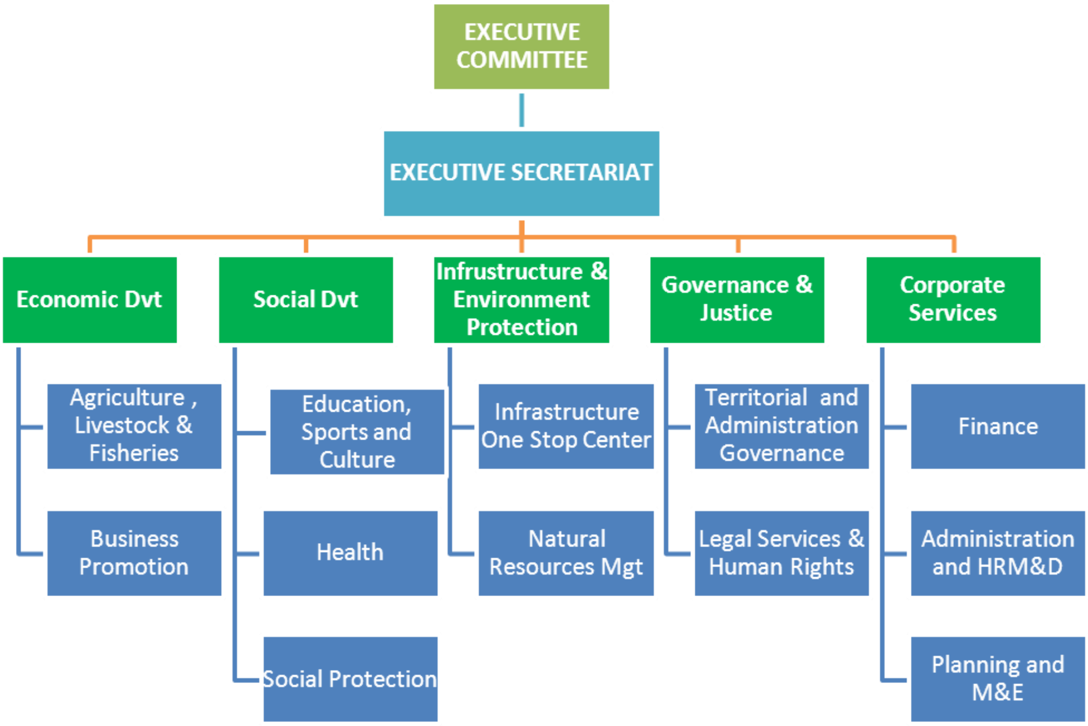



**FIGURE 2-2 DISTRICT STRUCTURE FOR URBAN AND RURAL (SOURCE: MINALOC)**

There is no provision for a representative for Land Management or Land Use. This makes monitoring of wetlands difficult at the District level, especially as Order 006/03 of 30/01/2017 assigns management, which includes monitoring of unprotected swamps, to the Ministry in charge of Land.

With respect to wetland-related activities, a review of several District Development Plans and District Development Strategies indicates that the districts mostly support riverbank stabilization projects, and sometimes pollution-related projects. They may also be involved in discouraging the use of wetlands where the designated use of that wetland is "protection", e.g. the Rugezi wetland, and in discouraging encroachment of small-scale agriculture within the prescribed buffer of a wetland or river.

#### 2.3.3.2 Sectors

At the Sector level, the organizational structure, as illustrated in FIGURE 2-3, provides for a sector called "Infrastructure and Land Management" which makes provision for 1 representative for land management, as well as a sector for "Agriculture and Natural Resources" also only providing for 1 representative. This provides more capacity than the Districts to provide extension to communities within the Sector.

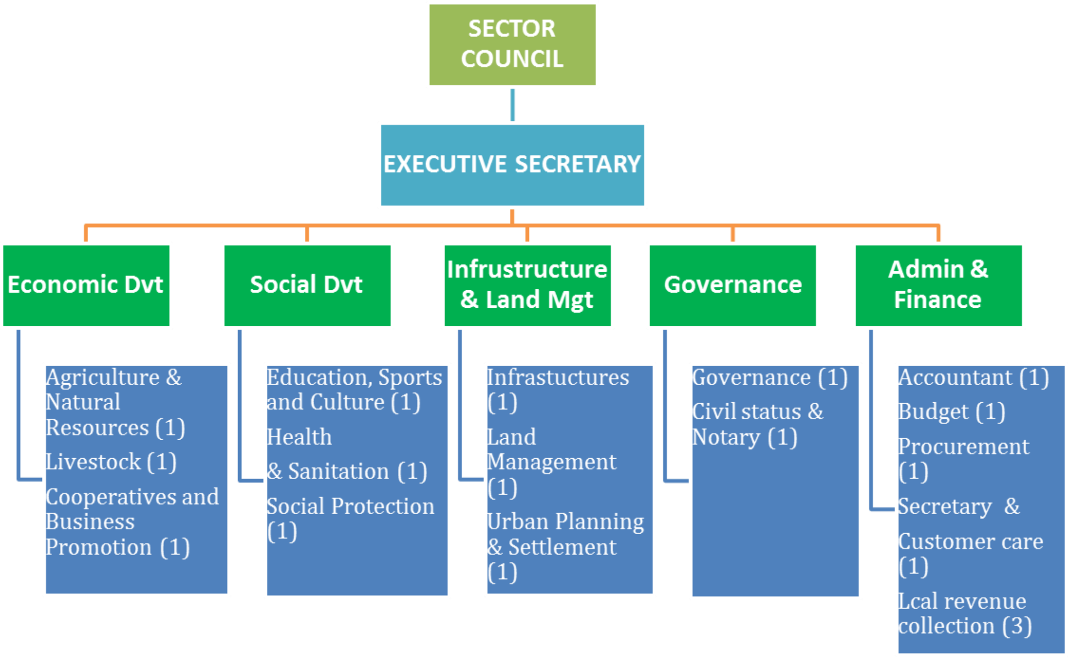



**FIGURE 2-3 SECTOR STRUCTURE. (SOURCE: MINALOC)**

#### 2.3.3.3 Environmental Protection Committees

The Environmental Law No. 48/2018 of 13/08/2018(Article 41) provides for the establishment of environmental protection committees at City of Kigali, District, Sector, and Cell level. These committees shall be responsible for conservation, protection and promotion of environment as well as climate change.. Their functioning and responsibilities are determined by the Prime Minister's Order.

While the law No 49/2018 of 13/08/2018 on water resources provides for the establishment of catchment committees for water resources management at catchment level. The composition, responsibilities, and functioning of the water resources management at catchment level are determined by a ministerial order.

#### 2.3.3.4 Community Engagement in Wetland Management

At the local level, the GoR commits to integrating citizen participation into local decision making, planning processes and development programs. Community involvement in national development and decision-making is supported within several national strategies (Heermans and Ikirezi, 2015). In Rwanda's second Economic Development and Poverty Reduction Strategy (EDPRS 2), under the thematic area of accountable governance (also the first pillar of Vision 2020), the GoR has sets goals for increasing citizen participation in national development activities. The National Strategy for Community Development and Local Economic Development (2013 – 2018) stated the need for increased community participation in local planning and development programs to promote decentralization and citizen empowerment. The NST 1, in its priority 6, stresses on increased citizen's participation, engagement and partnership in development. It further highlights under its section on cross-cutting areas, the cross sectoral coordination to ensure smooth implementation of environmental policies and regulations.

Community engagement should not be limited to process requirements of EIA's, but must provide for the ongoing dialogue with communities whose livelihoods are dependent on the wetlands. These communities hold valuable knowledge of the wetland that supports them, this is important information for the sustainable management and decision making regarding utilization of the wetlands.

### 2.3.4 Other role-players

Public institutions such as the Rwanda Standards Board (RSB), as well as higher learning and research institutions, including the University of Rwanda (UR), RAB research department, and the National Industrial Research and Development Agency (NIRDA) among others, are additional important role-players supporting environmental management and knowledge development in Rwanda, including in wetland areas.

Non-Governmental Organisations (NGOs) and partner agencies are also involved or financially supporting environmental management activities across Rwanda. International organisations active in the country include the Global Environment Facility (GEF), United Nations Environment Programme (UNEP), United Nations

Development Programme (UNDP), United Nations Food and Agriculture Organisation (FAO), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Bank (WB), International Union for Conservation of Nature (IUCN), JICA, World Bank and United States Agency for International Development (USAID), Nile Basin Initiative, African Development Bank (AfDB); East African Community/Lake Victoria Basin Commission (LVBC), Global Green Growth Institute (GGGI), Nordic Development Fund (NDF), etc. Other conservation stakeholders with a focus on wetlands include the International Crane Foundation/Endangered Wildlife Trust and the Rwanda Wildlife Conservation Association.

### 2.3.5 Findings and Recommendations

Findings and recommendations from analysis of the institutional status quo are provided in Table 2-7 below:

**TABLE 2-7 INSTITUTIONS: FINDINGS AND RECOMMENDATIONS**

| FINDINGS | RECOMMENDATIONS |
|---|---|
| Specific allocation of wetland management tasks was not found described in any documentation, and a gap remains for more specific responsibilities for the multiple tasks falling under the scope of wetland management to be further delegated within future action plans Heermans and Ikirezi (2015). Broadly, however, Rwanda Environment Management Authority (REMA), is charged with regulatory protection of wetlands at the national level and for EIA guidance and review, as well as involvement in developing knowledge and inventory of wetlands, and wetland rehabilitation. In turn, the RLMUA has led the spatial update of the GIS wetland boundary layer and has been tasked with the management of unprotected wetlands. Department of Conservation at RDB is tasked with review of EIAs and is assumed to be the responsible authority for managing protected wetlands; and the RWB supports the development of catchment plans and integrated water management | Even though specific tasks have been allocated to certain institutional departments, a plan should be implemented to ensure that these responsibilities are clearly documented in management plans, aimed specifically at the management of wetlands for each department. |
| There are several policies addressing wetlands. However, in terms of institutional structure no authority actually takes ownership of wetlands. Wetland management was a function of former RNRA but when it was dissolved wetlands fell through the gaps. Different aspects or functions of management fall under different authorities i.e. REMA, RLMUA, RDB, RAB and RWB RMB, Districts. This leads to confusion as to which activities which institution is tasked with, as well as leaving gaps and overlaps between the management functions | Together with the drafting of management frameworks and allocation of responsibilities, the GoR should encourage all departments to take ownership of their respective wetland related responsibilities. In any case, the District as a decentralised entity shall play a big role in wetland management in collaboration with other stakeholders. |
| The REMA structure, like the other institutional structure, does not provide for a person/section/unit in charge of wetlands. Therefore, within a particular institution there is uncertainty who is tasked with the wetland management function. Other natural resources are each administered by a specific Authority e.g. water resources, forestry resources, land use, etc. Wetlands are a natural resource in their own right, and should have their own authority which would eliminate the overlap, gaps and confusion between variety of institutions currently tasked with wetland management | As indicated above, together with allocating responsibilities for wetland management to certain departments, these responsibilities should also be linked to specific entities (either persons, sections or units) to ensure implementation of management measures. For instance, wetlands can be managed by both RWB and RLMUA. What is needed is to assign clear responsibility of each institutions and in terms of regulation REMA can keep coordinating. |

## 2.4 MANAGEMENT TOOLS SITUATION

### 2.4.1 Environmental impact assessments (EIA)

An Environmental Impact Assessment (EIA) is defined in the Rwandan Environmental law as a systematic process of identifying environmental, social and economic impacts of a project before a decision of its acceptance is made. It is a process that is used internationally to identify potential adverse impacts before a project has commenced in order to prevent and mitigate such adverse impacts, and to assess the feasibility of the project in terms of environmental impacts on the project and environmental impacts resulting from the project. It is also used to enhance positive impacts of the project and to assist in the rational use of natural resources to maximize the benefit of socio-economic development projects and ensuring sustainable development.

#### 2.4.1.1 Legal requirements of EIA

The Environmental Law No 48/2018 of 13/08/2018 determines the protection, conservation and promotion of environment in Rwanda. It makes provision for Environmental Impact Assessments (EIA) in its article 30, indicating that projects, works, and activities that must undergo environmental impact assessment are listed by a ministerial order (currently No 001/2019 of 15/04/2019) which also describes the procedure and requirements to conduct EIA. The M.O. categorises projects, works and activities into two, those which must undergo partial EIA and those which require a full EIA. The later include among others, works or activities for marshlands reclamation; construction of water storage dams, construction of artificial lakes, all works related to mining, works in areas designated as national parks, agriculture and breeding activities which use chemical fertilizers, and pesticides in wetlands, infrastructures (roads, bridges, hydropower, …), etc.

The Law No provides also for strategic environmental; assessment (SEA) in its article 31, indicating that every policy, strategy, plan, and programme must undergo SEA while the procedure shall be determined by a ministerial order. The article 32 of the law provides for an environmental audit and the list of projects subjects to environmental audit shall also be determined by a ministerial order.

The EIA has to conform to REMA “Guidelines and procedures for Environmental Impact Assessment” (2006). The guidelines categorize projects (based on a screening procedure), so as to determine the degree of detail required by the EIA; they also define details for approval of the EIA report and for monitoring. The general EIA process involves the four stages, namely, the Environmental Impact Initiation phase involving screening and scoping. Following this is the Impact Study Phase, which includes impact identification and analysis, development of mitigation measures and preparation of the report. The decision-making and authorisation phase entails review of EIA reports and to either approve or disapprove a project. Lastly, environmental management and follow-up phase deals with monitoring aspects of the project during its implementation (REMA, 2006).

**EIA Guidelines for Wetlands management (REMA, 2009)**

The EIA guidelines for wetlands management were developed in order to provide clear and detailed direction on carrying out effective EIA for wetland management. These EIA guidelines provide a means of compliance assistance to enable the process of wetland management EIA and submission of EIA reports to the Environmental Regulatory Authority in Rwanda. As set out in these guidelines (REMA, 2009), the objectives of EIA Guidelines for Wetland Management are:

i) to provide direction and information for decision making by RDB Environmental Compliance Department in wetland management EIA;

ii) to provide advice on EIA processes as regards to the management of wetlands;

iii) to enable proponents/developers and stakeholders to participate effectively in wetland management EIA process and related administrative actions; and

iv) to enable environmentally adequate management of all development project activities that may negatively impact wetlands.

These EIA guidelines are intended to be used by:

i) Rwanda Environment Management authority (REMA);

ii) EIA consultants undertaking Wetland Management EIA studies or projects that affect wetland in Rwanda;

iii) Proponents of projects with wetlands management components or projects with adverse impacts on wetlands;

iv) Stakeholders affected by wetland management proposals;

v) Community representatives, interested persons and organisations and

vi) Academic institutions and researchers among others.

vii) These guidelines also provide advice to encourage sound EIA outcomes across all phases of planning for projects in the wetlands from project conception and design to approval. These guidelines provide guidance on wetland specific features (e.g. location, type of wetland, conservation status of wetland, nature of project, etc.) and proposal specific issues that should be taken into account. The approach used to conduct the EIA should take account of the particular circumstances of individual proposals.

- Under these guidelines, the EIA report should address:
- the significance of potential environmental and social impacts;
- the nature, extent, duration, and likelihood of occurrence of these impacts;
- comparative assessments of potential environmental and social impacts of all identified alternatives;
- mitigation measures in addressing all impacts; and,
- monitoring and evaluation (M&E) programme for ensuring that the implementation of the development project meets its objectives.

#### 2.4.1.2 Institutional role-players of EIA

REMA is charged with the responsibility to oversee, co-ordinate and supervise the operationalisation of the EIA process in Rwanda. However, since 2009, the screening of EIAs of projects has been carried out by RDB by delegation of power. The approval of strategic environmental assessments, environmental inspections, and environmental audits is still carried out by REMA. As a development may impact on several natural resources as well as other sectors, the review of the EIA may require inputs and requirements from other institutions e.g. RWB, RFA, RAB, RLMUA, MINEMA, etc.

#### 2.4.1.3 Situation in Rwanda

The issues and challenges with regard to EIA process for wetland management in Rwanda are summarized as follows:

- Data Limitations and Uncertainty: For some EIA Studies like for Marshlands/wetlands development projects, data is unavailable, limited even inaccurate and outdated. For example, there are several versions of the wetland inventory, and there are several institutions working from the different versions of the inventory. It is recommended that a single, central agency be responsible for updating and distributing the latest wetland inventory to the relevant role-players in wetland management, this is a function of REMA.
- Non-Compliance of EIA guidelines/Procedures: In some projects the EIA has only been conducted once the project has been already in implementation phase, despite the EIA national EIA guidelines and Procedures requiring the project has to undergo screening before implementation and the national Environmental authority assess if EIA is required or not. All projects, including donor aid projects, must be compliant with the EIA procedures and requirements.
- Lack of comprehensive and complete legal, institutional framework and technical tools for Environmental and Social Safeguards: some of these tools are still undeveloped for some sectors including irrigation development projects in marshlands/wetlands. In absence of these tools, international versions such as of WB, AfDB or any other donor/funder should be used.
- There have been delays experienced in the granting/delivery of the EIA clearance Certificate to investors/promoters/Developers. However, since the introduction of the online EIA Certificate application by RDB/REMA, the delays have decreased.

Current Environmental and Social Best Practices for Wetland Management in Rwanda

Recommendations for Rwanda Best Practice, in reference to the EIA process and project design, include:

- In Rwanda, projects should not significantly convert or degrade wetlands unless:
    i) there are no technically and financially feasible alternatives – a detailed review of alternative actions, design or location must be considered;

ii) benefits from the project will substantially outweigh the project costs – this must be demonstrated through a comprehensive analysis to demonstrate that project benefits outweigh environmental cost, and should not be limited to monetary costs but also qualitative e.g. health, loss of ecosystem good and services and cost of replacing these through formal means; and

iii) any conversion or degradation is appropriately reduced or mitigated.

- An EIA is required for any development projects in wetlands. National EIA Guidelines for wetlands management already available since 2009 and all projects have to comply with these guidelines.
- Project design should seek to avoid significant conversion or degradation of natural habitat, primarily through project location or facility relocation such as:

  (1) Significant conversion or degradation can occur from

  (i) the elimination or severe diminution of the integrity of a wetland caused by a major, long- term change in land or water use or,

  (ii) the modification of habitat that substantially reduces its ability to maintain viable populations of native species.

  (2) Significant conversion or degradation, usually during project construction, may result from land clearing and mining, replacement of natural vegetation (e.g. by crops or tree plantations), permanent flooding (e.g. by a reservoir), or drainage/dredging/filling/ channelization of wetlands.

- Mitigation measures to ensure sound management of wetlands should be designed to achieve at least no net loss of wetland biodiversity. They should include a combination of the following actions:
  - onsite mitigation measures such as minimizing wetland habitat loss
  - identification of 'set asides' to avoid impacts on wetland biodiversity such as the preservation of a certain percentage of wetland habitat within the project area, or adjacent to it
  - post-project restoration of impacted areas with appropriate local native species
  - offsetting wetland biodiversity losses through the creation of effective long-term
  - conservation of ecologically comparable area/s elsewhere (comparable in size, quality and function), while respecting any ongoing use rights of local Peoples or traditional communities
  - compensating the direct users of the affected wetland biodiversity, commensurate with the loss caused by the project (e.g. people who have lost production benefits derived from forest access caused by project may be provided direct financial compensation or access to another forest area.
- While undertaking EIA studies, special attention shall be given to the importance of threatened wetlands to local communities and their value in terms of goods and services as well as the value to specific groups within those communities, such as women (using the wetland as a water source, or for other wetland products), fishing families, livestock owners, religious ceremonies e.g. baptisms, etc. Where possible, the EIA shall include a process of consultation of these groups. Mitigation and wetland management measures shall be developed in participation with the affected communities. National Environmental Authorities and International Development Agencies shall ensure that EIAs involve communities affected by loss of wetland benefits and relevant NGOs in the process as much as possible. An EIA study should not end with the production of a report or statement of the environmental impacts. It should be a process which includes the development of alternatives and mitigation measures; it includes the agreements with the affected communities and the monitoring of the implementation of the project itself and the mitigation measures. Since REMA has a limited number of staff for monitoring and audit, local authorities (District) shall be fully involved and support for day to day monitoring and inspection and quick report in case of noncompliance. Inspectors may provisionally suspend any project that is suspected to damage environment and potentially impose administrative fine provided by the environmental law. This is in line with the current environmental law (No 48/2018 of 13/08/2018) that indicates in its article 61 that inspectors for environmental matter include staff of the authority (currently REMA), staff of the City of Kigali and those from respective District. This supposes engagement from planning process up to the decommissioning of the project to ensure ownership. In fact, the same law (article 39) highlights responsibilities of local administrative entities in terms of environmental protection which include among others, land management (erosion control, rainwater management), forest management, protection of rivers, lakes, sources of water and underground water, efficient management and wise use of swamps, protection and management of reserved areas, historical sites and protected animal and plant species, etc. Consideration shall also be given to the evaluations of the effectiveness of the mitigation measures and any necessary follow-up measures. Further monitoring and evaluation of the mitigation measures

are necessary after the project has ended and this should be the responsibility of the concerned institutions (REMA as regulatory shall carry environmental audit, client or financial partner may also conduct impact evaluation).

#### 2.4.1.4 REMA Guidelines on EIA

REMA is charged with the responsibility to oversee, co-ordinate and supervise the operationalisation of the EIA process in Rwanda. The EIA process involves the four stages, namely, the Environmental Impact Initiation phase involving screening and scoping. Following this is the Impact Study Phase, which includes impact identification and analysis, development of mitigation measures and preparation of the report. The decision-making and authorisation phase entails review of EIA reports and to either approve or disapprove a project. Lastly, environmental management and follow-up phase deals with monitoring aspects of the project during its implementation (REMA, 2006). Other steps to follow during the EIA process are the submission of the EIA report to the Authority and to wait for the report to be reviewed by the authority and the decision-making. At this stage, the different reviewers should be strict in the review and approval of the report.

The environmental law 48/2018 of 13/08/2018 determines the protection, conservation and promotion of environment in Rwanda. It makes provision for Environmental Impact Assessment (EIA)(Article 31), whereas ‘The EIA procedure is specified in a Ministerial Order 001/2019 of 15/04/2019 establishing the list of projects that must undergo environmental impact assessment, instructions, requirements and procedures to conduct environmental impact assessment. The Ministerial Order No 001/2019 of 15/04/2019 establishes the list of projects that must undergo environmental impact assessment, instructions, requirements and procedures to conduct environmental impact assessment. The list if organized in two categories of projects: those requiring full EIA and those needing partial EAI. Among other projects requiring full EIA, those related to wetlands use or direct impacts are the following:

*i.* Construction of international, national and district roads and repair of large bridges

*ii.* Construction of hydro-dams, hydropower plants, end electrical lines of high and medium voltage;

*iii.* construction of terminal ports, airports and railways

*iv.* Agriculture and breeding activities which use chemical fertilisers and pesticides in wetlands

*v.* Large scale investment projects in agriculture and breeding activities which uses chemical fertilisers and pesticides on hill sides

*vi.* Construction of artificial lakes

*vii.* Construction of water storage dams

*viii.* Works or activities for marshland reclamation

*ix.* Etc. (Republic of Rwanda, 2019).

However, the same order highlights that a developer of a project not listed on either list (full or partial EIA) may be requested by the authority or authorized organ to fulfil the requirement of EIA if the project is judged to have negative and irreversible impacts on environment.

The EIA has to conform to REMA “Guidelines and procedures for Environmental Impact Assessment” (2006). The guidelines categorise projects (based on a screening procedure), so as to determine the degree of detail required by the EIA; they also define details for approval of the EIA report and for monitoring. Since 2009, the screening of EIAs of projects has been carried out by RDB. The approval of strategic environmental assessments, environmental inspections, and environmental audits is still carried out by REMA. During the approval of EIA, conditions are issued to be implemented in addition to the mitigations measures indicated in the report. Failing to comply with the mitigation measures and the conditions of approval, the certificate may be revoked. Therefore, the project proponent has interest to ensure compliance to avoid any cancellation of the certificate and potential fines by the competent authority (REMA) during environmental inspection and audit. As stated earlier, the environmental audit is under the responsibility of REMA. However, as stated by the environmental law not only REMA staff have the power of environmental inspectors, but also those of the City of Kigali and those of the concerned district. Other authorities may also be engaged for all matters under their responsibility (e.g. Rwanda Forestry Authority (RFA) for issues related to forestry, Rwanda Mines, Petroleum and Gas Board (RMB) for all matters related to mining, Rwanda Land Management and Use Authority (RLMUA) for issues related to land, Rwanda Water Resources Board (RWB) for all water consumption and use requirement including water permit, etc. This is also relevant for any additional clearance that might be needed (again subject to approval with conditions to be followed before and during project implementation).

In 2010, REMA prepared 11 practical technical tools intended to strengthen environmental management capacities of districts, sectors and towns, followed in 2014 by multiple sector specific guidance. Although not intended to provide an exhaustive account of approaches and situations, these tools are part of REMA's objective to address capacity-building needs of officers by providing practical guidelines and tools for an array of investments initiatives.

- REMA. 2002. Practical Tools on Land Management - GPS, Mapping and GIS.
- REMA. 2006. General Guidelines and Procedure for Environmental Impact Assessment.
- REMA. 2009. Guidelines for Environmental Impact Assessment for Wetland Management in Rwanda.
- REMA. 2010. Practical Tools on Restoration and Conservation of Protected Wetlands.
- REMA. 2010. Practical Tools on Sustainable Agriculture.
- REMA. 2010. Practical Tools on Soil and Water Conservation Measures.
- REMA. 2010. Practical Tools on Irrigated Agriculture on Non-Protected Wetlands.
- REMA. 2012. Draft Guidelines for Environmental Impact Assessment (EIA) For Mining Projects in Rwanda.
- REMA. 2014. Sector specific environmental audit guideline for agriculture projects.
- REMA. 2014. Sector specific environmental audit guideline for mining projects.
- REMA. 2014. Sector specific environmental audit guideline for industry projects.
- REMA. 2015. Draft Environmental Assessment and Management Guidelines for Peat Extraction and Use.

Within the requirements of developing and approving an Environmental Impact Assessment, there is a stipulation for an assessment of social impacts, so that projects consider and mitigate impacts to surrounding communities and people. Often, social impacts are only weakly assessed, and communities are rarely consulted; some EIAs are developed void of any interaction or direct contact with members of the community (Heermans and Ikirezi, 2015). Further reviews of social impacts could be part of a strengthened stipulation of social assessment within the EIA projects should be required to develop and implement mitigation measures to prevent negative social consequences (Heermans and Ikirezi, 2015). Social impacts of projects and commitments to undertake remedial measures to address anticipated negative outcomes should be a critical consideration in decisions to approve projects and can also be used to better understand current uses, productivity and cultural values characterizing a wetland area (Heermans and Ikirezi, 2015).

### 2.4.2 International Best Practice

Many international development agencies always recommend that full environmental impact assessment be carried out in certain very fragile environments such as wetlands including swamps, with special attention to off-site effects (up- and down- stream) of projects. The existence of an important wetland in or near a project area should be a criterion for determining the need for an EIA, especially if it is downstream of the project. An EIA shall be carried out if a project area includes or is hydrologically connected to any significant wetland ecosystems.

EIAs are not limited to a specific list of activities but should also be carried out for any development project which could result in the following impacts:

- changes in the hydrological regime (timing, flow rate, periodicity and duration of water flows and/or floods);
- changes in water quality (turbidity, sediment, chemical purity and temperature);
- changes in the health risks resulting from hydrological or water quality changes (e.g. malaria, schistosomiasis);
- loss or disturbance of flora and fauna from the wetland;
- the prevention of dispersal or migration of flora and fauna;
- loss of valued wetland products or functions.

As per OECD Guidelines, EIAs should be called for if the wetland falls into any of these following categories:

1. **Criteria for wetland conservation; Wetlands of international or national significance:**

   Criteria:

   - Prime or scarce habitat for migratory species

- Unique or rare and irreplaceable ecosystem or scenic landscape
- Critical habitat of endangered, threatened or endemic species

(N.B. Ramsar Recommendation C.4.2 contains more detailed criteria for identifying wetlands of international importance.)

2. **Wetlands of regional significance**:

Criteria:

- Valuable Habitat becoming scarce for fish and wildlife
- Regionally uncommon ecosystem or scenic landscape
- Valuable functional services for the region (flood control, water supply)

3. **Wetlands of local significance:**

Criteria:

- Abundant habitat for fish and wildlife
- Regionally common ecosystem or scenic landscape
- Valuable functional services to the locality (e.g. water supply, wastewater treatment, recreation)
- Important source of wetland products for local communities (fish, timber, reeds, wildlife).

For any particularly sensitive areas, Strategic Environmental Assessments (SEA) can be carried out and predict the carrying capacity of the area for cumulative impacts of future developments. EIAs shall also include environmental economic evaluation of wetland benefits and its use in cost benefit analyses of projects and this shall reflect the true costs of the project to society and the environment. Comparison of multi-criteria objectives for benefits which, cannot easily be evaluated economically, may be used.

Table 2-8 provides a checklist of action points in the EIA process which ensure that wetlands are considered. Early awareness of the environmental impacts in the design of a project can avoid the need for costly corrective measures after the EIA has been completed.

**TABLE 2-8 EXAMPLE CHECKLIST OF ACTION POINTS FOR WETLAND BASED EIAS. (SOURCE: OECD, 1993)**

| PROJECT CYCLE | EIA PROCESS | WETLANDS ACTION PLANS |
|---|---|---|
| **PROJECT IDENTIFICATION**<br>-Pre-feasibility Study | **PRELIMINARY ENVIRONMENTAL ASSESSMENT**<br>• Initial screening<br>• Potential impacts identified<br>• Possible mitigation measures<br>• Final screening | • Follow national wetland policy,<br>• Consider national water and wetland Issues;<br>• Consult wetland sites inventory;<br>• Address lists of potential project impacts upon wetlands |
| **PROJECT FORMULATION**<br>-Feasibility Study<br>-Project Planning and Detailed Design | **EIA PREPARATION**<br>• Scoping and public consultation;<br>• Terms of reference and EIA team selection;<br>• Identification of development alternatives;<br>• Detailed impact identification;<br>• Baseline studies;<br>• Impact prediction;<br>• Impact interpretation;<br>• Planning environmental mitigation;<br>• Identify monitoring needs | • Consult wetland specialists;<br>• Include wetland specialists in team;<br>• Describe water & wetland issues in project area;<br>• Describe wetlands in area (base line survey);<br>• Assess wetland functions, uses and values;<br>• Consult communities, wetland users and NGOs;<br>• Assess impacts of project on wetlands;<br>• Identify wetland indicators |
| **PROJECT APPRAISAL** | **EIA REVIEW**<br>• Review EIA report;<br>• Public consultation | • Consult communities, wetland users & NGOs |

| PROJECT CYCLE | EIA PROCESS | WETLANDS ACTION PLANS |
|---|---|---|
| **PROJECT APPROVAL**<br>-Negotiations<br>-Approval | • Incorporate environmental provisions into project documents | • Consult wetland and environmental law specialists |
| **PROJECT IMPLEMENTATION**<br>-Implementation and Supervision<br>-Implementation of Mitigation and Enhancement Measures<br>-Monitoring Project Performance | **ENVIRONMENTAL MONITORING**<br>• Monitoring of mitigation & enhancement measures;<br>• Monitoring of environmental indicators; Monitoring of socio-economic indicators | • Develop joint-management measures for wetland with wetland user communities, if appropriate<br>• Develop mechanisms for wetland management, training and financing to strengthen wetland institutions;<br>• Prepare & deliver wetland awareness, education, training campaign, if appropriate;<br>• Monitor wetland management indicators;<br>• Monitor wetland ecosystem status Indicators;<br>• Monitor wetland user group socio-economic status indicator |
| **PROJECT EVALUATION**<br>-Project Performance Audit<br>-Recommendations for Sustainable Follow-up | **ENVIRONMENTAL AUDIT**<br>• Effectiveness of mitigation & enhancement measures<br>• Recommendations for follow-up | • Carry out wetland ecosystem surveys;<br>• Carry out socio- economic of surveys wetland users |
| **FOLLOW-UP ACTIVITIES**<br>-Design New Project Activities, if Needed | • Adjust mitigation and management measures | • Sustain wetland conservation & wise use;<br>• Ensure institutional and financing mechanisms for continued wetland management |

### 2.4.3 Findings and Recommendations

Findings and recommendations from analysis of the management tools are provided in Table 2-9 below:

**TABLE 2-9 MANAGEMENT TOOLS SITUATION: FINDINGS AND RECOMMENDATIONS**

| FINDINGS | RECOMMENDATIONS |
|---|---|
| The Environmental law (48/2018) indicates that EIA is required for projects listed in the ministerial order 001/2019 of 15/04/2019 in which specific projects related to wetland use are also mentioned. Particularly, agriculture and breeding activities which use chemical fertilisers and pesticides in wetlands and works or activities for marshland reclamation must undergo full EIA. | It is recommended the ministerial order No 001/2019 of 15/04/2019 that lists projects that undergo environmental impact assessment and establishes instructions, requirements and procedures for environmental impact assessment shall be fully implemented to insure comprehensive EIA studies. |
| Within the requirements of developing and approving an EIA, there is a stipulation for an assessment of social impacts, so that projects consider and mitigate impacts to surrounding communities and people especially impacts to their health and livelihoods, cultural and traditional practices. Often, social impacts are only weakly assessed, and communities are rarely consulted; some EIAs are developed void of any interaction or direct contact with members of the community (Heermans and Ikirezi, 2015). | The EIA studies should consider equal weight of social assessment as part of Environmental Impact Assessment. Organization like the World Bank have preferred to consider Environmental and Social Impact Assessment "ESIA" not just EIA to stress on the need for social aspect of the assessment. This can also be formalized in national regulations of EIA. Stakeholder engagement and public hearing shall also be conducted as provided by the ministerial order on EIA. |
| Currently, procedures and guidelines do not make clear reference to environmental offsets to guide | Where impacts cannot be reasonably mitigated but it is beneficial for the development to continue, e.g. |

| FINDINGS | RECOMMENDATIONS |
|---|---|
| development options and alternatives during project planning. | construction of a water treatment works, the procedures and guidelines should make recommendations and provide guidance for offset mitigation, i.e. mitigation measures are implemented at other areas than the site to improve the state of the environment as an offset to the impacts cause to the environment through the development. In particular this should be considered where there is loss of habitat for biodiversity, in order to maintain the available habitat for biodiversity an alternative site must be protected as mitigation as an extension of the development. |

## 2.5 Wetland inventory

A wetland inventory is defined by the Ramsar Convention Secretariat (2010) as the "*collection and/or collation of core information for wetland management, including the provision of an information base for specific assessment and monitoring activities*".

The foundational importance of a wetland inventory is well recognised by the GoR, and is provided for within several policies and laws, including:

- the National Environmental Policy of 2003 which made provision to "draw up an inventory and characterised the components of the diversity of wetlands, while the new environment and climate change policy (2019) stresses on promotion of sustainable management of wetlands including, but not limited to development of master plan and implementation strategy for wetland management in Rwanda; developing guidelines for the use of wetland in Rwanda; identification of all polluted wetland and their decontamination plan; etc.
- Section 5.6.2 of the National Land Policy of 2004 which called for "comprehensive inventory of marshlands[2] and clarification of their location and purpose"; and most recently, a new policy was enacted in 2019 but it does not provide for the wetland inventory.
- Prime Minister's Order No006/03 of 30/01/2017 drawing up a list of swamp lands[3], their characteristics and boundaries and determining modalities of their use, development and management. This Order supersedes several earlier versions.

A wetland inventory typically includes a spatial component as well as the information associated with the spatial component (Refer to **Figure 2-4)**. Wetland spatial data which contains mapped wetland boundaries is captured, through a combination of desktop mapping and field survey, into a geographic information system (GIS) dataset. A range of information (attributes) can be associated with each mapped wetland polygon. The wetland inventory can include information on wetland location, size, type, condition, status, or other wetland characteristics. These may then form the basis for wetland monitoring, assessment, policy and management.

[2]Considered to be a synonym for wetland.

[3]Considered to be a synonym for wetland.

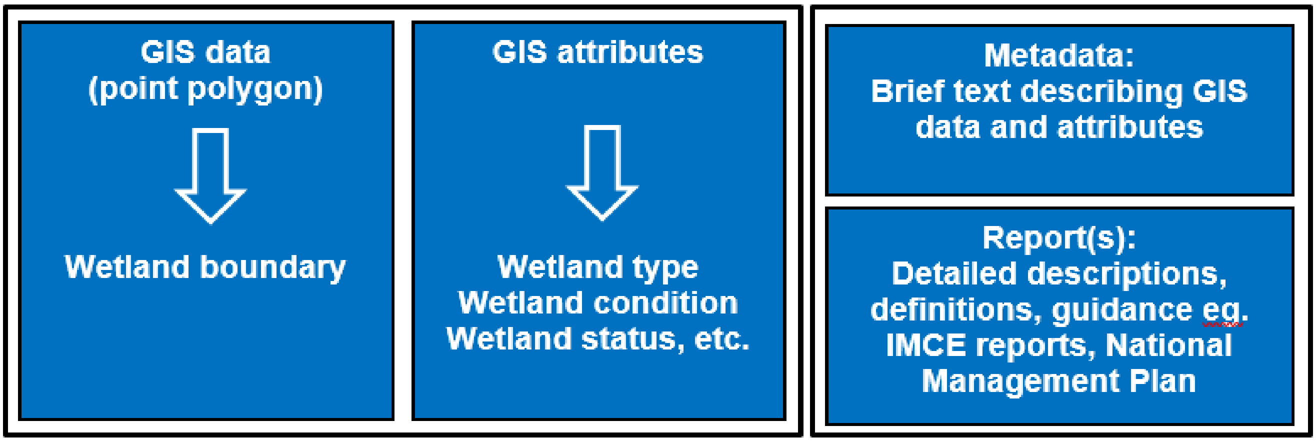



**FIGURE 2-4 COMPONENTS OF A WETLAND INVENTORY**

It is useful to accompany the wetland inventory spatial dataset, when it is shared publicly, with a one or two-page metadata (i.e. explanation about the data) text document briefly summarising the date of completion, content, intended purpose and other technical characteristics of the dataset. This helps to communicate essential supporting information to the intended users of the data and to ensure the most recent available dataset and information is used. Currently, the Prime Minister’s Order No006/03 of 30/01/2017 provides the most formal version of information about the most recent wetland dataset.

Multiple further technical and guidance documents typically support the range of information included in a wetland inventory (Figure 2-4).

### 2.5.1 Wetland spatial inventory

Rwanda has in place a comprehensive GIS coverage of the location and boundary (extent) of wetlands across the country, which is the result of several investments. The Food and Agriculture Organisation of the United Nations (FAO) contributed to Rwanda’s first wetland survey in 1998. This was followed by the Integrated Management of Critical Ecosystems (IMCE) project, funded by the World Bank, under MINIRENA, and housed within REMA. The IMCE project provided a significant contribution of information about the diverse range of wetlands in the country. In order to formalise the list of wetlands in the country into legal status, an extensive process took place between 2012 and 2015. This was supported by multiple institutions including police, district and national departments, to review wetland boundaries on the ground, and to communicate them to the public. This was an important communication process, as the allocated status of the wetland has implications for how a wetland may be used. The final boundary location of the wetland has implications both in terms of how far cultivation must be set back from the edge of the wetland, according to the implementation of the Law on the Environment (2018) (Republic of Rwanda, 2018) and how ownership or leasing of that piece of land is handled, according to the Land Law (2013). The resulting list was gazetted in 2017 under the Ministerial Order No006/03 of 30/01/2017 drawing up a list of swamp lands[4], their characteristics and boundaries and determining modalities of their use, development and management.

Since 2003, when the former National Environmental Policy was enacted, and 2004, when the former National Land Policy was enacted, the GoR has made significant progress on developing a comprehensive national wetland inventory, which very few other countries worldwide have yet achieved. A comprehensive GIS coverage of the location and boundary of wetlands across the country has been established and has been communicated in legislation (Republic of Rwanda, 2017) and through public engagement on the ground. Next steps include an exercise to review and update the wetland boundary to resolve identified conflicts, and to embark on a process of updating the wetland characteristics and management information included in the inventory as this is based on information collected in 2008, some of which is now outdated.

[4]Considered to be a synonym for wetland.

#### 2.5.1.1 Identify and communicate current best available dataset

Currently, several differing spatial (GIS) versions of the wetland inventory remain in circulation. A formal reconciliation of the datasets is needed, to review and resolve any discrepancies in the versions used across different departments and sectors. A way forward could be an official communication, naming the official GIS wetland inventory shapefile once it is achieved, and the preparation of a brief metadata document that would accompany the dataset in future, whenever it is shared. To remove any ambiguity, the list of attributes in the GIS layer should exactly match the list of information gazetted in Annex I. If there are any differences between the two, this should be explained in the metadata document. Brief explanations of all information included in the spatial dataset should be included in the metadata document to facilitate communication.

#### 2.5.1.2 Further update the wetland boundary

It is acknowledged that to update the wetland spatial inventory in future will require a similar extensive process to that described in support of the gazetting of Ministerial Order No006/03 of 30/01/2017, as any change to the boundary of a wetland or to the current status of the wetland will have legal implications for people on the ground. However, an update of the current wetland dataset is considered necessary, in order to incorporate minor changes to the wetland boundaries, revealed by a rapid review undertaken during the preparation of this interim report, of the most recent dataset over aerial imagery, and comparison against the most recent land cover dataset. The review revealed several minor areas where the wetland boundary could be extended, as well as areas where the land cover mapping category “irrigation” captures areas not yet included in the current wetland shapefile. Overall, however, this constitutes a small percentage of total wetland in the country. The methodology that was used to identify wetland and wetland boundary in the field during the 2012 to 2015 process, as well as for undertaking a future update, should be included in the metadata document. These could include identification of the presence of specific soil characteristics, typical vegetation species and hydrological observations, as well as desktop interpretation from imagery.

#### 2.5.1.3 Update the wetland attributes

As previously stated, the IMCE (2008) project was the origin of the information associated with the current spatial datasets in circulation. This includes the management status, extent of remaining natural vegetation and extent of cultivated wetland. Most of the information was collected prior to 2009 and has not been updated to reflect the current situation.

A programme of work to update the wetland inventory information is urgently needed as the current version stalls progress on clarifying exactly where to focus wetland protection efforts and develop strategic plans to guide decisions on appropriate use. During the next stage of work of updating the wetland information, it may be useful to expand, as well as consolidate, the current set of information. It is recommended that a two phased approach be followed to update the wetland inventory (**Table 2-10)**:

- Include the Level 1 and Level 2 catchment delineations
    - Rwanda catchment delineation is based on 4 levels. Level 1 division is based on the major water bodies (rivers and lakes) subdivided on the basis of the principal confluence locations, with Level 2 dividing Level 1 catchments into a limited number of sub sectors as per the major river branches and break points. Level 1 catchments are divided into 9 sub-catchments and Level 2 catchments are divided into 17 sub-catchments.
    - By including the Level 1 and Level 2 catchment delineations it will be possible to provide context to the location of wetlands within a catchment.
    - The inclusion of Level 1 and Level 2 catchment delineations can be achieved immediately through a rapid desktop exercise using existing spatial datasets.
- Include more detailed information about wetland type and condition
    - Building on the foundation of wetland type as described in the IMCE (2009) project, the main inclusion will be the HGM type.
    - Following a monitoring and assessment programme wetland condition should be included.
    - The inclusion of HGM unit and wetland condition will require a programme of work dedicated to updating the inventory.

**TABLE 2-10 POTENTIAL ADDITIONAL WETLAND ATTRIBUTE INFORMATION TO INCLUDE IN AN UPDATED DATASET**

| Attribute | Motivation for inclusion in the wetland inventory |
|---|---|
| **Part 1 implementation: Desktop** | |
| Level 1 catchment | To support rapid identification of which wetlands fall within a specified Level 1 catchment |
| Level 2 catchment | To support rapid identification of which wetlands fall within a specified Level 2 catchment |
| **Part 2 implementation: Requires a programme of work to update the wetland inventory** | |
| Wetland type | The foundation was firmly prepared during the IMCE (2009) project. Requires a combination of desktop application of characteristics in GIS, supported by strategic field investigation.<br>Wetland type includes the HGM unit, which would be either Floodplain or Valley-bottom. |
| Wetland condition | Requires the development of a monitoring and assessment programme |

This inventory and the GIS dataset should be made easily accessible to the public and across sectors to provide the basis for land use plans, and approvals of governmental projects and private investments. A metadata document should be generated to accompany the official version of the spatial (GIS) version of the wetland inventory when it is shared between departments and with the public.

Other recommendations are as follows:

- A further review against best available recent aerial imagery, for an updated wetland boundary undertaken on desktop should be undertaken to reconcile the best available GIS layers.
- A procedure should be outlined, as part of this national wetland management framework update, to undertake the next phase of the wetland inventory update, namely the updating of the attribute information to support wetland management, in particular, wetland status (protection level) and extent of cultivated wetland.
- An ongoing procedure should be set in place to monitor rates of wetland conversion. This information will underpin the process of updating appropriate use and protection designations.

#### 2.5.1.4 Use of the wetland inventory

The wetland inventory is an important resource for management of wetlands in the country. As discussed above the most important use of the inventory is the accurate delineation and mapping of wetland extent. The next step following this is a useful classification system for the mapped wetlands. The inventory also provides classification in terms of legislation (i.e. protected/non-protected wetlands). This will allow for effective management of wetlands as managers will be able to identify the following important characteristics of each wetland in Rwanda:

- Wetland extent (in Hectares)
- Wetland classification
    - Regional type and agro-climatic zone
    - ***Hydrogeomorphic unit (or location in the landscape)(Proposed additional attribute)***
    - Soil type
    - Ecosystem type
    - ***Ecosystem services provided by wetland (Proposed additional attribute)***
    - ***Wetland condition(Proposed additional attribute)***
- Wetland protection status
    - Wetlands under “total protection”
    - Wetlands which can be used under “specific conditions”
    - Wetlands which can be used “without specific conditions”

### 2.5.2 Wetland extent

The updated total number of wetlands for the 2017 updated and gazetted list is as follows:

- 176 337 ha of wetlands (935 wetlands).
- 120 000 ha of Lakes.

### 2.5.3 Wetland classification

Current characteristics used to classify wetlands in Rwanda include – wetland soil type, wetland vegetation, hydrology and climate zone.

Figure 2-5 provides an overview of this data by providing regional and location based context for the characteristics. When considering the characteristics of wetland in Rwanda the first step would therefore be to understand the regional context, the landscape based context and then the local context.

The Hydrogeomorphic Unit (HGM) would provide the landscape based context to the wetland inventory, which is currently missing. The motivation for its inclusion is based on the fact that the HGM unit relies on an understanding of the location of a wetland in a landscape as well as the flow of water into, through and out of a wetland. The HGM unit therefore provides a foundation from which to build on the localised context (i.e. soil, vegetation, ecosystem services and wetland health).

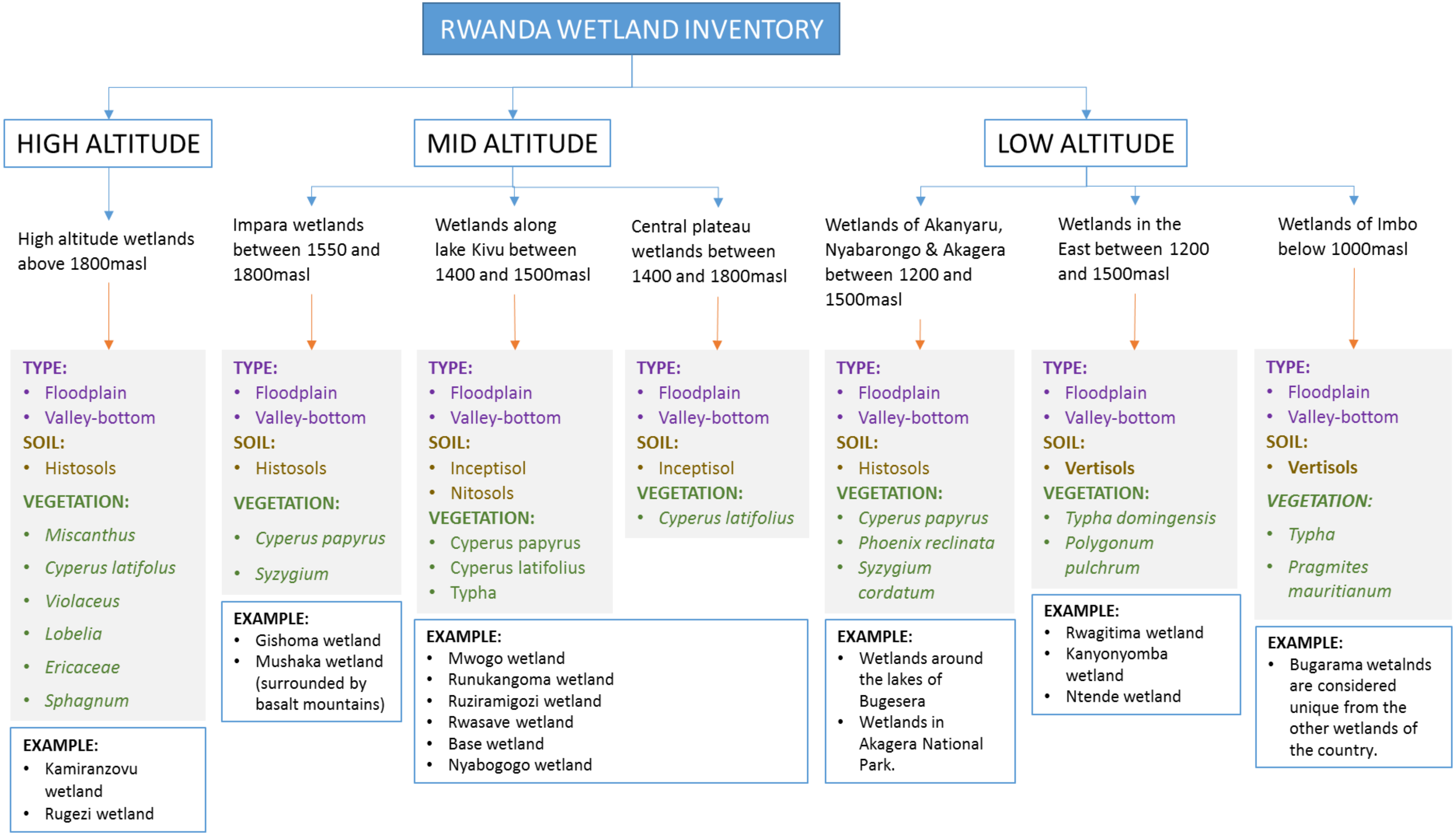



**FIGURE 2-5 THE WETLAND TYPES OF RWANDA**

#### 2.5.3.1 Regional type

The IMCE project considered the wetlands of Rwanda in relation to the 10 agro-climatic zones of the country, grouped into 3 altitude zones (high, mid and low). This resulted in 7 broad wetland groups.

- High altitude:
    1. High altitude wetlands above 1800 meters above sea level (masl)
- Mid altitude:
    1. Mid altitude Impara wetlands between 1550 and 1800masl
    2. Mid altitude wetlands along lake Kivu between 1400 and 1500masl
    3. Mid altitude central plateau wetlands between 1400 and 1800masl
- Low altitude:
    1. Low altitude wetlands of Akanyaru, Nyabarongo & Akagera between 1200 and 1500masl
    2. Low altitude wetlands in the East between 1200 and 1500masl
    3. Low altitude wetlands of Imbo below 1000masl

#### 2.5.3.2 Wetland HGM unit

The hydrogeomorphic (HGM) approach (Brinson, 1993) is a classification system that recognises the link between wetland types to water and their geomorphological position in the landscape. This approach is based on three fundamental factors that influence how wetlands function, namely:

- Position in the landscape (geomorphic setting);
- Water source (catchment hydrology); and
- The flow and fluctuation of the water once in the wetland (hydrodynamics).

The HGM approach classifies wetlands based on their differences in functioning, and importantly defines the functions that each class of wetland is likely to perform. The approach has been modified for use by a succession of authors, and most recently by Ollis et al. (2013) to form a consistent basis adopted for wetland specialist studies. It is considered applicable to Rwanda, since the local wetland systems identified fit into the classifications described. The individual hydrogeomorphic (HGM) unit is the smallest scale at which wetland assessments are undertaken.

The hydrological regime of a wetland, which describes the behaviour of water within the ecosystem (and its soils in the case of wetlands), directly affects the physical, chemical and biological characteristics of the wetland or aquatic ecosystem, and the overall functioning of the system. Although the hydrological regime is often used for classification of wetlands, it is directly influenced by the landscape setting, climate, topography and lithology of an area. This management framework proposes that wetlands be first classified according to whether they are floodplain or valley-bottom wetland, and only then further sub-divided according to hydrology, soil, and vegetation characteristics.

The review of documents describing the wetlands of Rwanda indicates that the HGM classification has not yet been widely applied. Wetlands associated with streams and rivers, i.e. within a fluvial context, have been described as zones of deposition, characterised by net accumulation of sediment (Kotze et al., 2008) in settings that are conducive to the development of wetland conditions (Ellery et al., 2009). Variation in stream discharge drives sediment accumulation and distribution, resulting in a variety of wetland forms and processes. From this point of view, at the broadest level, the wetlands of Rwanda may be divided into “floodplain wetlands” and “valley-bottom wetlands”. While both of these wetland types are found along valley floors in association with streams or rivers, they function quite differently in terms of how dynamic they are as ecosystems, overall transport of sediment, hydrological dynamics and the ecosystem services and functions that they support.

Regional variations in climate, geology, topography and slope gradient generate a range of conditions for valley-bottom and floodplain wetland development and these were drawn on by the IMCE project to understand the range of wetlands across the country. Topographic variability across the country has given rise to a diverse set of wetlands across the country. In addition, wetlands may be broadly grouped below 1 400 m in elevation (mostly within Bugesera, Gisaka and Umutara province), those between 1 400-1 800 m, and a third group of high altitude wetlands which occur about 1 800 m in elevation, with a corresponding range in rainfall, being generally highest at high altitude and lowest in the low altitude regions (IMCE, 2008). High altitude wetlands occur in both the north and west of the country within Kigali-Rural, Gitarama, Huye and a part of Gikongoro province (IMCE, 2008). Slope gradient also exerts an influence on the type of wetland, with valley-bottom wetlands generally associated with steep-sided, narrow valleys and floodplains with large, flat and open valley floors.

Note that a further group of wetlands, hillslope seep wetlands, could potentially provide a further category. Due to the scale of this project these wetlands have been grouped together with the valley-bottom wetlands of the country. They are likely to form smaller wetland HGM units in localised positions in the landscape. They are, however, worthy of individual consideration. Hillslope seepage wetlands are generally associated with shallow to deep, well-drained soils associated with an impeding horizon that limits deep infiltration. They typically reflect the presence of seasonal, shallow interflow. The dominant hydrological driver is lateral subsurface seepage across a semi-impermeable aquitard such as dense clay, soft or hard plinthite or parent material. The presence of hillslope seepage wetlands indicates the emergence of water that is retained in the landscape but which is moving in the subsurface, with the rate of flow being a function of head, slope, soil depth and porosity. Because of this relationship between interflow and its emergence at the soil surface, hillslope seepage wetlands are often associated with stream flow augmentation. Springs, where groundwater emanating from cracks in the underlying geology is expressed to the surface, are regarded similarly to seepage wetlands.

**TABLE 2-11 HYDROGEOMORPHIC WETLAND TYPES**

| HGM type | Definition |
|---|---|
| Floodplain | Dynamic, alluvial systems, typically characterised by a suite of geomorphological features associated with river-derived depositional processes, including point bars, oxbow lakes and levees. |
| Valley-bottom | Characterised by sub-surface and diffuse surface flow, low unit stream powers and sediment deposition leading to aggradation (deposition) of the wetland surface over time. |
| Seep | Dominated by groundwater or hillslope interflow inputs. May occur at the edge of valley-bottom and floodplain wetlands, where the water table intersects the land surface, either at the local or regional prevailing water level or due to impermeable strata directing groundwater flow to the surface, often manifesting in the lower portion of a break in slope. |

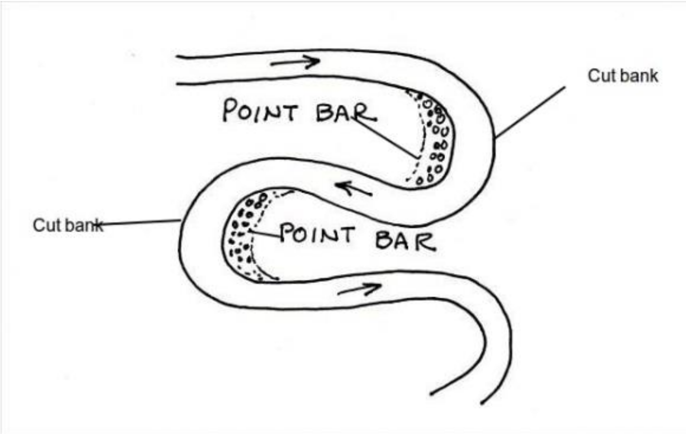
**FLOODPLAIN WETLANDS**

The large floodplains of the lower Nyaborongo, Akuyaru and Akagera rivers dominate the low-lying landscape of the country. Floodplain wetlands, as the name implies, generally form the flat plain adjacent to a river. Large rivers which generate floodplains typically have broad meanders as they move across the plain and deposit sediment over the course of hundreds of years.

Floodplains are typically characterised by a suite of geomorphological features associated with river-derived depositional processes, including point bars, oxbow lakes and levees. The overall longitudinal gradient is gentle, and a characteristic of these floodplain valleys are the large quantities of accumulated alluvial sediment layers that constitute the floodplain soils. The dominant ecological process is over-bank topping during longitudinal peak flow events, where the water escapes the channel and spreads out across the adjacent flood benches, dissipating energy. Sediment is deposited on the floodplain during flood events. Deposition of coarser sediment is focused in close proximity to the channel, leading to development of natural levees adjacent to the river channel. The combination of an aggrading stream bed and aggrading levees often leads to the river becoming elevated relative to the rest of the floodplain on what is called an alluvial ridge.

An additional geomorphological characteristic of floodplains is the formation of oxbows and ponded depressions within the broader floodplain. The oxbows are sometimes mid-floodplain or else against the valley walls, wherever a previous (historical) course of the river was once located. The extensive ponded areas are typically at the lowest elevations of the floodplain or dammed up against depositional features from incoming lateral tributary floodplain or valley bottom wetlands (this is discussed further in the section on lakes). Water enters the floodplain wetlands mainly as overspill from the river channel during flooding. Significant temporary storage of water may occur in floodplain depressions. Infiltration and evapotranspiration of water from a floodplain wetland can also be significant, particularly if there are a number of depression areas within the wetland.

A river **meander** is the twist and turns of a river course. Water flows faster at its outer bend, where the channel is deeper and there is less friction. This may cause lateral erosion and the river bank erodes causing cut banks. On the other side of the channel there is less energy and deposition of sediment occurs which creates a shallower channel. As the meander moves over time, **point bars** form. Point bars are the accumulation of deposited sediment.




In certain areas, some form of alteration to the river channel has taken place. Straightening a meandering river has the effect of steepening the average slope of the river by reducing its distance covered over the same change in altitude, thus making it a more efficient conduit for transporting water and sediment through and out of the floodplain. This is usually associated with channel incision, deactivating the floodplain and resulting in less frequent flood events (a longer flood interval). The system becomes less effective at attenuating floods and capturing sediments. As the water table drops and the floodplain desiccates, secondary impacts associated with channel straightening such as increased agricultural activities and the terrestrialisation of the floodplain vegetation often become significant.

**FIGURE 2-6 THE NYABARONGO FLOODPLAIN WETLAND (PHOTO: 2020)**

The typical form for a Floodplain wetland is indicated in Figure 2-7.

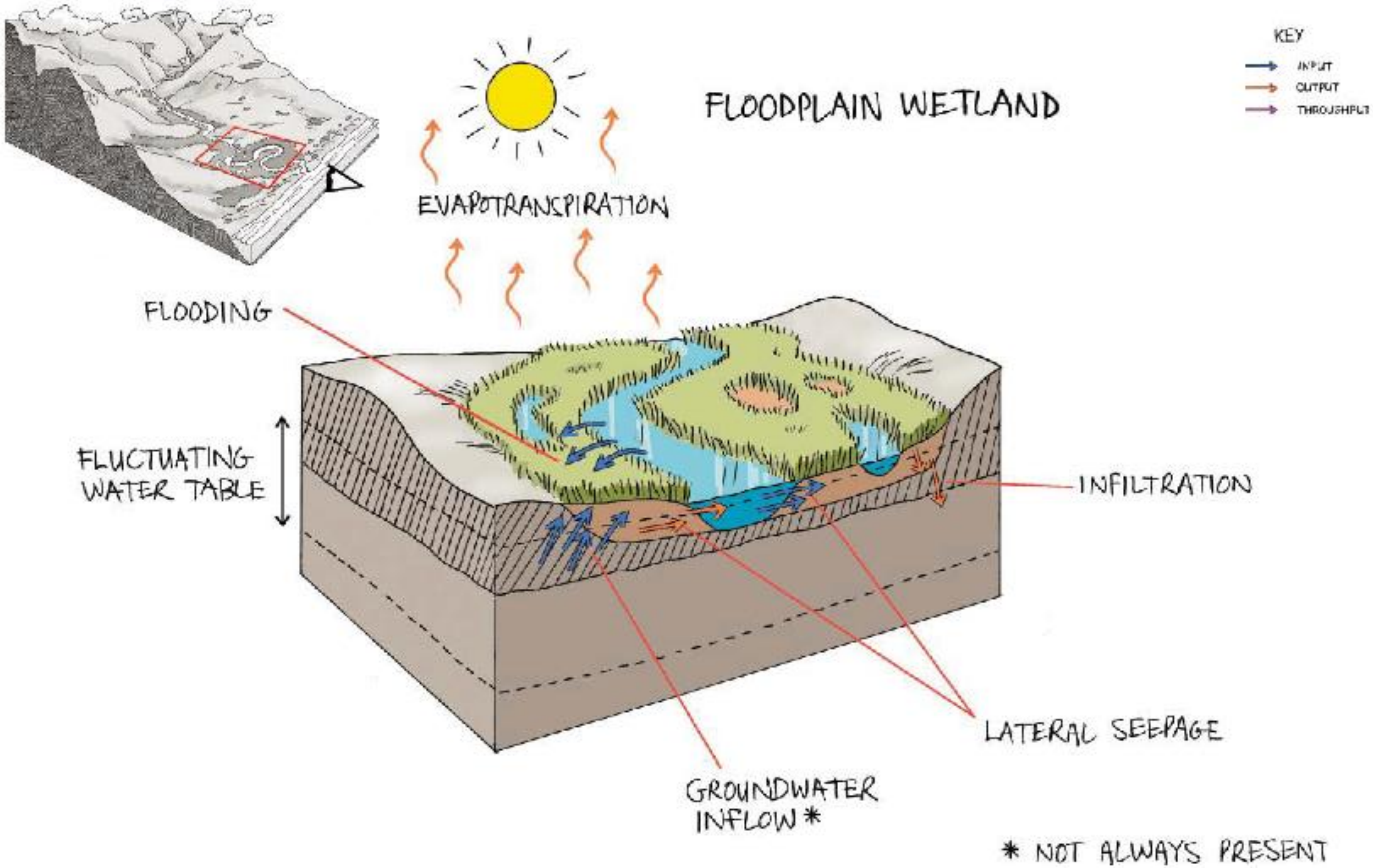



**FIGURE 2-7 CONCEPTUAL ILLUSTRATION OF A FLOODPLAIN WETLAND, SHOWING TYPICAL LANDSCAPE SETTING AND THE DOMINANT INPUTS, THROUGHPUTS AND OUTPUTS OF WATER (SOURCE: OLLIS ET AL., 2013)**

### VALLEY-BOTTOM WETLANDS

In contrast with floodplain wetlands, valley-bottom wetlands are generally characterised by subsurface and diffuse surface flow with low unit stream powers and limited capacity to transport sediment, leading to aggradation (deposition) (Grenfell *et al*., 2008). Sediment introduced from valley sides will tend to reduce gradient upslope of the point of sedimentation. If discharge and gradient within the valley is sufficiently low, and sediment supply is high, the ability of the valley stream to carry the sediment out of the valley will be exceeded and a valley bottom wetland may form.

Alternatively, as a stream enters a region of very low relief, water may be lost downstream through evapotranspiration and loss to groundwater such that channel size and definition decline downstream and sediment is deposited. In some valley bottom wetlands, channels may form due to high discharges, and lower rates of sediment input allowing for stream to form and persist within the valley wetland thus forming a channelled valley-bottom wetland. The majority of wetlands in the country are valley-bottom wetlands, and an example is Rugezi wetland, the country's only proclaimed Ramsar site.

A typical valley-bottom wetland in Rwanda is indicated in Figure 2-8, with the typical form indicated in Figure 2-9 and Figure 2-10. Valley-bottom wetlands can be either channelled or unchannelled.

**FIGURE 2-8 TYPICAL VALLEY-BOTTOM WETLAND IN NAKU, MUKARANGE, KAYONZA DISTRICT (PHOTO: 2020).**

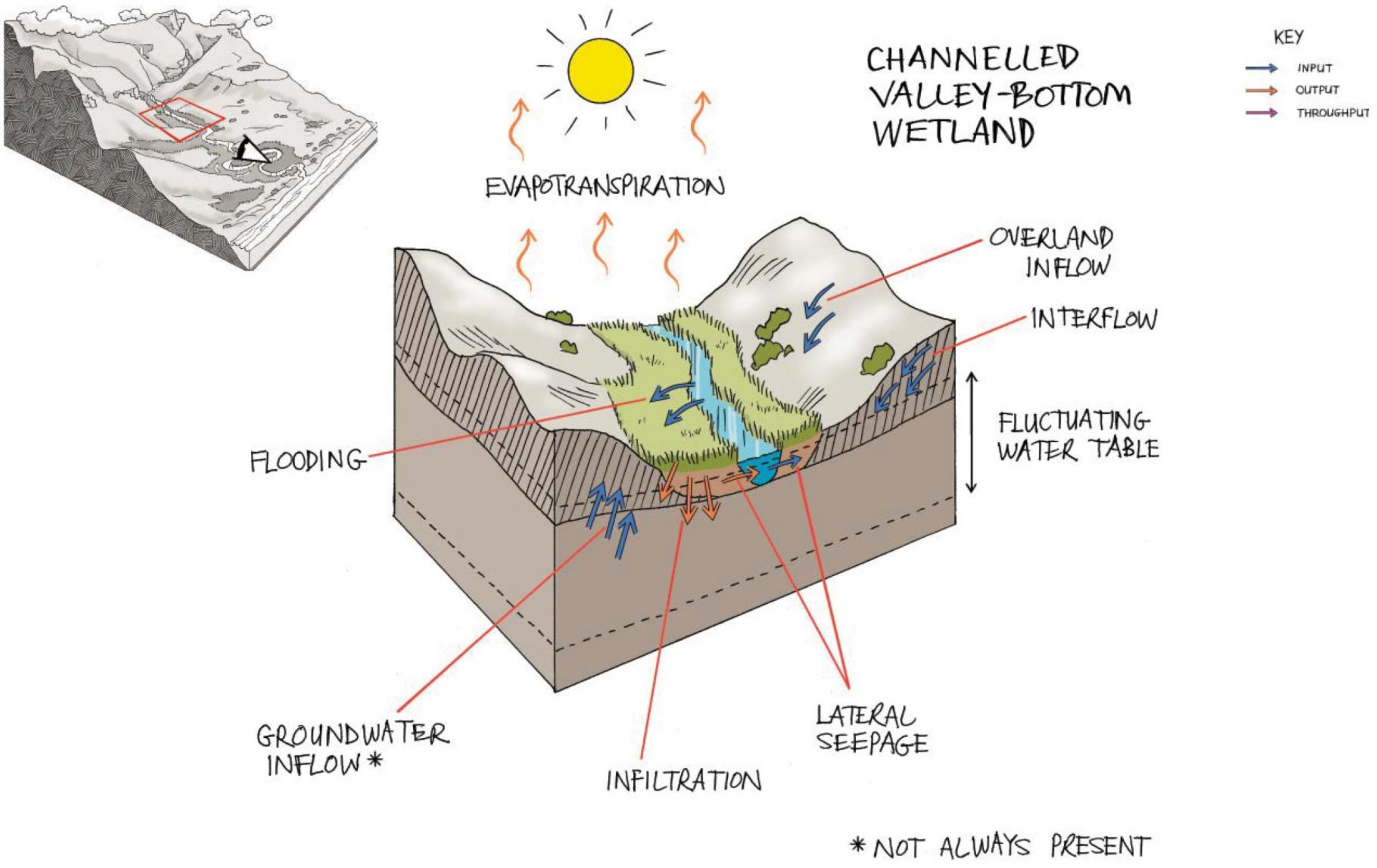



**FIGURE 2-9 FEATURES OF A CHANNELLED VALLEY-BOTTOM WETLAND, SHOWING TYPICAL LANDSCAPE SETTING AND THE DOMINANT INPUTS, THROUGHPUTS AND OUTPUTS OF WATER (SOURCE: OLLIS ET AL., 2013)**

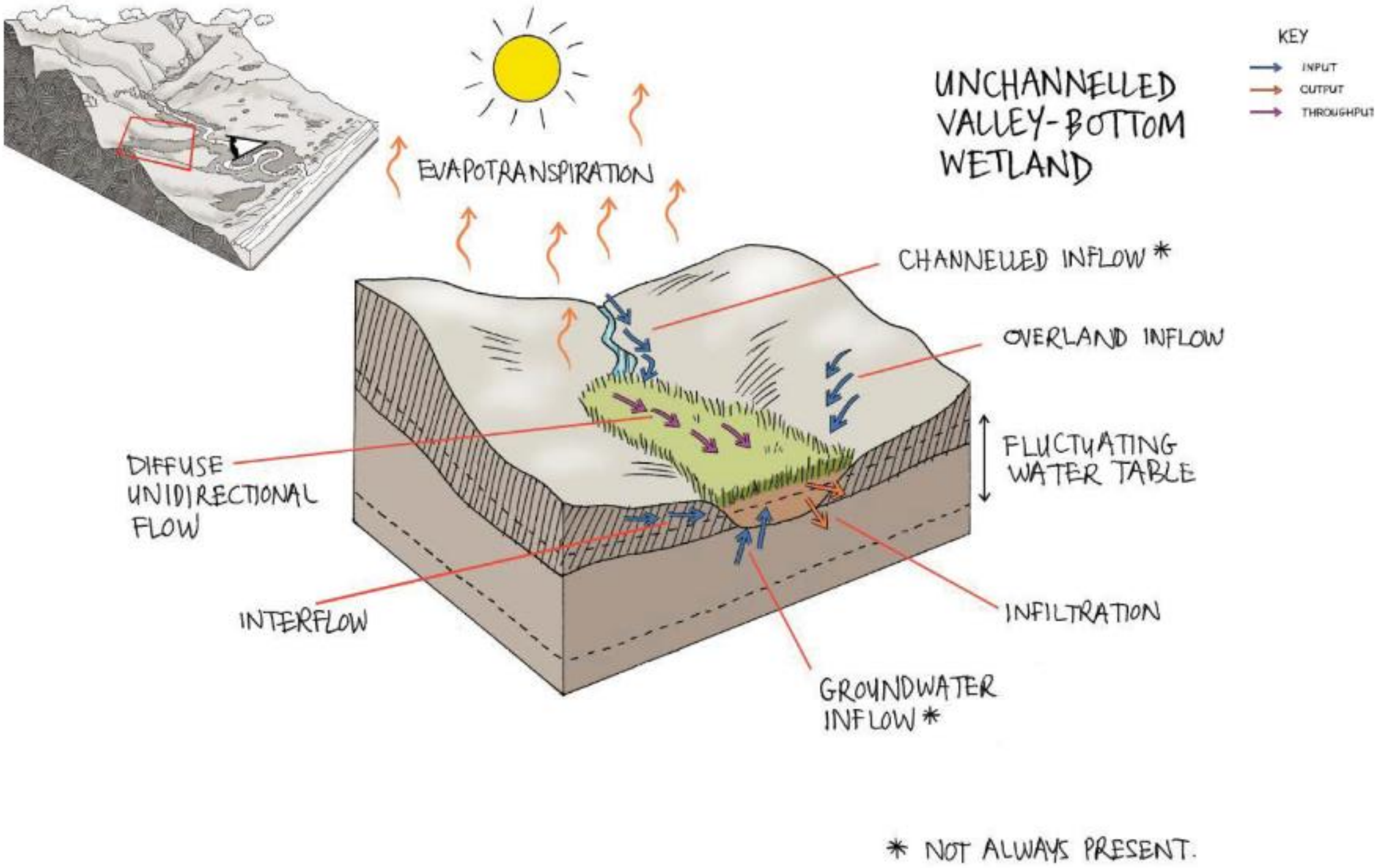



**FIGURE 2-10 FEATURES OF AN UNCHANNELLED VALLEY-BOTTOM WETLAND, SHOWING TYPICAL LANDSCAPE SETTING AND THE DOMINANT INPUTS, THROUGHPUTS AND OUTPUTS OF WATER (SOURCE: OLLIS ET AL., 2013)**

### HILLSLOPE SEEP WETLANDS

Hillslope seep wetlands are considered with valley-bottom wetlands due to their presence on the side-slopes of a valley. Water inputs are primarily from subsurface interflow, with diffuse overland flow being significant during rainfall events. A characteristic of hillslope seeps is their association with underlying geology and topography which causes rain-derived water to 'seep' down-slope as subsurface interflow.

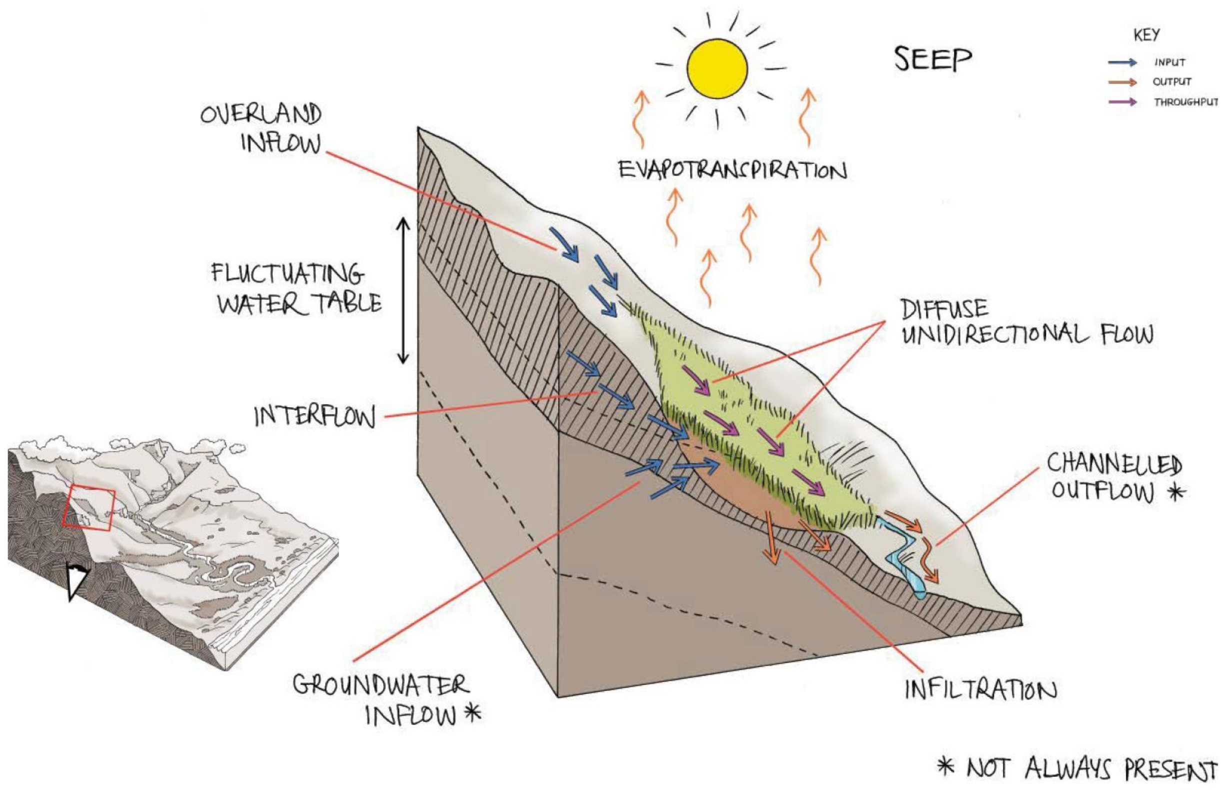



**FIGURE 2-11 FEATURES OF A SEEP WETLAND, SHOWING TYPICAL LANDSCAPE SETTING AND THE DOMINANT INPUTS, THROUGHPUTS AND OUTPUTS OF WATER (SOURCE: OLLIS ET AL., 2013)**

#### 2.5.3.3 Wetland soil type

Relatively extensive information is available about the range of mineral and peat soils in Rwanda's wetlands. The IMCE (2009) project identified four wetland groups according to their soil:

- *Peat soils, permanently saturated.* Typically occur at high altitude or in association with *Papyrus* vegetation, often cultivated, often acidic. An example vegetated with *Papyrus* includes sections of Akanyaru wetland.
- *Organic soils, permanently inundated*. Often in associated with river-transported alluvial sediment. Examples include the wetlands of Bugesera District and Akagera National Park.
- *Mineral soils*. The majority of valley-bottom wetlands of the country support a wide range of mineral soils.
- *Vertic soils.* Examples include the rice fields of Bugarama wetland and other low altitude wetlands.

In terms of the classification system within the wetland inventory (FAO soil units, 1974) the following soils are defined:

- **Histosol** (High altitude wetlands, Impara wetland and Akanyaru/Nyabarongo/Akagera wetlands)
    - Consisting primarily of organic materials (Peat).

  - Low bulk density and poorly drained soil due to peat holding water very well. Generally acidic and deficient in major plant nutrients which are washed away in the consistently moist soil.
  - Generally very difficult to cultivate because of the poor drainage and low chemical fertility.
  - Soils having an H horizon of 40 cm or more either extending down from the surface or taken cumulatively within the upper 80 cm of the soil; the thickness of the H horizon may be less when it rests on rocks or on fragmental material of which the interstices are filled with organic matter.

**FIGURE 2-12 AN EXAMPLE OF PEAT SOILS**

- **Nitosol (**Wetlands along Lake Kivu)
  - Deep, red, well-drained soil with a clay content of more than 30% and a blocky structure.
  - Limitations frequently include low phosphorus availability and low base status, but with additional input can have high agricultural potential and are often planted to crops.
  - Soils having an argillic B horizon with a clay distribution where the percentage of clay does not decrease from its maximum amount by as much as 20 percent within 150 cm of the surface; lacking plinthite within 125 cm of the surface; lacking vertic and ferric properties.
- **Inceptisol / Cambisol** (Wetlands along Lake Kivu and Central plateau wetlands)
  - Soil which form quickly through alteration of parent material. They have no accumulation of clays, iron oxide, aluminium oxide or organic matter.
  - Soils having a cambic B horizon or an umbric A horizon which is more than 25 cm thick.

**FIGURE 2-13 AN EXAMPLE OF CULTIVATION ON INCEPTISOL**

- **Vertisol** (Wetlands in the East and wetlands of Imbo)
    - High content of expansive clay that forms deep cracks in drier seasons or years.
    - Typically form from highly basic rocks, such as basalt, in climates that are seasonally humid or subject to erratic droughts and floods, or that impeded drainage. Depending on the parent material and the climate, they can range from grey or red to deep black.
    - The heavy texture and unstable behaviour of the soil makes it difficult for many tree species to grow.
    - Soils which, after the upper 20 cm are mixed, have 30 percent or more clay in all horizons to at least 50 cm from the surface; at some period in most years have cracks at least 1 cm wide at a depth of 50 cm, unless irrigated.

#### 2.5.3.4 Wetland vegetation community type

Vegetation is a strong indicator of wetland condition, reflecting the combination of physical characteristics of the geomorphology, as well as hydrology and soil. The two most commonly described wetland plant communities include *Cyperus papyrus* habitat, described as "swampy, with stagnant water on the surface" throughout the year, and *Cyperus latifolius* habitat where the water level fluctuates by some centimetres below the soil surface. These areas are favoured for cultivation in the dry season (IMCE, 2008). Other wetland habitats are more broadly described as "shrub-like vegetation, with ferns and tall grass", where free water never covers the surface of the soil, rather fluctuating below the surface according to the abundance of rains.

The IMCE project grouped wetlands according to their vegetation as follows (Figure 2-16):

- *Miscanthus violaceus* (High altitude wetlands)
    - Typically occur higher than 1800m elevation
    - Often in association with *Lobelia*, *Ericaceae* and certain high-altitude grasses, as well as *Sphagnum* and *Utricularia*species.
- *Cyperus latifolius* (High altitude, Impara, Lake Kivu and Central plateau wetlands)
    - Typically on mineral soils along the central plateau.

- *Cyperus papyrus* (Impara, Lake Kivu and Akanyaru/Nyabarongo/Akagera wetlands)
    - Inundated areas below 1800m.
    - Often in association with *Phoenix reclinata, Syzygium cordatum* and herbaceous species such as *Polygonum*.
    - Examples include wetlands associated with Nyabarongo, Bugesera and the Akagera valley, but also certain wetlands on the central plateau such as wetlands associated with the Mwogo River.

**FIGURE 2-14 AN EXAMPLE OF CYPERUS PAPYRUS (PHOTO: JULY 2017)**

- *Typha*.(Lake Kivu, East and Imbo wetlands)
    - In similar situations as *Cyperus papyrus*, but often also associated with mineral soils.

**FIGURE 2-15 AN EXAMPLE OF TYPHA CAPENSIS (PHOTO: MASSYN 2006)**

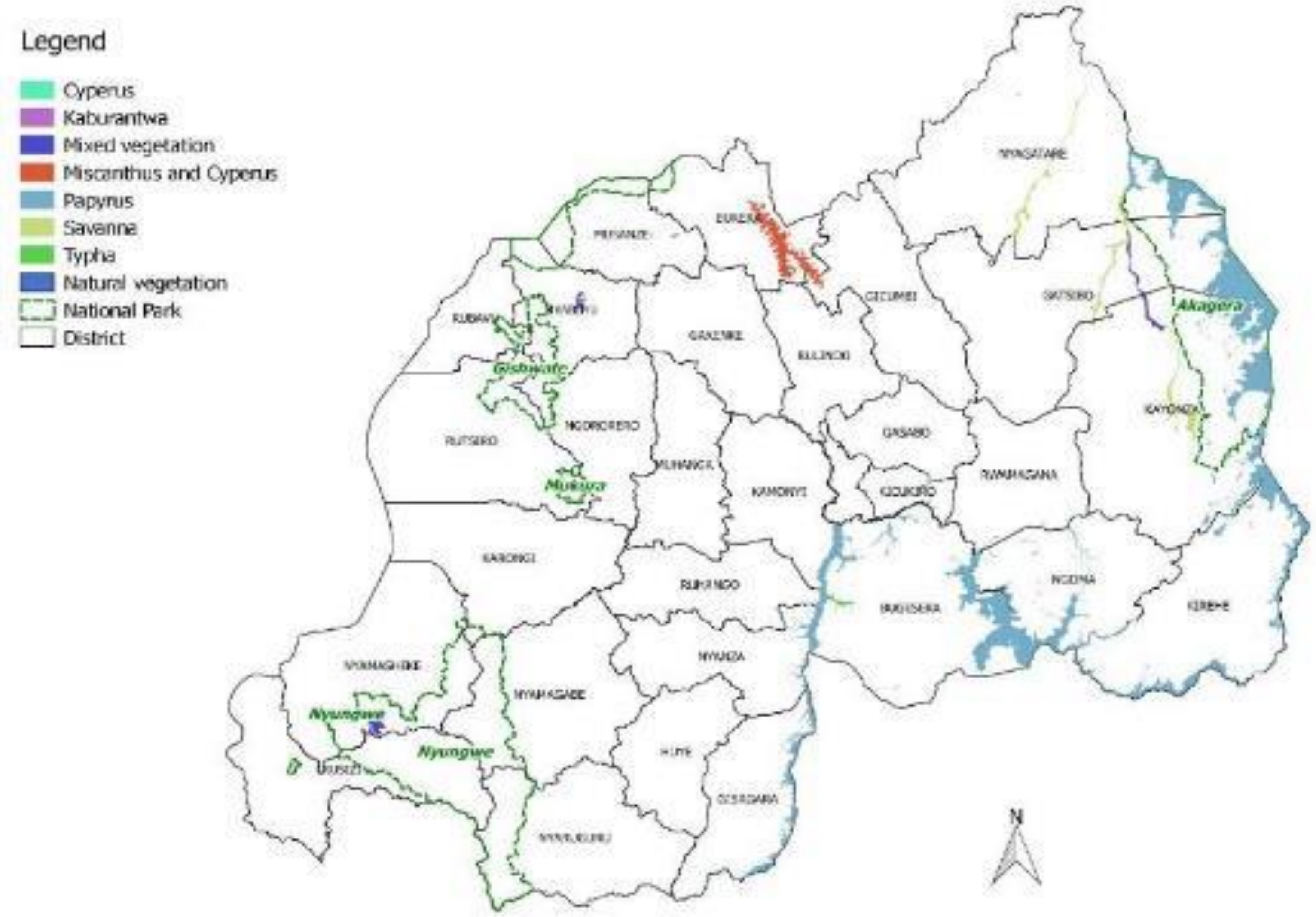



**FIGURE 2-16 VEGETATION COMMUNITY TYPE FOR RWANDA (REMA, 2009)**

#### 2.5.3.5 Ecosystem services of wetlands

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.

**TABLE 2-12 ECOSYSTEM SERVICES PROVIDED BY, OR DERIVED FROM, WETLANDS (MILLENNIUM ASSESSMENT, 2005)**

| Services | Comments and examples |
|---|---|
| **Provisioning** | |
| Food | Production of fish, wild game, fruits and grains |
| Freshwater (a) | Storage and retention of water for domestic, industrial and agricultural use |
| Fibre and fuel | Production of logs, fuelwood, peat and fodder |
| Biochemical | Extraction of medicines and other materials from biota |
| Genetic materials | Genes for resistance to plant pathogens, ornamental species, etc. |
| **Regulating** | |
| Climate regulation | Source of and sink for greenhouse gases; influence local and regional temperature, Precipitation, and other climate processes |
| Water regulation (hydrological flows) | Groundwater recharge/discharge |
| Water purification and waste treatment | Retention, recovery and removal of excess nutrients and other pollutants |
| Erosion regulation | Retention of soils and sediments |
| Natural hazard regulation | Flood control and storm protection |
| Pollination | Habitat for pollinators |
| **Cultural** | |
| Spiritual and inspirational | Source of inspiration; many religions attach spiritual and religious values to aspects of wetland ecosystems |
| Recreational | Opportunities for recreational activities |
| Aesthetic | Many people find beauty or aesthetic value in aspects of wetland ecosystems |
| Educational | Opportunities for formal and informal education and training |
| **Supporting** | |
| Soil formation | Sediment retention and accumulation of organic matter |
| Nutrient cycling | Storage, recycling, processing and acquisition of nutrients |

#### 2.5.3.6 Wetland condition (current condition/status)

Wetland ecosystems comprise the abiotic characteristics of an area together with the biotic community suited to the particular environmental conditions and natural disturbance regimes (MacFarlane et al., 2009). A reference ecosystem usually represents a non-degraded version of the ecosystem complete with its flora, fauna, abiotic elements, functions, processes and successional states that would have existed on the site had degradation, damage or destruction not occurred – but should be adjusted to accommodate changed or predicted environmental conditions (SER, 2016). Wetland health is defined as a measure of the similarity of a wetland to a natural or reference condition (MacFarlane et al., 2009).

Assessment of wetland health involves a step wise process. First the focus is on the human activities and impacts in the catchment as well as the wetland, then a likely trajectory of change is given, followed by an assessment of overall health. This is conducted for the ecological components of a wetland, which consists of hydrology, geomorphology and vegetation.

It is clear that an understanding of wetland type (in terms of a HGM unit type) provides the necessary foundation for an understanding of how to assess wetland health. The HGM unit defines the geomorphic setting, water source and pattern of water flow through the wetland. Understanding the overall functioning / operations of a HGM unit type, and the manner in which water enters, passes through and leaves a wetland system are important considerations when reviewing/assessing a wetland. Understanding the general functioning of a wetland allows for judgement to be passed in terms of the impacts on the system and the degree to which the system has been altered with regards to the overall functioning and integrity of the system.

Understanding the conditions and proximity of the impacts that have led to the degradation of the wetland habitat is crucial. Thus, not only do the in-system impacts need to be identified but impacts originating from the catchment or watershed, too. The formation/origin of wetlands are as a result of catchment characteristics, and thus changes in the catchment characteristics may greatly influence the condition of the wetland.

Catchment impacts are often associated with urbanisation, which includes increased hardened surfaces thus influencing the flood peak characteristics within the catchment; damming of rivers for water provisioning, changes in vegetation characteristics from well-vegetated landscapes to agricultural landscapes, which may lay barren for extended periods thus increasing the sediment loads into wetlands.

The most common in-system impacts, which are further detailed in **Section 2.7**, include among others the following:

- Agricultural activities
  - Informal subsistence agriculture
  - Consolidated small plots farmed cooperatively with synchronised annual crops
  - Large monoculture projects (both cooperative and estate managed)
- Mining
  - Brick making and associated quarries
  - Mining for peat
- Pollution (in-system and catchment related)
  - Point source
  - Nonpoint source.

### 2.5.4 Wetland protection status

As discussed in Section 2.5.2 the wetland extent (as reported in IMCE 2008) indicates that there are 176 337 Ha of wetlands in Rwanda. The following section of wetland protection status uses this number to determine the extent of protected wetlands.

Wetlands are managed according to the following criteria (according to the inventory):

- Wetlands under “total protection” (27% of wetlands)
- Wetlands which can be used under “specific conditions” (69% of wetlands)

- Wetlands which can be used “without specific conditions”(4% of wetlands)

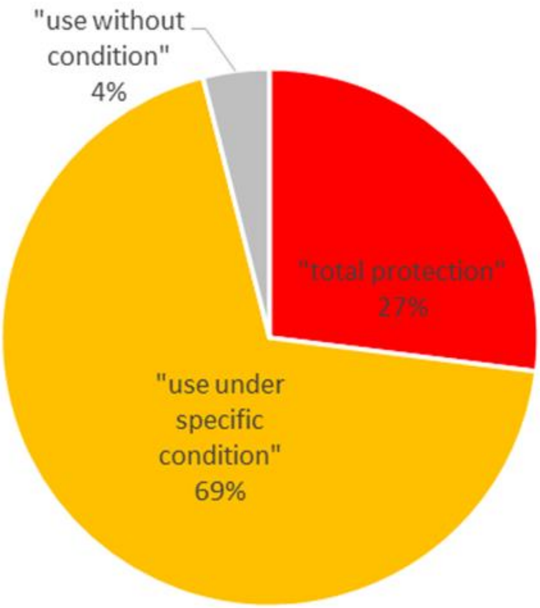



**FIGURE 2-17 THE CURRENT WETLAND PROTECTION EXTENTS IN RWANDA**

#### 2.5.4.1 Protected wetlands

Criteria to determine wetland classifications is not provided in policy, leaving wetlands vulnerable to vague management conditions and weakened protection. There is no procedure outlined where wetlands under “total protection” are required to be set aside for protection, while the emphasis is rather on determining allowed use of wetlands. Nevertheless, Ministerial Order No 006/03 of 30/01/2017 is clear that all activities other than research or science are prohibited within protected wetlands, assuming that “protected” wetland status is equivalent to “total protection”.

- 27% (48 021 ha) of all wetlands in Rwanda (176 337ha) are under “total protection” (Figure 2-18)

  - 64% of wetlands are formally protected within a National Park.
    - 97% of wetlands occur within Akagera National Park (Akagera wetland complex proposed for Ramsar status)
    - Other formally protected wetlands are within Gishwati-Mukura National Park and Nyungwe National Park (Kamiranzovu wetland proposed for Ramsar status)
      - 40% of wetlands proposed for Ramsar status occur within “total protection”
  - 36% of wetlands may be under “total protection” but 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 authorization of the Ministry of Environment.

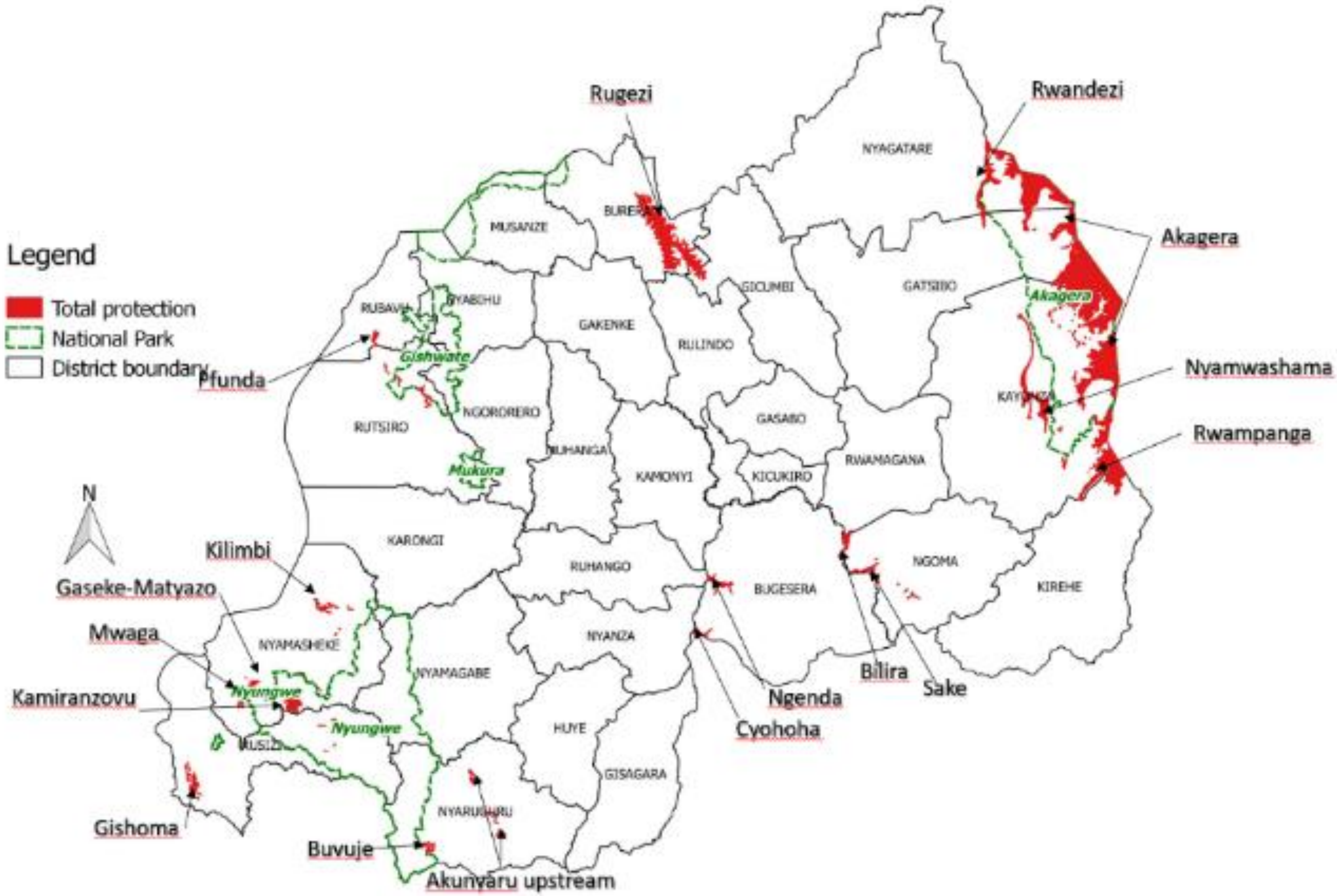



FIGURE 2-18 OVERVIEW OF WETLANDS WITH “TOTAL PROTECTION” STATUS

Wetlands under “total protection” fall within Akagera and Nyungwe National Parks, as well as the Rugezi wetland. Criteria for protection status of wetlands according to IMCE (2008) include:

- Wetlands belonging, at least partially, to a National Park or reserve (including their buffer zones)
- Wetland reserves of biodiversity recognised under RAMSAR convention. The Biodiversity criterion includes ecosystems containing specific flora and fauna, which are not yet formally protected. The degradation or development of such ecosystems results in the reduction or loss of biodiversity. Some elements of the fauna of the wetlands are recognized by law as endemic and classified by the Convention on International Trade in Endangered Species (CITES) to ensure their protection. These wetlands may also periodically support migratory birds and are considered as ecosystems of international importance under the Ramsar Convention (REMA, 2009) (Table 2-13).
- Spring wetlands
- Dam wetlands. Wetlands located between a lake upstream and a river downstream are critical to lake water level regulation. Development of these wetland areas may lead to the drainage and ultimate disappearance of the upstream water reservoir.
- Other criteria touched upon in legislation include peat and permanent inundation. The National Land Policy of 2004 stated that “For the sake of environmental protection, any form of disturbance of very fragile environmental sites should be avoided, such as highly peaty zones and marshlands found on high land which often constitute water reservoirs or water towers.”

**TABLE 2-13 IUCN REDLIST 2016**

| IBA | Common name | Scientific name | Status |
|---|---|---|---|
| **Akagera NP** | Madagascar pond heron | *Ardeola idae* | EN |
| **Akagera NP** | Shoebill | *Balaeniceps rex* | VU |
| **Rugezi, Volcano NP, Nyungwe** | Grauer’s swamp warbler | *Bradypterus graueri* | EN |
| **Rugezi, Nyabarongo, Akanyaru** | Papyrus yellow warbler | *Chloropeta gracilirostris* | VU |
| **Rugezi, Akagera NP, Nyabarongo, Akanyaru** | Papyrus gonolek | *Laniarius mufumbiri* | NT |
| **Rugezi, Nyabarongo, Akanyaru** | Grey crowned crane | *Balearica regulorum* | EN |
| **Rugezi** | Yellow billed duck | *Anas undulata* | LC |

**FORMAL PROTECTED AREAS OR NATIONAL PARKS**

Currently 65% of “total protection” wetlands are formally protected within two of the country’s National Parks (Table 2-14). Within Nyungwe National Park, four wetland areas are mapped, to a total area of 850 ha. One of the wetlands, Kamiranzovu wetland, is proposed for inclusion as a future Ramsar site. Within Akagera National Park, two large wetland areas and six lakes are mapped. The overall wetland complex within Akagera National Park is very extensive, covering a total area of more than 30 300 ha. The entire wetland complex is proposed for inclusion as a future Ramsar site.

In Gishwati-Mukura National Park, of the three wetlands mapped within the park, only one, Pfunda-Rushubi, has “total protection” status, the other two wetlands are mapped as use with conditions and are cultivated.

**TABLE 2-14 WETLANDS THAT FALL WITHIN NATIONAL PARKS.**

| National Park | Wetland complexes | Total wetland area in ha |
|---|---|---|
| Akagera | Kivumba; Akagera and lakes[5] | 30,354 |
| Nyungwe | Shyara (Nyungwe); Kamiranzovu; Shyara; Rubyiro-Rubona | 850 |
| Gishwati-Mukuraa | Rwankuba; Pfunda-Rushubi (Mubuga-Nyabirasi); Bihongoro | 85 |
| | **Total area** | **31,290** |

**Ramsar status**

The GoR has shown the importance it attaches to wetlands by ratifying the Ramsar Convention on wetlands of international importance in 2003, and the Rugezi wetland was designated a Ramsar site in 2005.

The extent of wetlands in Rwanda with Ramsar status or proposed Ramsar status are (Figure 2-19):

- 3% of Rwanda wetlands have Ramsar status, which encompasses Rugezi wetland
- 53% of Rwanda wetlands are proposed for Ramsar status

A very large area of the country's wetlands is proposed for Ramsar status. The convention requires that Ramsar sites be conserved i.e. their ecosystem function, but does not require that they be placed off-limits to human activity. Rather, the Convention recognises the inter-dependence of people and wetlands and the ecosystem services that wetlands provide.

The preamble to the Ramsar Convention reads: "Recognising the interdependence of man and his environment; Considering the fundamental ecological functions of wetlands as regulators of water regimes and as habitats supporting a characteristic flora and fauna, especially waterfowl; Being convinced that wetlands constitute a resource of great economic, cultural, scientific, and recreational value, the loss of which would be irreparable; Desiring to stem the progressive encroachment on and loss of wetlands now and in the future; Recognising that waterfowl in their seasonal migrations may transcend frontiers and so should be regarded as an international resource; Being confident that the conservation of wetlands and their flora and fauna can be ensured by combining far-sighted national policies with co-ordinated international action."

The Ramsar Convention lists nine criteria by which wetlands of international importance may be designated. A wetland should be considered internationally important if:

- it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region (Criterion 1)
- it supports vulnerable, endangered or critically endangered species or threatened ecological communities (Criterion 2)
- it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions (Criterion 4)
- it regularly supports 20 000 or more water birds (Criterion 5)

[5] Lake Hago, Lake Ihema, Lake Kivumba, Lake Mihindi, Lake Ngerenke, Lake Rwanyakizinga

- it regularly supports 1% or more of the individuals in a population of one species or subspecies of water bird (Criterion 6)
- it regularly supports 1% of the individuals in a population (of taxa other than water birds)
- it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
- A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
- it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity
- it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.

Figure 2-19 shows the location of wetlands designated for total protection. The majority of proposed Ramsar wetlands within the middle and south eastern part of the country, including Akanyaru, upper Nyaborongo and the Mugesera-Rweru complex of proposed Ramsar status wetlands do not have “total protection” status.

The Kamiranzovu and Rugezi wetlands both have broad wetland management plans prepared for them by the IMCE project in 2008. A sub-catchment scale wetland management plan was prepared at the same time for the Akagera national park wetlands and surrounds. Management plans must be developed for the remaining priority wetlands outside of the Parks, namely those with Total Protection status which still support natural vegetation. These wetlands outside of National Parks should also make up a consolidated list of wetlands to take forward for renewed application for Ramsar status. It is further proposed that the two wetland complexes that fall within National Parks, namely the Kamiranzovu wetland and the Akagera wetland complex also be rigorously promoted for Ramsar status.

The Association pour la Conservation de la Nature au Rwanda (ACNR) lists four wetland important bird areas (IBAs) for the country, namely, Nyabarongo wetland, Akanyaru wetland complex, Rugezi wetland, and Akagera National Park. Nyabarongo, Akanyaru and Rugezi wetlands were included on the list of IBAs in danger. Birdlife International (2002) include the above four sites and also the Nyungwe Forest and Volcano National Park wetlands. All six sites are shown on Figure 2-19.

**TABLE 2-15 LIST OF IMPORTANT AND VULNERABLE BIRD SPECIES IN THE COUNTRY (CITE SOURCE).**

| IBA | Common name | Scientific name | Status |
|---|---|---|---|
| **Akagera NP** | Madagascar pond heron | Ardeola idae | VU |
| **Akagera NP** | Shoebill | Balaeniceps rex | LR/nt |
| **Rugezi, Volcano NP, Nyungwe** | Grauer’s swamp warbler | Bradypterus graueri | EN |
| **Rugezi, Nyaborongo, Akanyaru** | Papyrus yellow warbler | Chloropeta gracilirostris | VU |
| **Rugezi, Akagera NP, Nyabarongo, Akanyaru** | Papyrus gonolek | Laniarius mufumbiri | LR/nt |
| **Rugezi, Nyabarongo, Akanyaru** | Grey crowned crane | Balearica regulorum | VU |
| **Rugezi** | Yellow billed duck | Anas undulata | LC |

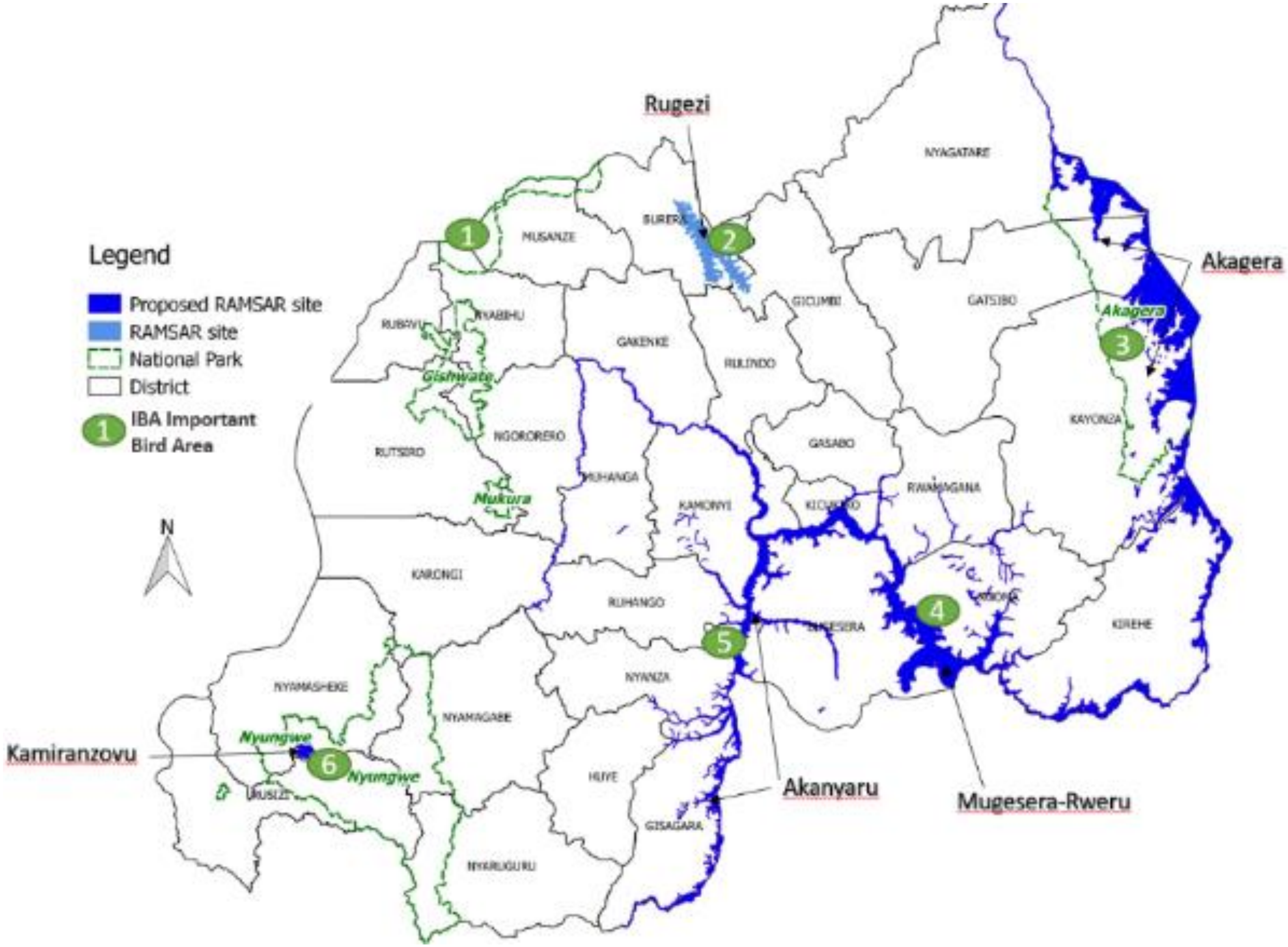



**FIGURE 2-19 OVERVIEW OF THE LOCATION OF RAMSAR, PROPOSED RAMSAR AND IBA WETLANDS**

**Natural vegetation**

Wetlands in a natural state should be given the highest level of protection status (Figure 2-20).

Of the wetlands in Rwanda designated for total protection:

- 27% (48 021 ha of 176 337ha) of all wetlands in Rwanda are under "total protection"
    - 96 % (46 056 ha of 48 021 ha) of total protection were mapped as natural vegetation
    - 4% (1 964 ha of 48 021 ha) were mapped as cultivated.

Of the wetlands in Rwanda proposed for Ramsar status:

- 94 055 ha of 176 337 ha (53%) of wetlands in Rwanda are proposed for Ramsar status
    - 76 685 ha of 94 055 ha (81%) are in a natural state

By far the majority of wetlands proposed for Ramsar status were in a natural state when the information was recorded in 2008 (REMA, 2009) (Figure 2-20). However, a rapid review over aerial imagery and Google Earth suggests that currently just over 50% of these sites remain in natural condition. The remaining sites in natural condition have been identified in Figure 2-20 and they are put forward as high priority sites for the country in which no further loss should take place.

#### 2.5.4.2 Non-protected wetlands

The importance of the environment is acknowledged by the GoR in key strategic documents, e.g., Vision 2020 (now being extended to vision 2050), Green Growth and Climate Resilience Strategy (2011) with 2050 horizon, and there is a strong strategic mandate for sustainable use of natural resources and the environment. Rwanda is also a contracting party to the Ramsar Convention, and is thus obligated to work towards wise use of all wetlands under the country's jurisdiction, through national plans, policies and legislation, management actions and public education. Ramsar (2010) defines wise use as "the maintenance of the ecological character [of wetlands], achieved through the implementation of ecosystem approaches within the context of sustainable development". This requires an "ecosystem approach" which explicitly considers the effects of use on the ecosystem.

This is particularly necessary given the unique situation of the country from a development context, and given its abundant and widespread wetlands, which are not only of global biodiversity significance but also critical for sustaining the country's resilience into the future under expected climate change impacts. As there is an urgent need to accelerate economic growth to uplift people out of poverty, and as wetlands offer economic value for agricultural production and energy supply, it is clear that wetlands are likely to be put under significant pressure. Thus, the policy and legislative framework should seek to embed a strong strategic mandate on the management of this critical resource for the country.

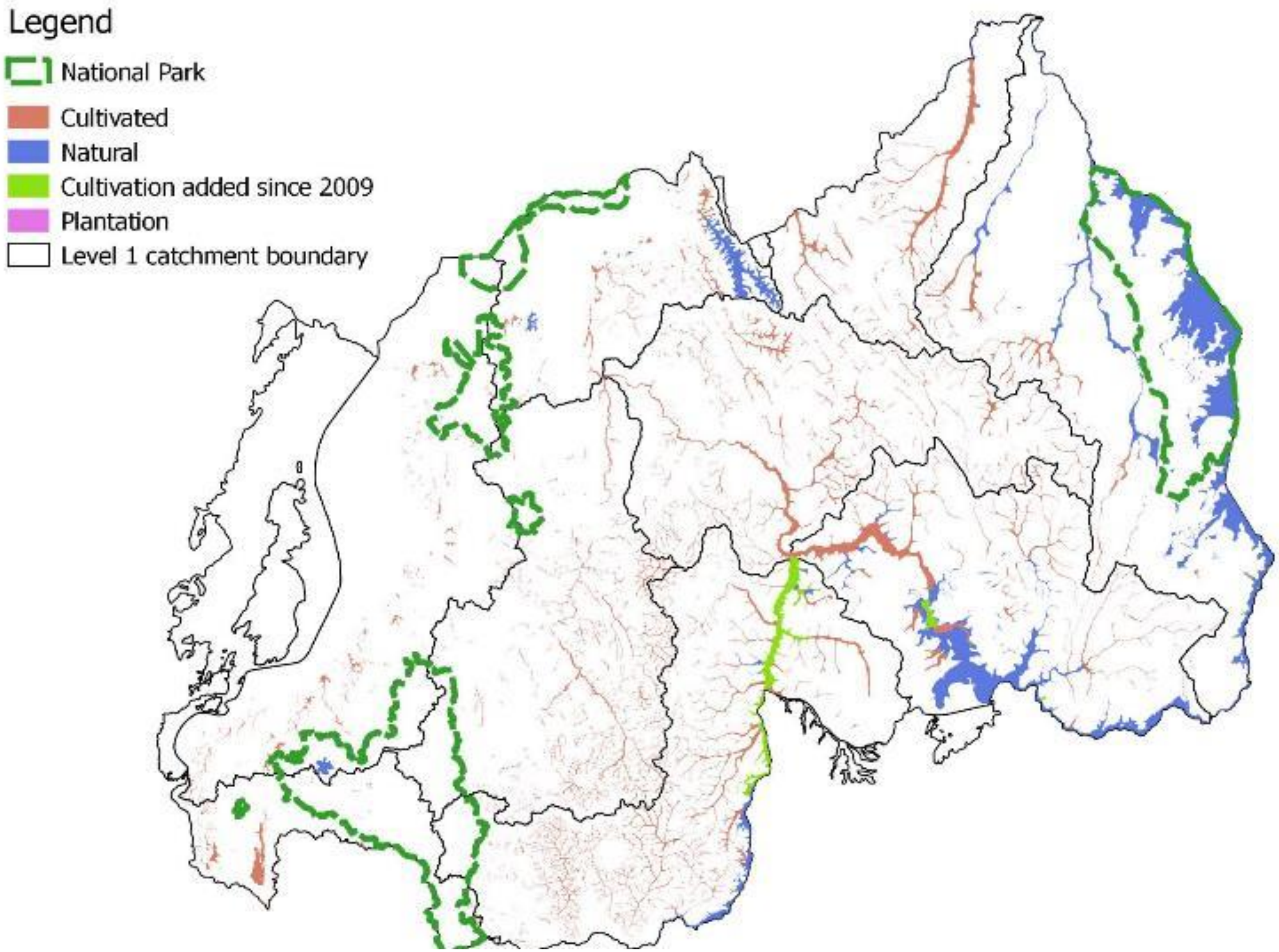



**FIGURE 2-20 WETLANDS IDENTIFIED AS NATURAL IN THE ABOVE FIGURE SHOULD BE AFFORDED HIGHEST PROTECTION STATUS**

## NON-PROTECTED WETLANDS WITH STATUS OF USE UNDER SPECIFIC CONDITIONS

Non-protected wetlands with the status of “use under specific conditions” are listed with other swamp lands in the Prime Minister’s Oder No 006/03 of 30/01/2017 drawing up list of all swamp lands, their characteristics and boundaries and determining modalities of their use, development and management. In this order, it is provided that the Ministry in Charge of land has the overall management of unprotected swamp land and prescribes the use of each swamp land (article 7) and the prescribed use may be changed by the same Ministry in case of a project of public interest (article 8). Currently the Ministry of Environment (also in charge of land) has already published in November 2019 the Kigali Wetland Master Plan and other wetlands will follow. The same order also clarifies that the competent authority in charge of the management of the swamp has the responsibility to plan and approve the use all unprotected wetland in line with the prescribed use by the Ministry in charge of land (Article 2 & article 8). Activities that can be allowed in the unprotected wetland are i) agriculture, ii) fish farming, iii) recreation, iv) tourism development, v) quarrying, vi) research, and vii) energy generation (article 6).

In some cases, retroactive governmental policy has been developed and action taken to protect and restore wetlands where pre-existing uses were not in line with environmental regulations. In the City of Kigali, for example, industrial uses in the Gikondo wetlands were approved and constructed prior to the enactment of the Organic Law on the Environment (2005). Following the transfer of wetlands to State domain, and the establishment of a Special Economic Zone (SEZ), the Ministry of Trade and Industry drafted a policy to relocate businesses from the Gikondo wetland to the SEZ, with substantial incentives offered to businesses in the form of new buildings, coverage of moving expenses and access to other land outside of the SEZ for business relocation. In 2018, a new law on environment and a new law on water resources were gazetted together with a law N°55/2018 of 13/08/2018 modifying Law n°05/2011 of 21/03/2011regulating Special Economic Zones in Rwanda which in its article 39 provides that a zone developer, operator and user must comply with laws determining modalities for protection, conservation and promotion of environment.

Wetlands which can be used under “specific conditions” are 68% of the wetlands in Rwanda (120 492 ha of 176 337 ha) (Figure 2-21 and Figure 2-22).

- 68% (120 492 ha of 176 337 ha) of all wetlands in Rwanda are under “use under specific condition”.
    - None are within a National Park
    - 47% are Proposed Ramsar sites
        - 33% wetlands are cultivated
        - **14% wetlands are natural**
    - The remaining wetlands (53%) have no other protection status
        - 48% wetlands are cultivated
        - **5% wetlands are natural**

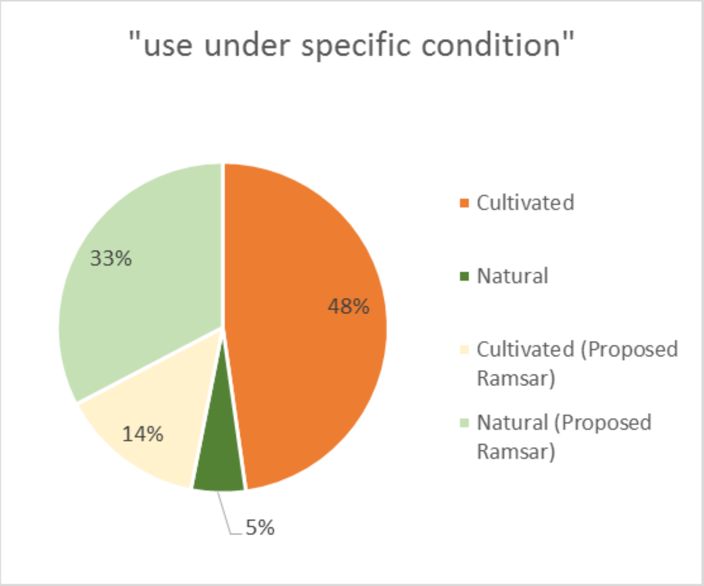



**FIGURE 2-21 OVERVIEW OF CONDITIONAL USE**

The criteria for identifying non-protected wetlands which require an EIA assessment prior to a change in land use were developed in 2008 by the IMCE project:

- Across border wetlands **Cross border wetlands** (Cr) are those which straddle several sectors, district or countries (regional, national, international). Most efforts to understand and safeguard natural resources and cross–border ecosystems are often circumscribed within the limits of administrative entities (sectors, districts and countries). However, if there are no joint management efforts, the effects of mismanagement of a part may affect the whole wetland ecosystem. Joint management is more difficult in the case of wetlands belonging to several countries.
- Wetlands belonging to 2 or more Districts
- High altitude (>1800 m) peat wetlands
- Other peat wetlands **Peat** (P) wetlands consist of layers of organic material which are formed and sustained under constant waterlogging. They are therefore extremely vulnerable to lowered water tables, which exposes them to risk of self-combustion (fire) and subsidence. High altitude peat wetlands are generally water reservoirs for areas located downstream. Consequently, the draining of peat lands may cause significant negative impacts downstream, risk of subsidence and drying out of the wetlands.
- Wetlands providing drinking water to cities The **Hydrology** (H) criterion is allocated to wetlands, especially those at high altitudes, which are sources of major rivers. Drainage causing the loss of the regulation function of these wetlands may lead to drought in downstream areas, increased runoff and erosion or disruption of the local climate. A special class under the wetlands with a hydrology criterion are wetlands which supply water for towns (Hw). Drainage of wetlands with a town water supply criterion can cause disruption in water supply, with important socio-economic impacts like water-related diseases or the interruption of industrial production in case it relies on the use of the water as part of their processes.
- Wetlands providing drinking water to villages
- Wetlands of Bugarama depression
- Wetlands with ≥100 ha or more under cropping (total surface / surface under cropping)
- Wetlands of ≥15 ha, partially under cropping, covered by ≥30% of natural vegetation
- Wetlands of <15 ha, partially under cropping, covered by ≥ 70% of natural vegetation

Wetlands under “use under specific conditions” require an EIA assessment prior to a change in land use. Refer to **Section 2.4** for more detail about this.

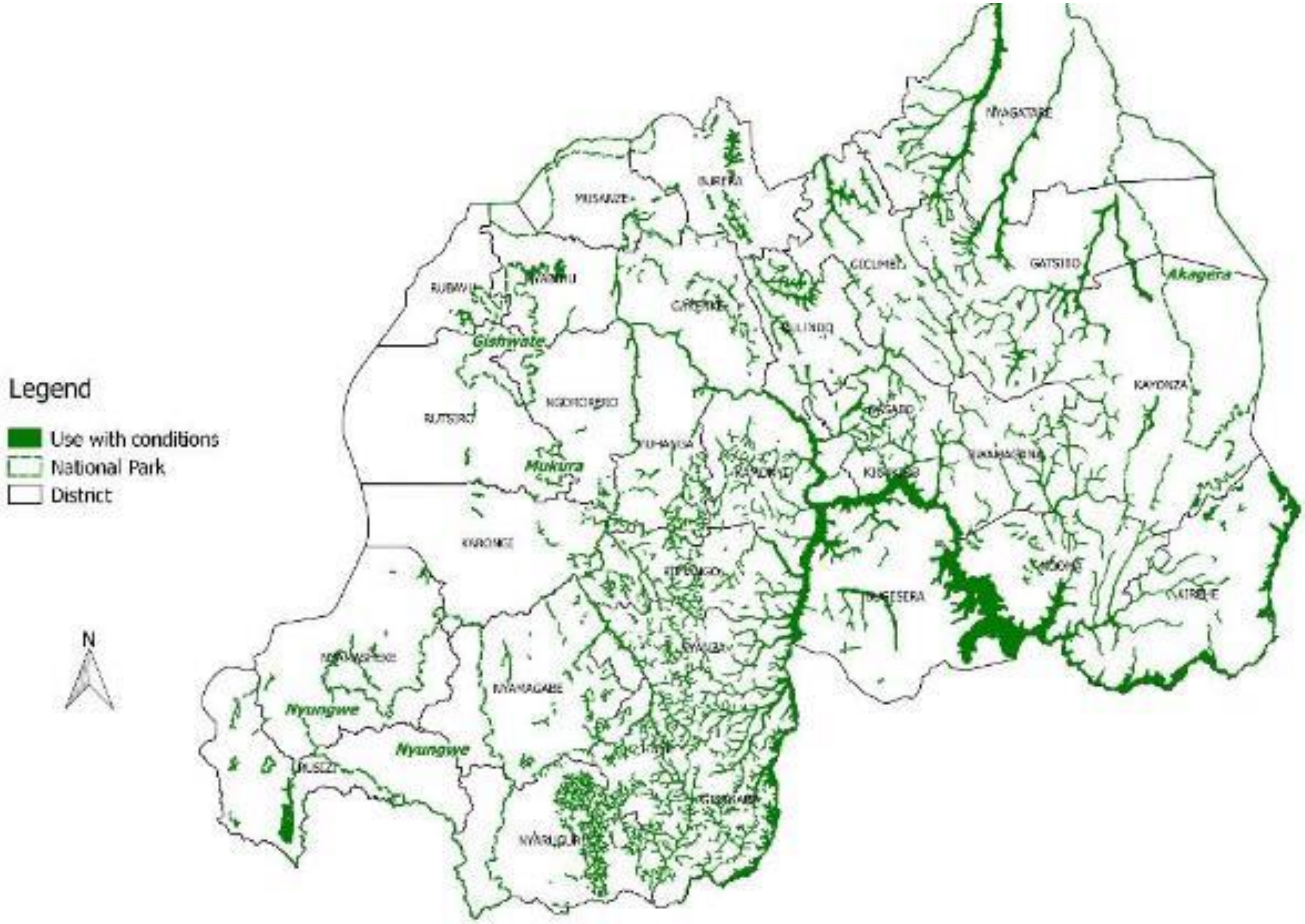



**FIGURE 2-22 NON-PROTECTED WETLANDS, USE WITH CONDITIONS**

**NON-PROTECTED WETLANDS WITH STATUS OF USE WITHOUT CONDITIONS**

In the original wetland inventory undertaken by the IMCE project, a category was developed for wetlands which could be used, or continue to be used, without the need to solicit permission. The main criteria was that they were small and did not meet the size threshold of wetlands included in the wetlands of Section 2.5.3.2. Although the body text of Ministerial Order No 006/03 of 30/01/2017 identifies only two categories, protected and non-protected wetland, each wetland listed in Annex I of has been assigned one of three status categories. Thus, a list of wetlands which have been assigned the status of use without conditions is included in the annex of the Ministerial Order.

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 wetlands of non-protected wetlands "use under specific condition" as there is no indication that they might not provide a certain level of ecosystem service delivery, and or be subject to a proposed use which may have negative impacts to the surrounding community and should be subject to an EIA.


**FIGURE 2-23 NON-PROTECTED WETLANDS, USE WITHOUT CONDITIONS**

### 2.5.5 Spot check verification

A wetland spot check was conducted to determine the functionality and health/integrity of certain wetland systems based their current condition, which included a site visit on the 9th October 2017 to the valley-bottom wetlands (Muhazi, Migiri and Nyamwashama valley-bottom wetlands), and on the 26thand 27th April, 2017 to the floodplain wetlands (Akagera River floodplain wetland within the Rweru-Mugesera wetland complex and Nyabarongo River floodplain wetland).

- **Wetland integrity**

The assessment of wetland integrity is common practice internationally as illustrated in Ollis and Malan (2014) and was performed for each of the hydrogeomorphic (HGM) unit types. The three biophysical drivers, namely hydrology, geomorphology and vegetation, are assessed against the wetlands' natural benchmark conditions in order to provide an indication of the systems' current overall integrity. This approach is based on the principles of the WET-Health (Macfarlane et al, 2009) assessment technique, which has been widely adopted in southern Africa to assess ecosystem integrity. The biophysical drivers are briefly described as follows:

- Hydrology – the movement of water into, through and out of the wetland and its associated soils;
- Geomorphology – the movement of sediment into, through and out of the wetland;
- Vegetation – the composition and structure of vegetation within the wetland.

The integrity of the wetland habitat is not only determined by the features within the system, but also the characteristics of the associated catchment.

- **Provision of ecosystem services**

The assessment of ecosystem services supplied by each of the identified wetlands was undertaken according to the methodology described by Kotze *et al*. (2007). Different wetland types provide ecosystem services based on their physical (hydrogeomorphic) characteristics, which largely dictate a wetland's ability to supply a particular ecosystem service. For example, a wide, flat, wetland which is seasonally saturated and densely vegetated, can allow water to spread out and slow down, can capture water at the end of the dry season when it still has capacity to "fill up" with additional water, and can further slow water as it flows through the dense vegetation. In this way, the wetland provides the service of protection against downstream flooding. The ecosystems' direct (cultural and provisioning) and indirect (regulating and supporting services) benefits are ranked on a scale of 0-4 for the current scenario, where 0 is poor or absent and 4 indicates a high level of functioning and service delivery (Kotze et al. 2007).

**Valley-bottom wetlands**

**MUHAZI VALLEY-BOTTOM WETLAND**

Wetland type: Valley-bottom wetland, located within one of the multiple wetland valleys which contribute to Lake Muhazi.
Location:.Rwamagana District, Gishari Sector
Size: Approximately 90 ha in size.
Management status: "use with conditions". In the years immediately preceding the Ministerial Order No 006/03 of 30/01/2017, wetland location, current use and management status were presented to the public and it was stipulated that the current use of the land by individuals be registered with the Ministry in charge of Land. Any future change in use should be supported by an environmental impact assessment.

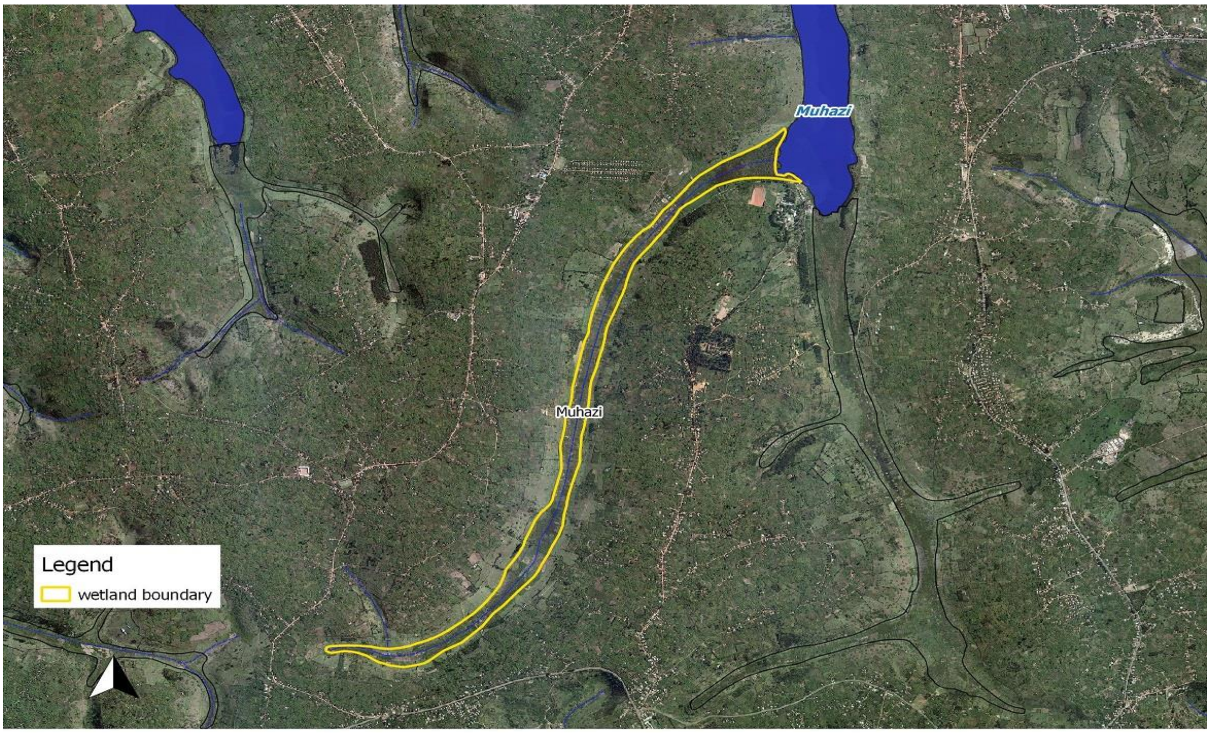



**FIGURE 2-24: DELINEATION OF THE MUHAZI VALLEY-BOTTOM WETLAND BOUNDARY**

*Wetland land use:*

This wetland was noted to be under cultivation since the wetland inventory of 2008 and it has not been converted to more intensive agriculture.

The wetland is almost entirely cultivated, with a mix of small-scale agriculture in the upper 50% of the wetland, and rice production dominant in the lower 50%. Small-scale agriculture fringes the rice production plots along the outer edge of the lower wetland (Figure 2-25). The Rwarutemya River has been channelized, and forms a central drainage line running through the centre of the length of the wetland (Figure 2-26). A section of wetland at least 700 m in length and dominated by *Typha dominguensis* presents the only remaining uncultivated area of wetland, and forms a buffer between the lake and the cultivated wetland. Small-scale agriculture has encroached into this buffer section of wetland, along its outer edge (Figure 2-25). Cultivation within the catchment of the wetland extends directly to the edge of the wetland.

**FIGURE 2-25: SMALL-SCALE CULTIVATION IS ENCROACHING INTO THE BUFFER OF NATURAL WETLAND VEGETATION WHICH PROTECTS THE LAKE (LEFT). RICE CULTIVATION DOMINATES THE LOWER REACHES OF THE WETLAND, AND IS FRINGED BY SMALL-SCALE VEGETABLE CULTIVATION PLOTS (RIGHT).**

**FIGURE 2-26: THE WETLAND HAS A MODERATE DENSITY OF DRAINAGE DITCHES AND A SHALLOW CENTRAL DRAINAGE DITCH.**

*Wetland condition:*

It is expected that an extensive loss of basic ecosystem functions has occurred along with the loss of natural habitat, due to cultivation of the entire wetland. The wetland provides very low biodiversity support, with the exception of the remaining area of *Typha dominguensis*, which is interspersed with *Cyperus latifolius* and small patches of *Phragmites mauritianus.* This is the only remaining area of undisturbed natural vegetation within the wetland. Although it has been encroached into by small-scale cultivation, it likely provides important habitat to birds and other wildlife, and slows down and allows to settle out suspended sediment from the upstream cultivation activities, before they reach Lake Muhazi.

Rice production requires that discrete areas of wetland be flooded for long periods of time. This partially mimics the natural effectiveness of the wetland to regulate streamflow and purify water by spreading water out over the wetland and allowing the sediment and pollutants to settle out and be assimilated. The artificially straightened river channel through the centre of the wetland somewhat negates this, by conveying upstream sediments and any pollutants downstream as quickly as possible.

The removal of vegetation cover during harvesting and disturbance of soils during cultivation increases the potential for erosion and loss of soil organic matter. The impacts of this to the wetland are considered to be moderate, the wetland gradient is relatively flat and cultivation is by hand, up to three times a year. The soil may be exposed for short intervals; but it was noted, especially in the wetter sections of this wetland, that fallow areas were typically covered with *Cyperus latfolius, Leersia hexandra* and other fast growing opportunistic species, limiting the time the soil remains exposed.

Water levels in the wetland are also expected to be lower than natural due to the central drainage channel and the moderately high density of drainage channels (Figure 2-26). Overall, the wetland water levels appear not to be lowered to the point that the wetland becomes desiccated, and the downstream lake also provides a base level for the wetland hydrology. Hydrology for the wetland is, therefore, considered to be only moderately altered.

The dominant ecosystem services are cultivation, harvesting and water supply. Direct human benefits from grazing and harvesting of plants have been largely lost due to the complete conversion of the wetland to cultivation. Water supply for domestic use is derived from the lake immediately downstream. A water treatment plant is located adjacent to the Lake within a kilometre of Muhazi wetland.

Migera valley-bottom wetland
<u>Wetland type:</u> Valley-bottom wetland
<u>Location:</u>Kayonza District.
<u>Size:</u>More than 700 ha
<u>Management status</u>: “use with conditions”

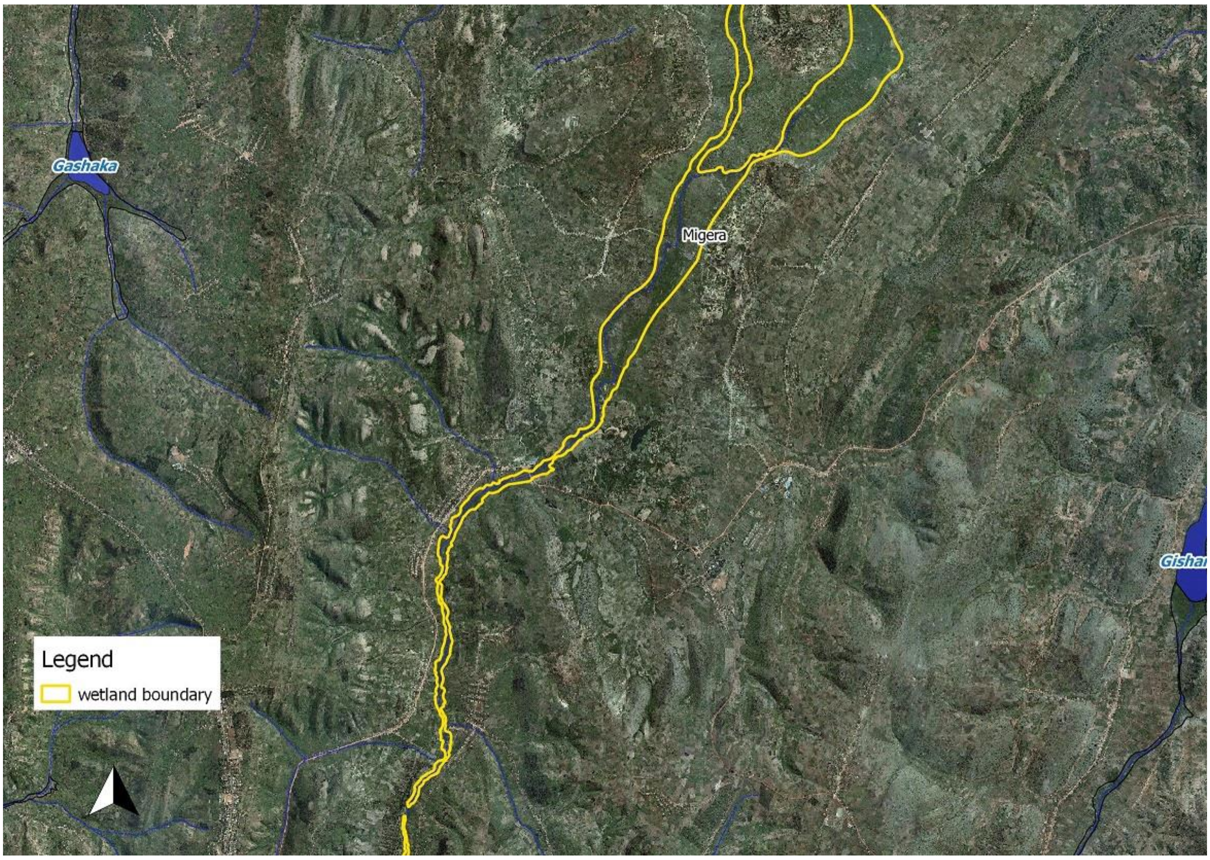



**FIGURE 2-27: DELINEATION OF THE MIGERA VALLEY-BOTTOM WETLAND BOUNDARY**

*<u>Wetland land use</u>*

The upper reaches of this wetland are mapped as peat soils and the wetland is named Rugazi-Bisenga. In the middle reaches, the wetland is named Migira wetland, and this wetland continues downstream to join Nyamwashama wetland. The Migira section of the wetland was assessed during the site visit. Together, the Rugazi-Bisenga and Migira sections amount to more than 700 ha. This wetland was noted to be under cultivation since the wetland inventory of 2008 and it has not been converted to more intensive agriculture.

The full area of this wetland is cultivated, apart from a large area of peatland within the upper reaches which has been converted to an extensive dam. Crops planted within the lower reaches of the wetland include sweet potatoes, corn, sorghum and bananas (Figure 2-28). The density of drainage ditches within this wetland is moderate and they are not closely spaced. The central drainage channel is relatively shallow. The change in wetland hydrology due to the ditches is expected to be moderate. A small number of fish ponds are present within the wetland, but the most extensive modification of wetland habitat is the large upstream dam, which changes the timing and delivery of water and natural amounts of sediment to the downstream wetland (Figure 2-29).

**FIGURE 2-28: CROPS WITHIN THE WETLAND INCLUDE SWEET POTATOES, CORN, SORGHUM, WITH BANANAS COMMON CROP ALONG THE DRIER EDGES.**

**FIGURE 2-29: A DAM WITHIN THE WETLAND AT A ROAD-CROSSING (LEFT). THE WETLAND HAS A SHALLOW CENTRAL DRAINAGE CHANNEL (RIGHT).**

*Ecosystem functioning and overall health*

The upstream presence of peat soils enhances the role of the wetland in storing carbon, and in moderating the quality and quantity of water to downstream areas through assimilation of phosphates and nitrates and storage of water in saturated peat soils. To do so effectively requires a combination of dense herbaceous vegetation and peat soils at the soil surface. Much of this benefit is lost where the peat soils are flooded by the dam.

The wetland provides low to no biodiversity support except for common species when patches of cultivated wetland are left fallow, or in localised patches of permanent wetland supporting *Cyperus latifolius*, *Phragmites mauritianus* and *Typha dominguensis*. Direct human benefits from grazing, harvesting of plants, and water are also considered to be impaired.

The main ecosystem services provided are socio-economic significance, cultivation, harvesting and water supply. The wetland's ability to moderate the quality and quantity in the form of phosphate trapping and nitrate and phosphate removal is also expected to be limited. Dense wetland vegetation plays a critically important role, acting as a buffer zone, trapping suspended sediment and pollutants from wetland cultivation and upstream erosion.

## NYAMWASHAMA VALLEY-BOTTOM WETLAND

Wetland type: Valley-bottom wetland
Location: Kayonza District, Kabare Sector.
Management status: “total protection”

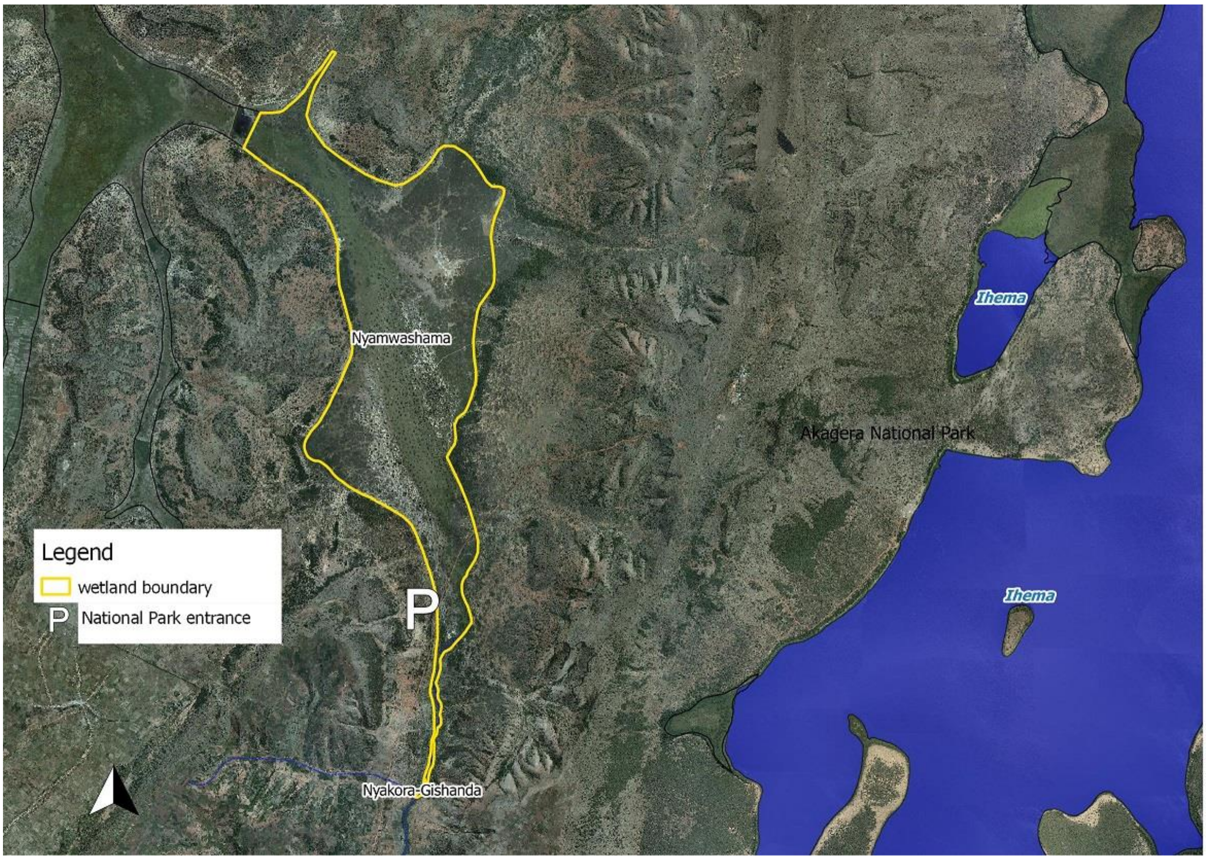



**FIGURE 2-30: DELINEATION OF THE NYAMWASHAMA VALLEY-BOTTOM WETLAND BOUNDARY**

*Wetland land use*

Nyamwashama wetland is a grassy valley-bottom wetland (Figure 2-31). The wetland is a seasonal wetland, drying out between rainy seasons. A small, stream channel cuts through the wetland. It is expected to carry water only during the rainy season. Wetland soils are mineral soils. The wetland is located just within Akagera National Park, therefore the management status of the wetland is “total protection”. It is currently protected within the park, and use of the wetland is solely for conservation and biodiversity support.

**FIGURE 2-31: NYAMWASHAMA WETLAND IS DOMINATED BY GRASSES.**

*Ecosystem functioning and overall health:*

The wetland is in a natural state, with the only apparent impact being a measure of overgrazing and presence of weedy grass species, possibly from the time during the late 1990s when much of the savannah area of the park was settled by former refugees and grazed by livestock. The dominant ecosystem services in NAKU catchment are provided in chapter 3 of this report.

#### 2.5.5.2 Floodplain wetlands

**AKAGERA RIVER FLOODPLAIN WETLAND WITHIN THE RWERU-MUGESERA WETLAND COMPLEX**

Wetland type: Floodplain wetland

Location: Within Bugesera District, but several of the lakes within the complex extend entirely into Ngoma District

Management status: The overall management status of the floodplain wetland is “use with conditions”, while three areas extending from the Akagera River channel to the open water of each of the three lakes (Mugesera, Birira and Sake) has a designated status of “total protection”. The Wetland complex has been proposed for Ramsar status.

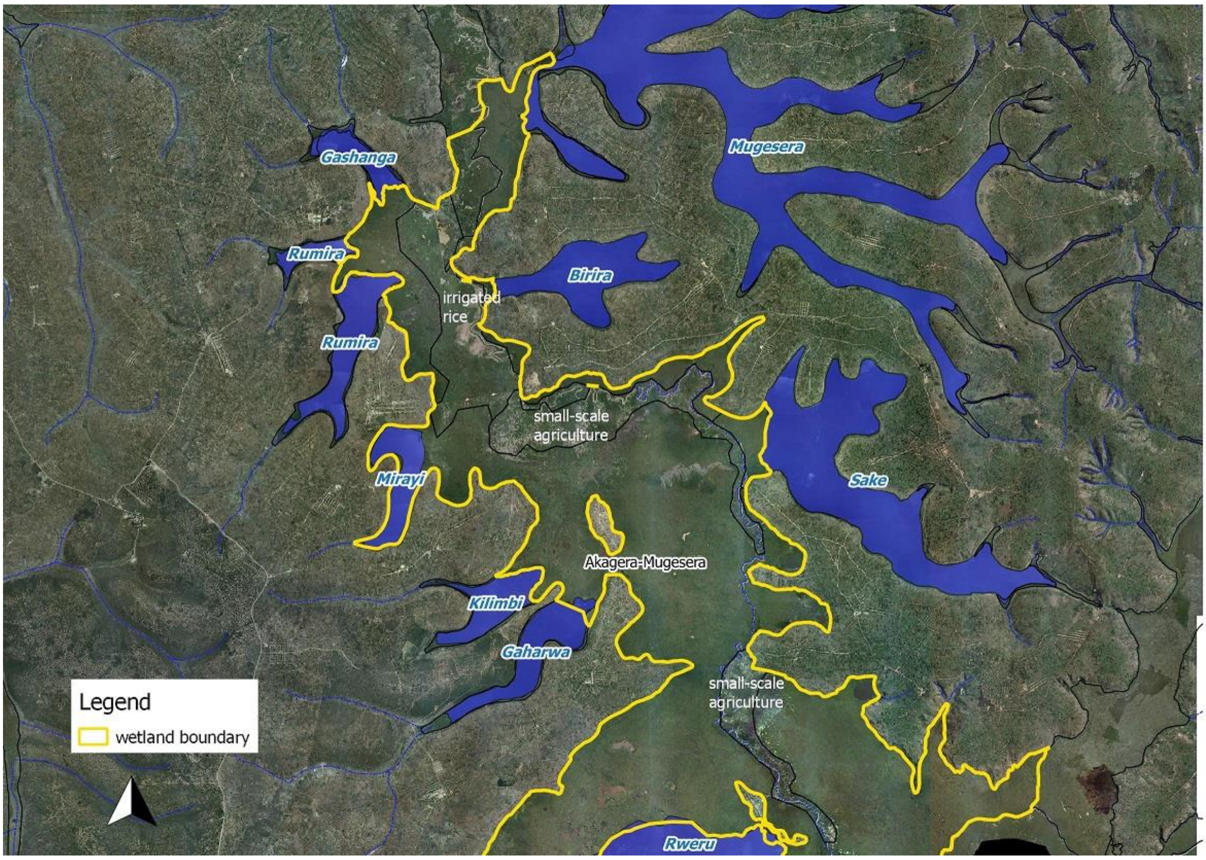



**FIGURE 2-32: DELINEATION OF THE AKAGERA FLOODPLAIN WETLAND BOUNDARY (PORTION OF THE WETLAND SPOT CHECKED)**

<u>*Wetland land use*</u>

A vast network of floodplain wetlands is associated with the Akagera River downstream of the confluence of the Nyabarongo and Akanyaru Rivers. The floodplain is broad, with the valley floor reaching 35 km wide in places. The area extending from the outlet of Lake Mugesera to the outlet of Lake Rweru is the focus of this overview. Within this area, the floodplain wetlands, in association with multiple lakes and the Akagera River, together form the Rweru-Mugesera wetland complex. In order to assess the relative impact of activities within the floodplain wetlands, it makes sense to consider the Rweru-Mugesera wetland complex as a functional whole.

The floodplain wetland consists of permanently wet and inundated areas, historically dominated by dense papyrus (*Cyperus papyrus)* vegetation and *Miscanthidium violaceum* (Figure 2-33). Floodplain grasses include *Hyparrhena filipendula*, *Hyparrhenarufa*, *Bothriochloa insculpta*, and *Themeda triandra*. In places, the papyrus forms massive floating islands. Papyrus can grow to 5 m tall, and may be associated with *Dryoperis gongloydes, Ipomea fragrans, Echinochloa cruspavonis, Hydrocotyle ranunculoides, Leeersia hexandra,* and *Vossia cuspidata*, among others (Hughes, 1992; REMA, 2009). Floating and submerged aquatic species present include *Lemna paucicosta, Ludwigia stolonifera, Nymphaea caerulea, Nymphaea nouchalii, Pistia stratiotes, Trapa natans, Ceratophyllum spicatum, Potomegeton pectinatus, Utricularia inflexa*, and *Vallisneria spiralis* (Hughes, 1992; REMA, 2009).

**FIGURE 2-33: DENSE PAPYRUS VEGETATION WITHIN THE REMAINING AREA OF NATURAL VEGETATION ADJACENT TO GASHORA.**

The area was visited on 26 and 27$^{th}$ April, 2017. The overall management status of the floodplain wetland is "use with conditions", while three areas extending from the Akagera River channel to the open water of each of the three lakes (Mugesera, Birira and Sake) has a designated status of "total protection". The areas under total protection are discussed further below. The area developed for rice is understood to have undergone an environmental assessment under MINAGRI. The small-scale cultivation was mostly in place and acknowledged in the Ministerial Order No 006/03 of 30/01/2017. However, some new fields were mapped by this project that were not included in the 2009 inventory dataset. All small-scale agriculture must be formally registered. The entire wetland complex has been proposed for Ramsar status.

These floodplain wetlands are, under natural circumstances, regularly replenished by sediments and water from the associated Akagera River. Water typically enters the floodplain wetlands as overspill from the river channel during flooding. During flood events, the broad, flat expanse provided by the floodplain wetlands allows the river flows to spread out and, thus, slow down. Dense natural vegetation further helps slow the flows. After flood events, the floodplain wetlands provide significant temporary storage of water. A characteristic of floodplains are the large quantities of accumulated alluvial sediment, deposited on the floodplain during flood events (Figure 2-34). The majority of the coarse sediment is typically deposited in close proximity to the river channel, often leading to development of natural levees adjacent to the channel, while the finer sediment is able to be carried further across the floodplain wetland. The levees play a role in supporting the temporary storage of floodwaters within the floodplain wetland.

**FIGURE 2-34: The Akagera river currently carries high levels of sediment, evident here in side bank deposits at the fore of the photograph (26 April 2017)**

Figure 2-35: Akagera Wetland in flooding period (photo taken May 2020).

Floodplains are dynamic systems, and their rivers typically have broad meanders as they move across the plain and deposit sediment over the course of hundreds of years. The functioning of the river, floodplain wetland, and lakes within this wetland complex is likely driven by a strongly interdependent relationship of sediment and hydrology. With the exception of Lake Rweru, which has a direct connection with the river for most of the year, most of the remaining lakes are arranged around the periphery of the wetland complex. Lakes along the east bank include Lake Mugesera, an un-named lake, Lake Birira and Lake Sake. Lakes along the west bank include Lakes Gashanga, Murago, Rumira, Mirayi, Kilimbi, Gaharwa, Rweru (a cross-border wetland, with Burundi) and Kazigiri (entirely within Burundi). Lake Mugesera is the largest (4 000 ha), followed by Lake Rweru at approximately 1 868 ha within Rwanda and a total surface area of 3 405 ha. While Lake Rweru is recorded to be 5.6 m deep, none of the other lakes are more than 5 m deep, with Mirayi noted to be 4 m and Rumira 3 m deep. Water levels are reported to rise quite significantly twice a year between 1 and 2 m, following the twice-yearly main rains when tributary rivers flow towards the complex of wetland and lakes from the surrounding hills. The source of water also includes water infiltration into deep soils from the surrounding hillslopes, percolating down to the saprolite and rock and ultimately reaching the wetlands laterally via interflow within the hillslopes (Hughes, 1987; Beuel, 2016). The lakes are located within much the same elevation as the floodplain and are hydrologically connected to the river via the wetland. In addition to receiving water from the river, the floodplain wetland is likely also receiving water from the periphery lakes and their catchments. This relatively stable hydrological relationship has led to the accumulation over thousands of years of a vast body of peat across the entire floodplain and continuing downstream for kilometres.

Any natural sediment deposition in the region of the lake outlets constitutes a critically important area which, together with rooted and floating beds of papyrus, form a natural dam and sustain the functioning of the lakes. The role of the river and floodplain in depositing sediment and maintaining the lake water level, as well as promoting the accumulation of peat, was recognized by the IMCE project leading to the designation of these areas for total protection.

All three designated areas of total protection at the lake outlets remain in a largely natural state, with the exception of the presence of small-scale agriculture which is focused along almost the entire river channel within the complex, presumably favouring the afore-mentioned alluvial areas which are slightly raised and drier. In the case of Lake Mugesera, this comprises a width of one or two fields extending from the river channel into the area designated for total protection. Overall, this is less than 5% of the area under total protection. In the case of Lake Birira, which only has a small “buffer” of papyrus between the open water and the river channel, approximately 50% of the total protection area is under small-scale agriculture. In the case of Lake Sake, only a small number of fields are encroaching, and overall, there is no cultivation along the river channel in this area and more than 98% of the papyrus remains intact. One potential factor distinguishing Lake Sake from the other two lakes is that, while a small area of peat soils are mapped at the outlets of the two lakes, immediately downstream of Lake Birira the area mapped as peat becomes very extensive and covers the entire floodplain, from Lake Sake to Lake Rweru and continuing downstream. The encroachment of the small-scale agriculture, therefore, has favoured the areas with less extensive peat, which are also less likely to be continuously inundated.

Following on from this, imagery from the last ten years shows the presence of small-scale agriculture over approximately 40% of the central floodplain wetland (approximately 15% of the total floodplain wetland), within and extending beyond the footprint of the current day Gashora rice field development. Of the mapped soils, this corresponds very well with the area mapped as poorly drained alluvial soils. In the present day, the main agriculture within the wetland floodplain is rice cultivation within the Gashora development, covering approximately 5% of the total floodplain wetland (Figure 2-36). A further 10% of the total floodplain wetland is under small-scale cultivation.

**FIGURE 2-36: Rice cultivation within Gashora wetland (left). Water is abstracted from Akagera river and pumped through the rice fields via ditches (right) (26 April 2017).**

*Ecosystem functioning and overall health:*

To the extent that inundation levels in the floodplain wetlands are closely associated with the Akagera River, fluctuating according to the rainy seasons and the close connection to river flows, the extensive berm (Figure 2-37) encircling the rice fields disconnects approximately 1 500 ha of floodplain from the river. This is, however, offset by the major contribution to the floodplain wetland of water from the side lakes and their catchments. The berm also confines the river channel within a narrow course, focussing all the energy which naturally, during floods, would be dissipated when spread out over a wide, flat floodplain, but within the confined area would use its energy to erode deeper, either lowering the overall water level or causing erosion or damage downstream. Currently, it is concluded that the development associated with the rice cultivation has a locally very high impact on hydrology of the floodplain wetland, but it does not spread across the full width of the floodplain, and the wetland retains sufficient connectivity with the remaining water sources that are sustaining the overall hydrology of the wetland. Long term monitoring of water levels across the floodplain wetland is recommended in order to make more accurate statements, especially in order to pick up any trend of a lowering water table. Lowering of the water table will have knock on consequences, potentially lowering associated lake water levels, as well as exposing peat soils to desiccation, subsidence and fires. If the development extends beyond its current footprint of 5% of the total wetland, especially if it extends beyond the area of alluvial soils, the negative impacts to the functioning of the wetland complex will be exponential.

**FIGURE 2-37: An extensive raised berm disconnects the remaining area of natural floodplain wetland (seen on the left) from the developed rice fields (right) (26 April 2017).**

Fischer (2016) lists further pressures on the wetlands from small-scale cultivation, cattle grazing, production of bricks (Figure 2-38**)**, burning of papyrus, and cutting of plants (Figure 2-38) for animal feeding and construction. Given the vast size of this wetland, the current activities impact on approximately 10% of the wetland. Within this 10%, most impacts are of low intensity, with small-scale agriculture moderately high. Mining for bricks is a very localised impact but should be strictly regulated.

**FIGURE 2-38: Hillside excavation adjacent to the wetland for brick-making (left) and harvesting of plants (right).**

The wetlands are considered critical grazing areas during dry seasons and support food production during the dry season (UNEP, 2007).During drought and the driest months of June to October, small-scale wetland cultivation may become the main source of food. Livestock watering is communal and lakes, rivers and streams are the main watering points. There are no designated livestock watering points and there are increasing restrictions on use of natural water sources because livestock trample on and degrade river banks and lake shores. It was reported by UNEP (2007) that milk production has declined significantly because of shortage of safe water and the fact that herds expend a lot of energy and get stressed in moving long distances in search of water. Intensive movement of livestock both within and outside the region could also contribute to increased livestock epidemics (UNEP, 2007).

In addition to the above provisioning ecosystem services, the floodplain wetland provides extensive regulating services such as flood amelioration, sediment trapping, water purification, groundwater recharge, micro-climate stabilisation, and wildlife habitat. The wetland complex is considered to be one of the country's most important wetland areas (REMA, 2010). In addition to its importance for ecosystem service support to people and ecology, it is known to provide critically important biodiversity support. More than 30 species of fish and 173 birds have been identified in the greater lake-wetland complex, of which 6 are considered vulnerable by CITES and IUCN (Nsabagasani, 2009; IMCE, 2009; Fischer et al. 2016).The wetland complex is one of very few remaining breeding areas in the country for grey crowned crane and has been identified by multiple conservation organisations as an area warranting conservation focus. The papyrus gonolek and the papyrus yellow warbler are noted to be present (Fischer et al., 2016) and are IUCN listed due to loss of habitat. Several populations of a rare plant species (*Pycnostachys dewildemaniana*) were recorded. Mammals include the blue monkey *(Cercopithecusmitis)*, hippopotamus (*Hippopotamus amphibius*), sitatunga (*Tragelaphus spekei)* are listed as vulnerable by CITES and IUCN, while the wetland also supports other antelope species, two species of otter (*Aonyx capensis, Lutra maculicilis)*, mongoose, genet, civet, and serval (Nsabagasani, 2009). The populations of large mammals, e.g. hippopotamus, are said to be considerably declining due to habitat loss. Nsabagasani (2009) also listed 13 species of amphibians and 6 species of reptiles as well as numerous snakes.

**NYABARONGO RIVER FLOODPLAIN WETLAND.**

<u>Wetland type:</u> Floodplain wetland
<u>Location:</u> Within Bugesera District, but several of the lakes within the complex extend entirely into Ngoma District

Management status: The overall management status of the floodplain wetland is “use with conditions”, while three areas extending from the Akagera River channel to the open water of each of the three lakes (Mugesera, Birira and Sake) has a designated status of “total protection”.

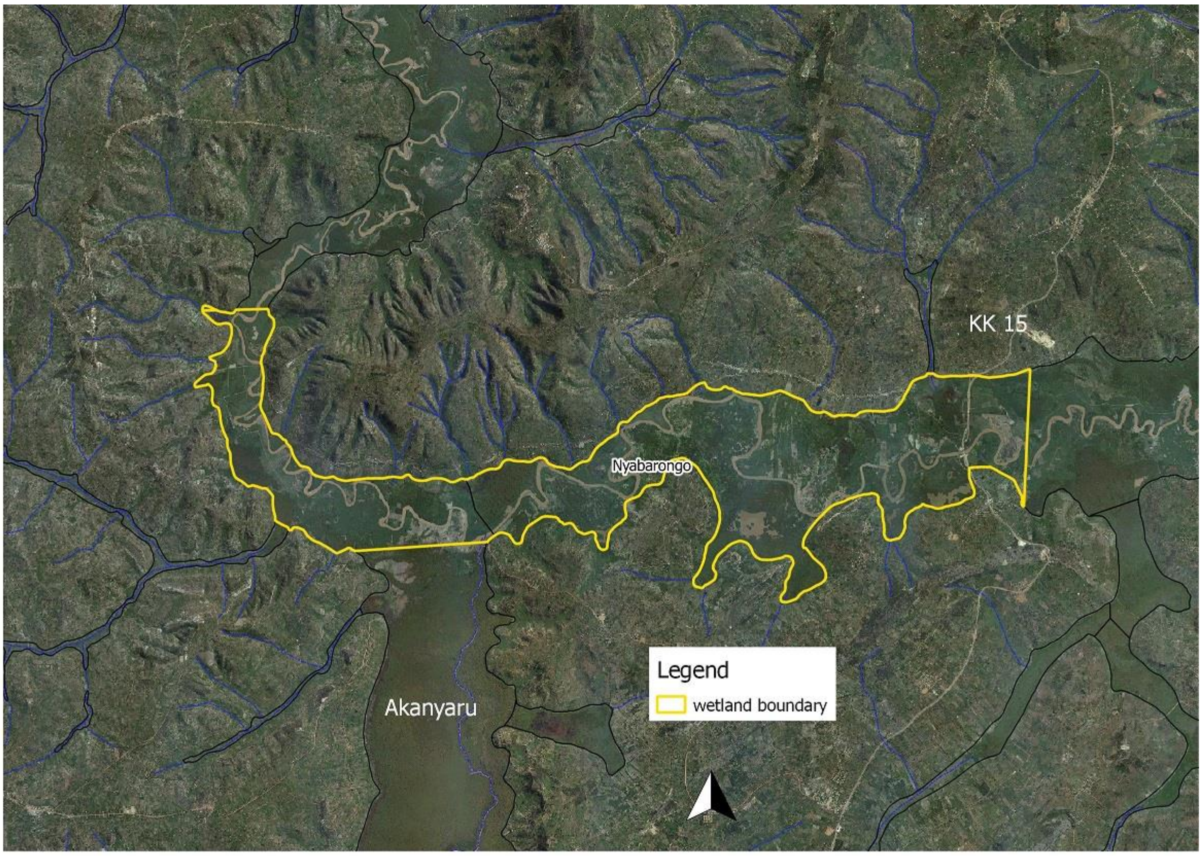



**FIGURE 2-39: DELINEATION OF THE NYABARONGO FLOODPLAIN WETLAND BOUNDARY (PORTION OF THE WETLAND SPOT CHECKED)**

*Wetland land use:*

A section of the Nyabarongo floodplain wetland was visited from its confluence with the Akanyaru River, downstream approximately 1 km to the bridge crossing of road NR5. The area is located predominantly within Kamonyi District. This is one of the largest floodplain wetland systems in the country. The wetland is typically permanently inundated and vegetated with *Cyperus papyrus*. Soils are predominantly alluvial. The management status of the floodplain wetland is “use with conditions”. It is unknown whether the area under private concession for sugar cane (Figure 2-40) underwent an environmental assessment and authorisation. The small-scale cultivation was mostly in place and acknowledged in the Ministerial Order No 006/03 of 30/01/2017. All small-scale agriculture must be formally registered. The entire floodplain wetland has been proposed for Ramsar status.

**FIGURE 2-40: A VIEW OF THE RIVER CONFLUENCE, WITH AKANYARU RIVER TO THE LEFT AND NYABARONGO RIVER TO THE RIGHT, SUPPORTING AN EXTENSIVE AREA PLANTED TO SUGAR CANE (26 APRIL 2017)**

The section of natural vegetation remaining within the Akanyaru River (Figure 2-41), as well as small patches of papyrus on the Nyabarongo floodplain, have the potential to support tourism, with a range of important bird, mammal and other faunal species noted for this area. The location of the wetland away from the main tourism route, and lack of tourism infrastructure limits the potential, however. The major use of the Nyabarongo floodplain wetland in this area is for agriculture (sugar cane but also small-scale agriculture). This use impacts on several of the other uses and on the basic ecosystem functions of the wetland. However, although the floodplain wetland in this area is more than 50% planted to sugar cane, and the sugar area may have been subject to some form of drainage ditching, the river channel has retained its natural character, without being channelised or diverted.

**FIGURE 2-41: A VIEW OF ONE OF THE LAST REMAINING AREAS OF NATURAL VEGETATION IN THE AKANYARU FLOODPLAIN WETLAND, CONSIDERED TO BE A CRITICALLY IMPORTANT BIODIVERSITY AREA (26 APRIL 2017).**

*Ecosystem functioning and overall health*

The gentle overall slope, relatively dense papyrus and sugar cane vegetation, as well as the broad surface area, makes this floodplain wetland particularly well suited to attenuate floods, as well as to trap sediments, phosphates and nitrates. Clay mining activities (Figure 2-42) were noted at the edge of the wetland. As the upstream catchment for this floodplain wetland is largely transformed to cultivation and subject to ongoing erosion of steep-sided valleys, it is expected that the wetland will play an important role in trapping sediment and phosphates. Communities receive some benefits from the wetland in the form of water supply for agricultural use and domestic use, as well as grazing and provision of fodder for livestock, and plant material for household items such a mats and baskets.

**FIGURE 2-42: Clay mining activities along the edge of the Nyabarongo floodplain wetland (December 2016).**

### 2.5.6 Wetland Situation assessment

A general overview of the wetlands in Rwanda, inclusive of those as described in the “spot check verification”, was conducted through the use of the wetland inventory and field assessment. A summary of results is provided below:

**TABLE 2-16 SUMMARY OF RWANDA WETLAND SITUATION ASSESSMENT**

| Altitude | Region | Wetland name | HGM unit | Soil | Vegetation | Wetland Condition | | | Ecosystem Services |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Vegetation | Hydrology | Geomorphology | |
| High | High altitude wetlands above 1800 meters above sea level | Kamiranzovu | Valley-Bottom | Histosols | Miscanthus, Cyperus latifolus, Violaceus, Lobelia, Ericaceae, Sphagnum | Important peat wetland. Supports dense herbaceous sedges including Cyperus denudatus and C. latifolius, fringed by swamp forest species such as Syzigium guineense. | Natural characteristics maintained. | Natural characteristics maintained. | Among the most important services provided by this wetland are as a high-altitude water source and storage area, and for biodiversity support. The wetland is one of the few remaining areas of intact fringing swamp forest species. The wetland also provides tourism and economic interest. |
| | | Rugezi | Valley-Bottom | Histosols | Miscanthus, Cyperus latifolus, Violaceus, Lobelia, Ericaceae, Sphagnum | Protected peat wetland dominated by Miscanthus violaceus and Cyperus latifolius. | Natural characteristics maintained. | Natural characteristics maintained. | An important water reserve that contributes to the regulation of utilitarian water flows in the northern hydrographic zone. |
| Mid | Impara wetlands between 1550 and 1800masl | Gishoma | Valley-Bottom | Histosols | Cyperus papyrus, Syzygium | Peat is said to have begun accumulating in this wetland from Cyperus latifolius, approximately 2000 years ago. Most of the wetland is cultivated but where fallow natural vegetation may be supported. | However, the review of GoogleEarth imagery for the site reveals a central drainage ditch as well as extensive ditches throughout the wetland | Cultivation within wetland. | Important water source for the downstream rice fields on the Bugarama and Rubyiro floodplain. Cultivation is the main service, but where natural vegetation occurs these provide important services. |
| | | Mushaka | Valley-Bottom | Histosols | Cyperus papyrus, Syzygium | | | | |

| Altitude | Region | Wetland name | HGM unit | Soil | Vegetation | Wetland Condition | | | Ecosystem Services |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Vegetation | Hydrology | Geomorphology | |
| | Wetlands along lake Kivu between 1400 and 1500masl ; Central plateau wetlands between 1400 and 1800masl | Cyabaralika and Kiguhu | Valley-Bottom | Inceptisol, Nitosols | Cyperus papyrus, Cyperus latifolius, Typha | Peat wetlands which are being mined for peat. Cyabaralika wetland appears to be cultivated around the fringe of the wetland but remains largely covered in natural vegetation. | Kiguhu wetland has been drained. | Peat mining causes erosion. | High altitude peat wetlands such as Cyabaralika have been identified for protection as water source areas. Few wetlands occur within this region thus this wetland is also a reservoir for biodiversity support and a representative of a rare wetland type. |
| | | Nyirabirandi and Nyamasho-Kara | Valley-Bottom | Inceptisol, Nitosols | Cyperus papyrus, Cyperus latifolius, Typha | Entirely cultivated. Patches of Cyperus latifolus. | Stable state of saturation to surface. | Cultivation within wetland. | These wetlands are water source areas, arising in the headwaters of the catchment. The marsh receives sediment from the upstream hills and its filter role is impaired due to low density vegetation cover. In this ecosystem, deeply modified by humans, the wild fauna has no place for foraging or breeding. Cyperus latifolius is used for making mats and for mulching crops.<br>The wetlands serve also for agriculture production. |

| Altitude | Region | Wetland name | HGM unit | Soil | Vegetation | Wetland Condition | | | Ecosystem Services |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Vegetation | Hydrology | Geomorphology | |
| | | Ndongozi | Valley-Bottom | Inceptisol, Nitosols | Cyperus papyrus, Cyperus latifolius, Typha | Entirely cultivated. Patches of Cyperus latifolus. | Stable state of saturation to surface. | Sediment accumulation from the surrounding hills was noted and it was noted that the wetland had lost most of its sediment-trapping function due to the sparse vegetation cover. | These wetlands are water source areas, arising in the headwaters of the catchment. The marsh receives sediment from the upstream hills and its filter function is impaired due to low density of vegetation cover. The ecosystem provides restricted habitat for fauna. Cyperus latifolius is used for making mats and for mulching crops. Due to the fact that this wetland's catchment is transformed to cultivation and footpaths, it is expected that the wetland will play an important role in trapping sediment and phosphates.<br>The wetlands serves for agricultural production |
| | | **Mwogo** | Valley-Bottom | Inceptisol, Nitosols | Cyperus papyrus, Cyperus latifolius, Typha | | | | Main services are cultivation, soil erosion and flood control |
| | | Rugeramigozi | Valley-Bottom | Inceptisol, Nitosols | Cyperus papyrus, Cyperus latifolius, Typha | Cultivated wetland with limited natural vegetation. | Multiple drainage channels, and water is pumped for distribution in Kabgayi and the town of Muhanga | Brick-making was noted to be taking place within and adjacent to the wetland. | Main services are cultivation. |

| Altitude | Region | Wetland name | HGM unit | Soil | Vegetation | Wetland Condition | | | Ecosystem Services |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Vegetation | Hydrology | Geomorphology | |
| | | Migira | Valley-Bottom | | | Peat soils upstream provides multiple benefits. Peat soils requires dense herbaceous vegetation. Benefits lost where inundated by dam. | Moderate change to hydrology due to drainage ditches. Upstream dam impacts timing and delivery of water to downstream wetland. | Moderate change due to upstream dam impacting delivery of sediment to downstream wetland. | Dominant services are socio-economic significance, cultivation, harvesting and water supply |
| | | Gitereri-Musenyi | Valley-Bottom | Inceptisol, Nitosols | Cyperus papyrus, Cyperus latifolius, Typha | Peat present. This wetland was entirely planted to perennial tea plants and deep ditches were evident throughout the wetland. | The perennial tea plants mean that soil disturbance is kept to a minimum. However, the deeper drainage ditches and absence of fallow parcels of land, impact on the hydrology of the wetland, as well as the biodiversity support. Tea plants are structurally able to withstand flooding and slow flood waters, but | Impacts from surrounding land use and tea cultivation. Heavy sedimentation from surrounding hillslopes. | The presence of peat soils enhances the role of the wetland in storing carbon, and moderating the quality and quantity of water in downstream rivers and wetlands. in the form of phosphate trapping and nitrate and phosphate removal. Local people do receive benefits from the wetland in the form of water supply for agricultural use and domestic use. |

| Altitude | Region | Wetland name | HGM unit | Soil | Vegetation | Wetland Condition | | | Ecosystem Services |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Vegetation | Hydrology | Geomorphology | |
| | | | | | | | denser, herbaceous vegetation is better at trapping sediment and pollutants. An artificial drainage channel runs the length of the centre of the wetland limiting the effectiveness of the wetland to regulate streamflow and purify water. Water levels in the wetland are expected to be lower than natural due to the drainage channel. | | |
| | | Nyabarongo | Floodplain | Inceptisol, Nitosols | Cyperus papyrus, Cyperus latifolius, Typha | 50% planted with sugarcane. Dense papyrus. | Natural characteristics maintained. | Erosion on steep sided valleys. | Communities receive some benefits from the wetland in the form of water supply for agricultural use and domestic use, as well as grazing and provision of fodder for livestock, and plant material for household items such a mats and baskets. |

| Altitude | Region | Wetland name | HGM unit | Soil | Vegetation | Wetland Condition | | | Ecosystem Services |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Vegetation | Hydrology | Geomorphology | |
| | | Koko | Floodplain | Inceptisol, Nitosols | Cyperus papyrus, Cyperus latifolius, Typha | Some pockets of peat (although rare). Mostly cultivated. As all wetlands within this region flow to Lake Kivu, dense wetland vegetation plays a critically important role, acting as a buffer zone, trapping suspended sediment and pollutants from wetland cultivation and upstream mining and erosion in the catchment, before they reach Lake Kivu. In the Koko floodplain wetland, a small band of natural vegetation, consisting of Cyperus latifolius, Phragmites mauritianus and Typha dominguensis, remains as a buffer between the wetland | High levels of sediment from surrounding hillslopes. General hydrology maintained. | Mukebera River tributary passes through a cassiterite mine and carries it to the wetland | Cultivation is the main service, but where natural vegetation occurs these provide important services. |

| Altitude | Region | Wetland name | HGM unit | Soil | Vegetation | Wetland Condition | | | Ecosystem Services |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Vegetation | Hydrology | Geomorphology | |
| | | | | | | cultivation and Lake Kivu. | | | |
| Low | Wetlands of Akanyaru, Nyabarongo & Akagera between 1200 and 1500masl | Akagera | Floodplain | Histosols | Cyperus papyrus, Phoenix reclinata, Syzygium cordatum | Wet areas dominated by papyrus vegetation and floodplain grasses. Relatively stable hydrological relationship in the past has resulted in peat across floodplain. There is some small scale agriculture in these areas. | Wetland has a dynamic relationship in terms of hydrology and sediment. Rice cultivation impacts hydrology but the floodplain retains connection to other sources. | Wetland has a dynamic relationship in terms of hydrology and sediment. Rice cultivation impacts sediment trapping capacity. | Dominant services are harvestable and cultivated goods and biodiversity maintenance. |
| | | Muhazi | Valley-Bottom | Histosols | Cyperus papyrus, Phoenix reclinata, Syzygium cordatum | Under cultivation, not intensive agriculture. Typha dominguensis forms buffer between lake and cultivation but generally low biodiversity support. | Lower water levels than natural due to central drainage channel. Wetland not dessicated, and downstream lake provides base level. | Removal of vegetation during harvesting and disturbance of soils increases potential for erosion and loss of soil organic matter. | Dominant services are cultivation, harvesting of natural resources and water supply. |
| | | Nyamwashama | Valley-Bottom | Histosols | Cyperus papyrus, Phoenix reclinata, Syzygium cordatum | Low change due to natural state of wetland. | Low change due to natural state of wetland. | Low change due to natural state of wetland. | Dominant services are biodiversity maintenance and tourism |

| Altitude | Region | Wetland name | HGM unit | Soil | Vegetation | Wetland Condition | | | Ecosystem Services |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Vegetation | Hydrology | Geomorphology | |
| | Wetlands of Imbo below 1000masl | Bugarama | Flood plain | Vertisols | Typha, Pragmites mauritianum | Most of wetland planted to rice with limited natural vegetation. Small patches of Cyperus papyrus remain. | The diversion of water and manipulation of hydrology has led to reported drier conditions downstream and a change to the planting of crops which like drier conditions | An exposed mining area is apparent on the slopes immediately above the wetland | Cultivation is the main service, but where natural vegetation occurs these provide important services. |

#### 2.5.6.2 Floodplain wetland examples in Rwanda

***BUGARAMA FLOODPLAIN WETLAND***

Bugarama is an immense floodplain wetland, more than 1 800 ha in size, and located along the Rubyiro River. It occurs within the Imbo region, a small region within the Western Rift Valley, dominated by the Bugarama floodplain wetland. It supports alluvial soils. Many tributary rivers flow into this floodplain along the length of the wetland, contributing further alluvium. Downstream of this wetland, the Rubyiro River joins the Rusizi and Ruhwa Rivers and together they flow into Lake Tanganyika.

Most of the wetland has been planted to rice since 1975. Other food crops such as maize, bananas, cassava, tomatoes and eggplants are also grown. The majority of the wetland is cultivated, thus the wetland provides low support for biodiversity, as well for all ecosystem services which rely on the presence of natural habitat. The main ecosystem service is food provision through cultivation. Farmers cultivate forage plants such as *Pennisetum purpureum* and *Tripsacum laxum* on the dikes surrounding the rice fields (IMCE, 2008).

The diversion of water and manipulation of hydrology has led to reported drier conditions downstream and a change to the planting of crops which like drier conditions (IMCE, 2008). An exposed mining area is apparent on the slopes immediately above the wetland. Small remaining areas of *Cyperus papyrus* were evident in imagery downstream of Bugarama floodplain wetland. It is recommended that any remaining papyrus be retained to stabilise the water level. The extension of rice cultivation has led to a shortage of water downstream.

***KOKO FLOODPLAIN WETLAND***

The Koko floodplain wetland was described by the IMCE project in 2008 as an alluvial plain regularly flooded by the Koko River. It occurs within Lake Kivu region. The wetlands of this region all flow into Lake Kivu, within narrow, steep-sided valleys. Both valley-bottom and floodplain wetlands are present in this region. Many larger, meandering rivers with associated floodplain wetlands also flow into Lake Kivu. Peat soils are rare within either these wetland types, although a few, scattered pockets have been mapped. Most soils mapped within the wetlands of this region are alluvial in nature.

The wetland is cultivated with sorghum, soybeans, bananas, eggplants, tomatoes and mulberry trees. The wetland likely regularly receives sediment brought by erosion of the surrounding steep hillslopes, and sediment slugs were evident along the river channel based on imagery. Mukebera River tributary passes through a cassiterite mine and carries it to the wetland. The suspended alluvium from erosion on the watershed and cassiterites contributes to the silting of Lake Kivu.

As all wetlands within this region flow to Lake Kivu, dense wetland vegetation plays a critically important role, acting as a buffer zone, trapping suspended sediment and pollutants from wetland cultivation and upstream mining and erosion in the catchment, before they reach Lake Kivu.

In the Koko floodplain wetland, a small band of natural vegetation, consisting of *Cyperus latifolius*, *Phragmites mauritianus* and *Typha dominguensis*, remains as a buffer between the wetland cultivation and Lake Kivu. The location of this vegetation, fringing the lake, also appears to provide biodiversity support, although this is limited by the small area of remaining habitat.

#### 2.5.6.3 Valley-bottom wetland examples in Rwanda

**GISHOMA VALLEY-BOTTOM WETLAND**

Gishoma valley-bottom wetland was described by the IMCE project in 2008, where it was classified as a peat swamp of the Rusizi volcanic uplands. It occurs within the Impara region, a slightly elevated plateau between Lake Kivu to the north and the Bugarama floodplain to the east, within the Western Rift Valley. The wetlands of this region mostly occur between 1 700 and 1 600 masl, approximately 700 m higher than Bugarama floodplain and the Rusizi River, which bound the plateau on either side. The wetlands are all valley-bottom wetlands, and all appear to support peat soils.

The Gishoma River flows from the outlet of Gishoma valley-bottom wetland towards the Bugarama and Rubyiro floodplain. Peat is said to have begun accumulating in this wetland from Cyperus latifolius, approximately 2 000 years ago, in a drier climate which favoured the terrestrialisation of a lake (originally formed from tectonic faulting) into a vegetated peat wetland. Landslides are also said to have contributed to damming of the river during this time, allowing peat to accumulate in the still waters. The peat is between 5 and 7 m deep.

Gishoma valley-bottom wetland, as well as all other valley-bottom wetlands of this plateau, appear to be entirely cultivated, based on a review of the most recent Google Earth imagery. Cultivation with rice, sweet potatoes, beans and corn, among other crops, is predominantly in the dry season as the farmers did not traditionally control the water levels (IMCE, 2008). However, the review of Google Earth imagery for the site reveals a central drainage ditch as well as extensive ditches throughout the wetland. This wetland is, furthermore, the site of the first peat power plant in the country, with construction of the plant completed early in 2017. Small, isolated areas of Gishoma valley-bottom wetland appear to be fallow, likely supporting small patches of *Cyperus latifolius*, *Cyperus denudatus* and *Leersia hexandra*.

Due to its size, the wetland appears to still provide some biodiversity support. Grey crowned cranes (*Balearica regulorum*) were noted by the IMCE project in 2008. The limited presence of the small clarias (*Clarias liocephalus*) and small Cyprinidae were also reported to the IMCE project by local residents.

### CYABARALIKA AND KIGUHU VALLEY-BOTTOM WETLANDS

Two valley-bottom peat wetlands are described in this region by Pajunen (1996). They are located between 1 770 and 1 800 masl, within the volcanic highlands. Following lava flows which blocked the basin and created conditions conducive to peat formation, the Cyabaralika wetland has accumulated peat up to 5 m deep over the course of approximately 10 500 years. This basin is located at over 1 800 masl. The Kiguhu valley-bottom wetland accumulated peat under similar conditions to the Cyabaralika wetland, since almost 13 000 years ago.

Both wetlands were exploited for harvesting of peat in the past, however, the Cyabaralika wetland was not drained, while the Kiguhu wetland was effectively drained (Pajunen, 1996). Based on a current review of Google Earth imagery, Cyabaralika wetland appears to be cultivated around the fringe of the wetland but remains largely covered in natural vegetation.

High altitude peat wetlands such as Cyabaralika have been identified for protection as water source areas. Few wetlands occur within this region thus this wetland is also a reservoir for biodiversity support and a representative of a rare wetland type.

### KAMIRANZOVU VALLEY-BOTTOM WETLAND

The iconic wetland for the Congo Nile divide is Kamiranzovu valley-bottom wetland, a high-altitude wetland formally protected within Nyungwe National Park. The wetland supports peat soils. Peat initiation is estimated to have been accumulating since as long ago as 37 000 years ago. Multiple further peat valley-bottom wetlands have been mapped within the National Park as part of the nation-wide soil map.

Kamiranzovu valley-bottom wetland remains in natural condition and supports dense herbaceous sedges including *Cyperus denudatus* and *C. latifolius*, fringed by swamp forest species such as *Syzigium guineense*.

Among the most important services provided by this wetland are as a high-altitude water source and storage area, and for biodiversity support. The wetland is one of the few remaining areas of intact fringing swamp forest species, while a wide range of invertebrates, mammals, reptiles, and bird species make use of the wetland all or some of the time for food, water and shelter. The wetland also provides tourism and economic interest, with people visiting the wetland and the downstream Kamiranzovu waterfall.

### RUGEZI VALLEY-BOTTOM WETLAND

The Rugezi valley-bottom wetland is a fairly homogeneous set of peat bogs and marshes, perched at about 2,050 meters above sea level. It also consists of a series of secondary valleys and intercollary bottoms. The main valley extends to the north by one of its tributaries, the Rubangambavu. This marsh is supplied with water by numerous streams and the main tributary of the Rugezi River, the Rubagambavu, extends it to the North-West. The waters of the Rugezi Valley flow into Lake Burera after descending the falls, located in Rusumo, from a height of about 200 meters. Rugezi wetland is located in Buberuka highands region. This region also supports the country's only proclaimed Ramsar site, Rugezi valley-bottom wetland, as well as several lakes, two of which are linked immediately downstream of Rugezi and are included under the Ramsar status, namely Ruhondo and Burera lakes. Rugezi wetland as well as many of the other, smaller, valley-bottom wetlands in the region, support peat soils.

This marsh is protected and dominated by natural vegetation. It is also possible to distinguish what is grown in the marsh although it is protected. The vegetation is dominated by *Miscanthus violaceus* and *Cyperus latifolius*.

Ultimately, the Rugezi marsh is an important water reserve that contributes to the regulation of utilitarian water flows in the northern hydrographic zone. The marsh is protected by the Ramsar Convention for its biological diversity and hydrological role.

**FIGURE 2-43 RUGEZI VALLEY BOTTOM WETLAND (28 APRIL 2017)**

**FIGURE 2-44 RUGEZI VALLEY BOTTOM WETLAND EXTENT (28 APRIL 2017)**

**NYIRABIRANDI AND NYAMASHO-KARA VALLEY-BOTTOM WETLANDS**

Nyirabirandi valley-bottom wetland flows into Nyamasho-Kara valley-bottom wetland and then to Lake Burera. These wetlands were visited by the project on the 28th of April 2017. Both wetlands support peat soils within a relatively narrow, flat valley. These wetlands are located in Buberuka highlands region.

The wetlands are entirely cultivated with no natural vegetation, except in patches of fallow land, where Cyperus latifolius was noted. At the time, the wetland water regime appeared to be in a relatively natural state of saturation to the surface.

These wetlands are water source areas, arising in the headwaters of the catchment. The marsh receives sediment from the upstream hills and its filter role is impaired due to low density vegetation cover. In this ecosystem, deeply modified by humans, the wild fauna has no place for foraging or breeding. *Cyperus latifolius* is used for making mats and for mulching crops.

**FIGURE 2-45 NYAMASHO-KARA WETLAND (LEFT) (28 APRIL 2017) AND NYIRABIRANDI WETLAND (RIGHT) (28 APRIL 2017)**

### NDONGOZI WETLAND VALLEY-BOTTOM WETLAND

Ndongozi wetland was also visited in the field on the 28th of April 2017. This long, narrow, valley-bottom wetland also supports peat soils and flows to Burera Lake. This wetland is located in Buberuka highands region.

As with Nyirabirandi and Nyamasho-Kara wetlands, Ndongozi valley-bottom wetland is entirely cultivated, with no natural vegetation, except in patches of fallow land, where *Cyperus latifolius* and weedy plant species were noted. At the time, the wetland water regime appeared to be in a relatively natural state of saturation to the surface. Sediment accumulation from the surrounding hills was noted and it was noted that the wetland had lost most of its sediment-trapping function due to the sparse vegetation cover.

These wetlands are water source areas, arising in the headwaters of the catchment. The marsh receives sediment from the upstream hills and its filter function is impaired due to low density of vegetation cover. The ecosystem provides restricted habitat for fauna. *Cyperus latifolius* is used for making mats and for mulching crops. Due to the fact that this wetland's catchment is transformed to cultivation and footpaths, it is expected that the wetland will play an important role in trapping sediment and phosphates.

**FIGURE 2-46 NDONGOZI WETLAND HEADWATERS (LEFT) AND WITH A VIEW OF THE CENTRAL DRAINAGE DITCH WHICH HAS BEEN DEVELOPED FURTHER DOWNSTREAM IN THE WETLAND (RIGHT) (28 APRIL 2017).**

**FIGURE 2-47 NDONGOZI WETLAND FURTHER DOWNSTREAM. SOILS APPEAR MINERALISED AND BEDS ARE RAISED ABOVE THE WATER TABLE TO SUIT THE CROP (28 APRIL 2017)**

### GITERERI-MUSENYI VALLEY-BOTTOM WETLAND

Gitereri-Musenyi valley-bottom wetland, was also visited on the 28th of April, 2017. As with the other valley-bottom wetlands of this region, the wetland supports peat soils. This wetland is located in Buberuka highands region.

This wetland was entirely planted to perennial tea plants and deep ditches were evident throughout the wetland. The perennial plants mean that soil disturbance is kept to a minimum. However, the deeper drainage ditches and absence of fallow parcels of land, impact on the hydrology of the wetland, as well as the biodiversity support. Tea plants are structurally able to withstand flooding and slow flood waters, but denser, herbaceous vegetation is better at trapping sediment and pollutants. The wetland is close to a village, and as such is exposed to disturbance and pollution from the village.

It is expected that an extensive loss of basic ecosystem functions (loss of biodiversity support function along with loss of habitat) has occurred with the large loss of natural habitat, due to cultivation of the entire wetland. An artificial drainage channel runs the length of the centre of the wetland limiting the effectiveness of the wetland to regulate streamflow and purify water. Water levels in the wetland are expected to be lower than natural due to the drainage channel. Direct human benefits from grazing, harvesting of plants, and water are therefore also impaired, with impacted water quality and complete loss of fodder. However, source of food from cultivation is enhanced. The presence of peat soils enhances the role of the wetland in storing carbon, and moderating the quality and quantity of water in downstream rivers and wetlands. In the form of phosphate trapping and nitrate and phosphate removal. Local people do receive benefits from the wetland in the form of water supply for agricultural use and domestic use.

**FIGURE 2-48 BASE WETLAND AND GITERERI-MUSENYI WETLANDS PLANTED TO TEA (28 APRIL 2017).**

FIGURE 2-49 GITERERI-MUSENYI UPPER WETLAND WITH GITERERI STREAM SHOWING EVIDENCE OF BANK COLLAPSE EXACERBATED BY CULTIVATION TO THE EDGE OF THE BANK (28 APRIL 2017).

FIGURE 2-50 A VIEW OF HIGH LEVELS OF SEDIMENT BEING DROPPED IN GITERERI-MUSENYI WETLAND, BURYING SOME AREAS OF CULTIVATION (LEFT). THE BASE RIVER DOWNSTREAM OF GITERERI-MUSENYI WETLANDS CARRYING A HEAVY LOAD OF SEDIMENT EVIDENT IN THE RED COLOUR OF THE WATER (RIGHT) (28 APRIL 2017).

**RUGERAMIGOZI VALLEY-BOTTOM WETLAND**

Rugeramigozi valley-bottom wetland is found between Shyogwe and Gahogo sectors, in the valley of the Rugeramigozi river, a tributary to the Nyabarongo River. This wetland occurs within the Central plateau.

The cultivated wetland has a surface of 120 hectares, 80 of them are used for rice while other 40 are used for vegetables, maize and beans. Much of the wetland is utilised by small-scale agriculture, with multiple drainage channels, and water is pumped for distribution in Kabgayi and the town of Muhanga. Brick-making was noted to be taking place 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.

**FIGURE 2-51 THE IN-STREAM DAM ON RUGIRAMAGOZI RIVER AND THE IRRIGATED RICE IN THE WETLAND BELOW (PHOTO JULY 2017).**

Wetlands of the Eastern Plateau and Eastern Savanna region are represented in the more detailed spot check descriptions.

### 2.5.7 Wetland Inventory: Findings and Recommendations

Findings and recommendations from analysis of the wetland inventory are provided in Table below:

**TABLE 2-17 WETLAND INVENTORY: FINDINGS AND RECOMMENDATIONS**

| FINDINGS | RECOMMENDATIONS |
|---|---|
| The wetland inventory requires an update with current spatial area of wetlands, addition of the HGM unit, condition and ecosystem services of wetlands in order to improve monitoring and management of wetlands in the country. | A desktop study, in partnership with field visits, is required in order to ground truth the data captured in the wetland inventory. All wetlands should have an updated extent and updated classification which includes the HGM unit, wetland condition and ecosystem services. |

## 2.6 Wetland rehabilitation

Traditionally management of wetlands and rivers in Rwanda has been based on local knowledge in order to meet small scale food production. Management has been based on the local knowledge of hydrology, soils and vegetation gained over decades of working and observation (Nabahungu, 2012). Community practices are mainly aimed at meeting immediate food and cash needs with little consideration for the environment. The small scale of these systems, especially if cultivation did not cover the entire wetland, generally meant that the impact on ecosystem services was moderate. More recently, small-scale cultivation tends to cover wetlands entirely from bank to bank, and traditional management has been superseded by national interventions, the role players of which are both national and local government institutions. This has increased the scale of the impact within wetlands. In addition, wetlands are increasingly under pressure from unnaturally high sedimentation due to erosion in the catchment, as well as impaired water quality runoff from mining, urbanisation, and coffee-washing stations, to mention only a few.

To counteract the impact on wetlands from sedimentation, there has been large-scale implementation of tree-planting interventions on riverbanks, lake shores and wetland areas. Trees are selected for their bank stabilisation properties and particularly for their usefulness for firewood, fodder and building material. They also play a further role in providing a clear indication of the edge of the designated buffer, beyond which no cultivation should take place. However, the trees are typically widely spaced and, overall, play a poor role in providing the wetland buffering services typically understood in rehabilitation practice, where dense, herbaceous vegetation is planted adjacent to a wetland to trap sediment as well as nutrients and other pollutants within the fringing vegetation, preventing them from reaching the wetland. The selection of plant species for rehabilitation interventions is very important when considering the mitigation measures they intend to address. Whatever choice of plant species is made, it should always be clear that the greater the diversity of species mix the greater the chance of the system surviving the stresses of changing characteristics (Russel et al., 2010). It is proposed that this form of buffer enhancement follow on from, and complement, the roll out of planting of trees. Following upon the successful implementation of tree buffers, herbaceous vegetation can also be selected for multiple purposes, selectively choosing fodder plants or plants suitable for basket-weaving, for example.

The first step to determining the functioning services provided by a wetland is to determine the hydrological benefits are likely, depending on its hydrogeomorphic type **(Table 2-18)**.

**TABLE 2-18 THE HYDROLOGICAL BENEFITS LIKELY TO BE PROVIDED BY A WETLAND BASED ON ITS HYDROGEOMORPHIC TYPE (KOTZE ET AL. 2009)**

| Wetland type | REGULATORY BENEFITS POTENTIALLY PROVIDED BY WETLAND | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flood attenuation | | Stream flow regulation | Enhancement of water quality | | | | |
| | Early wet season | Late wet season | | Erosion control | Sediment trapping | Phosphates | Nitrates | Toxicants |
| Floodplain | ++ | + | 0 | ++ | ++ | ++ | + | + |
| Valley-bottom Channelled | + | 0 | 0 | ++ | + | + | + | + |
| Valley-bottom unchannelled | + | + | + | ++ | ++ | + | + | ++ |

Rating: 0 Benefit unlikely to be provided to any significant extent
\+ Benefit likely to be present at least to some degree
++ Benefit very likely to be present (and often supplied to a high level)

Floodplains generally receive water during high flow events, where waters overtop banks (Kotze et al., 2009). They are considered important for flood attenuation due the nature of the vegetation and setting of the wetland in the landscape. In general, once floods overtop banks the velocity of flow decreases, allowing for deposition of sediments and phosphates. The short residence times means that nitrate and toxicant removal is short-lived, therefore the capacity to provide this benefit is low. Examples of floodplain wetlands are at the confluence of the Akanyaru and Nyabarongo Rivers, Nyabarongo River floodplain wetland and Akagera-Mugesera floodplain wetland.

Channelled valley-bottom wetlands may resemble floodplains, yet they are characterised by less active deposition of sediment (Kotze et al., 2009). They contribute less to flood attenuation and sediment trapping, but nitrate and toxicant removal is present to some extent. Examples of channelled valley-bottom wetlands are Buhingo valley-bottom wetland, Gitereri-Musenyi valley-bottom wetland and Rugezi Ramsar site valley bottom wetland.

The second step to consider is biodiversity conservation. No hydrogeomorphic type is considered to be more important than another, but the main principles of biodiversity conservation are to ensure the representation of a diversity of different types of animals and plants. The conservation status of a wetland will also be important in this regard.

Rehabilitation is the process of assisting in the recovery of a wetland that has been degraded or in maintaining the health of a wetland that is in the process of degrading (Kotze et al., 2009). The aim of rehabilitation will therefore assist to regain the abovementioned services. Interventions may take the following forms:

- **Restoration**

  Returning a degraded wetland or former wetland to a pre-existing condition or as close to that condition as possible

- **Rehabilitation**

  Returning one or more of the functions performed by a wetland, which decreases other functions

- **Protection**

  A buffer zone of vegetated land designed and managed so that sediment and pollutant transport carried from source areas via diffuse surface runoff is reduced to acceptable levels.

In principle wetland rehabilitation should first reinstate hydrology, then move to reinstate self-sustaining processes and develop interventions specific to goals. The choice of wetland interventions should match the goal, which will be different for biodiversity protection of functions for sustainable use and other ecosystem services **(**

**Table** 2-19**)**.

In Rwanda activities with the goal of riparian or wetland rehabilitation are not only just based in close proximity to the target area, but also extend into the upstream catchment. The rehabilitation projects in Rwanda have been reviewed according to the form of rehabilitation (i.e. Restoration, Rehabilitation or Protection) as well as the location in the landscape (within the wetland, within a buffer or in the upstream catchment of a wetland).

**TABLE 2-19 RESTORATION, REHABILITATION AND PROTECTION INTERVENTION OVERVIEW**

| Process to be re-instated | Goal of activity | Intervention examples | | |
|---|---|---|---|---|
| | | Restoration | Rehabilitation | Protection |
| **Within wetland** | | | | |
| **Hydrology** | Rehabilitate water regime (timing and duration) | | Plug drains, remove berms or other structures | |
| **Geomorphology** | Halt non-natural erosion | | Fill or back-flood erosion gullies, restore link to natural sediment source, remove berms or other structures | |
| **Biodiversity** | Rehabilitate habitat within the wetland | Re-instate natural hydrology, leave fallow allowing indigenous vegetation to recover, plant specific vegetation | | |
| **Livelihoods** | Provide sustainable livelihood options for sustainable use of wetland | Allow controlled access to the wetland, allow indigenous vegetation to recover, plant specific vegetation | | |
| **Within wetland buffer** | | | | |
| **Hydrology** | Improve water quantity by slowing and spreading water | | | Dense vegetation buffer |

| | | | | |
|---|---|---|---|---|
| | entering from side slopes | | | |
| | Improve water quality by trapping pollutants (carried in sediments) | | | Dense vegetation buffer |
| **Geomorphology** | Trapping sediments coming into the wetland from the hillslopes | | | Dense vegetation buffer |
| **Biodiversity** | Provide habitat for many species requiring both aquatic and adjacent terrestrial habitat for their life cycle | | | Dense vegetation buffer with specific plant species and habitat characteristics |
| | Create awareness of the important fauna and flora in the wetland | Communication and community outreach | | |
| | Prevent encroachment into wetland | | | Agroforestry buffer set back from edge of wetland |
| **Livelihoods** | Provide sustainable livelihood options | | | Agroforestry buffer |
| **Within wetland catchment** | | | | |
| **Geomorphology** | Reduce erosion on hillslopes | | | Terracing and agroforestry |
| **Livelihoods** | provide sustainable livelihood options to alleviate encroachment into wetland | Bee-keeping and agroforestry | | |

The types of interventions within a wetland, within a wetland buffer and within the upstream catchment of a wetland were reviewed for Rwanda. A site assessment was undertaken in July 2017 to assess certain interventions. The sites visited were within the following catchments:

- **Nyabarongo Valley Catchment: NNYL_2**[6]
  - The particular sites visited were the rehabilitation on Base River and associated tributaries.
- **Nyabugogo Catchment: NNYL_1**
  - The particular sites visited were Cyonyonyo River and associated tributaries.

[6] NNYL_2, Nyabarongo Valley, is the level 2 catchment, which is part of NNYL, Nyabarongo, which is a Level 1 catchment

- **Upper Nyabarongo Catchment: NNYU_2**[7]
    - The particular sites visited were Mwogo River and associated tributaries.
- **Akagera Mugesera Catchment: NAKU_1**
    - The particular sites visited were Rweru Akagera System.

### 2.6.1 Rehabilitation and restoration interventions within wetlands

Hydrology of a wetland is a key characteristic of a wetland which affects many important processes. Altering the hydrology can occur through human modifications to the water supply coming into a wetland and to the distribution and retention pattern of water within a wetland (MacFarlane et al., 2009). Removing any modifications within a wetland allows for the natural flow regime to be reinstated. Wetlands are also subject to inputs and outputs of sediment. In general wetlands are characterized by the temporary storage of sediment, and therefore if too much sediment is removed from the wetland the natural equilibrium of the system will be reduced. The accumulation of sediments is also important, as this fundamentally controls how water flows through a wetland, which in turn effects the habitat for the biota in a wetland (MacFarlane et al., 2009). Floodplain wetlands are characterized by sediment deposition and are considered to be relatively resilient to changes in sediment input, with erosional features generally reflecting localized adjustment to changes in slope (MacFarlane et al., 2009).

The Rugezi system is one of the few examples where cultivation has been pulled back and wetland drains plugged **(Figure 2-52)**. The important biodiversity of the system was one driver of this initiative, but the main imperative was that the hydropower generation downstream was under threat due to lowered water table in the wetland. In response to its electricity crisis, the Government of Rwanda sought to restore the degraded Rugezi-Burera Ruhondo watershed by halting on-going drainage activities in the Rugezi wetland and banning agricultural and pastoral activities within the wetland. The challenge with this intervention was that people living around and using wetlands have their livelihoods impacted. This type of intervention should only be considered where alternative sustainable livelihoods can be ensured or ensure that the community is assisted to create alternative sources of livelihood (improving hillside agriculture / improved farming techniques, improved seeds, improved livestock, off-farm jobs, etc.). Furthermore, previous occupants of the buffer lands, could be allowed to plant fodder plants in the buffer zones, ensuring that the soil is never bared.

**FIGURE 2-52 A VIEW OF RUGEZI WETLAND**

The LVEMP II project on Lake Rweru cleared 100 hectares of the Lake of the alien invasive plant water hyacinth, *Eichhornia crassipes*. This project was initiated because it was noted that during the wet season water hyacinth moves through the Lake and either creates ‘pockets’ of infestation on the lake shore or moves downstream to Akagera. During the dry season these ‘pockets’ of infestation stay behind and impact the natural biodiversity (**Figure 2-53**). The manual removal of the aquatic weed provided jobs and has increased the fish yield, which has benefited the local population. The LVEMPII project also provided training to fishermen on the techniques of controlling the weeds as well as composting them for agriculture use.

[7] NAKU_1, Akagera Mugusera, is the level 2 catchment, which is part of NAKU, Akagera, which is a Level 1 catchment

Seburanga et al. 2014 identified in a study on the removal of water hyacinth in Mukungwa Valley and Burera Lake that mechanical removal is perceived by communities to be the most efficient to control water hyacinth. Although the effect was only short-lived. This was in comparison to using biocontrol agents as the use of biocontrol agents requires high resource inputs and a good understanding of the processes. To the layman's eye the outcome of mechanical removal was more obvious, even though the impact of mechanical removal was only short-lived because of high growth rates, poor accessibility of areas and high capacity of regeneration as the few propagules that are not removed can quickly restore a viable population.

Water hyacinth removal by mechanical removal is considered a viable option only if there are resources to follow up with the removal of the population or 'pockets' of infestation that remain.

**FIGURE 2-53 A VIEW OF LIMITED WATER HYACINTH STILL OCCURING IN THE RWERU-AKAGERA WETLAND SYSTEM**

There are no specific projects addressing appropriate agricultural land use within wetland but certain existing practices are more conducive to sustainability which should be encouraged and promoted. Due to the characteristic of certain wetlands having the ability to capture and store sediment, any cropping practices that maintain this ability will be more appropriate than those that promote erosion, soil loss and soil break-down (oxidation of organic matter). The common method of cultivation in most wetlands throughout Rwanda is hand hoeing. Though very labour intensive the ancient method is far less destructive than mechanical (tractor) ploughing. The production of three crops a year in terms of the land use consolidation and intensification programme results in multiple cultivation and soil disturbance activities. This level of soil disturbance inevitably leads to a degree of soil erosion and break-down. The growing of perennial crops such as tea and coffee have the benefit of having very little soil cultivation/disturbance once the plants are established (**Figure 2-54**). The full-canopy of these crops ensures that the soil is protected from rain-drop action (which promotes soil erosion) and to some extent simulates the natural vegetative cover in a wetland.

**FIGURE 2-54 PERRENIAL TEA CROPS IN NYABARONGO VALLEY CATCHMENT (PHOTO: JULY 2017)**

The wetlands of Sub-Saharan Africa are home to resident Grey Crowned Cranes. These iconic cranes face many threats, fuelled by growing demands for land, water, energy, and other natural resources throughout Africa. In order to protect the cranes resident in Rwanda, it is necessary to address large-scale threats that will ultimately benefit far more than cranes. The International Crane Foundation, in close collaboration with the Endangered Wildlife Trust/Kitabi College of Conservation and Environmental Management, works on engaging communities in the conservation of Grey Crowned Cranes and their wetland habitats across Rwanda. The International Crane Foundation works with communities in the Rugezi wetland as well as Akanyaru and Akagera-Mugesera wetland complexes and they have been successful in sharing the conservation importance with young and old. The Albertine Rift Conservation Society is also currently focussing on livelihood opportunities, especially in the Akagera-Mugesera wetland complex, while the Rwanda Wildlife Conservation Foundation is currently undertaking Grey Crowned Crane conservation efforts within Akagera National Park and nearby areas. It is noted that wetlands in Rwanda, once supported an incredible diversity of faunal species. Support of the Grey Crowned Crane directly also supports the preservation or rehabilitation of habitat for many of these other species, however, in future planning, particular habitat needs of vulnerable, threatened and endemic species should be considered.

### 2.6.2 Vegetation buffer interventions

A vegetation buffer zone may be considered to be a protection intervention designed and managed so that sediment and pollutant transport carried from source areas via diffuse surface runoff is reduced to acceptable levels. In Rwanda activities with the goal of riparian or wetland rehabilitation are not only just based in close proximity to the target area, but also extend into the upstream catchment (**Figure 2-55**). This indicates that a catchment management approach is necessary for managing aquatic ecosystems. Buffer zones associated with water resources have been shown to perform a wide range of functions, and as such have been proposed as a standard method to protect water resources and associated biodiversity (MacFarlane and Bredin, 2017, (**Table 2-20**).

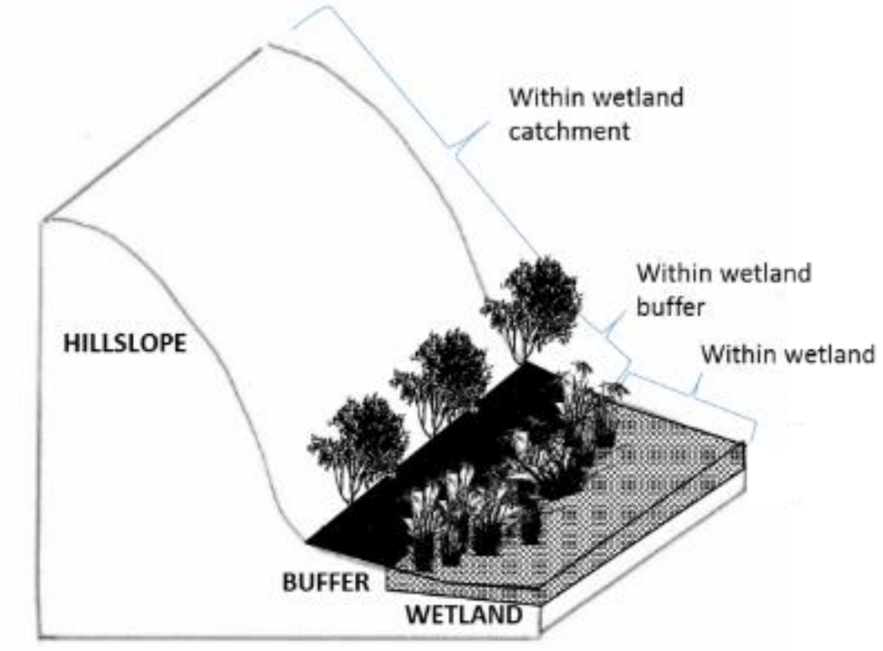



**FIGURE 2-55 CONCEPTUALISATION OF A WETLAND/RIPARIANVEGETATION BUFFER**

**TABLE 2-20 THE LINK BETWEEN THE PROCESS AND THE GOAL OF ACTIVITY FOR VEGETATION BUFFERS**

| Process to be re-instated | Goal of activity |
|---|---|
| **Hydrology and Geomorphology**<br>Providing basic aquatic processes and reducing impacts from upstream activities and adjoining land uses | **Maintaining channel stability**<br>Riparian vegetation, particularly root systems, strengthens stream banks and groundcover increases erosion resistance. This is important during flood events, with erosion being reduced greatly by good vegetation cover along stream banks.<br>**Flood attenuation**<br>Well-developed riparian vegetation increases the roughness of stream margins, thus slowing down flows. This acts as a cost effective alternative to engineered structures.<br>**Storm water attenuation**<br>Flooding into the buffer zone increases the area and reduces the velocity of storm flow. Vegetation reduces velocity through increasing resistance to flow, which reduces erosion potential.<br>**Sediment removal**<br>Surface roughness provided by vegetation reduces the flow of runoff and aids the settling of particles.<br>**Removal of toxins, nutrients and pathogens**<br>Buffer zones also remove toxins, lower the level of nutrients and encourage deposition of pathogens (which soon die once exposed to the elements). |
| **Biodiversity**<br>Providing habitat for fauna and flora | **Provision of habitat for aquatic and semi-aquatic species**<br>Riparian vegetation along the stream line provides food and habitat for aquatic fauna. Semi-aquatic species rely on terrestrial habitats to recruit juveniles.<br>**Habitat connectivity**<br>Vegetation buffers along water resources provide corridors to allow for the connection of breeding, feeding and refuge sites which help maintain populations of semi-aquatic and terrestrial species.<br>**Provision of habitat for terrestrial species**<br>Vegetation buffers may provide the only remaining terrestrial habitat for species, especially in highly developed areas. |
| **Livelihoods**<br>Providing livelihood opportunities | **Reduced flood risk**<br>Vegetation buffers increase resistance to flow, and increase the residence time of floodwaters, reducing flow velocities, thus reducing flood peaks. This provides safety to people and property in the downstream catchment.<br>**Economic benefits**<br>The use of beneficial trees and vegetation provides economic benefits to the surrounding community. |

A buffer of vegetation could provide the dual use of ‘buffering’ the water/sediments flowing into a wetland as well as providing benefits to the flora and fauna and local communities. However, to effectively improve water quality It ideally needs to be dense herbaceous vegetation. This was absent in all of the rehabilitation sites visited. The type of vegetation used as a buffer is therefore important in order to maintain this dual use. The vegetation buffer also provides a noticeable division between wetland and surrounding land use, in order to demarcate where cultivation ends. In Rwanda legislation limits agricultural and pastoral activities around bodies of water. Land-use activities need to be undertaken at a distance of 20 meters from the banks of wetlands, 50 meters from the banks of lakes and 10 m from the boundaries of streams and rivers. For rivers and streams, the Ministerial Order

N°007/16.01 Of 15/07/2010 Determining the length of land on shores of lakes and rivers transferred to public property clarifies that 10 m of buffer zones shall be enforced on shores of big rivers (listed in the same order) and 5 m buffer for small rivers, also listed in the order; all remaining streams / rivers not listed in the order, a buffer of 2 m shall be observed (Republic of Rwanda, 2010).

The land within the buffers was incorporated into public land. However, some specific activities are only allowed to be carried out even beyond this general buffer. For examples, according to the guidelines of Rwanda Utility Regulatory Authority on management of waste disposal sites / landfills (RURA, 2009), the edge of a waste disposal site shall not be closer than 60 meters from water body; cemeteries shall be in a distance not less than 200-300 m (RLMUA, 2017); and kettle kraals, slaughter house, and cattle market shall be allowed in a distance of sixty metres (60 m) away from the banks of streams and rivers and two hundred metres (200 m) away from the lake banks (law on environment, 2018) (Republic of Rwanda, 2018).

In any case, buffer zones act to limit the impacts of surrounding areas on rivers and lakes. As highlighted in the Buffer Management Guideline, variable buffer zones may be adopted in conjunction with suitable mitigation activities, to assist in protecting the adjacent water resource. The adoption of suitable mitigation measures and ongoing monitoring would provide invaluable information with regards to the degree the buffer zone is assisting in the protection of the water resource.

The Lake Victoria Environmental Management Project (LVEMP) II had a main focus on up scaling successful interventions piloted under the Decentralized Environment Management Project (DEMP) and the Integrated Management of Critical Ecosystems (IMCE) project (REMA, 2011). The watershed management component focused on 12 priority Districts in Rwanda (REMA, 2011), particularly for the Nyabarongo River and associated tributaries (**Table** 2-21). Interventions in Nyabarongo Valley Catchment, Nyabugogo Catchment, Upper Nyabarongo Catchment and Akagera Mugesera Catchment were visited. Interventions include riverbank protection, lake buffers and community development driven (CDD) projects.

**TABLE 2-21 THE 12 PRIORITY DISTRICTS FOR THE LVEMP II PROJECT INTERVENTIONS IN RWANDA**

| Province | District | Type[8] |
|---|---|---|
| West | Kamonyi | Rehabilitation of Nyabarongo catchment |
| | | Rehabilitation of Kajaba and Nyakavugo |
| | | Rehabilitation of Mwogo riverbank |
| | Ngororero | River bank protection |
| | | Improved cassava production |
| | Karongi | Bamboo plantation[9] |
| | | Hillside terraces |
| | | Progressive terraces |
| | | Riverbanks |
| | | Improved Goats production sub project |
| | | Modern Beekeeping sub project |
| | | Improved Pig production sub project |
| | | Improved Cassava Production sub project |

[8] The proposed interventions to be adopted within the various districts should at all times ensure that best-practice is adopted and thus ensuring that the impacts on the water resources are limited and controlled.

[9] Note that even though the establishment of bamboo plantations is encouraged, the National Rwanda Bamboo Policy (Ministry of Forestry and Mines, March 2011) stipulates that the provisions of the Environmental Organic Law need to be taken into consideration.

| Province | District | Type[8] |
|---|---|---|
| East | Ngoma | Demarcation Line Establishment for lakeshores rehabilitation by plantation of agroforestry |
| | | Radical Terraces |
| | | Water Hyacinth Removal |
| | | Fish farming production |
| | | Goat livestock production |
| | | Vegetable production |
| | Bugesera | Demarcation Line Establishment for lakeshores rehabilitation by plantation of agroforestry |
| | | Goat livestock production |
| | | Vegetable production |
| | | Cassava production |
| North | Gakenke | Progressive terraces |
| | | Radical terraces |
| | | Nyabarongo River bank protection |
| | | Base river bank |
| | | Modern beekeeping subproject |
| | | Improved pig livestock subproject |
| | | Improved pineapple production |
| | | Banana plantation subproject |
| | Rulindo | Progressive terraces |
| | | Yanze River Bank protection |
| | | Radical terraces |
| | | Progressive terraces |
| | | River bank protection |
| | | Base River bank protection |
| | | Improved pig livestock subproject |
| | | Potatoes seed multiplication |
| | | Banana plantation subproject |
| South | Muhanga | Rehabilitation of Nyabarongo catchment in Muhanga District, riverbanks |
| | | Improved Goat Livestock production |
| | | Improved Pig Livestock |
| | Huye | Mwogo riverbanks protection |
| | | Hillside progressive terraces on Mwogo river |
| | | Mwogo riverbanks protection |
| | | Mwogo riverbanks progressive terraces |
| | | Improved pig livestock subproject |
| | | Improved pineapple production subproject |

| Province | District | Type[8] |
|---|---|---|
| | | Vegetable production subproject |
| | | Improved banana production subproject |
| | Nyanza | Mwogo hillsides progressive terraces |
| | | Improved Goat Livestock production |
| | | Improved pineapple production |
| | Nyamagabe | River rehabilitation |
| | | Improved goats livestock subproject |
| | | Improved beekeeping livestock subproject |
| | | Improved pig livestock subproject |
| | | Improved potato production subproject |
| | Ruhango | Mwogo hillsides progressive terraces |
| | | Riverbanks protection |
| | | Improved pineapple production |

A characteristic of most of the riverbank protection sites visited was that in terms of the underlying objective for riverbank protection the bamboo plants seem to be performing their purpose. It is likely that during large storm events the plants provide a definitive buffer to the harmful effects of floodwaters due to the “berm” type effect of the bamboo and the stabilising features of the root system. Further investigation of the impacts of the bamboo on the river banks **(Figure 2-56)** indicate that there may be localised control of river bank erosion as the bamboo will protect the bank where it is planted. In the future, once the trees mature it is expected that the localised area will increase but in the interim banks are still slumping and removing the 10m buffer of “natural vegetation”. As can be seen via the LVEMP I intervention, more mature bamboo plants have a much larger localised area **(Figure 2-63)**. It is also clear through these interventions that within this localised area there is limited natural vegetation, as the bamboo outcompetes most plants. It is also clear that the mature bamboo plants provide a significant visual barrier or demarcation of the river buffer, but that these plants occur as individual clumps with only bare ground and leaf litter beneath. Even though the bamboo is partially contributing towards the stabilisation of the banks, the practice is considered to be undesirable and the establishment of indigenous vegetation would have been preferable. The Rwanda Botanical Garden can be consulted to define suitable indigenous vegetation that could be promoted, in partnership or as a substitute for Bamboo in some cases.

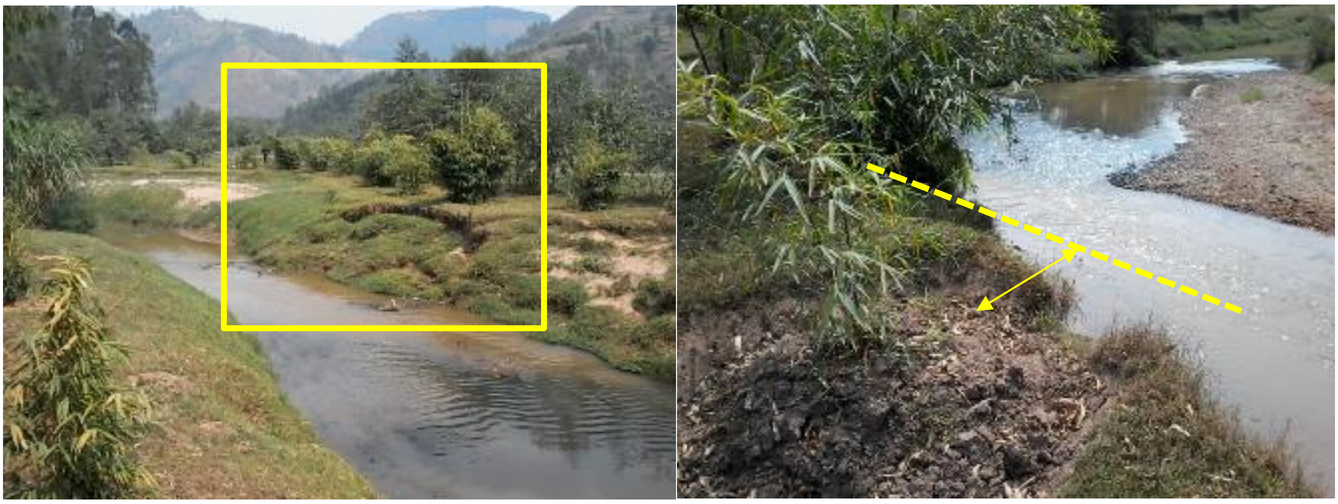


**FIGURE 2-56 THE BAMBOO SEEMS TO BE EFFECTIVE FOR A LOCALISED AREA, AS INDICATED IN THE YELLOW BLOCK WHERE A BANK HAS SLUMPED UP UNTIL THE BAMBOO PLANT. THE YELLOW ARROW INDICATES THAT THE BANK HAS ERODED UP UNTIL THE BAMBOO PLANT (PICTURE: JULY 2017)**


**FIGURE 2-57 IN COMPARISON TO THE GROWTH OF THE LVEMP I BAMBOO ON NYABARONGO RIVER, THE LVEMP II BAMBOO ON BASE RIVER IS LESS MATURE (3 YEARS OLD, VERSUS 6 YEARS OLD) (PICTURE: JULY 2017)**

Part of this project has been the development of a vegetation buffer for the Lake Rweru. Rweru-Akagera wetland is situated between Ngoma and Bugesera Districts in the Eastern Province and forms part of Burundi's border with Rwanda (REMA, 2012). The wetland complex acts as water supply to the surrounding areas as well as providing tourism and fishing activities. Threats to the wetlands complex are through the encroachment of surrounding agricultural activities as well as increasing sedimentation. The wetland complex is in effect the outlet of the Nyabarongo River, therefore there are significant levels of sediment entering the system. Increased levels of sediment are an issue of concern as this reduces water storage capacity and impacts biodiversity.

The aim of a vegetation buffer around the wetland and lakes of the Rweru-Akagera System is mainly to reduce impacts of surrounding land uses. The strategy implemented is planting an agroforestry tree buffer strip around the wetland/lakes in order to demarcate the buffer zone. Trees have not been harvested as yet as the intention is to wait until they are mature. During the dry season communities farm within the buffer due to the improved productivity potential and the access to water. Apparently the region where they farm becomes inundated with water in the wet season. During the site visit it was noted that papyrus is removed and the soil dug up to plant vegetables. Papyrus is then used as mulch.

As described in the Buffer Management Guidelines, activities within the buffer zone should be limited, particularly directly adjacent to water resources. Should the adoption of an agricultural-free buffer zone not be readily attainable, the land management practices adopted within these areas during the dry season should be guided by best-practice to ensure that the impacts of the agricultural activities within the dry season do not detrimentally affect the condition of the water resource during the wet season.


**FIGURE 2-58 THE TREE BUFFER (LINE OF AGROFORESTRY TREES) EXTENDING ACROSS A DEMARCATION AROUND THE WETLAND AREA OF LAKE RWERU AND CULTIVATION OCCURING WITHIN THE DEMARCATION ZONE (PICTURE: JULY 2017)**

**FIGURE 2-59 THE TREE BUFFER EXTENDING ACROSS A DEMARCATION AROUND THE LAKE RWERU (PICTURE: JULY 2017)**

Other projects which had a focus on the development of buffers of trees are the IMCE project on Rugezi, Kamiranzovu, Mugesera-Rweru and Akagera; the LDCF I project along Nyamukongoro River, upstream of Karago Lake; the Decentralization and Environment Management Project (DEMP) for Muhazi lakeshores and Mugesera lakeshores; and the Supporting Ecosystem Rehabilitation and Protection for Pro-Poor Green Growth (SERPG) and the Vulnerable Ecosystem Recovery Program (VERP) on Burera and Ruhondo lakes.

The IMCE project found that the *Penissetum* (vetiver grass) buffer had positive impacts because it creates a micro climate and an area of refuge for animals as well as protection of the banks. However, none of the sites visited had planted vetiver. It is noted that although bamboo trees may act to stabilise a river bank, its capacity to act as a vegetation buffer needs to be interrogated due to its innate capacity to outcompete natural vegetation, leaving bare areas under its canopy. Density, height and type are the most important characteristics affecting the capacity of vegetation to retain sediments on riparian land. Density of vegetation is most important at ground level in order to reduce overland flow velocity and to trap sediments. Having only sparsely spaced “bunches” or thickets of bamboo may have the negative effect of concentrating flow and causing rills. Buffer trees have been chosen for their agro-forestry usefulness, however, a goal has been proposed in forestry replanting projects of including 10% indigenous tree species.

### 2.6.3 Interventions in the upstream catchment

The predominant method to reduce soil erosion from a hillslope is the use of mechanical terracing, through the levelling of a section of a cultivated slope. This form of land use is prevalent in Rwanda, and is used for crops requiring a lot of water (REMA, 2010). Terraces may be either radical or progressive. Radical terraces are principally designed to reduce soil losses through enhanced retention and infiltration of runoff, to promote permanent agriculture on steep slopes and to promote land consolidation and intensive land use. First farmers isolate the topsoil, then they re-work the subsoil to create a reverse-slope bench, after which the topsoil is spread over the surface (WOCAT database reference: T_RWA003en). After establishing a terrace, a riser is shaped and grasses or shrubs/trees are planted. In comparison progressive terraces require less input and ‘progress over time’. Progressive terraces are progressively expanded to form a fully developed terrace system in order to reduce runoff and soil erosion on medium to high angled slopes. Tree seedlings are planted in rows along the contour between rows, or trees are planted in pits. Around each tree, soil from the upper parts of the slope is removed and deposited below in order to extend the flat land (WOCAT database reference: T_CHN053en). Over 5-10 years, the terraces become enlarged around each tree and form a terrace with the neighbouring trees along the contour.

For the LVEMP II project river rehabilitation and hillside terraces were developed in Rulindo and Gakenke Districts. This included setting up a 10m demarcation zone around the river, planting reeds and bamboo in the buffer area and creating terraces on surrounding hillslopes (LVEMP II Rwanda Newsletter 4, 2015). There has been 300 ha of progressive terraces developed, 20 ha of radical terraces and up to 50 ha of river bank protected. Base River, one of the Nyaborongo River tributaries also received protection through setting up 10 m demarcation zones around the river, planting reeds and bamboo in the buffer area and creating terraces on surrounding hillslopes (LVEMP II Rwanda Newsletter 4, 2015). Nyanza and Ruhango Districts were targeted for interventions in 2015 after the above-mentioned interventions, with the aim of rehabilitating the areas above Nyaborongo River. Progressive terraces, agroforestry and fruit trees and river bank protection were developed in these areas.

**FIGURE 2-60 THE RADICAL TERRACES ABOVE BASE RIVER (PICTURE: JULY 2017).**

The Land Husbandry, Water Harvesting and Hillside Irrigation Program (LWHP) is a two-phased program to implement improved land-husbandry and increased productivity in 101 pilot watersheds covering 30,250 ha of land. Land husbandry measures have been applied to various projects, using an analysis of slope combined with soil depth and land use/cover. Through this assessment land-husbandry units can be defined for a catchment in order to determine the locations most or least suitable for development. Aside from the use on individual projects, this assessment also provides support for decision-making.

The Rural Sector Support Program (RSSP) was introduced to develop a modified watershed approach learnt from LWH experience introduced for sustainable land husbandry measures on hillsides adjacent to the marshlands on selected sites. 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 dams or wetlands.

The project refers to “rehabilitation of marshlands”, but the project focus is on rehabilitating the hillslopes surrounding the wetland in order to allow farmers increased productivity during the wetland crop growing period. The project is now carrying on its activities in 22 existing rice wetlands 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. Over 4 500 ha have been already treated in eight sites. Over 1 000 ha in three marshlands (Cyili, Gacaca and Rwagitima extension) are under development works with two water retaining dams. Although no statistics on the total area of farmland susceptible to or affected by erosion and the area protected from erosion has been obtained, field observations reveal that most farmers cultivate steep slopes without any soil/ water conservation, measures and many may not adequately counter the effects of soil erosion on land productivity.

### 2.6.4 Provision of livelihood alternatives

In order to alleviate encroachment of cultivation and other uses within a wetland it is necessary to provide local communities with alternative livelihood activities. This may be achieved through both livestock and crop/cultivation support, mainly through the formation of co-operatives.

Co-operatives include agricultural (livestock and crop) support, which ranges from the following:

- Livestock:
    - Goat production
    - Pig production
    - Beekeeping
    - Fish farming
- Crop support:
    - Cassava
    - Banana
    - Pineapple
    - Potato
    - Vegetable


**FIGURE 2-61 CO-OPERATIVES IN THE BASE RIVER CATCHMENT, GAKENKE DISTRICT**

LVEMP II provides sustainable community driven livelihood improvement subprojects. The private or family owned land brought under the livelihoods improvement interventions are aimed at intensifying natural resources use and reducing harvesting pressure on forests and wetlands resources in the targeted sub catchments of the selected Districts. The interventions include support to income generating activities benefiting the poor.

An example of a co-operative that was visited, is the Banana cooperative near Mwogo River. In order to account for the displacement of community members who used to have plots within the buffer zone on the Mwogo River a community driven development project was initiated to provide alternative livelihoods. The project is based on a cooperative of 22 households who produce bananas on a commercial scale. The private or family owned land brought under the livelihoods improvement interventions are aimed at intensifying natural resources use and reducing harvesting pressure on forests and wetlands resources in the targeted sub catchments of the selected Districts.

The co-operatives are successful in that they are well run and in terms of agricultural there have been high yields. The co-operatives are also being provided with additional inputs of fertilizer and lime. Napier grass is also planted on the edges of plots, which is used for fodder. The farmers are also using sustainable agriculture techniques such as using leaves for mulch in order to increase yields.

**FIGURE 2-62 A BANANA CO-OPERATIVE IN THE MWOGO RIVER CATCHMENT, HUYE DISTRICT**

In the Gishwati ecosystem in Western Rwanda, as part of the LDCF I project there has been 8 000 avocado trees grafted and given to community for planting in Ngororero District and 7 000 fruit trees produced in Rubavu for 50 households. 3,200 of passion fruit seedlings have been produced and given to families in Rutsiro for planting. There has also been training provided to 782 persons on tree nursery establishment, fruit tree grafting, and horticulture and forestry trees cultivation techniques.

### 2.6.5 Identified challenges

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.

Wetlands are transient features of a landscape. They are dynamic over relatively short ecological periods (Ellery et al., 2009). An understanding of why wetlands form where they form is important, to ensure that there are no unexpected outcomes from rehabilitation. Moving water, and the sediment it carries, play a very important role in shaping the earth's surface. A working understanding of this will provide some insight into the occurrence, morphology and dynamics of wetlands. This means that it is important to consider the movement of water and sediment at a catchment scale in order to understand wetland functioning, and thus rehabilitate a wetland effectively.

The number of indigenous tree species included in buffer plantings appears to be low. The buffers currently do not provide a strong water quality or sediment trapping role. Similar to the agro-forestry concept, rolling out a new phase of buffer projects with selected multiuse plants is desirable.

Although the GoR has evidently identified this among the national priorities, there is urgent need for a comprehensive and coordinated soil and water conservation strategy undertaken as a national effort to effectively addressing the issue. Terracing and other initiatives are still driven by projects and tend to be area-based and therefore narrow in scope. In order to ensure long term sustainability of the intervention, it is necessary to focus on a range of different components within the localised wetland of concern, as well as its surrounding catchment.

### 2.6.6 Findings and Recommendations

Findings and recommendations from analysis of wetland rehabilitation are provided in Table 2-22 below:

**TABLE 2-22 WETLAND REHABILITATION: FINDINGS AND RECOMMENDATIONS**

| FINDINGS | RECOMMENDATIONS |
|---|---|
| Current wetland rehabilitation are within wetland, vegetation buffers around wetlands as well as interventions above a wetland (in the wetland catchment). These projects are often developed in isolation, without an understanding of the wetland system which will be benefiting from rehabilitation activities. | An understanding of the HGM unit, or the location of the wetland in the landscape, as well as the characteristic functioning of floodplain/valley-bottom wetlands will help with appropriate rehabilitation at a catchment scale. |

## 2.7 Issues in wetland management

It must be noted that the current demands placed on the environment are directed towards the intensification of the production sector in order to meet the needs of a large and poor population and which must depend on the productivity of its environment in order to meet its basic needs. Cultivated wetlands provide a critically important ecosystem service within the country. However, this use is largely incompatible with biodiversity support and, to some extent, with water quality ecosystem service support. Accordingly, these cultivated wetlands should fall under a very different management regime and be used within a different set of limits. They can be further divided according to whether they meet the Ramsar threshold for maintenance of wetland ecological character. Limits of use for all wetlands should be forward-looking, and ensure that they can be farmed, for example, for the next 20-40 years.

At a minimum, objectives should be set for what currently appear to be the key valued ecosystem services, namely agriculture, water quality improvement, flood attenuation, livelihoods support, and biodiversity support. Under this ecosystem driven limits of use approach, the most important wetlands should be identified and limits of use that are harmonious with conserving biodiversity should be established and enforced in those wetlands. Similarly, areas where wetlands are needed for the water quality enhancement service should be identified and limits of use set and enforced for those wetlands.

Important biodiversity, identified in Section 2.5.3 will benefit from buffering from adjacent heavily utilised areas (including wetlands) where a different limit of use is set. For example, stipulating in certain areas that no more than 30% cultivation of the wetland can occur. A key consideration with cultivation in wetlands is that current extent and type of use will influence the potential for, and cost of, wetland rehabilitation in 20-30 years.

A national wetland management framework ideally will assist in balancing the productive use of wetlands with conservation objectives of the country. Even though environmental policy is commonly a balancing act between protection and use, wetland policies should be specific enough so that administrators working to achieve national energy or agriculture goals do not approve unsustainable uses that risk wetland degradation (Heermans and Ikirezi, 2015).

### 2.7.1 Setting wetland limits of use

The low overall gradient of the majority of cultivated wetlands in Rwanda, together with the favourable climate and relatively sustained groundwater and interflow supporting these wetlands, leads them to appear relatively resilient in the face of extensive use for agriculture. A recent guideline by the FAO recommends that, rather than generalising about the balancing of ecosystem services, ensuring the provisioning services of wetlands could be focussed on more specifically when setting national and catchment goals for wetlands.

The following **Figure 2-63,** adapted from McCartney *at al.* (2014) suggests an approach for setting wetland management objectives based on a linear series of decisions. Socio-economic prevailing conditions provide a critical context for managing use of wetlands. For example, use of wetlands for agriculture constitutes one of the most important contribution (a contribution of between 50 and 75%) to people's livelihoods. Following from this, the biophysical characteristics of a wetland dictate what kind of uses the wetland can support, and the condition of the wetland influences the potential of the wetland to support the use depending on the degree of degradation of the wetland. The low overall gradient of the majority of cultivated wetlands in Rwanda, together with the favourable climate and relatively sustained groundwater and interflow supporting these wetlands, means they are relatively resilient in the face of extensive use by agriculture. Lastly, any use of a wetland should be viewed against the risk posed both to the loss of a livelihood benefit to people, or degradation of wetland habitat.

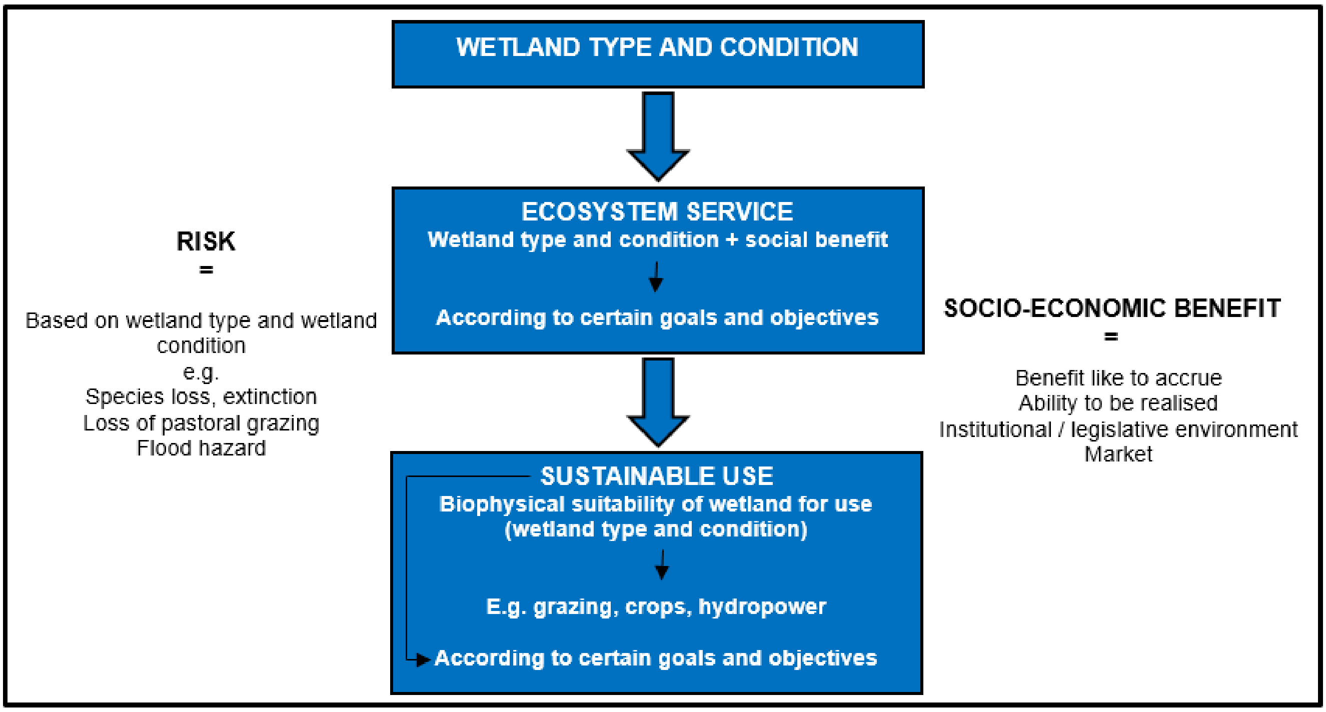



**FIGURE 2-63 AN OVERVIEW OF BROAD STEPS TOWARDS SETTING LIMITS OF USE FOR WETLANDS (ADAPTED FROM MCARTNEY ET AL., 2014).**

In the case of managing the use of wetlands for agriculture, Kotze (2010) offers a set of criteria for setting desired condition thresholds to sustain the ability of the wetland to continue to support that specific use. Thus, in the table below, wetlands used for small-scale agriculture (livelihood support) can allow hydrology to be somewhat degraded (by means of changing retention time of water within the wetland through the presence of drainage ditches), whereas, for wetlands under total protection status where the goal may be to ensure biodiversity support, impacts to the hydrology of a wetland remaining mostly unimpacted.

**TABLE 2-23 THRESHOLDS OF POTENTIAL CONCERN (TPCS) FOR THE FIVE KEY ELEMENTS CONSIDERED BY WET-SUSTAINABLE USE AND FOR THREE DIFFERENT MANAGEMENT OBJECTIVES (SOURCE: KOTZE, 2010)**

| ***Key elements considered by WET Sustainable Use that determine wetland environmental condition*** | **Threshold impact value for different primary management objectives (The continuum of impact values ranges from 0 [no impact] to 10 [critical impact])** | | | |
|---|---|---|---|---|
| | **Biodiversity conservation** | **Catchment water quality management** | **Livelihood support** | **Rationale for the choice of threshold values** |
| ***Hydrology*** *(the distribution and retention of water in the wetland)* | >1 | >2 | >4 | Hydrology is the most important determinant of wetland structure and function, and therefore the level of disruption to the hydrology should generally be minimal in order to maintain wetland biodiversity. The capacity of a wetland to enhance water quality is also dependent on a low level of disruption to the hydrology. An important way in which wetlands generally support livelihoods is through wetland cultivation, which, by its nature, generally disrupts hydrology. If livelihood support is the primary objective then the threshold is set at a moderate level of disruption, unless there is direct dependency on the wetland for water supply, in which case a much more stringent threshold may be required. |
| *The retention (or erosion) of* ***sediment*** *in the wetland* | >2 | >2 | >3 | Impacts on sediment retention should be kept low in order to maintain wetland biodiversity, and the capacity of a wetland to enhance water quality, which is also dependent on low impacts to sediment retention. Cultivation of wetlands will generally lead to some erosion impacts, but these should not exceed a moderately low level, otherwise sustained production is likely to be under threat. |
| *The accumulation of* ***SOM*** *in the wetland* | >2 | >2 | >3 | Impacts on the accumulation of SOM should be kept low in order to maintain wetland biodiversity and the capacity of a wetland to enhance water quality. Cultivation of wetlands will generally lead to some impacts on SOM, but these should not exceed a moderately low level, otherwise sustained production is likely to be under threat. |
| *The retention and internal cycling of* ***nutrients*** | >2 | >1 | >3 | Impacts on nutrient retention should be kept low in order to maintain wetland biodiversity. This factor is the most critical in terms of the capacity of the wetland to maintain a high water quality, so impacts should be minimal. Cultivation of wetlands will generally lead to some nutrient retention impacts, but these should not exceed a moderately low level, otherwise sustained production is likely to be under threat. |
| *Natural* ***vegetation*** *composition in the wetland* | >2 | >6 | >5 | In order to maintain wetland biodiversity, impacts on the natural vegetation should be kept low, given that vegetation is an important part of biodiversity and provides habitat for many other taxa. Provided that plant production is maintained, the retention and internal cycling of nutrients may be little diminished (or may even be enhanced) by a change in vegetation composition. Livelihood support generally does not require that vegetation is minimally impacted. However, if there is direct dependency on resources which are only present when the vegetation is minimally impacted, then a much more stringent threshold may be required. |

Note: the threshold values given in

**Table** 2-19 are preliminary and require validation in the field. In addition, the table assumes a simple linear relationship between health score and the delivery of management objectives. In reality this relationship is likely to be more complex.

### 2.7.2 Expansion of wetland use by agriculture

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 (marshlands[10]) 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.

The Irrigation Master Plan and District Development Strategies highlight the considerable extent of planned wetland development. For example, the entire extent of the Nyaborongo floodplain wetland within Kamonyi District is proposed for irrigation development, extending from the confluence with the Akanyaru River to the border of Gakenke District and the proposed Shyorongi dam. This is an area of approximately 3 000 ha. Impacts will include the development of high embankments disconnecting the floodplain wetlands from the river channel and preventing positive enrichment of nutrients, sediment and floodwaters. A "catch-water drain" is also proposed along the hill side slope, disrupting water contribution to the wetland from the side slopes. Irrigation will be undertaken by pumping water from the river to feed the main canal and conveyed by gravity through a network of canals, then drainage pumping of any excess water back into the river. In some limited areas, not large enough to develop, natural vegetated wetland will be left in place, and it is only in these areas that allowance is made for meander cut-off channels and overbank flows.

#### 2.7.2.1 Crops and fodder types in wetlands

The main climatic variables of temperature, rainfall and altitude have been used to divide Rwanda into 10 agro-climatic zones (ACZs) (Verdoodt and Van Ranst, 2003). The ACZs can be used to classify the country according to agricultural suitability. The ACZs are further subdivided into 38 agro-ecological zones (AEZs). AEZs are characterised according to pedological and climatic criteria. The basic information for this classification was taken from the PNUD/FAO/RWA/006 database.

For the purposes of this wetland report, agricultural suitability has been consolidated from the agro-climatic zones into the three broad regions of Rwanda, namely the Western Highlands, Central Plateau and Eastern Lowland regions. The economically important crops suited to and grown on a significant scale in each region, are summarised in **Table 2-24**.

**TABLE 2-24 ECONOMICALLY IMPORTANT CROPS SUITED TO AND GROWN IN THE THREE MAIN REGIONS OF RWANDA**

| Region | Perennial crops | Annual crops |
|---|---|---|
| Western Highlands | Tea, coffee, pyrethrum, banana, avocado. | Potato (Irish), dry bean, maize, soybean, sweet potato, vegetables. |
| Central Plateau | Tea (northern areas only), coffee, pineapple, banana, sugarcane | Potato (Irish), dry bean, maize, sorghum, wheat, soybean, sweet potato, vegetables, rice, wheat, cassava. |
| Eastern Lowlands | Sugarcane, banana, mango, papaya. | Rice, maize, sorghum, potato (Irish), dry bean, soybean, sweet potato, cassava, vegetables. |

#### 2.7.2.2 Soil types associated with crop production in wetlands

The potential of a wetland soil for agriculture is determined by inherent soil properties, which may be limiting to production within an environment, and for a given crop.

In the higher altitude areas (more than 2 000 m), where the climate is isomeric, peat predominates over mineral soils. All the soils are in general acidic and very poor in exchangeable bases. The agricultural potential is low to average and the altitude limits the variety of crops. Physical properties are good and the risk of acute dryness is limited by the climate.

In the area of plateaus and hills (1 400m to 2 000 m altitude) is a high density of small wetlands. The climate is udic isothermic, many wetlands have organic soils which are fairly to very acid and relatively poor in exchangeable bases, as well as mineral soils. The agricultural potential of these wetlands is variable. In rain fed situations the risks of extreme and sometimes irreversible dryness exists for both organic soils and clayey soils.

In the east of the country, and in the south-west in Bugarama, where there is a hot, ustic climate, wetland mineral soils are generally rich in exchangeable bases and are often vertisolic. Their pH is at least 5 or more, and their colour is dark. In general, the agricultural potential of these soils is considered to be very high, but the vertic character found in some areas makes their development difficult.

#### 2.7.2.3 Agricultural land-use types in wetlands

Agricultural land use, in wetlands, includes both irrigated and rain-fed production, and consists of five broad types:

Firstly, **informal subsistence farming** on small units of less than 0.5 ha with a wide range of food crops such as maize, potato, sweet potato, beans and vegetables which are grown with minimal inputs. These may be either irrigated or rain-fed.

Secondly, **consolidated small plots farmed cooperatively** and with intensive, synchronised production of up to three crops per year, with improved inputs. These may be either irrigated or rain-fed.

Thirdly, **large monoculture, perennial crop projects farmed cooperatively,** such as the extensive tea and coffee projects. Although mainly under irrigation, this category can also be rain-fed.

Fourthly, **large monoculture, annual crop projects farmed cooperatively,** such as the extensive rice projects. Although mainly under irrigation, this category can also be rain-fed.

The fifth type is the **large private-sector managed estates,** which mainly produce sugarcane, either irrigated or rain-fed.

**The different types of agricultural land use in wetlands are summarised in**

**TABLE 2-25 AGRICULTURAL LAND-USE TYPES IN WETLANDS**

| Type | Ownership | Production area | Cropping system | Crop example |
|---|---|---|---|---|
| Estate Project | Private sector | Large (>500 Ha) | Monoculture (rain-fed) | Sugar cane |
| Cooperative projects (Community-based) | Community | Moderate to large (>100 Ha) | Monoculture Annual crops (irrigated or rain-fed) | Rice |
| Cooperative projects (Community-based) | Community | Moderate to large (>50 Ha) | Monoculture Perennial crops (irrigated or rain-fed) | Tea, coffee |
| Cooperative projects (Community-based) | Community | Moderate to large (>5 Ha) | Synchronized crops in rotations (irrigated or rain-fed) | Maize/potato/beans |
| Informal cropping (subsistence farming) | Household | Small (<1 Ha per unit) | Multi-cropping (irrigated or rain-fed) | Vegetables, Potato, Sweet potato, Maize, beans etc |

The types of wetland agriculture are illustrated in Figure 2-64**,** Figure 2-65**,** Figure 2-66 and Figure 2-67below.

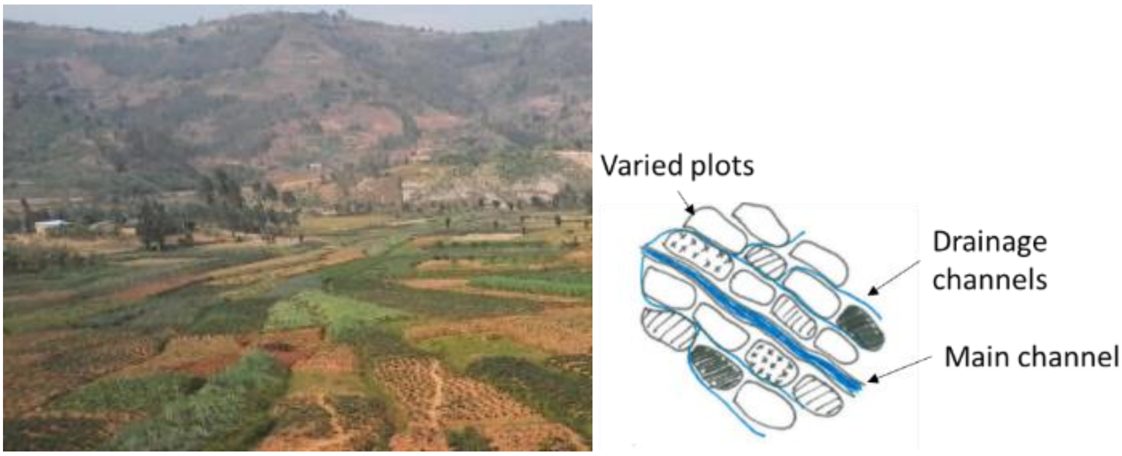



**FIGURE 2-64** **EXAMPLE OF INFORMAL SUBSISTENCE FARMING ON SMALL UNITS OF LESS THAN 0.5 HA WITH A WIDE RANGE OF FOOD CROPS SUCH AS MAIZE, POTATO, SWEET POTATO, BEANS AND VEGETABLES WHICH ARE GROWN WITH MINIMAL INPUTS AND EITHER IRRIGATED OR RAIN-FED.**

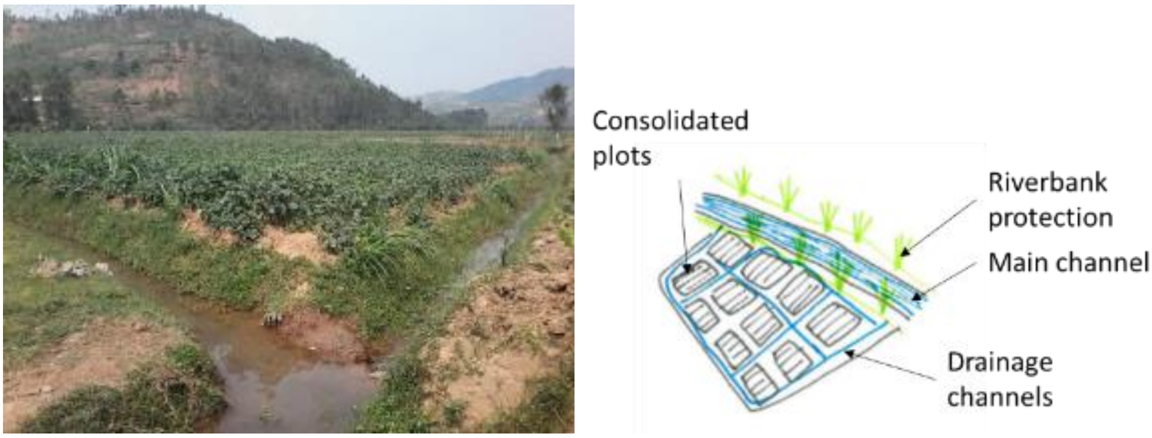



**FIGURE 2-65** **EXAMPLE OF CONSOLIDATED SMALL PLOTS FARMED COOPERATIVELY AND WITH INTENSIVE, TEA PRODUCTION (MONOCULTURE–PERENNIAL CROP) AND EITHER IRRIGATED OR RAIN-FED.**

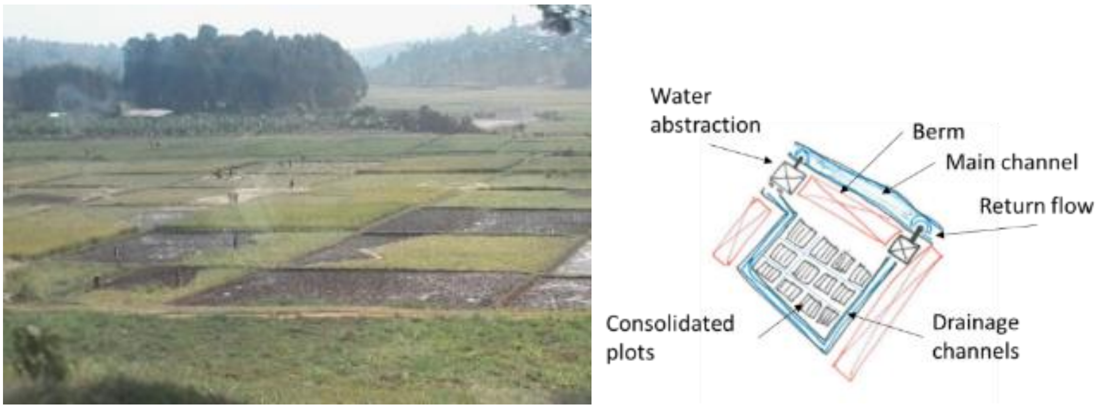



**FIGURE 2-66** **EXAMPLE OF LARGE MONOCULTURE PROJECTS SUCH AS THE EXTENSIVE RICE PROJECTS WHICH ARE ALSO MANAGED INTENSIVELY ON A COOPERATIVE BASIS. ALTHOUGH MAINLY UNDER IRRIGATION, THIS CATEGORY CAN ALSO BE RAIN-FED WITH RICE OR MAIZE.**

**FIGURE 2-67 EXAMPLE OF LARGE PRIVATE-SECTOR MANAGED ESTATES WHICH MAINLY PRODUCE SUGARCANE, EITHER IRRIGATED OR RAIN-FED.**

#### 2.7.2.4 Impact of land-use types on wetlands

The land-use types in wetlands impact is the vital function of wetlands in various ways, some more severe than others. These impacts are summarised as follows:

***Informal subsistence agriculture***

- Forming of small raised beds and earth canals/drainage lines between beds which causes soil disturbance and lowers the water table.
- Hand cultivation for seedbed preparation and weed control which exposes soil to erosion.
- Random cropping patterns which create a “patchwork” effect of different crops and fallow beds.
- Creation of an artificial network of “pathways” for vertical and lateral water connectivity, which to some extent simulates the natural wetland function of river flow buffering (water storage and peak flow delay).

***Consolidated small plots farmed cooperatively with synchronized annual crops***

- Forming of small raised beds and earth canals/drainage lines between beds which causes soil disturbance and lowers the water table.
- Hand cultivation for seedbed preparation and weed control which exposes soil to erosion. Synchronized cropping with enhanced productivity (three crops in one year and improved yields) which may reduce the periods of exposed soil (between crops) when the soil is vulnerable to erosion and runoff.
- Creation of an artificial network of “pathways” for vertical and lateral water connectivity, which to some extent simulates the natural wetland function of river flow buffering (water storage and peak flow delay).

***Large monoculture projects (both cooperative and estate managed)***

- Construction of diversion berms; diversion of natural flow of water through the wetland into lined canals and the controlled channelling of water into and out of the wetland for irrigation.
- This artificial control of water movement compromises the ability of the wetland to fulfil its function of river flow buffering.
- The monocropping of perennial crops such as sugarcane, tea and coffee has a positive impact by ensuring limited soil cultivation and exposure to erosion because of their full-canopy.
- The mono-cropping of annual crops such as rice also has a positive impact by limiting soil exposure to erosion during the growing season. However annual land cultivation for planting does expose the soil to erosion for a limited period.

#### 2.7.2.5 Assessing the impact and sustainability of the agricultural land-use types in wetlands

Sustainable development comprises three mutually reinforcing pillars: economic development, social development and environmental protection at the local, national, regional and global levels (UN, 2002). In broad terms, the concept of sustainable development is an attempt to combine concerns about environmental issues with socio-economic issues (Hopwood *et al.,* 2005).

Sustainable development can also be defined as 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. However the term sustainable development is open to misuse in situations where the economic dimension predominates over the social and environmental dimensions. Given the conflicting interpretations that are likely to arise around sustainable development and the need for greater clarity of meaning, more specific guidance and criteria are required to measure attainment of sustainable development (Sunderlin, 1995; Lawrence, 1997).

"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), are expanded in **Table 2-26.**

**TABLE 2-26 THE FIVE KEY ENVIRONMENTAL COMPONENTS CONSIDERED IN ASSESSING THE EXTENT TO WHICH USE OF A WETLAND ALTERS THE ENVIRONMENTAL CONDITION OF THE WETLAND (SOURCE: KOTZE, 2010)**

| Key components | Rationale |
|---|---|
| 1. 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. |
| 2. 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 wateris 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. |
| 3. 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 uptake by plants (Miller and Gardiner, 1998; Mills and Fey, 2003; Sahrawat, 2004). |
| 4. 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). |
| 5. 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 |

| Key components | Rationale |
|---|---|
| | plant species may also have direct economic importance (e.g. for use in craft production). |

**Table 2-27** 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.

**TABLE 2-27 CHARACTERISTIC LIVELIHOOD IMPACTS RESULTING FROM ALTERATIONS TO THE FIVE KEY ELEMENTS DETERMINING THE ENVIRONMENTAL CONDITION OF A WETLAND.**

| Key elements considered | Likely impact on the livelihoods of local people using the wetland |
|---|---|
| 1. Hydrology (the distribution and retention of water in the wetland) | The reduced extent and duration of flooding/saturation in the wetland potentially allows for greater opportunities for the cultivation of wetland areas that were naturally too wet for cultivation. From a livelihoods perspective, this is positive. However, these alterations may also have negative effects on local livelihoods, particularly where important resources such as papyrus reeds for harvesting are dependent on a close-to-natural flooding regime. An artificial drying out of the wetland is also likely to reduce the value of the wetland as a source of water for domestic and livestock use and small-scale irrigation, particularly during dry years. Over-drainage of a wetland may also directly reduce the crop production potential of a wetland during dry years by subjecting crops to desiccation. |
| 2. The retention (or erosion) of sediment in the wetland | Reduced retention of mineral sediment (usually as a result of erosion) will almost always have a negative impact on wetland productivity, which in turn will impact negatively on the supply of provisioning services and the livelihoods that these sustain. This might be expressed rapidly (e.g. if soils are inherently shallow or the intensity of erosion is very high) or slowly (e.g. if erosion intensity is low).<br><br>Erosion may also impact on water quality downstream, by increasing sediment and nutrient loads. |
| 3. The accumulation of soil organic matter SOM) in the wetland | Reduced organic matter leads to both reduced nutrient retention and water-holding capacities, which in turn result in reduced productivity and provisioning services.<br><br>In the short term, increased mineralization of SOM (e.g. as a result of desiccation from artificial drainage) is likely to increase nutrient availability for crops, which is potentially positive for livelihoods. However, as the SOM store is depleted, this release of nutrients will come to an end and the soil will often be left both depleted of nutrients and with a poor capacity to hold any nutrients that may enter the system. This in turn will impact negatively on the capacity of the wetland for producing crops. The time taken for this point to be reached may vary greatly from one wetland to the next, and will depend on the size of the SOM store, which may be very large in peatlands with deep peat deposits or very small in some seasonally saturated mineral soils. |
| 4. The retention and internal cycling of nutrients in the wetland | As in the case of erosion, reduced nutrient retention and internal cycling will almost always have a negative impact on wetland productivity, which in turn will impact negatively on the supply of provisioning services and the livelihoods that these sustain.<br><br>A reduction in this capacity is also likely to impact negatively on the water quality of downstream areas, thereby affecting those that depend on this water. |
| 5. The natural composition of the wetland vegetation | A decline in the richness of native species reduces the resource base of wild plants, including medicinal plants and plants for crafts and thatching. Plants of value for grazing livestock may also potentially be lost. |

In order to assess the sustainability of the six types of agricultural land use in Rwanda's non-protected wetlands, as described above, and using the "WET-Sustainable Use" principles, each of the above levels of impact were given an empirical value from 1-5 (1= low impact/high sustainability; 5 = high impact/low sustainability) which provides an impact intensity score. In this simple application of the concept, there was no weighting of the environmental components. Weighting will be necessary when considering wetlands with high levels of importance or sensitivity.

**Table 2-28** shows the relative intensity of impact of the six wetland agricultural land-use types on the five environmental components.

**TABLE 2-28 RELATIVE INTENSITY OF IMPACT OF EACH OF THE WETLAND AGRICULTURAL LAND-USE TYPES ON THE FIVE ENVIRONMENTAL COMPONENTS (INDICATORS)**

| Type | 1. Estate Projects<br>Private sector<br>Monoculture<br>(Sugar cane) | 2.Cooperative projects<br>Monoculture<br>(perennial crops –Tea coffee) | 3.Cooperative projects<br>Monoculture<br>(annual crop – rice) | 4.Cooperative projects<br>Synchronized crop rotation<br>(annual crops- maize, potato, beans) | 5. Informal cropping<br>Multi-cropping<br>Annual crops – vegetables., sweet potato, maize, bean s |
|---|---|---|---|---|---|
| 1. Hydrology - Distribution and retention of water | 3 | 3 | 3 | 3 | 4 |
| 2. Retention of sediment | 2 | 3 | 3 | 4 | 5 |
| 3.Accumulation of soil organic matter (SOM) | 2 | 2 | 3 | 4 | 5 |
| 4.Retention and internal cycling of nutrients | 2 | 2 | 3 | 4 | 5 |
| 5. Retention of the natural composition of wetland vegetation | 5 | 5 | 5 | 5 | 5 |
| Impact intensity<br>(Average) | 2.8 | 3.0 | 3.4 | 4.0 | 4.8 |

The main factors contributing to the sustainability rating of the land-use types are summarized in Table 2-29.

**TABLE 2-29 MAIN FACTORS CONTRIBUTING TO THE SUSTAINABILITY RATING OF THE LAND-USE TYPES (SOURCE: KOTZE, 2010).**

| Type | Impact/ Sustainability rating | Main factors affecting rating |
|---|---|---|
| 1. Estate Projects<br>*Private sector*<br>*Monoculture*<br>*(Sugar cane)* | 2.8 | **Hydrology:**<br>➢ Construction of diversion berms;<br>➢ Diversion of natural flow of water through the wetland into lined canals<br>Compromises ability of wetland to fulfil its function of river flow buffering.<br><br>**Retention of sediments:**<br>➢ Sugarcane is a perennial crop with minimal soil disturbance in the production cycle (7 years).<br>➢ Full canopy cover of this grass species and dense shallow rooting system, simulates the natural vegetation of a wetland reasonably well.<br><br>**Organic Matter accumulation**<br>➢ Sugarcane produces high volumes of OM (avoid burning of trash)<br><br>**Nutrient retention** |

| Type | Impact/ Sustainability rating | Main factors affecting rating |
|---|---|---|
| | | ➢ Soil nutrient levels are partially replenished with fertilizers.<br>➢ Excessive fertilization can cause downstream water quality reduction.<br>**Natural vegetation retention**<br>The natural composition of the wetland vegetation is completely replaced. |
| 2.Cooperative projects<br>*Monoculture*<br>*(perennial crops –Tea coffee)* | 3.0 | **Hydrology:**<br>➢ Artificial network of "pathways" for vertical and lateral water connectivity, partially simulates the natural wetland function of river flow buffering (water storage and peak flow delay).<br>**Retention of sediments:**<br>➢ Tea and coffee are perennial crops with minimal soil disturbance in the production cycle.<br>➢ The canopy is not as dense or as close to the ground as sugarcane and the rooting system is not as shallow and dense.<br>➢ Access paths between rows are required for harvesting which enhances runoff.<br>**Organic Matter accumulation**<br>➢ OM accumulation less than sugarcane.<br>➢ Minimal soil cultivation reduces soil breakdown.<br>**Nutrient retention**<br>➢ Soil nutrient levels are partially replenished with fertilizers.<br>➢ Excessive fertilization can cause downstream water quality reduction<br>**Natural vegetation retention**<br>The natural composition of the wetland vegetation is completely replaced. |
| 3.Cooperative projects<br>*Monoculture*<br>*(annual crop – rice)* | 3.4 | **Hydrology**<br>➢ Construction of diversion berms;<br>➢ Diversion of natural flow of water through the wetland into lined canals<br>Compromises ability of wetland to fulfil its function of river flow buffering.<br>**Retention of sediments:**<br>➢ annual cultivation exposes the soil to oxidation of organic matter and erosion into drainage canals<br>➢ The full canopy cover and dense shallow rooting system of rice simulates the natural vegetation of a wetland reasonably well<br>**Organic Matter accumulation** |

| Type | Impact/ Sustainability rating | Main factors affecting rating |
|---|---|---|
| | | ➢ Where rice stover (residue) is ploughed back into the soil organic matter content is well retained.<br><br>**Nutrient retention**<br>➢ Soil nutrient levels are partially replenished with fertilizers.<br>➢ Excessive fertilization can cause downstream water quality reduction<br><br>**Natural vegetation retention**<br><br>The natural composition of the wetland vegetation is completely replaced. |
| 4.Cooperative projects<br><br>*Synchronized crop rotation*<br><br>*(annual crops- maize, potato, beans)* | 4.0 | **Hydrology**<br>➢ Artificial network of "pathways" for vertical and lateral water connectivity, partially simulates the natural wetland function of river flow buffering (water storage and peak flow delay).<br><br>**Retention of sediments:**<br>➢ Forming of small raised beds and earth canals/drainage lines between beds causes soil disturbance and erosion and lowers the water table.<br>➢ annual cultivation exposes the soil to oxidation of organic matter and erosion into drainage canals<br>➢ The regular cultivation of soil for annual crop production (up to three crops per year under irrigation) results in erosion of soil into drainage canals.<br><br>**Organic Matter accumulation**<br>➢ With up to three crops grown in one year (under irrigation) the regular cultivation exposes the soil to oxidation of organic matter.<br><br>**Nutrient retention**<br><br>Soil nutrient levels are partially replenished with fertilizers.<br><br>**Natural vegetation retention**<br><br>The natural composition of the wetland vegetation is completely replaced. |
| 5. Informal cropping<br><br>*Multi-cropping*<br><br>*Annual crops – vegetables., sweet potato, maize, bean s* | 4.8 | **Hydrology:**<br>➢ Artificial network of "pathways" for vertical and lateral water connectivity, partially simulates the natural wetland function of river flow buffering (water storage and peak flow delay).<br><br>**Retention of sediments:** |

| Type | Impact/ Sustainability rating | Main factors affecting rating |
|---|---|---|
| | | ➢ Forming of small raised beds and earth canals/drainage lines between beds causes soil disturbance and erosion and lowers the water table.<br>➢ The unsynchronized cropping patterns result in a high level of soil exposure for runoff and downstream sedimentation.<br>**Organic Matter accumulation:**<br>➢ With up to three crops grown in one year (under irrigation) the regular cultivation exposes the soil to oxidation of organic matter.<br>**Nutrient retention:**<br>➢ Very low levels of fertilizer application depletes the natural soil fertility levels in the wetland soils<br>**Natural vegetation retention:**<br>The natural composition of the wetland vegetation is completely replaced. |

#### 2.7.2.6 Recommendations to enhance sustainable agricultural use of wetlands

**1 Cultivation methods**

With one of the key elements in the definition of a wetland being its effect as a “sediment sink”, any cropping practices that maintain that effect will be more appropriate than those that promote erosion, soil loss and soil break-down (oxidation of organic matter). The common method of cultivation in most wetlands throughout Rwanda is hand hoeing. Though very labour intensive, the ancient method is far less destructive than mechanical (tractor) ploughing. The land use Intensification programme promotes the gradual increase in tractor use to improve agricultural productivity. In contrast however the strategy for Agricultural Mechanisation, 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), which is subtitled “Shifting from subsistence agriculture to market orientated agriculture”, recognizes:

- ➢the wide range of operating conditions in Rwanda and proposes a range of alternative mechanization options to suite specific tillage conditions,
- ➢that care should be taken to minimise any negative socio-economic consequences of mechanization,
- ➢the need for environmentally- friendly mechanization practices that conserve natural resources such as land, water and soil nutrients.
- ➢The need for mechanization options that allow direct sowing, minimum/reduced tillage, land levelling and retention of crop residues.

The recommended mechanisation types for the range of operating conditions are summarised in Table 2.22.

**TABLE 2-30 RECOMMENDED MECHANISATION TYPES FOR THE RANGE OF OPERATING CONDITIONS IN RWANDA.**

| Operating conditions | Mechanisation type |
|---|---|
| **Terraced lands** on steep slopes<br>(>5% -<55%) | Animal drawn operations for primary and secondary tillage |
| **Shallow sloped lands**<br>( <20% ) | Animal drawn operations for primary and secondary tillage |
| **Flat Dryland**<br>(<5%) | Tractor drawn operations for primary and secondary tillage<br>or Animal drawn operations for primary and secondary tillage |
| **Marshlands** | Animal drawn operations for primary tillage and<br>Single axle tractors for secondary tillage |

The focus on animal drawn “mechanisation” is strongly supported from a sustainability perspective. However, it raises its own challenges such as the availability of oxen on a national scale and their feeding requirements in the context of governments programme to limit free-roaming cattle in the country and the focus on penned cattle.

There is an urgent need for the testing and demonstration of animal-draft-friendly conservation tillage implements, and single-axil power tillage implements to support the Agricultural mechanisation Strategy.

The principles of conservation agriculture which embrace the concept of conservation tillage methods should also be tested and expanded in wetland cropping areas. Conservation tillage methods are designed to minimise soil disturbance and maximise mulching of the soil surface. This reduces erosion and maintains organic matter levels. However, conservation tillage is not an easy system to adapt to and will not be adopted readily by farmers without a well-supported programme of trial and demonstration. It is proposed that the Crop Intensification Programme is the appropriate vehicle for this purpose. The Crop Intensification Programme is considered the right vehicle because of its strong presence in wetland farming areas and its appropriate mandate. Under MINAGRI, the crop intensification program (CIP) is responsible for the overall planning of land area that needs to be consolidated for growing priority food crops. One of the key components of CIP includes consolidated use of farm lands in the production areas. Under CIP, agricultural inputs such as improved seeds and fertilizers are distributed to farmers through public-private partnerships. Extension services on the use of inputs and improved cultivation practices are also rendered to farmers. Although farmers’ participation in land use consolidation is voluntary, consolidation is a condition for availing the other benefits under CIP. Although the technical plan for land use is drawn by MINAGRI, it is implemented in conjunction with local administration authorities. The district and sector agronomists and other field officers in the cells mobilize the farmers for growing the priority crops in a consolidated fashion.

## 2 Crop selection

The production of “annual” crops (up to three crops a year in terms of the land use consolidation and intensification programmes) results in multiple cultivation and soil disturbance activities. This level of soil disturbance inevitably leads to soil erosion and loss of organic matter. The growing of perennial crops such as tea and coffee have the benefit of having very little soil cultivation/disturbance once the plants are established. The full-canopy of these crops ensures that the soil is protected from rain-drop action (which promotes soil erosion) and to some extent simulates the natural vegetative cover in a wetland.

Tea and coffee are suited to specific climatic conditions and their expansion is therefore restricted to suitable areas and to market constraints. From a livelihoods perspective the other widely grown food crops cannot all be replaced by “industrial” type crops. However the expansion of the tea and coffee industry in climatically suitable wetland areas should be promoted as preferred crops (where climatically and economically viable) in preference to other crops but with due consideration to food security needs.

3 **Cropping systems**

Where annual food crops are grown, the synchronized crop rotation system which is being 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 conservation tillage methods and other more sustainable forms of crop production using various “conservation agriculture” techniques.

4 **Alternatives to rice production in prioritized wetlands**

Where prioritized and vulnerable wetlands have been “earmarked” for the expansion of rice production, serious consideration should be given to finding alternative and compensatory agricultural production options outside of those wetlands and preferably to the benefit of the same communities that would be involved in the wetland rice projects.

Finding an alternative to paddy rice production is a challenge because of the GoR’s concerted drive to promote and support wetland rice production as guided by the National Rice Development Strategy and most other policy documents relating to agricultural development. This programme has been successful for a number of reasons including:

- The suitable agro-climatic conditions for wetland rice production (national average yields are close to 6.0t/ha).
- Rapidly escalating Rwandan consumer preference for rice over other staples and the government’s initiative to effect rice import substitution by stimulating local production.
- Proliferation of private-sector rice milling operations which provide guaranteed markets and production financing support.
- Higher financial returns from rice compared with other annual crops.
- Relatively low capital and operating costs of irrigation in wetlands compared to areas outside wetlands.
- High labour requirement and related job creation.

Any alternative crop will have to show the equivalent level of productive land use, income generation, job creation, and import substitution for it to be successfully adopted. The one crop that might meet these requirements is Upland rice. This crop, which has similar growth habits to other traditional field crops like maize, does not need the saturated growing environment of rice paddies. The RAB, in partnership with the Chinese Agricultural Technology Centre, is researching Upland rice production. New variety trials have been conducted for five years at the RAB-owned research stations of Mututu, Nyanza and Rubona, in Huye District. Yields, under trial conditions, of up to 7.5 t/ha have been achieved. This indicates the Upland rice may be competitive with wetland rice under good rainfall conditions or under irrigation. The Upland rice varieties tend to have a growing season about a month shorter than paddy rice and have lower water requirements. The trials are also testing the adaptability of the new varieties to different soil types and conditions. While the main purpose of the Dryland rice programme is to increase rice production in Rwanda there is an opportunity to promote this crop as an alternative to paddy rice production in priority wetlands. Upland rice will require “radical” terracing to create flat cultivation beds on the hill slopes surrounding the wetlands.

Although irrigation of Upland rice is not imperative to produce a crop, to compete with the yields of paddy rice, irrigation of Upland rice projects will have to be considered. The capital development costs of irrigation infrastructure for upland rice and the operating costs are likely to be higher than for wetland rice irrigation. However the major advantage of protecting priority wetlands should justify the additional expenditure on irrigation.

### 2.7.3 Use of wetlands in mining

#### 2.7.3.1 Impacts of large scale mining waste

There are some 102 mines registered with the Rwanda Mines, Petroleum and Gas Board (2015 count). Currently the key minerals being mined in Rwanda include cassiterite (a tin ore); colombo-tantalite (commonly called coltan - an ore that is the source of niobium and tantalum); wolfram (a tungsten ore); and Gold mined from Gicumbi and Nyamasheke districts. Other key minerals include ambrigonite, beryl and semi-precious stones such as tourmaline, topaz, corundum, chiastorite, amethyst, sapphires, opal, agate and flint. Construction materials which can be used in their primary state or processed include amphibolites, granites and quartzites, volcanic rocks, dolomites, clay, kaolin, sand and gravel (Ministry of Forestry and Mines, 2010). The Mining Policy of 2010 (Ministry of Forestry and Mines, 2010) set out a policy which sought to comprehensively cover all aspects of the regulation, institutional and investment framework for the mining industry, as well as provide plans of action to support the sector's growth. The major concern of large scale mines are concentrations of heavy metals in soils and stream sediments downstream of the mines.

The mining industry is one the industries that are expected to grow in future. The Mining Policy set out its objectives as increasing productivity by establishing 3 industrial mines by 2020, increasing investment to 500 million by 2020, creating more employment opportunities and higher paying jobs (50,000 employees by 2015 in the sector), increasing exports to $240million per year by 2020, reduced imports to $10million per year fall in construction material imports, increasing tax revenue by $30million per year by 2020, reducing environmental impacts by allowing no artisanal treatment in rivers, and ensure greater macro-economic stability. The growth in the mining industry is a concern with respect to pollution, especially if this is not undertaken in an environmentally sustainable manner but focused on short term gains.

#### 2.7.3.2 Brick making and associated quarries

In the Eastern province manufacturing of bricks is done in Nyagatare district at Rwimiyaga, Karama and Barija. Barija site is adjacent to River Muvumba (Kiptum et al., 2014). Manufacturing of bricks was also observed near Yanze River (**Figure 2-68)**, where wetland soil had a high clay content, and in Bugesera District (**Figure 2-69**). Brick making is an issue of concern when brick makers have quarries near river banks or wetlands as the natural vegetation gets destroyed.

**FIGURE 2-68 THE CLAYEY SOIL IN THE UPPERER YANZE RIVER WHICH IS USED TO MAKE BRICKS (PICTURE: JULY 2017)**

**FIGURE 2-69: ORGANIC SOILS USED FOR BRICKS PRODUCTION IN RULINDO DISTRICT, NYARUBUBA WETLAND (PICTURE: MAY 2020)**

#### 2.7.3.3 Mining for peat

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 depth and volume of peat results in fragmentation and degradation of the larger ecosystem. Cutaway peatlands that are not reflooded have no viable seed banks and very hostile conditions for plant colonization, (low water levels, temperatures extremes, danger of peat fires, exposure, etc.), large free water area now replacing what was a shrub/rushland peat deposit.

Peat extraction as a land use changes results in a switch of peatlands from a GHG sink to that of a GHG source. When peatlands are drained, CH4 (methane) emissions decrease, but CO2 (carbon dioxide) and N2O (nitrogen dioxide) emissions increase. This leads to net emissions from oxidising peat of 10 up to possibly 100 tons of CO2-eq. per ha and year. Drainage, associated with fires, increases these emissions substantially (Joosten & Couwenberg, 2009). 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.
- Changes to it as a sustained source of water.
- Loss of area for cultivation in sometimes degraded environments.
- Changes in its fire regime.
- Decrease in aesthetics and nature appreciation.

- Introduction of exotic species.
- Changes in available habitats for wildlife.
- Changes in vegetation species composition.

The Government of Rwanda (GoR) currently has plans to harvest peat on a large scale to help meet the demand for electricity within the country.

The 15MW Gishoma peat-to-power plant in Bugarama, Rusizi District, and Western Province is in its final stage of completion. Peat in the Rwabusoro wetland and around the Akanyaru River is the next target (Ministry of Infrastructure, 2015). The GoR has already signed a Power Purchase Guarantee and a Concession Agreement with Hakan Mining and Generation Industry and Trade Inc. to develop and manage a peat extraction and electricity generating plant at South Akanyaru in Gisagara District, Southern Province. This plant aims to generate 100MW and the construction activities have already started (Rwanda Development Board, 2015). While peat extraction activities have started around Akanyaru River, the government has highlighted the Rwabusoro wetland and Rucahabi in the districts of Nyanza and Bugesera as having significant opportunities for large-scale peat harvesting for power generation. If the Akanyaru peat-to-power plant is successful, these wetlands will be next with a possibility of expanding to further wetlands. It is already highlighted in the Energy Sector Action Plan by African Development Bank Group (2013) that Rwanda aims to increase peat-based power to 300MW by 2025.

Currently two firms are mechanically harvesting peat in Rwanda (Hope Magazine, 2012)

- PEC (Peat Energy company) supplies 2,000 tons per month to a cement plant
- RAS (Rwanda Auto Service) supplies peat to prisons for cooking

Although harvesting peat resources presents a significant opportunity for power for the country, it is also a threat to a wide range of wetland and ecosystem services biodiversity and ecosystem services and has other negative environmental impacts. If peat-to-power production was to take place at most of the identified sites, this would have a far-reaching environmental impact and this has not been sufficiently examined. Peat-to-power projects are a short-term strategy and peat energy is not renewable. It is estimated that Rwanda could only benefit from its peat resources for the next 25 years.

### 2.7.4 Pollution and damages of wetlands

Rwanda is experiencing a range of water pollution problems. Issues ranges from high sediment loads in rivers; microbial pollution and water-borne pathogens; hotspots of salinization; nutrient enhancement and eutrophication; acidity and alkalinity; solid waste and litter; dissolved oxygen, BOD/COD and organic pollution; agrochemicals and toxic substances; heavy metals; and invasive alien plants.

Wetlands are among the most productive aquatic ecosystems in Rwanda, performing valuable ecological, social and economic functions. A key function that wetlands help to maintain the quality of surface and ground water. This means that it is important to note the levels of pollution issues within a wetland as although wetland vegetation may act to reduce certain levels of pollution there are thresholds of concern for the amounts of sediment, SOM and nutrients which if exceeded will lead to the degradation of a wetland. This would reduce the wetlands capacity to maintain the quality of Rwanda’s water supply.

The Law on environment 48/2018 of 13/08/2018 defines **pollution** as the contamination caused by waste, harmful biochemical products derived from human activities that may alter a person’s habitat and cause adverse effects on the environment including a person's social wellbeing, flora, fauna and the world he/ she lives in;

For the wetlands, the following were recognized by the law as

**The article 47 of the law considers the following as acts that pollute or damage wetlands:** washing minerals in streams, rivers and lakes; draining swamps without prior authorization of the competent authority; draining, diverting or blocking a river without prior authorization of the competent authority. These acts are fined by three million Rwandan Francs (3,000,000) and subsequent rehabilitation

**The article 48 discusses offences related to the change of the nature of wetland** which includes any activity compacting or changing the nature of the wetland; or any activity, except those related to research and science, in protected swamps.

**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

- **Article 36: Water use permit:** Any person who uses water or carries out a water-related activity without a water use permit as required under this Law commits an offence.

- **Article 37: Water pollution:** Any person who pollutes water bodies by dumping, spilling or depositing chemicals of any nature above tolerable limit for human health or aquatic life, commits an offence.

- **Article 38:** Any person who directly or indirectly dumps, spills or deposit one or a lot of things into an ecological or groundwater that may pollute water resources commits an offense.

All the offences above are sanctioned, after conviction, by administrative fines with subsequent rehabilitation of damages.

Sources of pollution are generally divided into two categories, namely point sources and nonpoint sources:

- A **point sources** of pollution is one whose initial impact on a water resource is at a well-defined local point (such as a pipe or canal). The US EPA describes point sources of pollution as any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.
- **Nonpoint sources** (also called diffuse sources) of pollution whose initial impact on a water resource occurs over a wide area or long river reach (such as un-channelled surface runoff from agricultural land or storm water and dry-weather runoff from a dense settlement). The US EPA describes nonpoint source pollution resulting from land runoff, precipitation, atmospheric deposition, drainage, seepage or hydrologic modification. Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. NPS pollution is caused by rainfall moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, and ground waters.

Point sources are generally defined as discernible and confined sources of pollution that discharge from a single point of conveyance, such as a pipe, ditch, channel, tunnel of conduit. Key point sources of pollution in Rwanda which impact wetlands are:

- Industrial point sources
- Wastewater treatment works
- Mining wastewater
- Coffee washing stations
- Solid waste dumps

**FIGURE 2-70: DUMP SITE POINT SOURCE POLLUTION, BUGESERA DISTRICT (LEFT) AND MUSANZE-CYUVE (RIGHT) (PICTURE: MAY 2020)**

Nonpoint source of pollution of surface waters in Rwanda is largely caused by rainfall and the associated surface runoff, or groundwater discharge. Key nonpoint sources of pollution in Rwanda which impact wetlands are:

- Agricultural runoff
- Runoff and drainage from urban areas
- Gravel roads and erosion
- Soil erosion, sedimentation of wetlands and water bodies

Figure 2-71: Cut material from road construction dumped on road side on a slope

Road construction should take care, not to dump cut material and other overburden on road side in order to avoid soil degradation and wetland siltation. This is particularly very serious for roads constructed in a steep terrain, when it rains, the material is taken by runoff towards rivers, lakes and wetlands. Approved dumping sites should be used and regulated by local authority in support of REMA and the authority in charge of road construction.

**FIGURE 2-72: Gravel road non-point source pollution above valley-bottom wetlands during construction of Base-Butaro-Kidaho road**

### 2.7.5 Monitoring and evaluation

Monitoring is normally undertaken to verify or check that the conditions imposed on the project are being enforced or to check the status of the affected environment. Audits are periodic assessments to test the accuracy of impact predictions and check if the environmental management practices applied by the developer (user) are compliant to the conditions or requirements stipulated in the EIA.

It is a requirement that Environmental Audits (EA) are conducted for on-going activities that are likely to have significant impacts on the environment, and to ensure compliance with EIA certificate conditions and environmental laws.

For on-going projects that do not have EIA certificate of approval, EAs help to ensure that they comply to the minimum requirements for environmental compliancy. It is noted, however, that these national documents do not provide sufficient detail on how to carry out EA in specific sectors and in 2014, Sector Specific EA Guidelines for Industrial, Agriculture and Mining Projects have been developed to facilitate the EA process within stated sectors.

To ensure against wetland degradation, Environmental law and water resource management law articulate strong measures to deal with projects that are not compliant with use agreements or inflict damage on wetlands and these should be implemented.

The draft Prime Minister's Order outlines monitoring and evaluation procedures, which could be strengthened so that monitoring results trigger enforcement of use restrictions and restoration activities in cases of degradation (Heermans and Ikirezi, 2015).

Equipping a strong inspection team with the resources needed to monitor wetlands, collect data on wetlands condition, and record uses in wetlands would facilitate compliance with use agreements and help wetland users better understand boundary fluctuations, gauge condition and act quickly when degradation becomes apparent (Heermans and Ikirezi, 2015). Some monitoring responsibilities should be delegated to District and Sector environmental officers so that quick site visits can be made to check conditions and ensure regulatory compliance of projects. Yet, many District and Sector offices are already stretched thin and typically do not have the resources or capacity to collect and process technical environmental data (Heermans and Ikirezi, 2015). To account for this, the majority of monitoring responsibilities should be delegated to an experienced wetlands inspection unit within MINIRENA and REMA, which is equipped to manage data on wetlands use and conditions over time at a national scale (Heermans and Ikirezi, 2015). Within the City of Kigali, monitoring and enforcement is effectively performed by REMA. A recent result of such monitoring put a halt on the renovation of Kigali's golf course due to non-compliance with terms of the project's EIA (Heermans and Ikirezi, 2015). A similar level and quality of monitoring rigor needs to be afforded to wetland use projects across all provinces as well.

A monitoring system would also be able to create a robust source of data that could be used to improve wetland management strategies over time.

The draft Prime Minister's Order also suggests the use of incentives and penalties to motivate sustainable use and regulatory compliance. Incentives may be in the form of lease extensions, lease rate discounts or monetary rewards for projects that contribute to enhanced wetlands sustainability, restoration or other conservation activities (Heermans and Ikirezi, 2015). Incentives should be tailored specific to each project and included in use agreements before project initiation. Penalties should be geared to prevent wetland degradation or loss (Heermans and Ikirezi, 2015). Penalties issued for non-approved uses or degradation could include fines, revocation of use agreements, and, in serious cases even imprisonment, but should be stringent and consistent across all wetlands use projects (Heermans and Ikirezi, 2015). The use of incentives and penalties requires extensive monitoring so that rewards or fines are issued fairly and appropriately. MINIRENA, as well as District and Sector environmental units, should be prepared with the necessary resources to closely monitor private projects to ensure regulatory compliance and avoid wetland degradation or loss. To ensure that wetlands management activities are properly resourced, fees generated by wetlands leases and penalties should be reinvested in monitoring, incentives and restoration activities (Heermans and Ikirezi, 2015). Fees and penalties often roll back into general government funds or are reallocated for non-related purposes, which could leave wetlands underfunded and ill-equipped to ensure sustainable use and protection (Heermans and Ikirezi, 2015).

Apart from project specific monitoring and evaluation against project specific objectives, there currently seems to be little national monitoring of wetlands in Rwanda.

### 2.7.6 Findings and Recommendations

Findings and recommendations from analysis of wetland management are provided in Table 2-31 below:

**TABLE 2-31 WETLAND MANAGEMENT: FINDINGS AND RECOMMENDATIONS**

| FINDINGS | RECOMMENDATIONS |
|---|---|
| The majority of Rwandans use wetlands for agricultural purposes. This puts a strong pressure on wetlands for food security. The | Rather than generalising about the balancing of ecosystem services there should rather be a focus on ensuring that the provisioning services |

| FINDINGS | RECOMMENDATIONS |
|---|---|
| productive use of wetlands needs to be within limits in order to allow for continued functioning of a wetland. | of wetlands be more specific when setting national and catchment goals for wetlands. The biophysical characteristics of a wetland dictate what kind of uses the wetland can support, and the condition of the wetland influences the potential of the wetland to support the use depending on the degree of degradation of the wetland. The low overall gradient of the majority of cultivated wetlands in Rwanda, together with the favourable climate and relatively sustained groundwater and interflow supporting these wetlands, means they are relatively resilient in the face of extensive use by agriculture. Lastly, any use of a wetland should be viewed against the risk posed both to the loss of a livelihood benefit to people, or degradation of wetland habitat. |

# CHAPTER 3 ENVIRONMENTAL AND SOCIAL CONDITIONS IN THE STUDY AREA

## 3.1 NAKU Catchment

This task was supposed to gather information considering the existing knowledge on status and health of wetlands in Nile Akagera Upper catchment (NAKU). The guiding paths proposed by District Environment offices and Natural resources officers together with field observations including the use of questionnaire helped in understanding the baseline information on ecosystem services provided by wetlands in this catchment. These include identification of wetlands degradation indicators, the extent to which wetlands are managed and to propose the interventions to address the existing problems concerning wetlands management. The map below highlights the spatial distribution of land use/Land cover (LULC) in NAKU catchment.

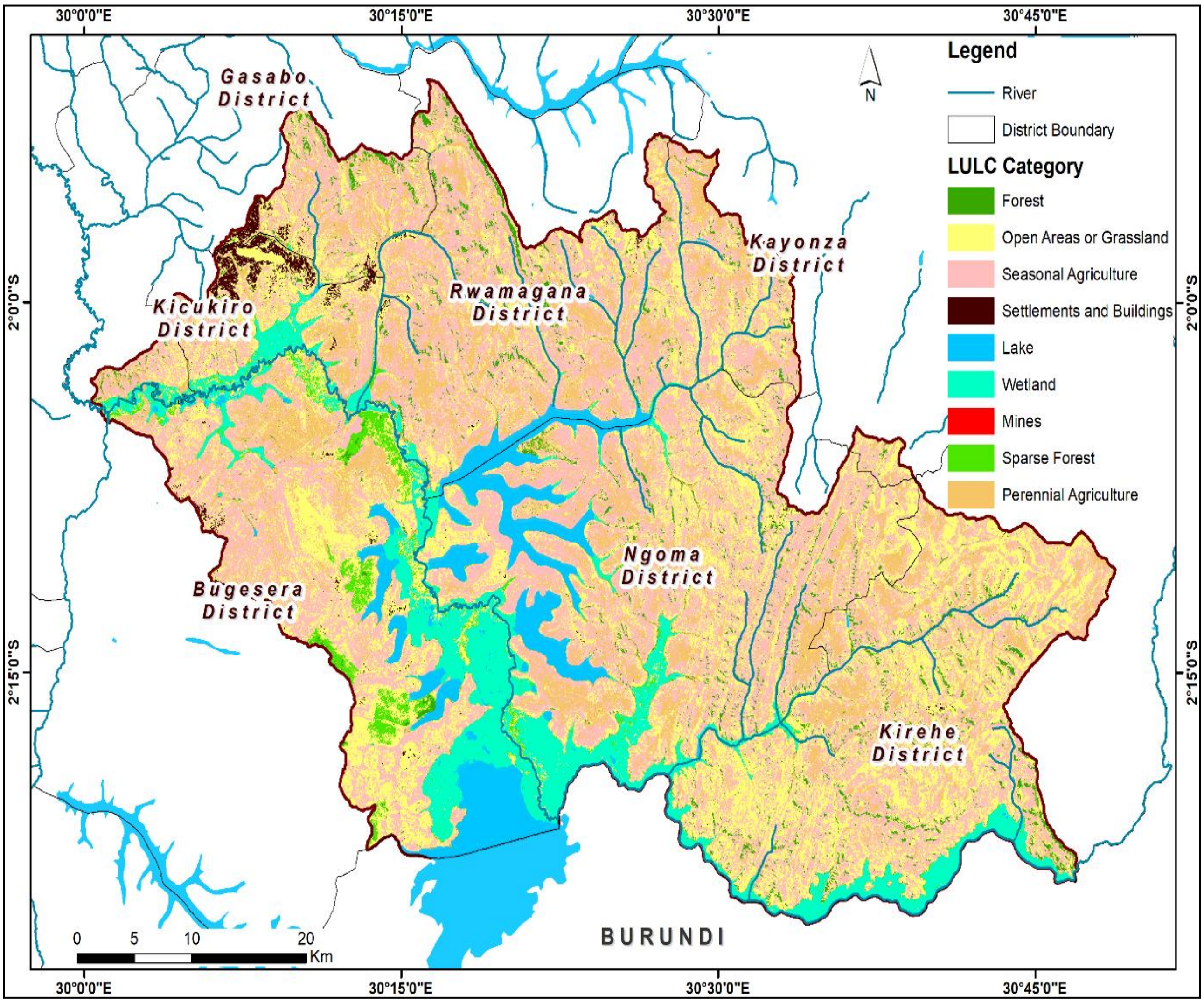



**Figure 3-1: Spatial distribution of existing LULC in NAKU catchment**

The Districts considered in this catchment are Kirehe, Ngoma, Bugesera, Rwamagana and Kicukiro. Most of the visited wetlands in NAKU catchment are dominated by agricultural activities with both subsistence and cash crops. Based on the information provided by the District officials, these wetlands are under management of the Districts in partnership with respective key stakeholders. The table below indicates area coverage of existing LULC in NAKU catchment.

**TABLE 3-1 AREA COVERAGE OF EXISTING LULC IN NAKU CATCHMENT**

| S/N | LULC Category | Area (Ha) | Area (%) |
|---|---|---|---|
| 1 | Seasonal Agriculture | 125,442.7 | 40.9 |
| 2 | Perennial Agriculture | 38,263.0 | 12.5 |
| 3 | Dense Forest | 8,711.9 | 2.8 |
| 4 | Sparse Forest | 5,254.2 | 1.7 |
| 5 | Open Areas or Grassland | 87,081.4 | 28.4 |
| 6 | Settlements and Buildings | 2,437.2 | 0.8 |
| 7 | Waterbody | 13,996.8 | 4.6 |
| 8 | Wetland | 25,282.0 | 8.2 |
| 9 | Mines | 3.2 | 0.0 |

### 3.1.1 Perception about ecosystem services with different land uses

The main goal in this section was to understand the community perception on ecosystem services provided by different wetland uses in NAKU catchment. A total of 200 respondents were interviewed and only wetland land use was evaluated considering provisioning services, regulating & supporting services and cultural services within the wetlands localized in this catchment.

Provisioning services under consideration as can be seen on the below figure were subsistence crops, commercial crops (cash crops), wild foods, livestock feed, fuel, fresh water, ornamental resources and natural plants-derived medicines. Considering the number of respondents interviewed in this catchment, wetlands in this catchment are dominated by subsistence crops and cash crops. Note that in this study, cash crops are defined as crops that can be sold directly to a user for money such as rice, wheat, corn and sugar cane and commercial crops are defined as crops that are sold to a second party for refinement into new products to sell such as coffee, tea and pyrethrum were considered together as commercial crops.

The respondents highlighted that all the wetlands in NAKU catchment provide more subsistence crops, cash crops, wild food and fresh water compared to other provisioning services. In this catchment, the most subsistence crops observed are cabbages, beans and fruit-trees while cash crops included rice, maize, and pepper.

Other provisioning services provided by wetlands in NAKU catchment considerably are wild foods especially fish and plants, livestock feed, ornamental resources especially flowers and clay and plant-derived medicine. On the other hand it was found that wetlands within this catchment do not provide fuel resources at a considerable level and the provision of cash crops, mainly rice, by the wetlands in this catchment was observed to be highly reliable on the market.

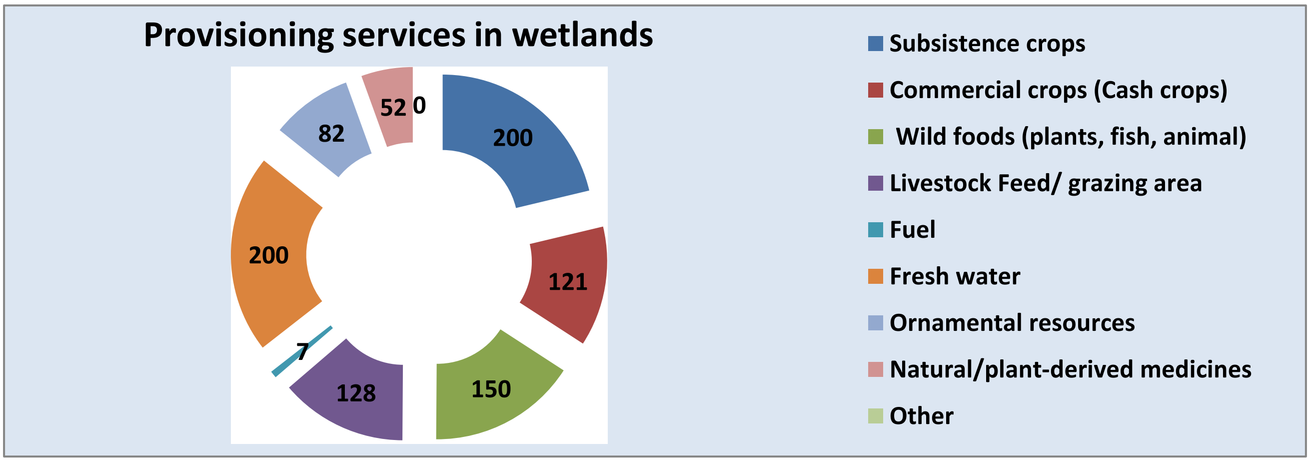



**Figure 3-2: Perception of provisioning services in NAKU catchment**

Regulating and supporting services considered in this section are regulation of air quality, water purification, regulation of disease & pests, flood regulation, erosion regulation, noise buffering and soil formation. As highlighted on the figure below, the major and important regulating and supporting services provided by wetlands in NAKU catchment include water purification, flood regulation, erosion regulation and soil formation. However, most of the respondents did not provide their answers on the regulation of air quality, regulation of diseases & pests and noise buffering probably because they do not have much knowledge about them.

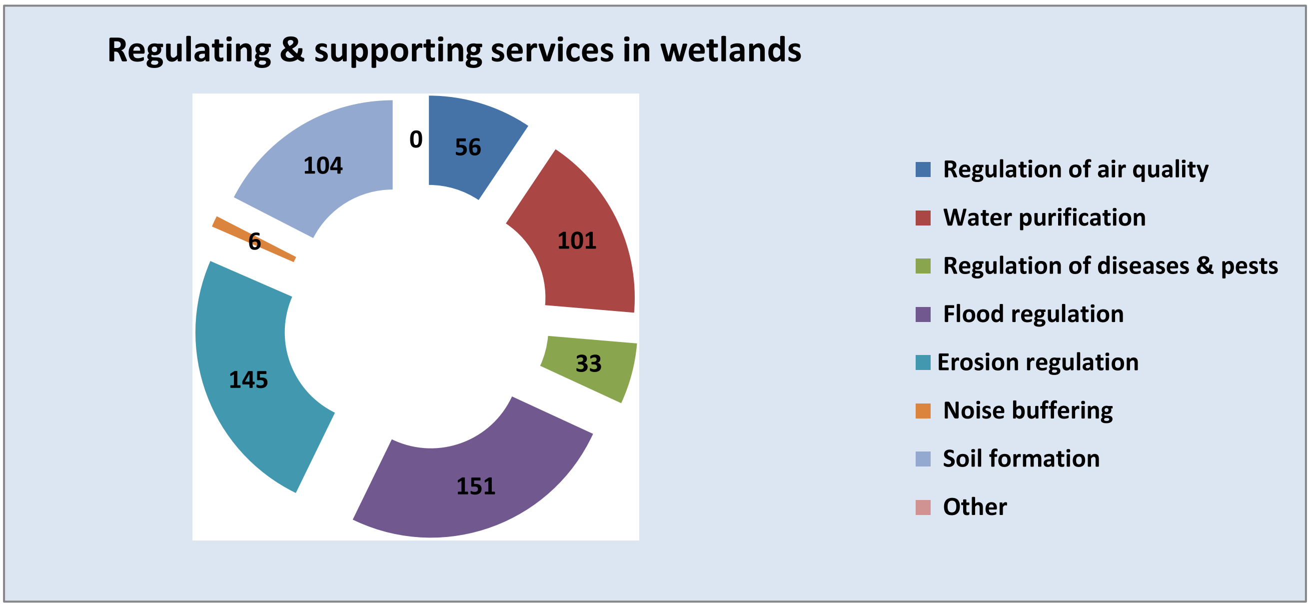



**Figure 3-3: Perception of regulating & supporting services in NAKU catchment**

The responses received on cultural services showed that this category does not highlights much frequency of responses compared to other ecosystem services described before. Cultural services considered in this category include spiritual values, cultural heritage & practices, education & knowledge systems, recreation, and ecotourism. Therefore, as can be seen on the below figure, spirituals values, education &knowledge systems, recreation, and ecotourism are highlighted as ecosystem services provided by the wetlands in this category but at a low frequency while cultural heritage & practices were not highlighted based on the answers from the respondents.

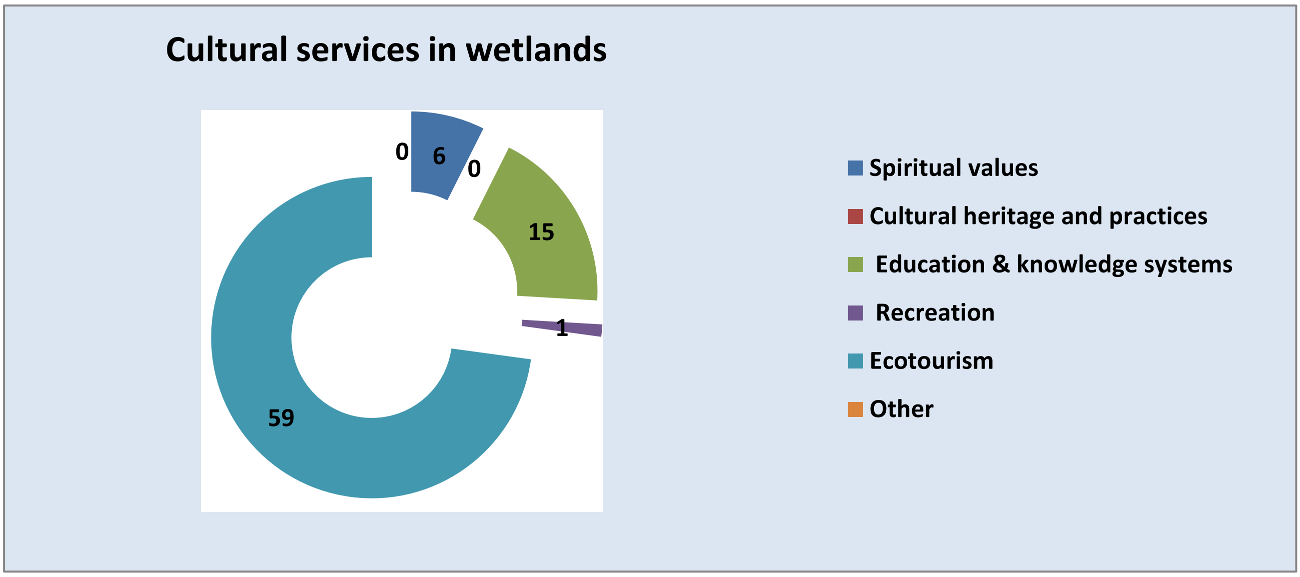



**Figure 3-4: Perception of cultural services in NAKU catchment**

### 3.1.2 Perception about importance of ecosystem services with different land uses

The main goal in this section was to assess the importance of ecosystem services in NAKU catchment provided by the wetlands for everyone. Knowledge of the role of wetlands together with the extent to which activities practiced in wetlands contributes to the wellbeing of the community were also assessed. The ecosystem services under consideration in this section were provisioning services, regulating & supporting service and cultural services. Starting with provisioning services as can be seen on the figure below, services under consideration in this category were subsistence crops, commercial crops, wild food, livestock feed, fuel, fresh water, ornamental resources and natural/plant-derived medicine. Based on the knowledge of respondents, services provided by the wetlands in this catchment highlighted as very important are subsistence crops, fresh water, wild foods, and cash crops with more than 50 responses each respectively. Services highlighted as somehow important are wild foods, livestock feeds, and cash crops with more than 50 responses each respectively.

Ecosystem services highlighted as not important in this category are: fuel, natural/plant-derived medicine, ornamental resources and livestock feed with more than 50 responses each respectively. Finally, ecosystem services highlighted as not known in this catchment are cash crops, natural/plant derived medicine and fuel with more than 50 responses each respectively.

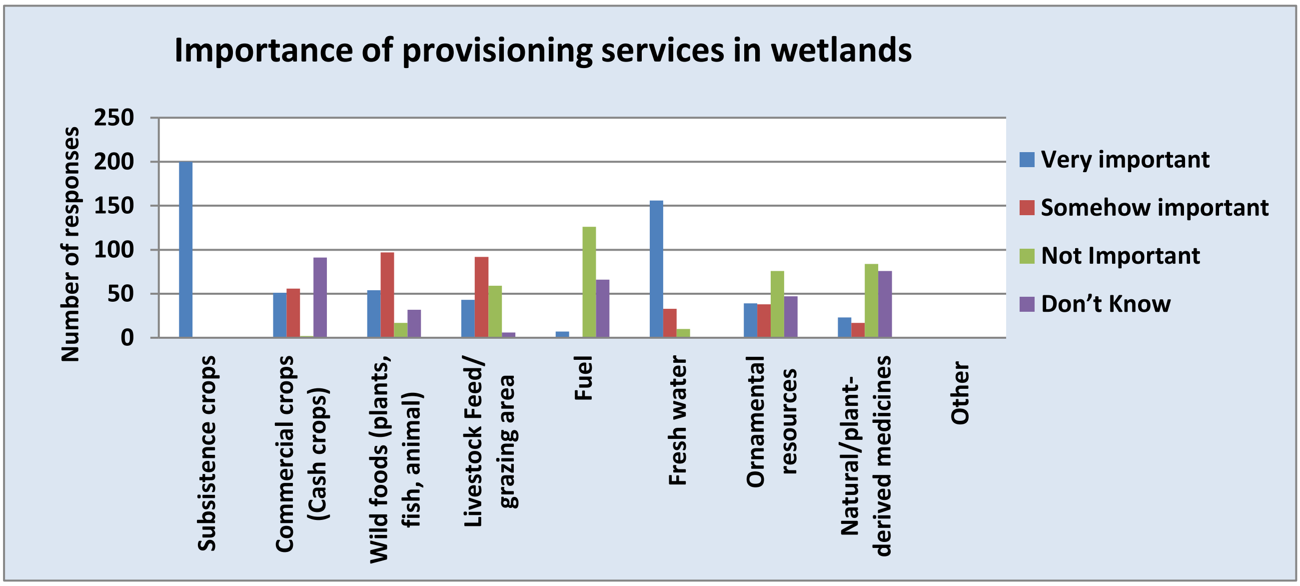



**Figure 3-5: Perception of importance of provisioning services in NAKU catchment**

Regulating and supporting services considered in this section are regulation of air quality, water purification, regulation of disease & pests, flood regulation, erosion regulation, noise buffering and soil formation. Based on the knowledge of respondents about the ecosystem services in this category, services highlighted as very important are flood regulation, regulation of air quality, water purification and erosion regulation with more than 30 responses each respectively. Ecosystem services highlighted as somehow important are erosion regulation, flood regulation and soil formation with more than 70 responses each respectively as shown in the below figure.

On the other hand, ecosystem services highlighted as not important are regulation of disease & pests and regulation of air quality with more than 10 responses each respectively while ecosystem services highlighted as not known in this category are noise buffering, regulation of air quality, water purification, soil formation and regulation of diseases & pests with more than 100 responses each respectively.

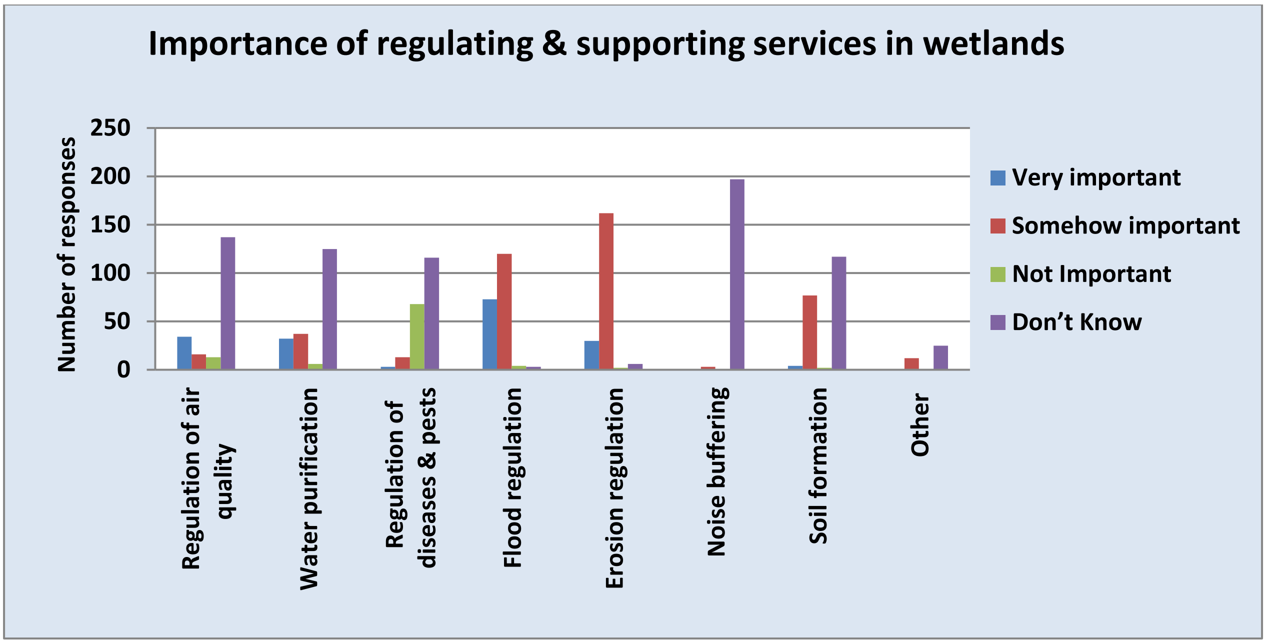



**Figure 3-6: Perception of importance of regulating & supporting services in NAKU catchment**

Cultural services includes spiritual values, cultural heritage and practices, education and knowledge systems, recreation and ecotourism. Based on the responses from the respondents, there is no ecosystem services highlighted as very important in this category while ecosystem services highlighted as somehow important are ecotourism and spiritual values with more than 10 responses each respectively. Ecosystem services highlighted as not important in this category are recreation, spiritual values, education & knowledge systems, ecotourism and cultural heritage & practices with more than 60 responses each respectively. Finally, ecosystem services highlighted as not known as shown in the below figure are cultural heritage and practices, education and knowledge systems, spiritual values, recreation and ecotourism with more than 80 responses each respectively.

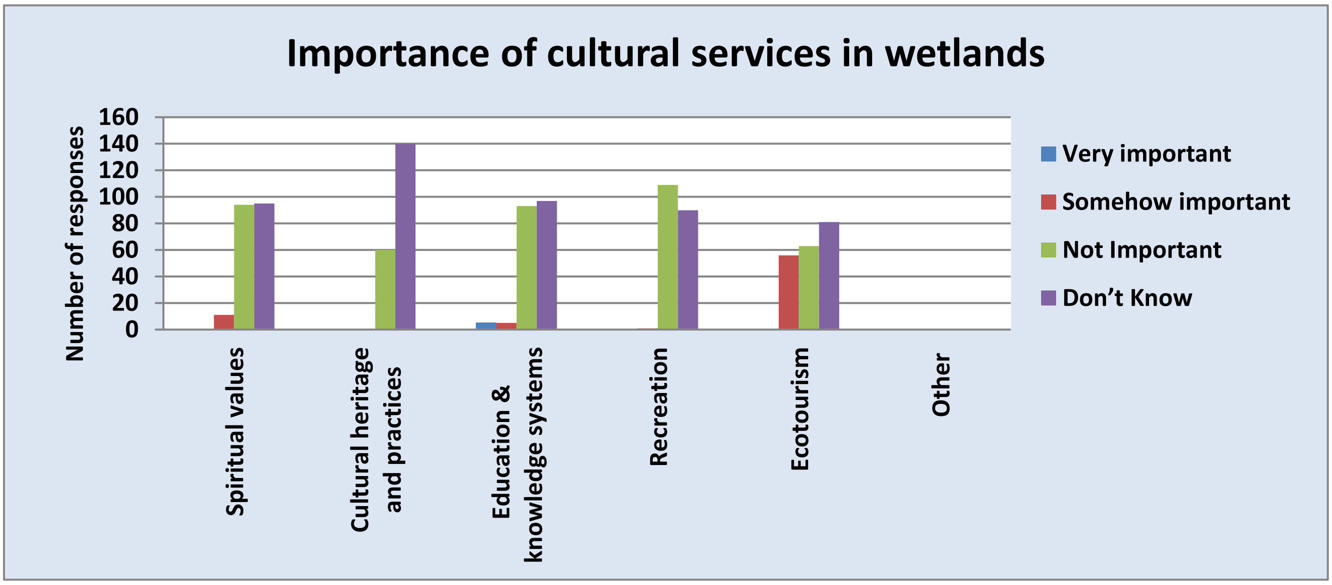



**Figure 3-7: Perception of importance of cultural services in NAKU catchment**

### 3.1.3 Economic and livelihood dependence on wetlands

The main goal of this section was to assess the extent of economic and livelihood dependence of the population on wetlands in NAKU catchment mostly by rating ecosystem services. The only services under consideration in this category are provisioning services and the analysis allows identifying ecosystem services that the majority of population considers as being essential and wetland dependable. As can be seen on the figure below, the ecosystem services highlighted as highly dependent are subsistence crops, fresh water , wild foods, commercial crops, and ornamental resources with more than 30 responses each respectively. This shows the extent at which economic and livelihood depend on these ecosystem services provided by the wetlands in this catchment. Also commercial crops, fresh water, and wild food, and livestock feed are highlighted as somehow dependent with more than 45 responses each respectively. Ecosystem services highlighted as not dependent at all are: fuel, livestock feeds, and ornamental resources with more than 60 responses each respectively. This shows the extent at which economic and livelihood do not depend on these ecosystem services provided by the wetland. Though fuel is not a dependable ecosystem service in this catchment, it is again highlighted as not known together with natural/plant-derived medicine with more than 100 responses each respectively.

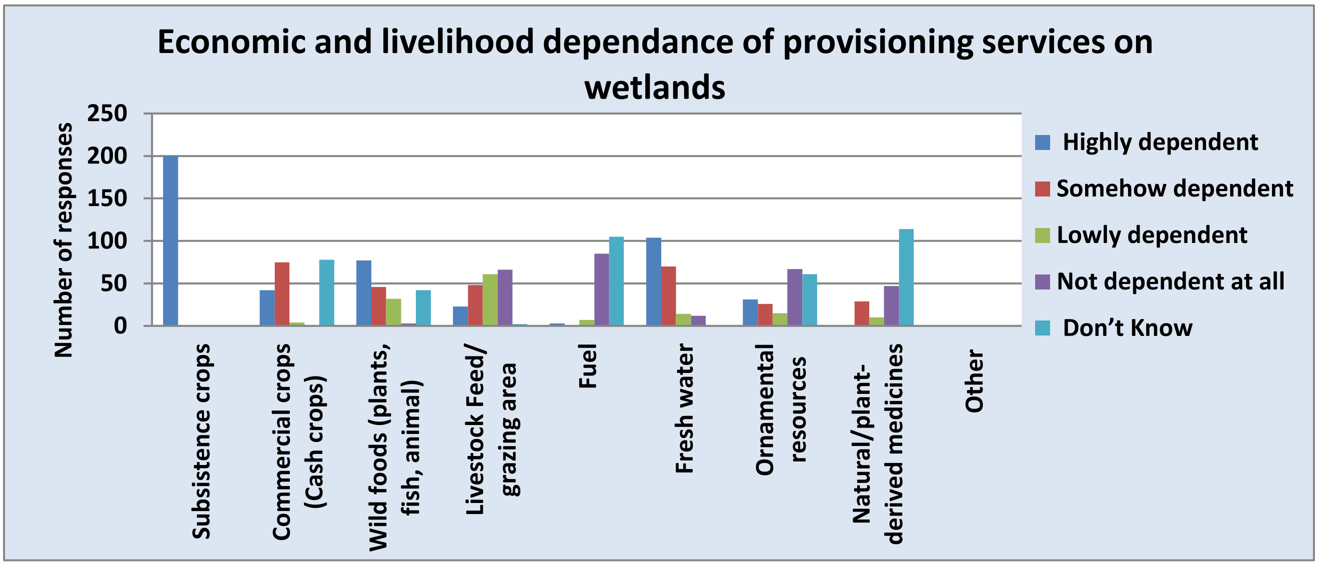



**Figure 3-8: Economic dependence and livelihood on wetlands in NAKU catchment**

### 3.1.4 Trends of ecosystem services provision associated with wetlands in the past 5 years

The main goal of this section was to assess the trend of ecosystem services provided by the wetlands in NAKU catchment over past five years. The ecosystem services under consideration in this category are provisioning services, regulating & supporting services and cultural services. From the responses, provisioning services have been increasing in past five years with regards to fresh water, subsistence crops, cash crops, and wild foods with more than 60 responses each respectively. On the other hand, ecosystem services like wild foods, livestock feed, and ornamental resources highlighted no change in past five years with more than 50 responses each respectively as can be seen on the figure below.

However, provisioning services highlight a decrease in past five years with regards to subsistence crops and livestock feeds with more than 30 responses each respectively. Finally, the trend of other provisioning services delivered by wetlands in past five years is not known with regards to fuel, natural/plant-derived medicine, ornamental resources, cash crops, and livestock feeds with more than 70 responses each respectively.

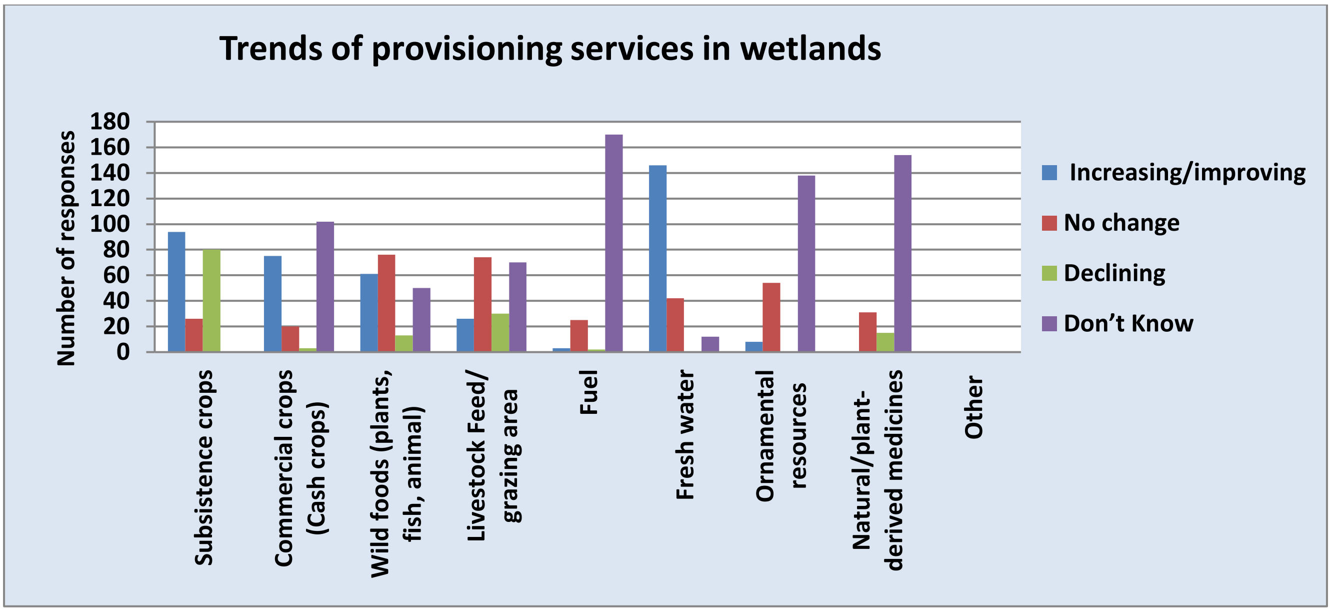



**Figure 3-9: Trends of provisioning services by wetlands in NAKU catchment over the past 5 years**

The trend of regulating and supporting services provided by the wetlands in NAKU catchment is increasing with regards to soil formation, regulation of air quality, water purification, erosion regulation, and flood regulation with more than 25 responses each respectively as can be seen on the figure below. However, other ecosystem services trend is highlighted as no change in past five years, and those include flood regulation, erosion regulation, regulation of disease & pests, water purification, and regulation of air quality with more than 30 responses each respectively.

Concerning the ecosystem services classified as declining, it is highlighted on the figure that erosion regulation and flood regulation are declining services over a period of past five years with more than 20 responses each respectively. Lastly, the community in NAKU catchment seem to have no information about the trend of some ecosystem services like  noise buffering, regulation of air quality, regulation of disease & pests, soil formation, and water purification with more than 100 responses each respectively.

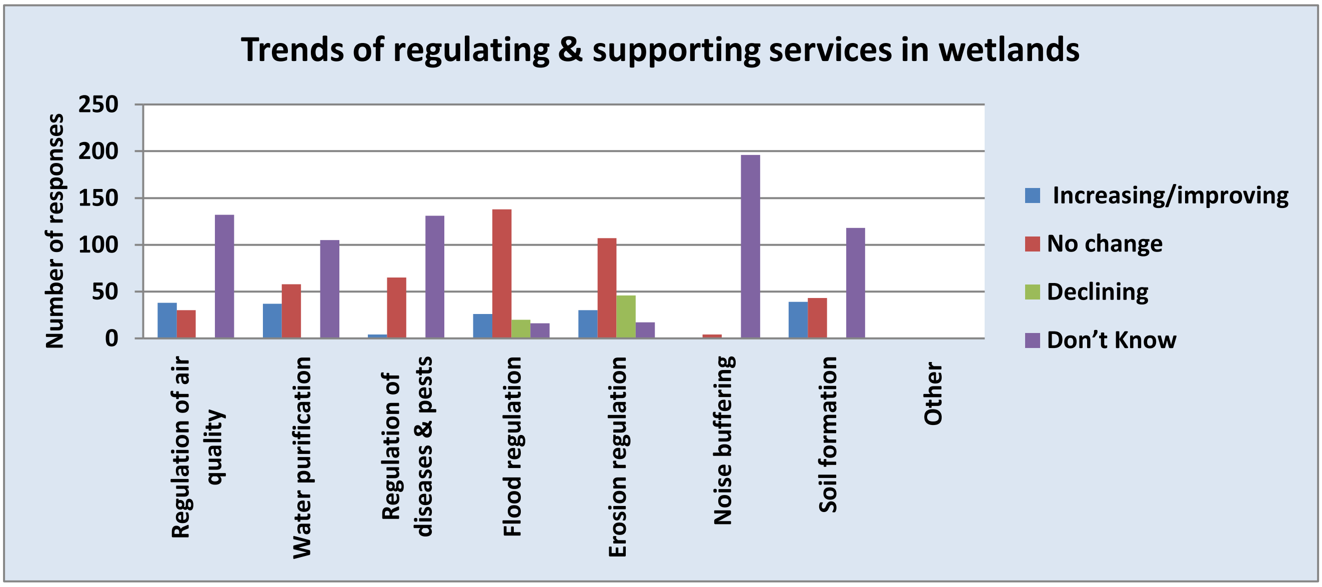



**Figure 3-10: Trends of regulating & supporting services by wetlands in NAKU over the past 5 years**

Cultural services highlights only education & knowledge systems which is increasing with 8 responses respectively and some respondents admitted that ecotourism, spirituals values, education & knowledge systems, and recreation have no change when overlooked in a period of past five years with more than 5 responses each respectively. Otherwise, all the services under consideration in this category are highlighted as not known with more than 160 responses each respectively as can be seen on the figure below.

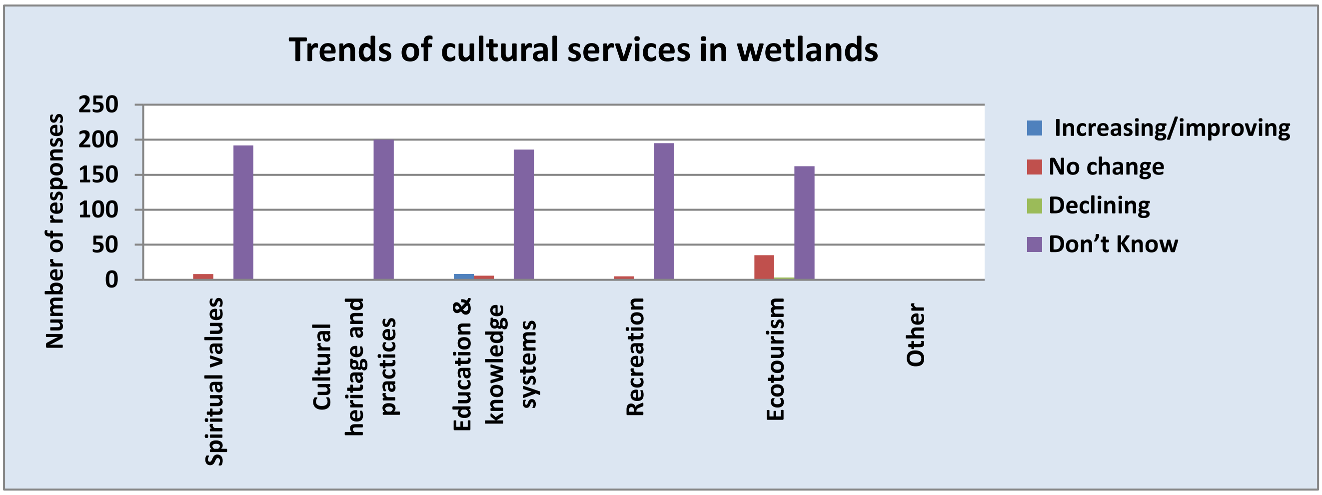



**Figure 3-11: Trends of cultural services provided by wetlands in NAKU catchment over the past 5 years**

### 3.1.5 Most important driver for the indicated trend of change

The main goal of this section was to analyse the drivers of ecosystem services identified as declining previously. All the ecosystem services under consideration are provisioning services, regulating & supporting services, and cultural services. The trends of drivers over past five years have been analysed in the figure below within NAKU catchment. Based on the numbers of respondents, other (drivers) occupy 56% of responses respectively. Those other drivers include: Sugar cane cultivation, flooding, erosion, saline water, unfertile soil, poor management of agriculture, rising of water table and Invasion by Hippopotamus.

Provisioning services, regulating & supporting services, and cultural services mentioned as declining in this catchment over a period of past five years have been mostly driven by climate change(27%), infrastructure development (12%), changing land use (2%), changing agro-chemical input use (1%), and changing market demand (1%) of responses respectively as it is highlighted below.

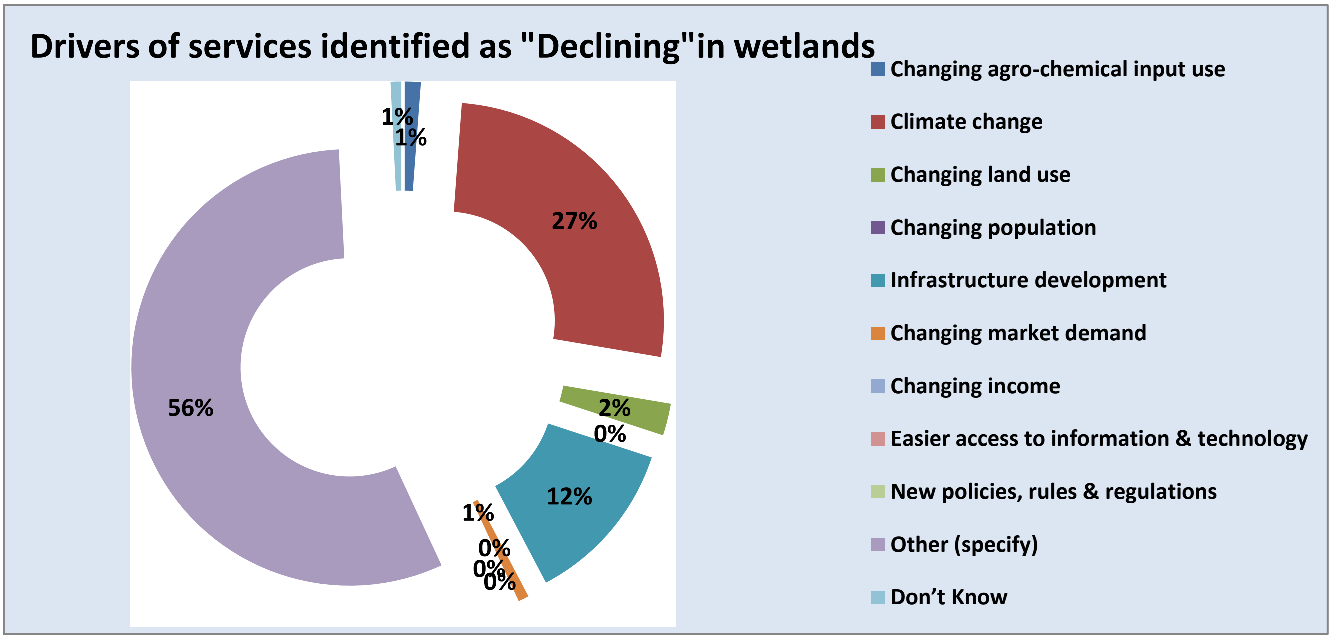



**Figure 3-12: Drivers for the trend of change/ declining of ecosystem services in NAKU catchment**

### 3.1.6 Natural hazards in the wetland area and surrounding

The main goal of this section was to assess the natural hazards currently occurring in wetlands and surrounding area within NAKU catchment. The natural hazards under consideration in this section are: flood events, mass movements, strong sedimentation coming from the water course, erosion of river banks, and disease caused by contaminated water. It should be noted that the population highlighted that wetlands are affected by flood events, erosion of river banks, diseases caused by contaminated water, and strong sedimentation coming from the water course with more than 90 responses each respectively. As can be seen on the figure below, wetlands and terrains in NAKU catchment are least affected by mass movements /landslide/rock fall with 13 responses respectively.

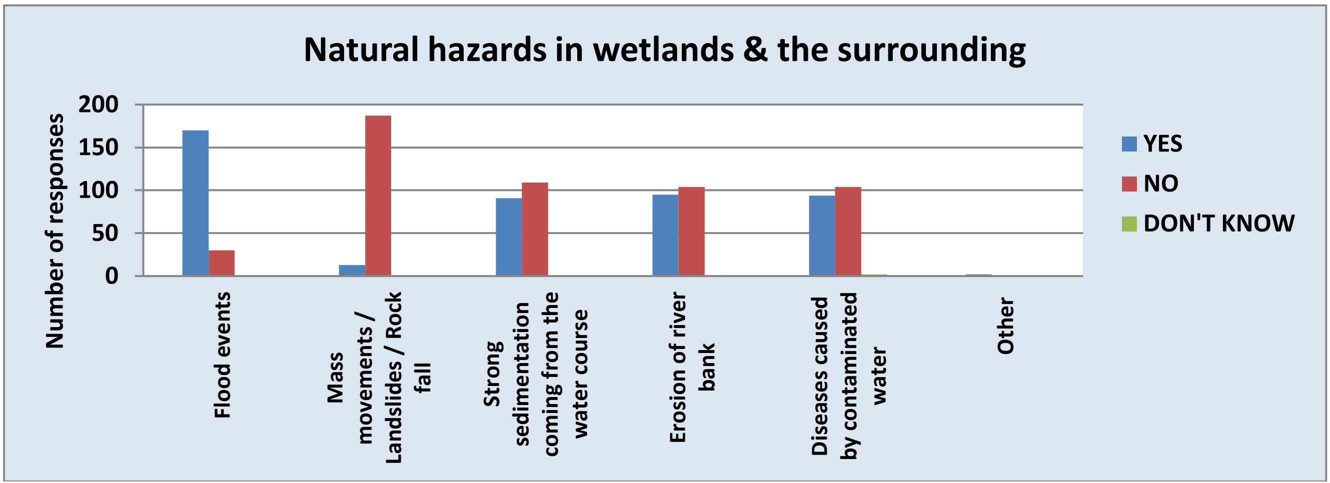



**Figure 3-13: Natural hazards in the wetland area and surrounding in NAKU catchment**

### 3.1.7 Opinion concerning wetland restoration: Fears and Opportunities

The main goal of this part was to assess communities' interests and concerns regarding wetlands restoration in NAKU catchment. Based on the opinions provided by the respondents the main fears for the restoration of wetlands in NAKU catchment are "loss of livelihood"," loss of assets", and "loss of land" with 200,199, and 88 responses respectively. On the other hand, the population do not fear the "loss of cultural heritage and practices" as can be seen on the figure below.

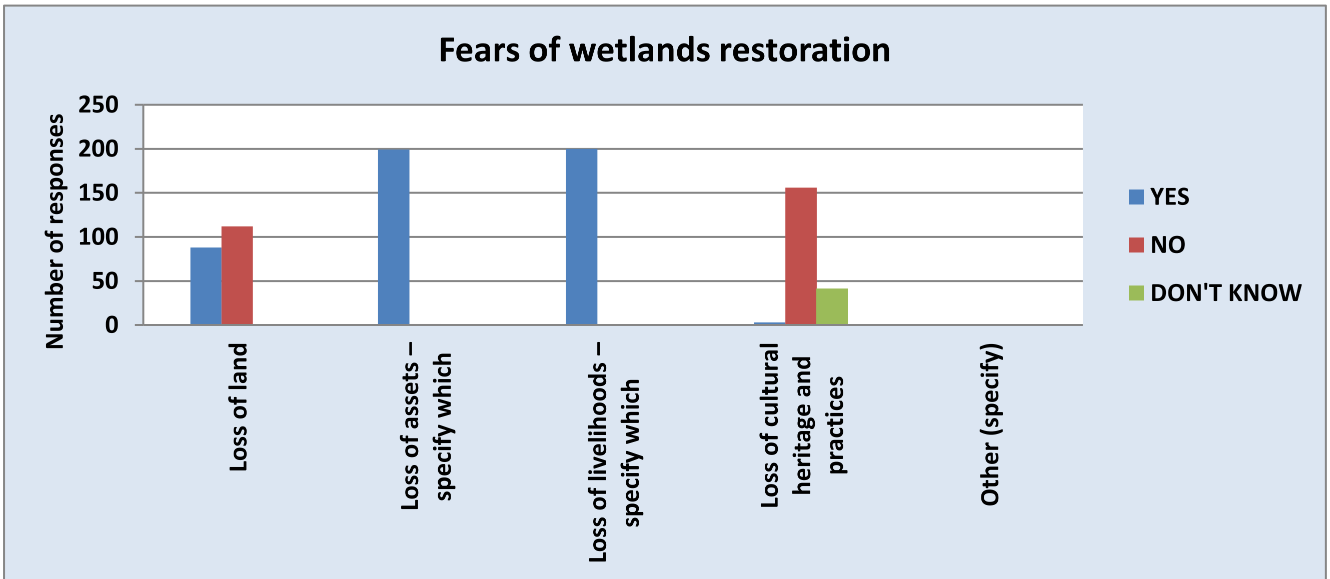



**Figure 3-14: Fears about the wetlands restoration in NAKU catchment**

In addition, restoration of wetlands in NAKU catchment can provide a good opportunity for "water purification", "erosion regulation", "flood regulation", "regulation of disease and pests", and "regulation of air quality" with more than 165 responses each respectively as can be seen on the figure below. Soil formation and ecotourism can be a good opportunity for wetland restoration in NAKU catchment while education and knowledge systems, recreation, and noise buffering cannot be seen as good opportunities for wetlands restoration process.

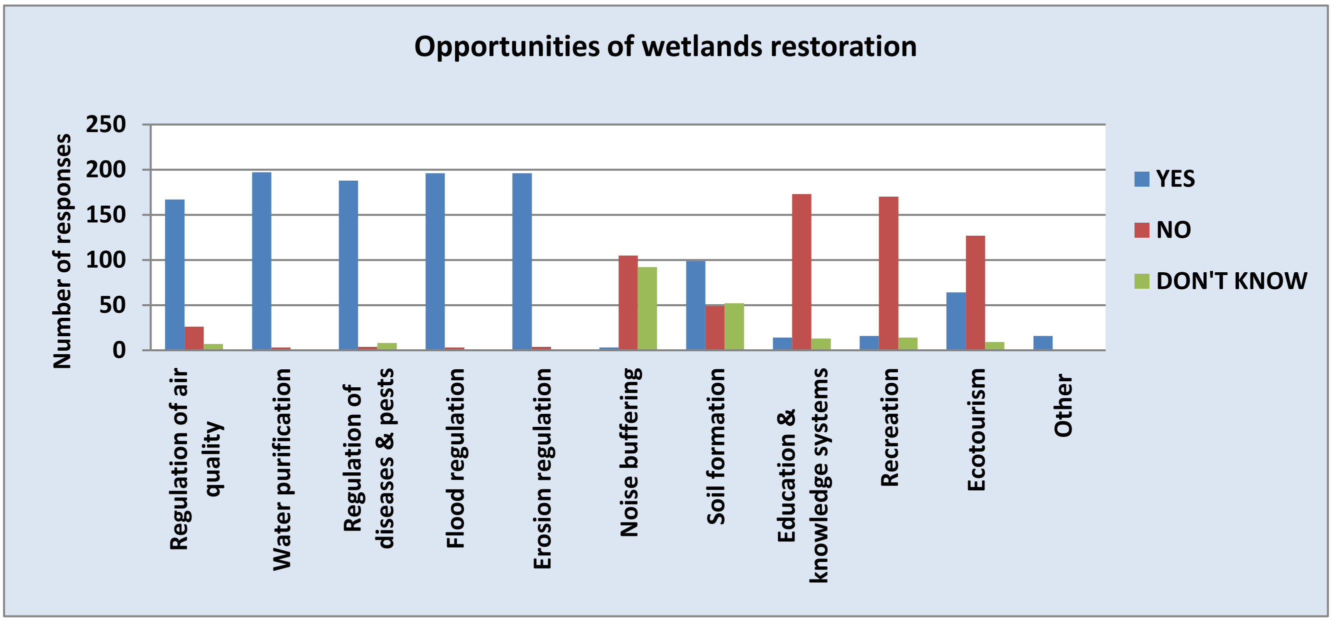



**Figure 3-15: Opportunities about wetlands restoration in NAKU catchment**

### 3.1.8 Analysis of drivers of wetland degradation

The main goal of this section was to understand the drivers of change by assessing the extent at which the drivers of ecosystem degradation under consideration are practiced in the area. The figure below highlights the drivers considered in this category which are: Agricultural activities, eutrophication and pollution, infrastructure development, wetland overharvesting, emergent invasive species, loss of indigenous species, and alteration of biogeochemical cycles. In line with responses, the communities consider wetland overharvesting, infrastructure development, and eutrophication & pollution as the main drivers of ecosystem degradation of wetlands and neighbouring environment in NAKU catchment while agricultural activities are not considered as part of the root cause of ecosystem degradation and other drivers like emergent invasive species, loss of indigenous species, and alteration of biogeochemical seem to be strange to the community because they are not known by the community either causing or not causing ecosystem degradation.

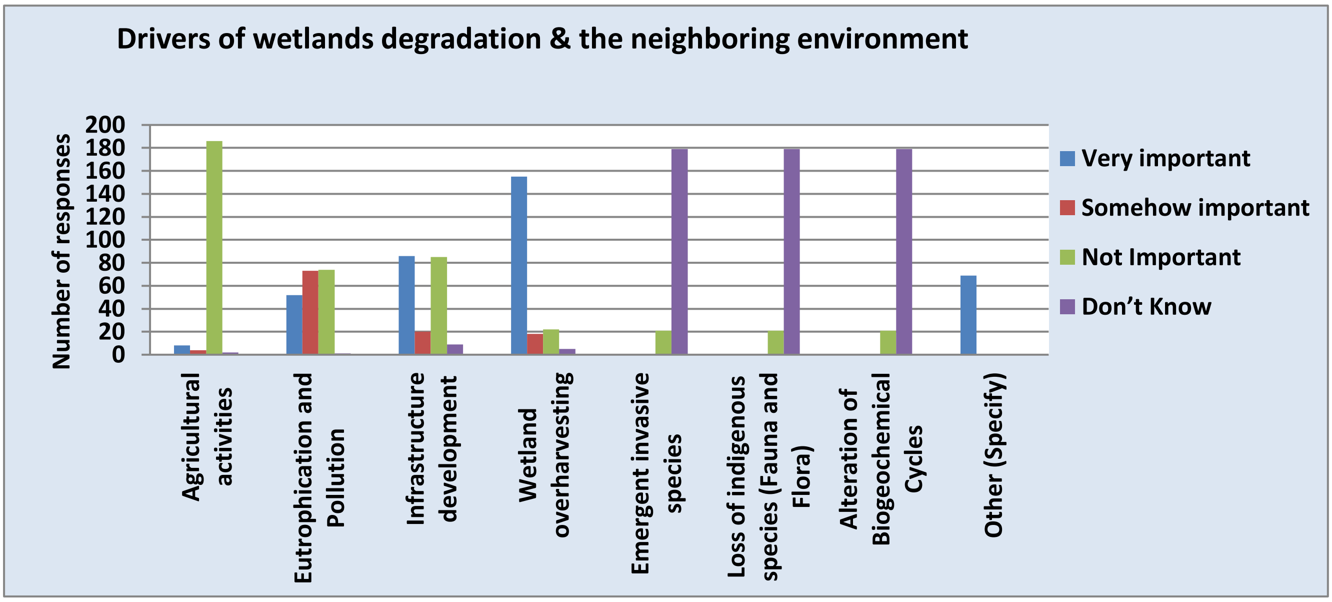



**Figure 3-16: Drivers of change for wetland degradation in NAKU catchment**

### 3.1.9 Wetland degradation indicators in catchment

Through field visits observations, questionnaire respondent opinions and interviews with district environmental officers and/ or natural resource management directors, each of the following rating was classified according to the status of wetland in terms of degradation:

- **High**: indicators have a considerable effect on the ecosystem services, the rating range between 61% and 100%
- **Medium**: indicators have a moderate effect on the ecosystem services, the rating range between 31% and 60%
- **Low**: indicators have no or less effect on the ecosystem services, the rating range between 0% and 30%

**TABLE 3-2 Indicators of wetland degradation in visited wetlands**

| VISITED WETLANDS | CATCHMENT | DISTRICT | WETLAND DEGRADATION INDICATORS | | | | | | | | STATUS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Erosion | Flood | Eutrophication | Wetland overharvesting | Infrastructure development | Agricultural activities | Mass movements/ land slides | Sedimentation | |
| MAKERA | **NNYU** | MUHANGA | High | High | High | High | High | Low | Low | High | Not well managed |
| RUGERAMIGOZI I | **NNYU** | MUHANGA | High | High | Low | High | Low | Low | Low | High | Not well managed |
| RUGERAMIGOZI II | **NNYU** | MUHANGA | High | High | High | High | High | Low | Low | High | Not well managed |
| GACURABWENGE | **NNYL** | KAMONYI | High | Medium | Medium | High | Low | Low | Low | High | Not well managed |
| RUBUMBA | **NNYL** | KAMONYI | High | High | High | Low | Medium | Low | Low | High | Not well managed |
| UNILAK | **NNYL** | GASABO/KICUKIRO | Low | High | High | Medium | High | Low | Low | Low | Not managed |
| UMUSHUMBAMWIZA | **NNYL** | KICUKIRO | Medium | Medium | High | High | High | Low | Low | Medium | Not well managed |
| RWAMPARA | **NNYL** | NYARUGENGE | Medium | Medium | High | Medium | Low | Low | Low | High | Not managed |
| NYABUGOGO | **NNYL** | NYARUGENGE | Low | High | High | High | Low | Medium | Low | High | Not managed |
| MAGERAGERE | **NNYL** | NYARUGENGE | High | High | Medium | High | High | Low | Low | High | Not well managed |
| NZOVE | **NNYL** | NYARUGENGE | High | High | High | Low | High | Low | Low | Medium | Not managed |
| KINYINYA | **NNYL** | GASABO | Low | High | High | Medium | High | Low | Low | Low | Not well managed |
| NYAKIREHE | **NNYL** | GASABO | Low | Low | High | Low | Low | Low | Low | Low | Not managed |
| KUDASHYA | **NNYL** | GASABO | Medium | High | Medium | Medium | Low | Medium | Low | Medium | Not managed |
| FUMBWE | **NNYL** | GASABO | Medium | Medium | Low | Medium | Low | Low | Low | Low | Not well managed |
| MULINDI | **NNYL** | GASABO | Medium | High | Low | High | High | Low | Low | Medium | Not well managed |
| MUKARANGE | **NNYL** | KAYONZA | Medium | High | High | High | Medium | Low | Low | Low | Managed |
| GAHINI | **NAKL** | KAYONZA | Medium | Medium | High | Medium | Low | Low | Low | Low | Not well managed |
| KANYONYOMBA I | **NNYL** | GATSIBO | Medium | Medium | Low | Medium | Low | Low | Low | High | Managed |
| KANYONYOMBA II | **NNYL** | GATSIBO | Medium | Medium | Low | High | Low | Low | Low | Medium | Managed |
| NTENDE | **NMUV** | GATSIBO | Low | Medium | Low | Medium | Low | Low | Low | Low | Well managed |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NYARUTARAMA | **NMUV** | GICUMBI | Medium | Medium | Low | Medium | Low | Low | Medium | Low | Not managed |
| BUKURE | **NNYL** | GICUMBI | High | High | Low | High | Low | Medium | Low | High | Not well managed |
| BWANYA | **NNYL** | GICUMBI | Medium | High | High | Low | Low | Low | Low | High | Not managed |
| NYARUBUBA | **NNYL** | RULINDO | Medium | Medium | Low | High | Low | Low | High | High | Not well managed |
| BAHIMBA | **NNYL** | RULINDO | High | High | Medium | High | Medium | Low | High | High | Not well managed |
| NYAMUGENDERAMFURA | **NNYL** | RULINDO | Low | Low | Low | Medium | Low | Low | Low | Low | Managed |
| NYABARONGO | **NMUK** | NGORORERO | High | High | Medium | Low | Low | Low | High | High | Not managed |
| BUSENGO | **NMUK** | GAKENKE | High | High | Low | High | Low | Low | High | High | Not managed |
| MUKINGA | **NMUK** | GAKENKE | Medium | Medium | Low | Low | Low | Low | Low | Medium | Not managed |
| NDONGOZI | **NMUK** | BURERA | High | High | Low | High | Low | Low | High | High | Not well managed |
| NEMBA | **NMUK** | BURERA | High | High | Medium | High | Low | Low | High | High | Not managed |
| RWAZA | **NMUK** | MUSANZE | High | High | Low | High | Low | Low | Low | High | Not managed |
| GASHORA | **NAKU** | BUGESERA | Medium | Low | Low | Low | Medium | Low | Medium | Low | Not well managed |
| NTARAMA | **NAKU** | BUGESERA | Medium | Medium | Low | High | Low | Low | Low | Medium | Not well managed |
| RIRIMA | **NAKU** | BUGESERA | High | High | High | Medium | Medium | Medium | High | High | Not managed |
| GASHANDA | **NAKU** | NGOMA | Low | High | Medium | Low | Low | Low | Low | Low | Not managed |
| MURAMA | **NAKU** | NGOMA | Medium | High | Low | High | Low | Low | Low | Low | Well managed |
| RURENGE | **NAKU** | NGOMA | Low | Medium | Low | Medium | Low | Low | Low | Medium | Well managed |
| AKAGERA | **NAKU** | KIREHE | Medium | High | High | Low | Medium | Low | Low | Medium | Protected |
| CYUNUZI | **NAKU** | KIREHE | Low | Low | Low | Medium | Low | Low | Low | Low | Well managed |
| GATORE | **NAKU** | KIREHE | Low | Medium | High | Low | Low | Low | Low | Medium | Not well managed |
| MWOGA | **NAKL** | KIREHE | Low | High | High | High | Low | Low | Medium | Medium | Not managed |
| MUSHA | **NAKU** | RWAMAGANA | Low | Low | Low | Medium | Medium | Medium | Low | Low | Not managed |
| MUYUMBU & NYAKARIRO | **NAKU** | RWAMAGANA | High | High | Low | High | High | Low | Low | High | Not well managed |
| GAHANGA | **NAKU** | KICUKIRO | Medium | High | High | High | Medium | Low | Low | Medium | Not managed |
| MASAKA | **NAKU** | KICUKIRO | High | Medium | Medium | Low | Medium | Low | Low | Medium | Not well managed |
| MODEL WETLAND | **NAKU** | KICUKIRO | Low | Low | Low | Low | Low | Low | Low | Low | Properly managed |

### 3.1.10 Socio-economic status of NAKU catchment

The purpose of this section is to provide a brief overview of NAKU, in terms of socio-economic status of its population. NAKU catchment is covered by eight districts that include Kirehe, Ngoma, Bugesera, Rwamagana, Kayonza, Gasabo, Kicukiro and Nyarugenge which covers a small area of the catchment. It commences at the confluence of the Lower Nyabarongo and Akanyaru Rivers and belongs to the Nile basin. The first half of the catchment is located within Rwanda but after Lake Rweru, the Akagera River forms the boundary between Rwanda and Burundi.

#### Population distribution and poverty rates in NAKU

Based on 2012 population census, the total population of NAKU catchment is approximately 1,318 million with highest densities in and around the urban centres of the City of Kigali. The majority of sectors (42.6 %) have a population density ranging from 400-800 habitants/km2 while a small number (7.1%), mainly in the City of Kigali attain a population density arising between 4000-8000 habitants/km2. The poverty ranges from moderate to low. However, compared to the rest of the catchment, extreme poverty is observed in eastern parts, especially in Ngoma District (e.g. Mugesera Sector) and Kirehe District (e.g. Gahara Sector). The Figure 3-17 present the population density per sector, while Figure 3-18 provide the poverty levels in NAKU catchment and detailed information are provided in Table 3-4.

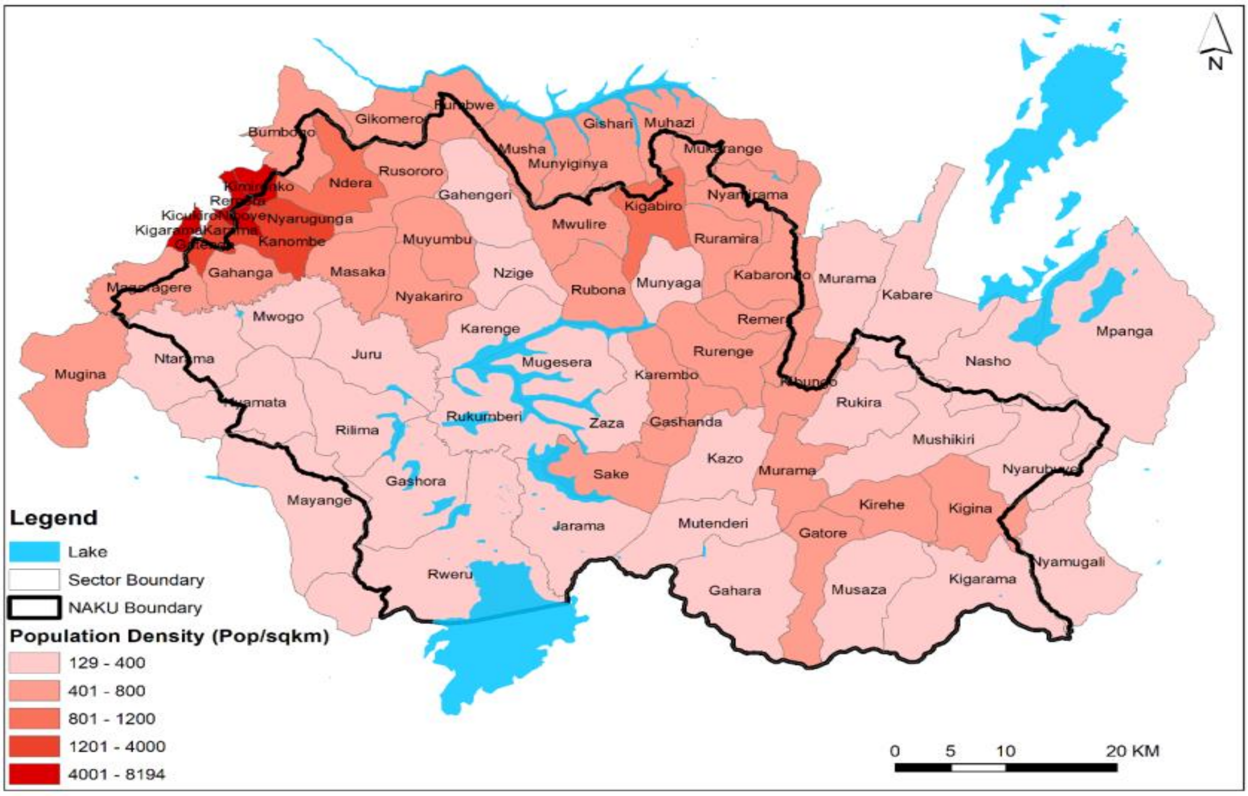



**Figure 3-17: Population density in NAKU catchment**

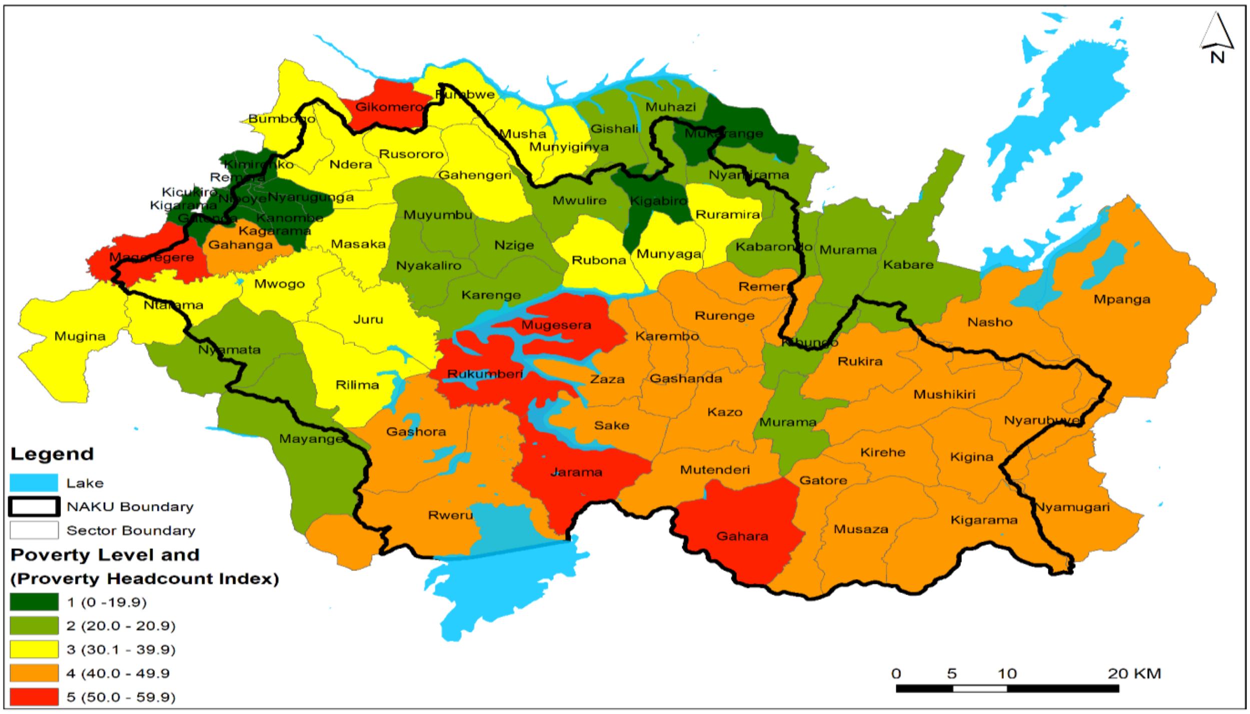



**Figure 3-18: Poverty level and poverty headcount index in NAKU catchment**

**TABLE 3-3 Key features on population density and levels of poverty in NAKU**

| Population density per Sector in NAKU | | | | Level of poverty per Sector in NAKU | | | |
|---|---|---|---|---|---|---|---|
| S/N | Population density (pop/sqkm) | Number of Sectors | % of Total Sectors in the Catchment | S/N | Poverty Level and (Poverty Headcount Index) | Number of Sectors | % of Total Sectors in the Catchment |
| 1 | 129 - 400 | 29 | 41.4 | 1 | 1 (0 – 19.9) | 11 | 15.7 |
| 2 | 401 – 800 | 30 | 42.6 | 2 | 2 (20.0 – 29.9) | 15 | 21.4 |
| 3 | 801 – 1200 | 2 | 2.6 | 3 | 3 (30.1 – 39.9) | 16 | 22.6 |
| 4 | 1201 – 4000 | 4 | 5.7 | 4 | 4 (40.0 – 49.9) | 22 | 31.4 |
| 5 | 4001 - 8194 | 5 | 7.1 | 5 | 5 (50.0 – 59.9) | 6 | 8.7 |
| | | | | 6 | 6 (60.0 – 69.9) | 0 | 0 |

**Socio-economic activities and basic infrastructures in NAKU**

The socio-economic activities and basic services infrastructure in NAKU catchment are characteristic of those of the urban areas, particularly in the City of Kigali and rural areas. The catchment's largest employment activities include agriculture mainly with subsistence and cash crops, fishing, forestry, utilities and financial services trade and manufacturing activities such as brickmaking and recycling of scrap metals (iron). There are also several quarries and mines with cassiterite and coltan deposits being mined in the Eastern Province particularly in Rwamagana and Ngoma Districts. Figure 3-19 presents key socio-economic activities and basic infrastructure in this catchment and details were provided in Table 3-4.

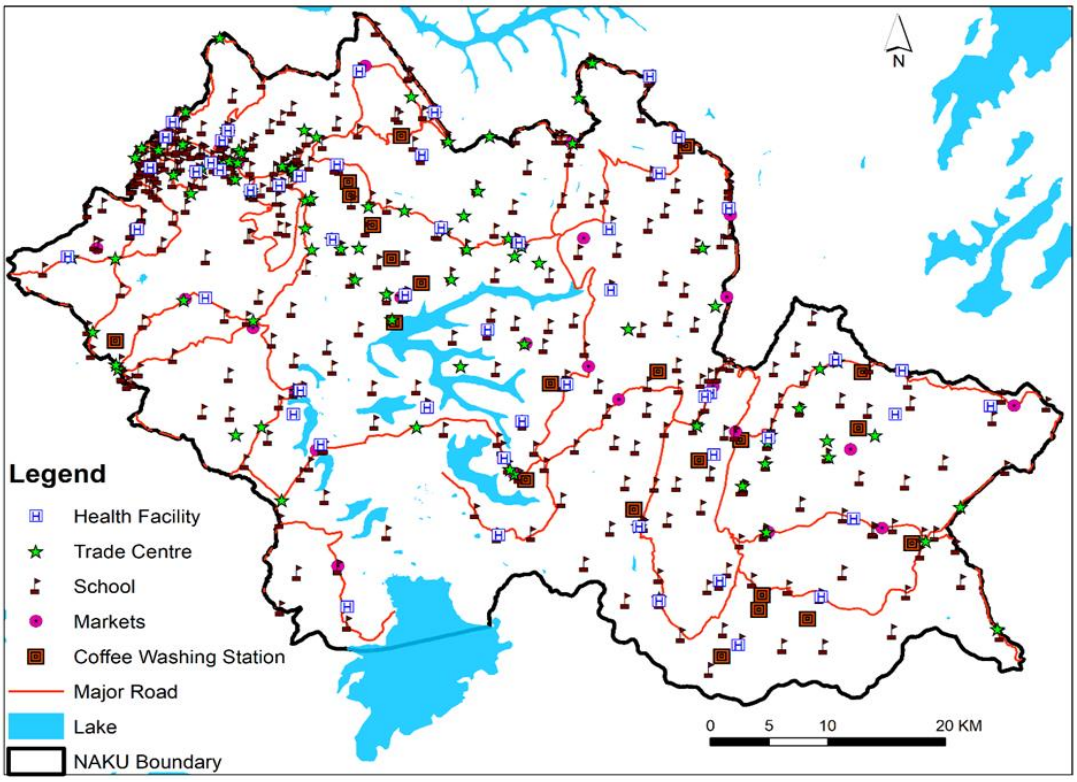



**Figure 3-19: Socio-economic basic infrastructures in NAKU**

**TABLE 3-4 Number of different socio-economic infrastructure in NAKU**

| S/N | Socio-economic Infrastructure | Number |
|---|---|---|
| 1 | Health Centres | 52 |
| 2 | Trade Centres | 91 |
| 3 | School | 381 |
| 4 | Markets | 29 |
| 5 | Coffee Washing Stations | 22 |

### 3.1.11 DPSIR analysis

Drivers, pressures, state, impact and response (DPSIR) model of intervention is a causal framework for describing the interactions between society and the environment: Human impact on the environment and vice versa because of the interdependence of the components. Table 3-5 provide the key DPSIR analysis in the study area:

**TABLE 3-5 DPSIR analysis**

| Drivers | Pressure | State | Impact | Response |
|---|---|---|---|---|
| - **Population & urbanization**<br>- **Climate change**<br>- **Land use in catchments (agriculture, mining, housing, roads, etc.)** | - Siltation<br>- Extreme climate events (floods or draught)<br>- Mining of clay soil for brick making<br>- Agriculture conversion<br>- Mining that leads to river and wetland sedimentation | - Sedimentation<br>- Floods<br>- Eutrophication<br>- Pollution<br>- Polluted fishes | - Water borne diseases<br>- Reduced wetland productivity<br>- Damage of infrastructure and properties in or near wetland | - Catchment restoration<br>- Enforcement and proper management of wetland buffer zones<br>- Pollution prevention from upstream (e.g. point sources like wastewater, solid waste, etc.). |

| | | | | |
|---|---|---|---|---|
| - **Topography (slopes)**<br>- **Poverty**<br>- **Education and level of awareness** | - Invasive species<br>- Water abstraction<br>- Peat extraction<br>- Wetland compaction<br>- Wetland defragmentation (roads embankment during road construction)<br>- Wastewater and solid waste from urban areas | | - Loss of biodiversity | - Relocation of house and other infrastructure from wetlands and their buffers (houses, industries, etc.). |

**Drivers**

According to the National Strategy for Transformation, Rwanda has targeted to have 35 % of its population in urbans areas by 2024 from 18.4% in 2016/2017. However, urban areas are linked with wastewater and solid waste increase. This has a negative aspect on adjacent wetlands particularly the City of Kigali which has a direct interaction with wetlands (Gikondo, Nyabugogo, Nyabarongo and Akagera). It is urgent to align the targeted urbanization to sanitations strategies to avoid any potential water and wetland contamination. In the study conducted on Fate of heavy metals in Nyabugogo wetland revealed a heavy metals accumulation particularly in sediments of Nyabugogo Wetlands. This contamination was mainly from industries and reached fishes (clariaas sp, Oreochromis sp and Oligochaetes) with high concentration in cadmium (Cd), Chromium (Cr) and lead (Pb); therefore a human concern for the people using water and Nyabugogo wetland products (Sekomo *et al.* 2010).

Plastic pollution is another threat to wetland functions. Thanks to the Government of Rwanda to prohibit the importation, production, sale and use of plastic bags (law No 57/2008 of 10/09/2008) and recently another law on plastic carry bags and single use plastic items (Law No 17/2019 of 10/08/2019).

Negative impacts of urbanization, agriculture, mining and other land use activities are worsened by the hilly topography of Rwanda and climate and weather related hazards especially heavy rains that trigger soil erosion, landslides, and floods that are followed by wetland sedimentation and pollution of different kind.

**Figure 3-20: Plastic waste in Akagera wetlands (Gashora bridge on 12 January 2018).**

Plastic bottles accumulation in Akagera river (Gashora Bridge) when there was a pontoon bridge before construction of the bridge) January 12, 2018). Fortunately enough the new law No 17/2019 of 10/08/2019 banned the importation, manufacturing, sale, and use of single use plastic bottle. Without this pontoon bridge that acted as a barrage to the bottles and other floating waste, it would proceed until Lake Victoria! These plastic bottles were probably mostly from the city of Kigali. Without proper sanitation regulation and enforcement, water bodies and wetlands may get polluted by different waste types from urban settlement in catchments.

Land use in catchments may also affect wetlands ecological character particularly agriculture, mining, urbanization, etc. This may led to sedimentation, point or diffuse sources of pollutions, etc.

**Pressure**

The following are the key activities that affect the wetlands:

- *Mining*: Mining is also one of the sources of soil erosion and sedimentation and water pollution (siltation, accumulation of heavy metals in floodplains, etc.) especially with open mining on steep slopes, changes in surface and ground water flows, etc. Particularly in upper Nyabarongo catchment, Bijyojyo, Mbobo and Gatumba are examples of open cast mining that are associated with soil erosion and sedimentation. Apart from the impacts from mining done hillside, mining inside rivers and wetlands was also highlighted by the Auditor General of states finance as a challenge (NISR, 2019).
- *Catchment management:* various activities in the catchments have direct impact on the ecological functions of the downstream wetlands: siltation, water pollution, nutrients accumulation and eutrophication, etc.
- *Agriculture*: Mainly rice production and other crops
- *Housing*: Informal settlement within wetlands and their buffer zones was causing pressure to wetlands, particularly in urban areas. Likely enough, the government decided to relocate most of infrastructure from wetlands.

**State**

- Floods: Floods affected many economic activities, including agriculture (crop damage like paddy fields), transport (roads and bridges, traffic shortage, etc.).
- Polluted wetland and water resources
- Reduced size of wetlands: encroachment to wetlands and their buffers is accompanied with reduced size of wetlands which also affects ecological functions of wetlands.
- Wetland area reduced by 13% up to 2015 (NISR, 2018).

**Impact**

- Traffic hindrance due to floods with subsequent socio-economic impact: limited access to socio-economic services (schools, markets, health facilities, etc.).
- Damages of infrastructure: bridges, roads, electric lines, etc.
- Health impacts associated with consumption polluted water and fish resources

**Response**

- Relocation of people from high risk zones, including in wetlands where settlers were under risk of floods

**Figure 3-21: Nyabugogo wetland after the relocation of population (February 2020)**

- Restoration of degraded wetlands like Nyandungu wetland restoration and conservation

### 3.1.12 Conclusion and recommendations

This survey in NAKU catchment has provided the community perception on ecosystem services delivered by wetlands, the importance of ecosystem services, economic and livelihood dependence on wetlands, trends of ecosystem services in past five years, drivers of declining ecosystem services, natural hazards occurring in wetlands and neighbouring area, wetlands restoration opinions and wetlands degradation indicators. The purpose is for a better strategic plan for Ecosystem Based Adaptation and wetland management framework in Rwanda.

The level of wetlands management in NAKU catchment was analysed particularly in Eastern Province and the District’s interventions to address the existing problems in wetlands and other concerned sectors were also suggested by the District officials. The main categories of wetlands found in this catchment are fully protected wetlands; partially protected wetlands and non- protected wetlands. The detailed analysis of key issues concerning wetlands management in this catchment found that flooding is a major issue of concern. The survey also highlights other significant major issues of concern in this catchment like erosion, wastes management, water contamination, violation of buffer zones and substandard quarry & mining activities. Understanding the connection between these issues to allow a suitable strategy to be developed and the selection of most suited interventions, the report recommends the followings:

i. Wetlands in this catchment are affected by flooding and erosion from neighbouring environment. Developed measures to minimize the level of flooding and erosion should be implemented for a better management of wetlands in this catchment. This should be supported by establishment of well-designed drainage systems within the wetlands.

ii. The current deforestation rate in Kicukiro District part of this catchment is the root cause for erosion. Reforestation of Rebero Mountain should be reinforced on yearly basis by focusing on indigenous species plantation.

iii. Substandard mining activities are still applied in Ngoma District and lead to pollution of wetlands and both surface and ground water.

iv. Wastes management is still a major issue in this catchment. Sustainable wastes management including the construction of modern landfill and composting are recommended for the benefit of public health improvement and the protection of environment including wetlands.

## 3.2 NNYL catchment

This task was aiming to collect information by considering the existing knowledge on status health of wetlands in Nile Nyabarongo Lower catchment (NNYL). The guiding paths proposed by District Environment offices and

Natural resources directors together with field works interventions including the use of questionnaire helped in understanding the baseline information on ecosystem services provided by wetlands in this catchment, identification of wetlands degradation indicators, the extent to which wetlands are managed and to propose the interventions to address the existing problems concerning wetlands management. The Figure 3-22 highlights the spatial distribution of Land Use/Land Cover (LULC) in NNYL catchment.

In general, the analysis of NNYL catchment indicated that wetlands within need a proper management to sustain life of community depending on the services provided by wetlands, because these services impact the economic status and livelihood of the community. Based on the number of responses and field observation, the most important provisioning services are substance crops, fresh water and ornamental resources. Regulating & supporting services in this catchment are indicated as important with regards to flood regulation, erosion regulation and soil formation. Moreover, cultural services are also important in this catchment with regards to spiritual values, education and knowledge systems and recreation services.

Wetlands restoration in this catchment seem to be a good opportunity to the community but accompanied with fear of losing land, assets and properties. Wetlands management in this catchment need to be reinforced through ecosystem-based adaptation approach.

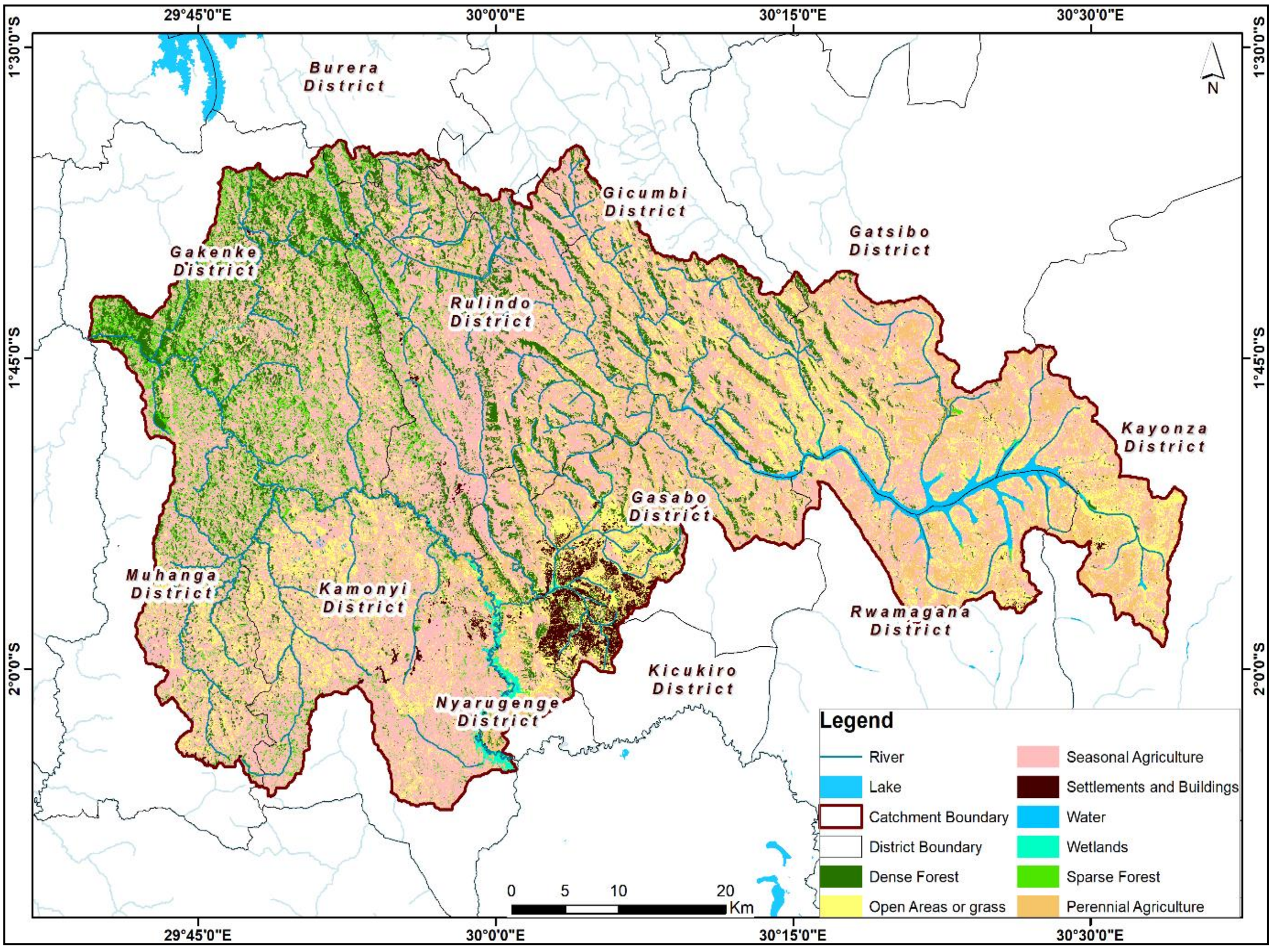



**Figure 3-22: Spatial Distribution of Existing LULC in NNYL catchment**

The districts considered in this catchment are Nyarugenge, Gasabo, Kicukiro, Gatsibo, Kayonza, Gicumbi, Rulindo and Kamonyi. Most of wetlnds in this catchment are dominated by a variety of subsistence crops with wetlands in Gatsibo and Kayonza dominated by rice and maize. Based on the information provided by District officials and field observations, wetlands in NNYL are under management of the Districts in partnership with key stakeholders. During the field visits in February 2020, wetlands in Gasabo and Nyarugenge Districts were dominated by community operations subjected to not suitable in wetlands such buildings and they were being relocated by that time. The table below indicates area coverage of existing LULC in NNYL catchment.

**TABLE 3-6 Area coverage of existing LULC in NNYL catchment**

| S/N | LULC Category | Area (Ha) | Area (%) |
|---|---|---|---|
| 1 | Seasonal Agriculture | 181,399.8 | 54.8 |
| 2 | Perennial Agriculture | 26,612.5 | 8.0 |
| 3 | Dense Forest | 35,574.0 | 10.7 |
| 4 | Sparse Forest | 20,637.3 | 6.2 |
| 5 | Open Areas or Grassland | 55,841.9 | 16.9 |
| 6 | Settlements and Buildings | 5,134.6 | 1.5 |
| 7 | Waterbody | 4,628.0 | 1.4 |
| 8 | Wetland | 1,486.1 | 0.4 |

### 3.2.1 Perception about ecosystem services with different land uses

The main goal was to understand the community perception on ecosystem services provided by different land uses in NNYL. Around 215 respondents were interviewed in this catchment and only wetland land uses were evaluated in regards to provisioning services, regulating & supporting services and cultural services within the wetlands located in NNYL catchment. Provisioning services considered in this catchment were subsistence crops, commercial crops, wild foods, livestock feed, fuel, fresh water, ornamental resources and natural plant-derived medicine. Wetlands in this catchment are dominated by subsistence crops, livestock, fresh water and ornamental resources.

All the respondents admitted that the wetlands in NNYL catchment provide more substance crops, fresh water, livestock and ornamental resources compared to other provisioning services. Subsistence crops observed in catchment are beans, fruit trees and cabbages while observed cash crops were rice and tea plantation. Other provisioning services provided by wetlands in NNYL catchment considerably as shown on the Figure 3-23 are wild foods especially fish and plants and natural plants derived medicines.

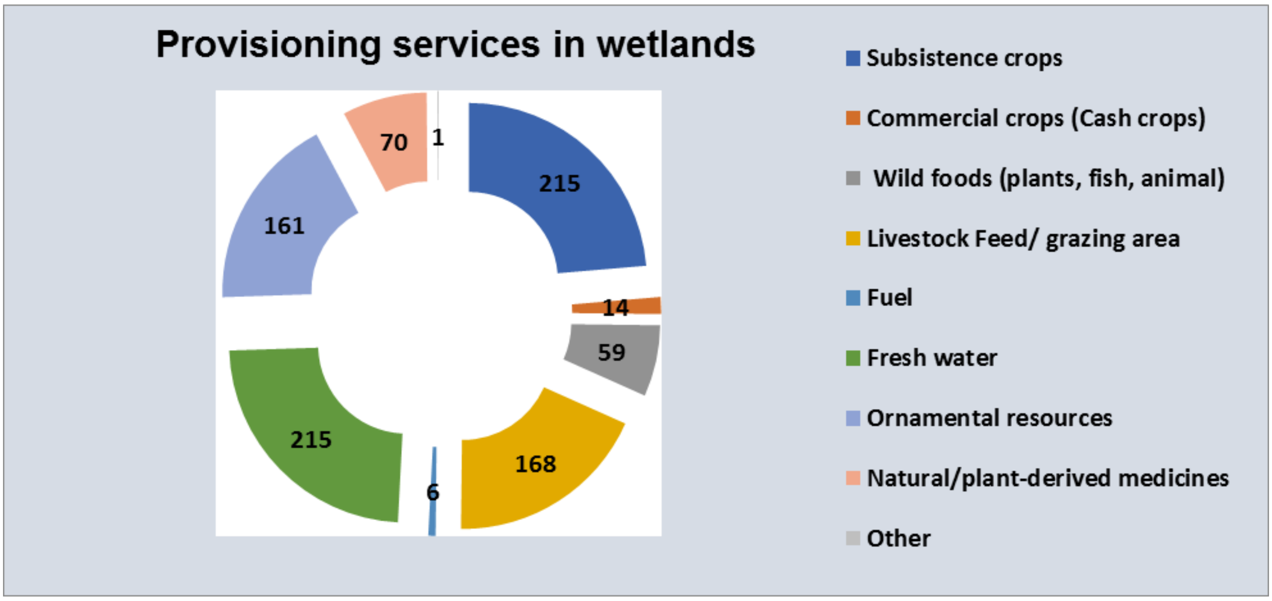



**Figure 3-23: Perception of provisioning services provided by wetlands in NNYL catchment**

Considered regulating and supporting services, wetlands provides regulation of air quality, water purification, regulation of diseases and pests, flood regulation, noise buffering and soil formation. As highlighted in Figure 3-24, the main indicated regulating and supporting services provided by the wetlands in NNYL catchment are regulation of air quality, water purification, flood regulation and erosion regulation. However, the replies on regulation of disease and pest, and noise buffering services were at a very low frequency compared to other regulating and supporting services.

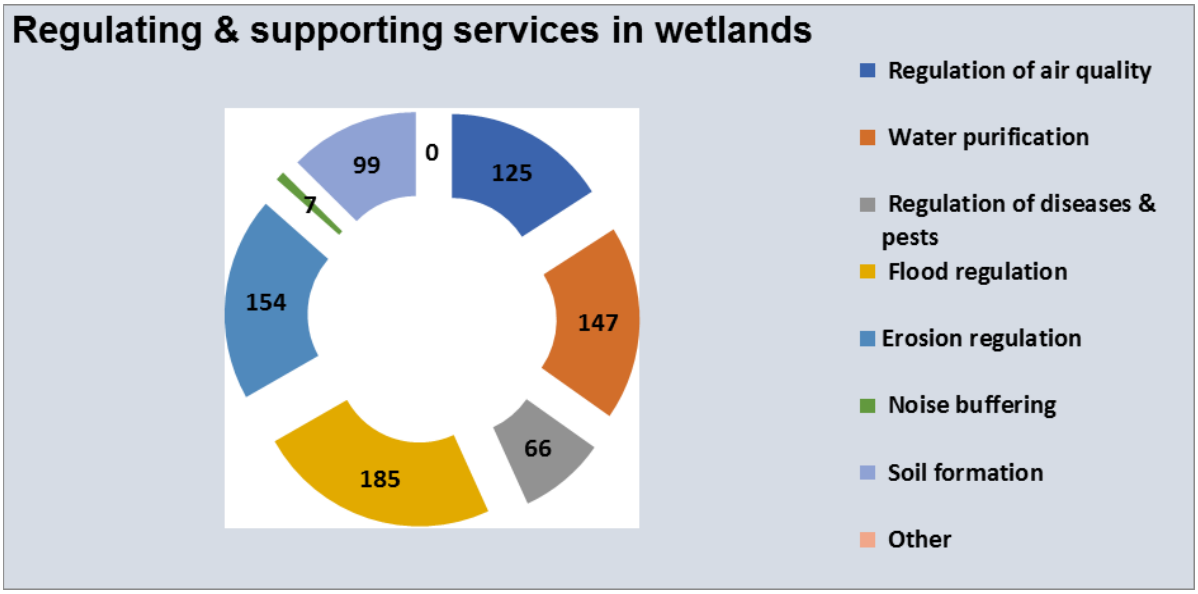



**Figure 3-24: Perception of Regulating & supporting services provided by wetlands in NNYL catchment**

Cultural services provided by wetlands in NNYL catchment indicated that recreation service is the most highlighted on a high frequency compared to other services in this section. Moreover, education and knowledge systems, spiritual values and ecotourism are also the services highlighted as shown in Figure 3-25.

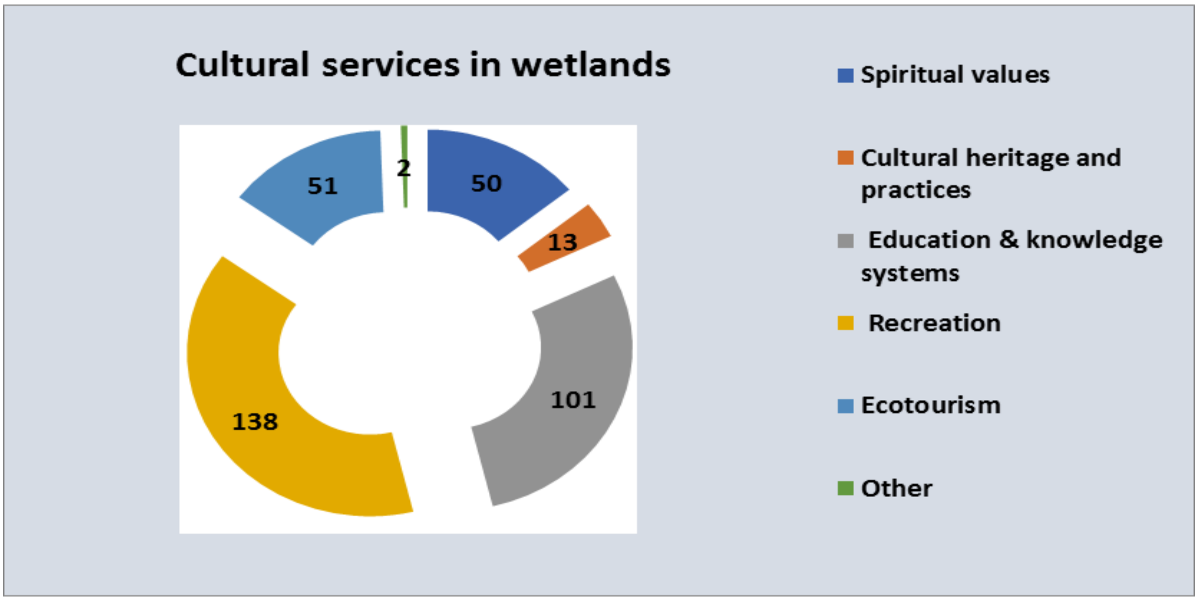



**Figure 3-25: Perception of cultural services provided by wetlands in NNYL catchment**

### 3.2.2 Perception about importance of ecosystem services with different land uses

The main goal in this section was to assess the importance of ecosystem services in NNYL catchment provided by the wetlands for everyone. Knowledge of the role of wetlands together with the extent to which activities practiced in wetlands contributes to the wellbeing of the community were also assessed. The ecosystem services under consideration in this section were provisioning services, regulating and supporting services, and cultural services.

Importance of ecosystem services described in this section are subsistence crops, cash crops, wild food, livestock feed, fuel, fresh water, ornamental resources and natural/plant-derived medicine. Services indicated as very important in this catchment are subsistence crops, fresh water and livestock feed with more than 85 responses per each respectively as shown in Figure 3-26. Services highlighted as somehow important are ornamental resources, livestock feed, natural plant-derived medicine with more than 50 responses each respectively. Ecosystem services highlighted as not important are cash crops, fuel and wild foods.

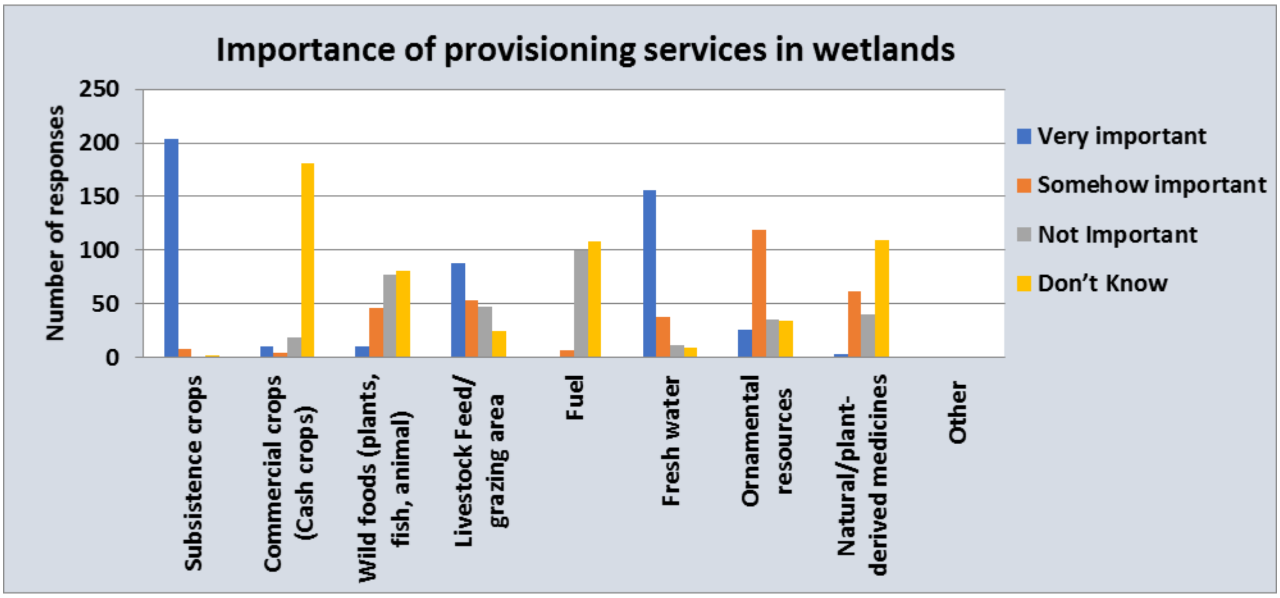



**Figure 3-26: Perception of importance of provisioning services provided by wetlands in NNYL catchment**

Regulating and supporting services considered in this catchment are regulation of air quality, water purification, regulation of disease and pests, flood regulation, erosion regulation, noise buffering, and soil formation. In line with the responses and the knowledge of respondents about the ecosystem services in this category, services highlighted as very important are regulation of air quality, water purification, soil formation and erosion regulation with a low frequency of more than 25 responses each respectively. Services highlighted as somehow important are flood regulation, erosion regulation, water purification and soil formation with more than 90 responses each respectively. Regulation of disease and pests together with flood regulation and erosion regulation are highlighted as not important based on the respondents' views.

Though these services have been described with regards to their importance, it shown Figure 3-27 that they also exhibit a high frequency of "don't know" which means that most of the respondents didn't have much knowledge on these services.

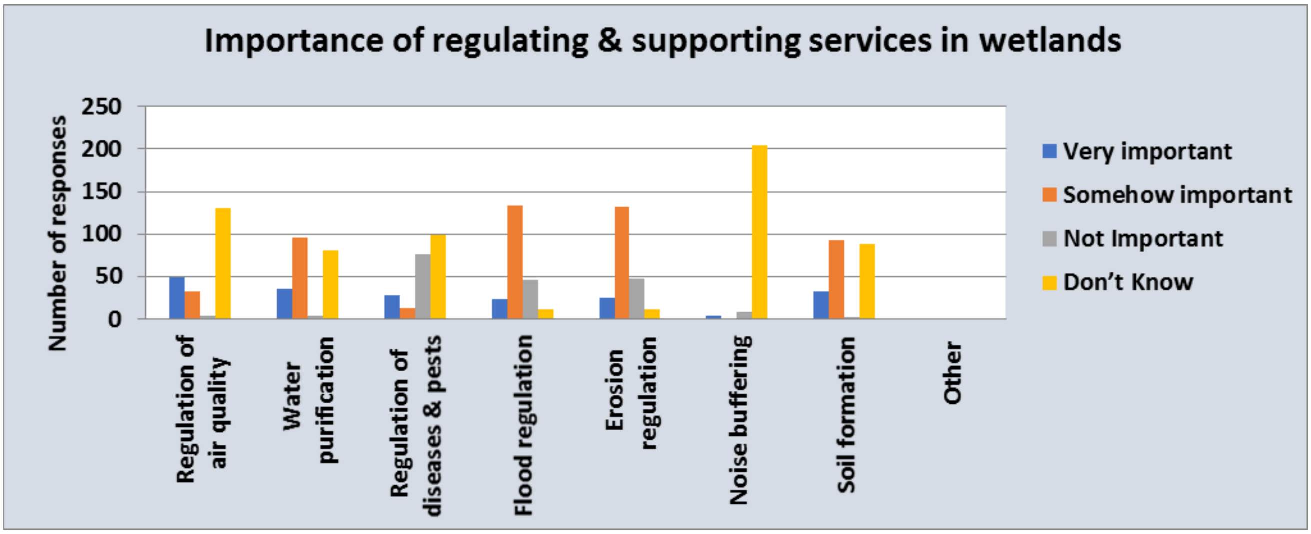



**Figure 3-27: Perception of importance of regulating & supporting services provided by wetlands in NNY catchment**

The analysis of importance of cultural services was based on the consideration of spiritual values, cultural heritage and practices, education and knowledge system, recreation and ecotourism. A small number of respondents indicated that spiritual values, education and knowledge systems and recreation are very important. On the other hand, recreation is highlighted as somehow important with 108 responses respectively. A number of respondents ranging between 20 and 70 indicated that culture services as shown in Figure 3-28 are not important while most of the respondent do not have much knowledge on the services in this category**.**

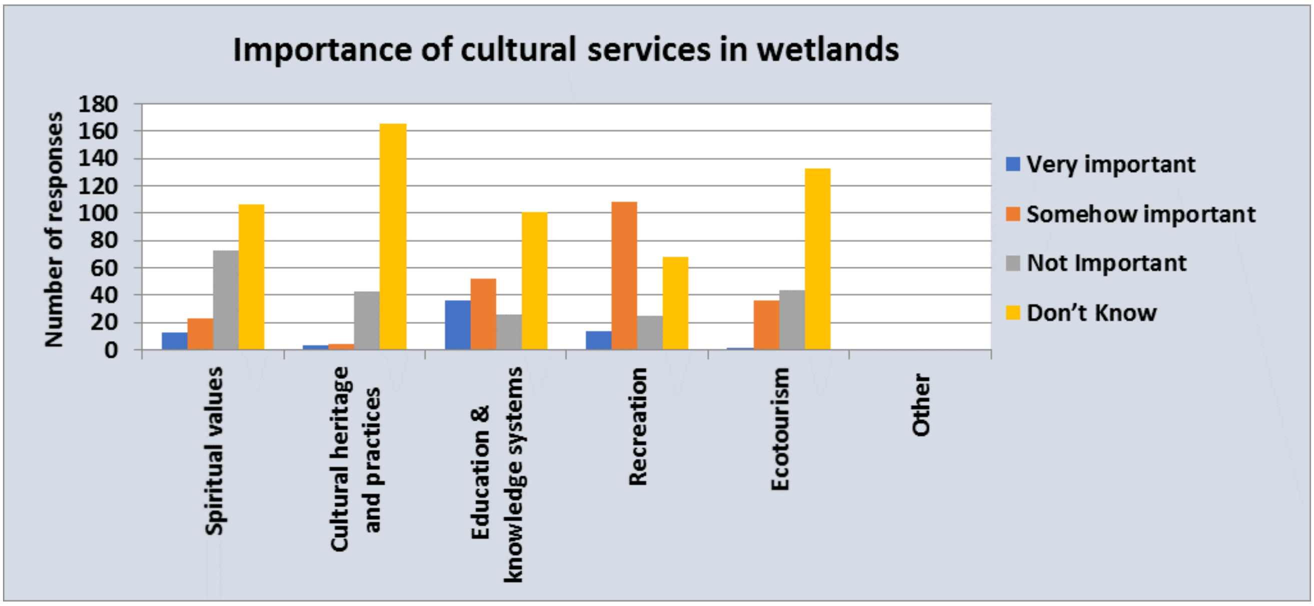



**Figure 3-28: Perception of importance of cultural services provided by wetlands in NNYL catchment**

### 3.2.3 Economic and livelihood dependence on wetlands

The main goal of this section was to assess the extent of economic and livelihood dependence of population on wetlands in NNYL catchment mostly by rating ecosystem services. The services under consideration in this category are provisioning services and the analysis identified ecosystem services that the majority of population considers being essential for their livelihood. In line with the number of respondents, the ecosystem services highlighted as very dependent on are subsistence crops, fresh water and ornamental resources with more than 65 responses each respectively.

This is an indication of how the economy and livelihood of the community dependent on the services provided by wetlands in NNYL catchment. In addition, fresh water and livestock feed are highlighted as somehow dependent in this catchment. Ecosystem services highlighted as not dependent at all in this catchment are wild foods, fuel, ornamental resources, livestock feed, natural/plant-derived medicine and cash crops with more than 35 responses each respectively. This shows the extent at which economic and livelihood do not depend on these ecosystem services provided by the wetlands. Lastly, cash crops, fuel, natural/plant-derived medicine and fuel are not much known as shown in Figure 3-29.

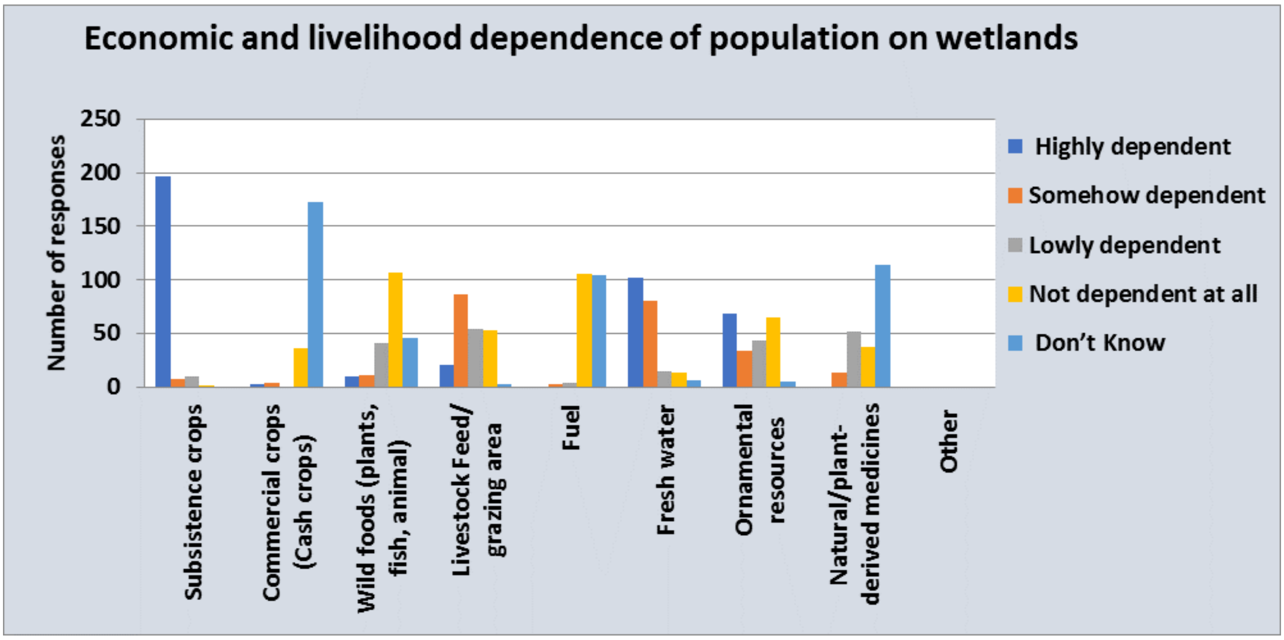



**Figure 3-29: Perception of economic dependence and livelihood on wetlands in NNYL catchment**

### 3.2.4 Trends of ecosystem services provision associated with wetlands in the past 5 years

The main goal in this section was to assess the trend of ecosystem services provided by wetlands in NNYL catchment for the last five years. The ecosystem services under consideration in this section are provisioning services, regulating and supporting services and cultural services. Provisioning services have been increasing in past five years with regards to subsistence crops, fresh water and ornamental resources with 193; 172 and 66 responses respectively while livestock feed and natural/plant-derived medicine have been declining in past five years as it is shown in Figure 3-30.

However, subsistence crops highlight a low declining trend in past five years with 10 responses, while most of respondents indicated that they don't know if the services have been increasing or declining in last past five years with regards to cash crops, wild foods, fuel and natural/plant-derived medicine with 204; 163; 186 and 134 responses respectively.

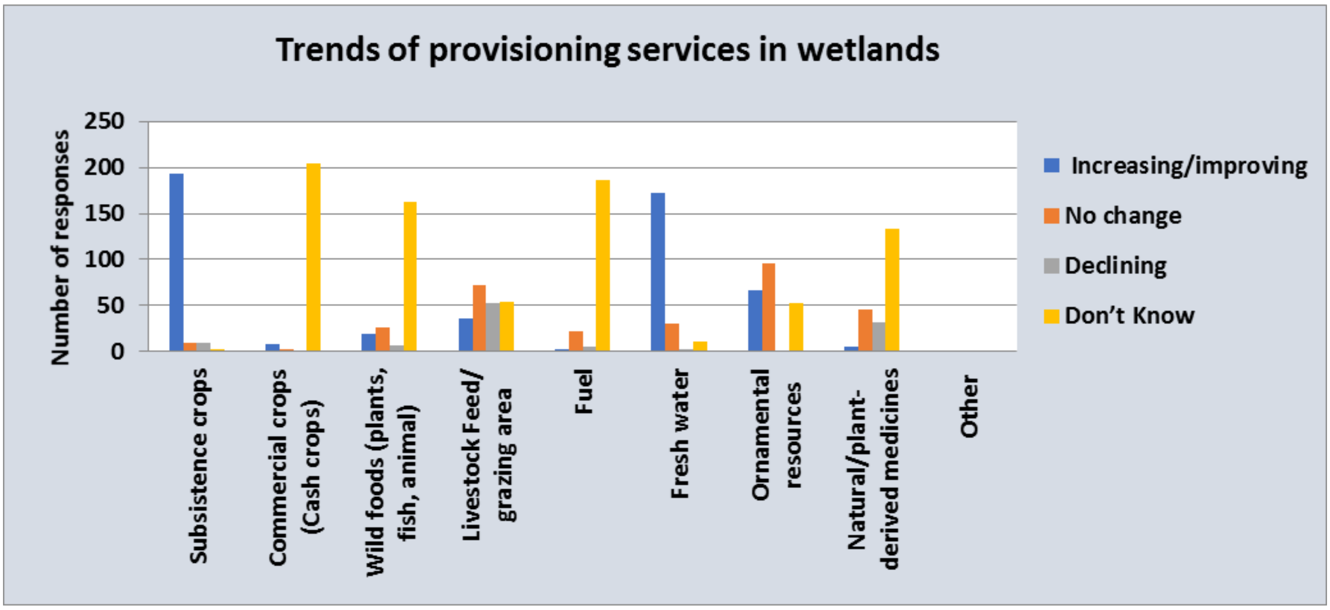



**Figure 3-30: Trends of provisioning services provided by wetlands in NNYL catchment over past 5 years**

### 3.2.5 Most important driver for the indicated trend of change

The main goal of this section was to analyse the drivers of ecosystem services identified as declining previously. All the ecosystem services under consideration are provisioning services, regulating & supporting services, and cultural services. The trends of drivers over past five years have been analysed within NNYL catchment. The suggested drivers from the questionnaire have been analysed in this catchment. However, in line with the responses it has been found that there are other drivers which impacted ecosystem services and caused them to decline over past five years but not indicated in the questionnaire.

Provisioning services, regulating and supporting services, and cultural services mentioned as declining in this catchment over a period of past five years in NNYL catchment have been mostly driven by climate change (42%), changing land use (20%), changing population (5%), infrastructure development (5%), changing market demand (1%) and new policies, rules and regulations (1%) of responses respectively as it is highlighted in Figure 3-31. Based on the numbers of respondents, it is shown that other (drivers) occupy 23% of responses respectively. Those other drivers include one type of crops, flooding and erosion.

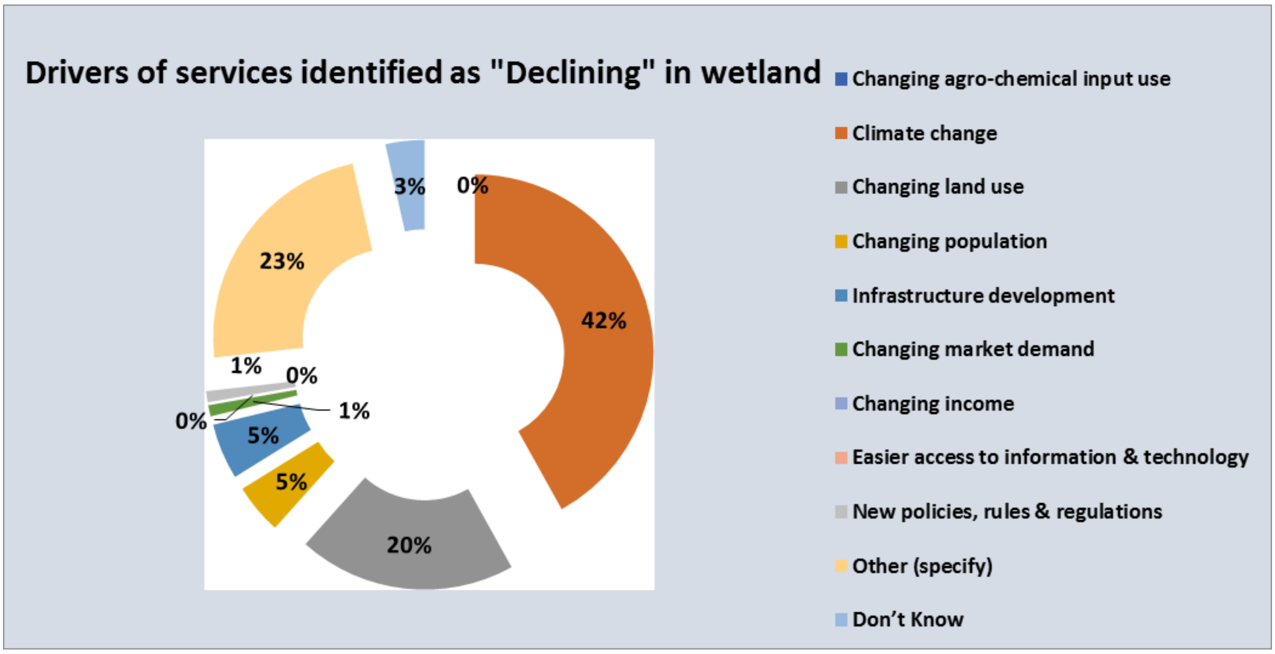



**Figure 3-31: Drivers for the trend of change of ecosystem services considering declining ecosystem services in NNYL catchment**

### 3.2.6 Natural hazards in the wetland area and surrounding

The main goal of this section was to assess the natural hazards currently occurring in wetlands and surrounding area within NNYL catchment. The natural hazards under consideration in this section as can be seen in Figure 3-32 are: flood events, mass movements, strong sedimentation coming from the water course, erosion of river banks, and disease caused by contaminated water. It should be noted that the population highlighted that wetlands are most affected by flood events, strong sedimentation coming from the water course and erosion of river banks with more than 120 responses each respectively. It should be noted that wetlands and terrains in NNYL catchment are least affected by mass movements /landslide/rock fall and disease caused by contaminated water.

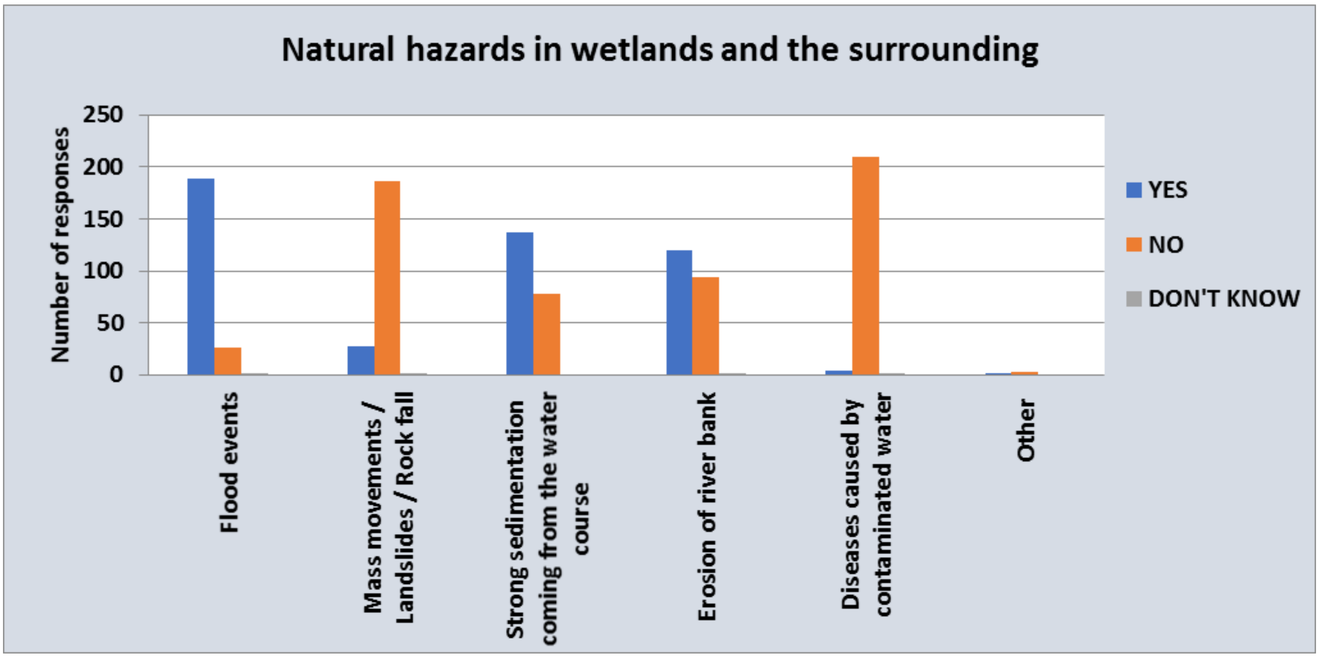



**Figure 3-32: Natural hazards in the wetlands area and surrounding in NNYL catchment**

### 3.2.7 Opinion concerning wetland restoration: Fears and Opportunities

The main goal of this section was to assess communities' interests and concerns regarding wetlands restoration in NNYL catchment. Based on the opinions provided by the respondents, the main fears for the restoration of wetlands in NNYL catchment, are loss of livelihood, loss of assets and loss of land with 210; 201 and 104 responses respectively as it is highlighted in Figure 3-33.

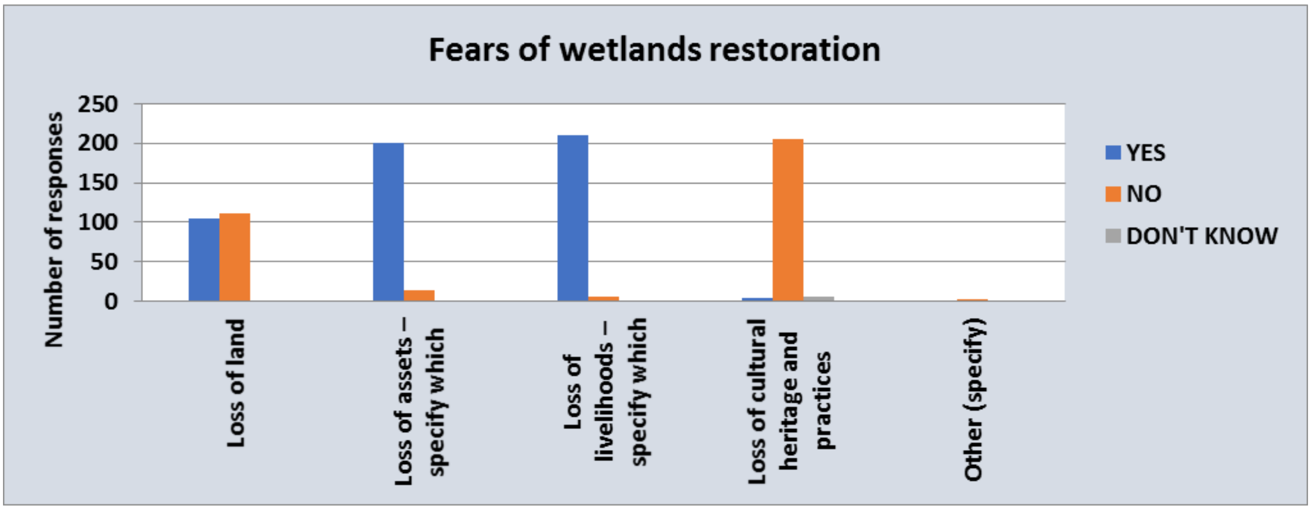



**Figure 3-33: Fears about wetlands restoration in NNYL catchment**

In line with the opinion provided by the respondents, restoration of wetlands in NNYL catchment can provide a good opportunity for "flood regulation", "erosion regulation", "water purification", "regulation of disease and pests", "regulation of air quality" and "soil formation" with more than 140 responses each respectively as can be seen in Figure 3-34. Additionally, recreation, education and knowledge system and ecotourism can be a good opportunity also for wetland restoration in NNYL catchment.

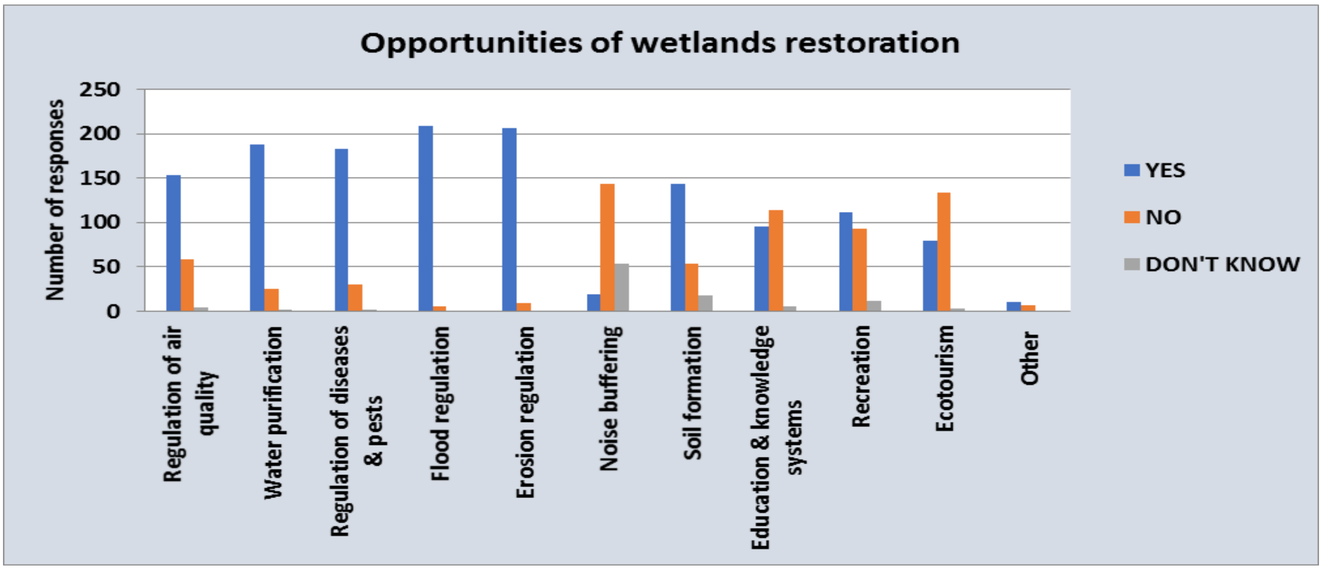



**Figure 3-34: Opportunities about wetlands restoration in NNYL catchment**

### 3.2.8 Analysis of drivers of wetland degradation

The main goal of this section was to understand the drivers of change by assessing the extent at which the drivers of ecosystem degradation under consideration are practiced in the area. Figure 3-35 highlights the drivers considered in this category which are: Agricultural activities, eutrophication and pollution, infrastructure development, wetland overharvesting, emergent invasive species, loss of indigenous species, and alteration of biogeochemical cycles.

In line with responses, the communities consider wetland overharvesting, infrastructure development, and eutrophication and pollution as the main drivers of ecosystem degradation of wetlands and neighbouring environment in NNYL catchment. Agricultural activities are not considered as part of the main root cause of ecosystem degradation and other drivers like emergent invasive species, loss of indigenous species, and alteration of biogeochemical seem to be strange to the community because they are not known by the community either causing or not causing ecosystem degradation.

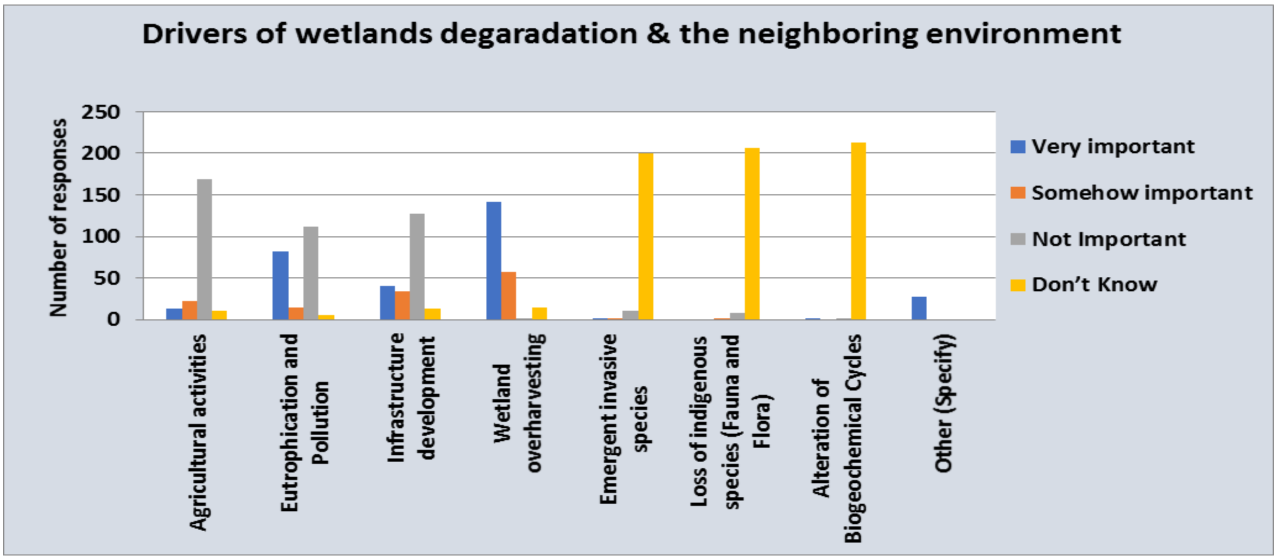



**Figure 3-35: Drivers of wetland degradation in NNYL catchment**

### 3.2.9 Conclusion and recommendations

The category of wetlands found in NNYL catchment are partially protected and others are non-protected wetlands which makes them to be dominated by agricultural activities. Wetlands in this catchment are degraded by erosion, flood and strong sedimentation. Building infrastructures located in these wetlands were almost removed to prevent anthropogenic contamination of wetlands. Therefore, to promote wetlands management in this catchment, the following recommendation are suggested.

i. Runoff should be retained before it reaches the wetlands (especially on belt of the wetland) to prevent flooding and erosion.

ii. The District of Nyarugenge still has people living in high risk zones, with around twenty thousand (20,000) people. Therefore, relocation strategies should be initiated and trees should be planted on the hills to reduce soil erosion and landslides. The implementation of urban settlements should comply with Kigali master plan provision by focusing on water harvesting good practices.

iii. Sustainable wastes management activities should be enforced in the entire NNYL catchment, especially in Nyarugenge part for Nyamirambo and Kigarama sectors.

iv. Substandard mining activities are still applied in Gatsibo District and lead to both pollution and degradation of the environment affecting both surface and ground water. Similarly, in Rulindo District, officials and farmers in Nyarububa wetland witnessed an illegal mining/extraction of Gold in the wetland. Therefore, all mining activities within NNYL catchment should be legalized and standardized. This should be supported by mining sites rehabilitation by planting bamboo trees around the mining sites.

v. The best wetland management practices through ecosystem-based adaptation approach for buffer zones protection should be applied. This will prevent the violation and delimitation of buffer zones in NNYL catchment especially in Gicumbi District.

vi. The protection of rivers banks, especially Nyabarongo River, small rivers and streams discharging in Nyabarongo should be of the first priority.

## 3.3 NNYU catchment

This task was supposed to gather information considering the existing knowledge on status and health of wetlands in Nile Nyabarongo Upper catchment (NNYU). The guiding paths proposed by District Environment officers and Natural resources directors together with field works interventions including the use of questionnaire helped in understanding the baseline information on ecosystem services provided by wetlands in this catchment. These include identification of wetlands degradation indicators, the extent to which wetlands are managed and to propose the interventions to address the existing problems concerning wetlands management. The map below highlights the spatial distribution of land use/Land cover (LULC) in NNYU catchment.

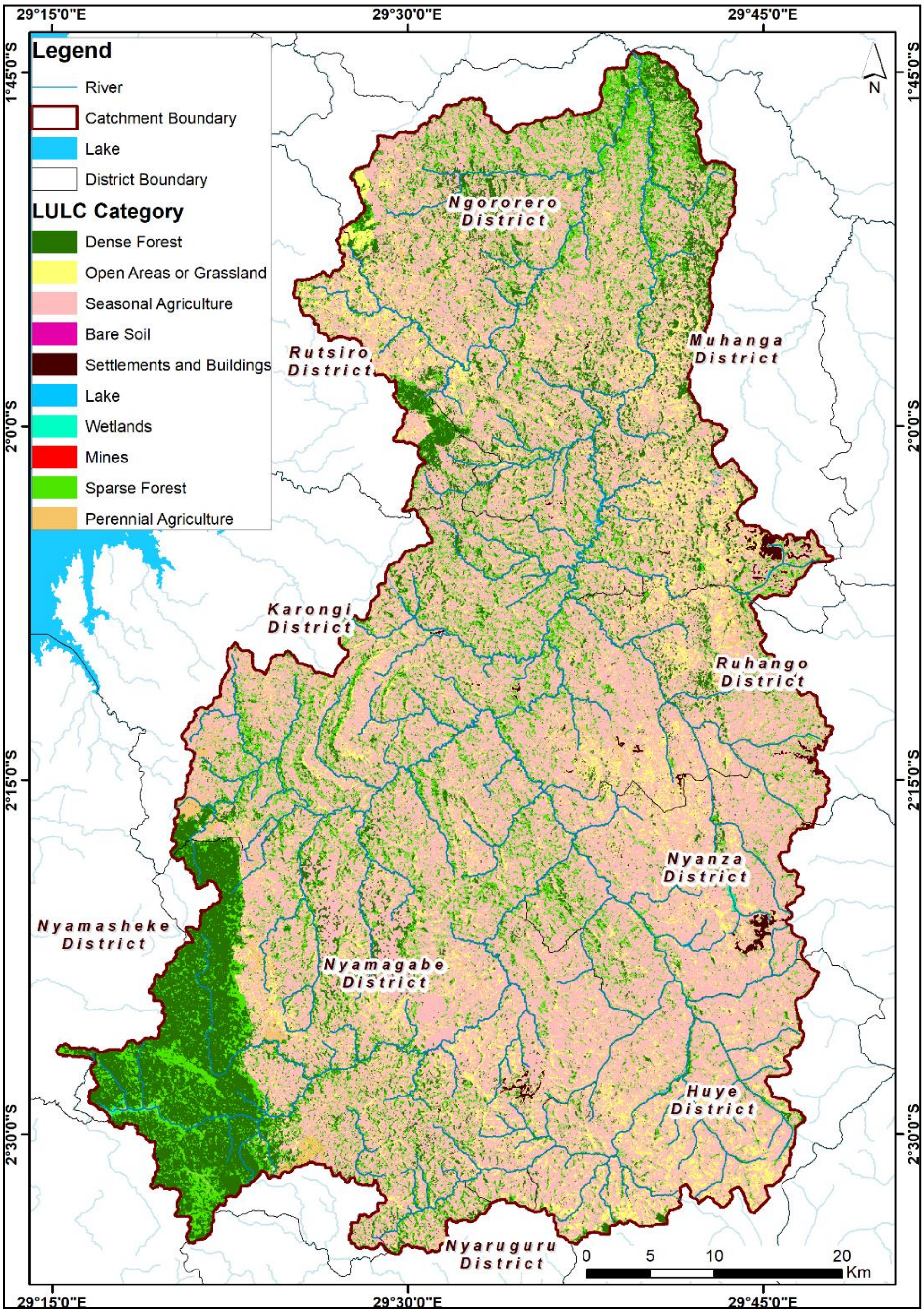



**Figure 3-36: Spatial Distribution of Existing LULC in NNYU catchment**

NNYU catchment include Huye, Nyamagabe, Nyanza, Ruhango, Muhanga, Ngororero, Rutsiro, Karongi, and Nyamasheke Districts. In this study, only the District of Muhanga was the considered. According to the District officials and farmers who have agricultural activities in the visited wetlands, the wetlands are under management of the District. Table 3-7 indicates area coverage of existing LULC in NNYU catchment. The main activity practiced in the visited wetland is agriculture with a dominance of substance and cash crops and farmers work under cooperatives for the improvement of their socioeconomic status.

**TABLE 3-7 Area coverage of existing LULC in NNYU catchment**

| S/N | LULC Category | Area (Ha) | Area (%) |
|---|---|---|---|
| 1 | Seasonal Agriculture | 203,175.7 | 60.6 |
| 2 | Perennial Agriculture | 6,786.0 | 2.0 |
| 3 | Dense Forest | 43,493.0 | 13.0 |
| 4 | Sparse Forest | 46,266.5 | 13.8 |

| | | | |
|---|---|---|---|
| **5** | Open Areas or Grassland | 32,006.0 | 9.5 |
| **6** | Settlements and Buildings | 1,524.6 | 0.5 |
| **7** | Waterbody | 1,799.1 | 0.5 |
| **8** | Wetland | 164.0 | 0.0 |
| **9** | Mines | 2.1 | 0.0 |

### 3.3.1 Perception about ecosystem services with different land uses

The main purpose of this section was to understand the community perception on ecosystem services provided by different land uses in NNYU. With the fact that only one District was considered within this catchment, notably Muhanga District, a total of 100 respondents were interviewed and only wetland land uses was evaluated by considering provisioning services, regulating and supporting services as well as cultural services from the wetlands. The considered provisioning services include subsistence crops, commercial crops (cash crops), wild foods, livestock feed, fuel, fresh water, ornamental resources and natural/plants-derived medicines. As shown in Figure 3-37, considering the number of respondents, the visited wetlands in this catchment are dominated by subsistence crops mainly beans and vegetables and cash crops such as rice and maize produced particularly for the program of seed multiplication. Most of the respondents highlighted that wetlands in this catchment provide more subsistence crops, cash crops, livestock feed and fresh water, compared to other provisioning services. Other provisioning services offered at low level include fish production, natural/plant-derived medicine, ornamental resources, notably clay.

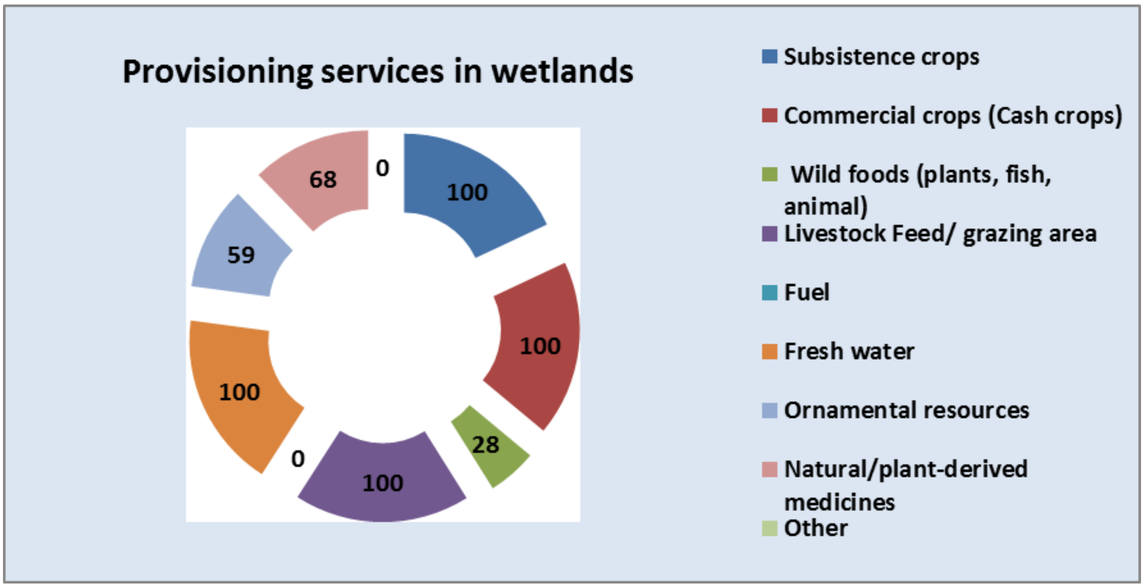



**Figure 3-37: Perception of provisioning services provided by wetlands in NNYU catchment**

Regulating and supporting services considered in this section were regulation of air quality, water purification, regulation of disease and pests, flood regulation, erosion regulation, noise buffering and soil formation. Figure 3-38 shows that almost all the respondents consider that these wetlands provide services like regulation of air quality, water purification and flood regulation. Soil formation had only 44 responses while there were no answers for services related to erosion regulation, regulation of disease & pests and noise buffering. This is probably due to the lack of knowledge for the local population about the provision of these services by wetlands because the field observations noted that these other regulating and supporting services exist as well.

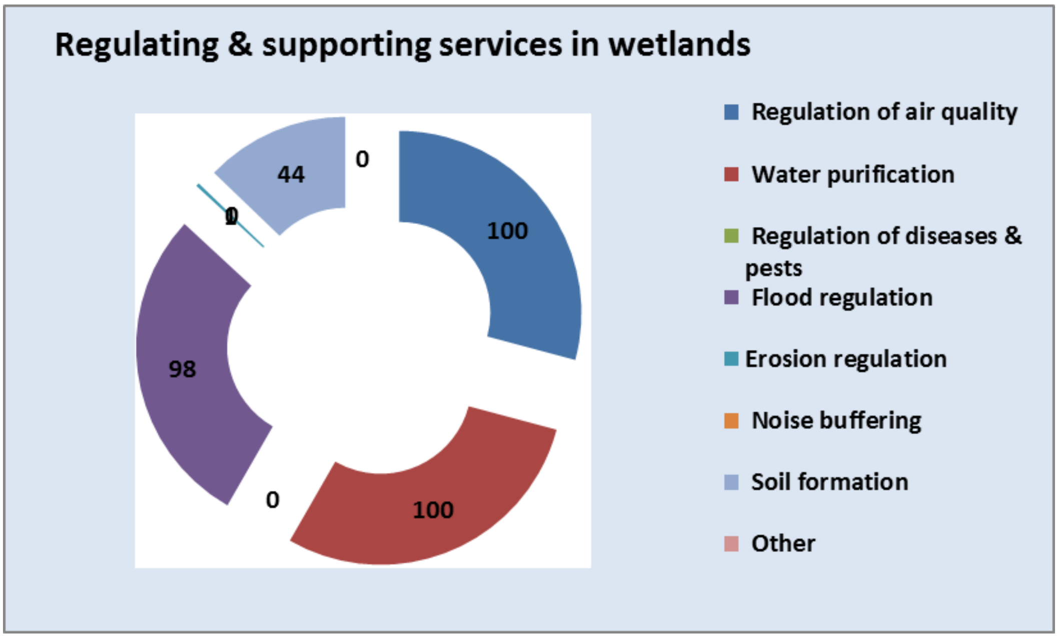



**Figure 3-38: Perception of Regulating & supporting services provided by wetlands in NNYU catchment**

Cultural services considered in this category included spiritual values, cultural heritage and practices, education and knowledge systems, recreation, and ecotourism. According to the respondents as shown in Figure 3-39, the only cultural services provided by this catchment are education and knowledge systems and recreation with 88 and 57 responses respectively.

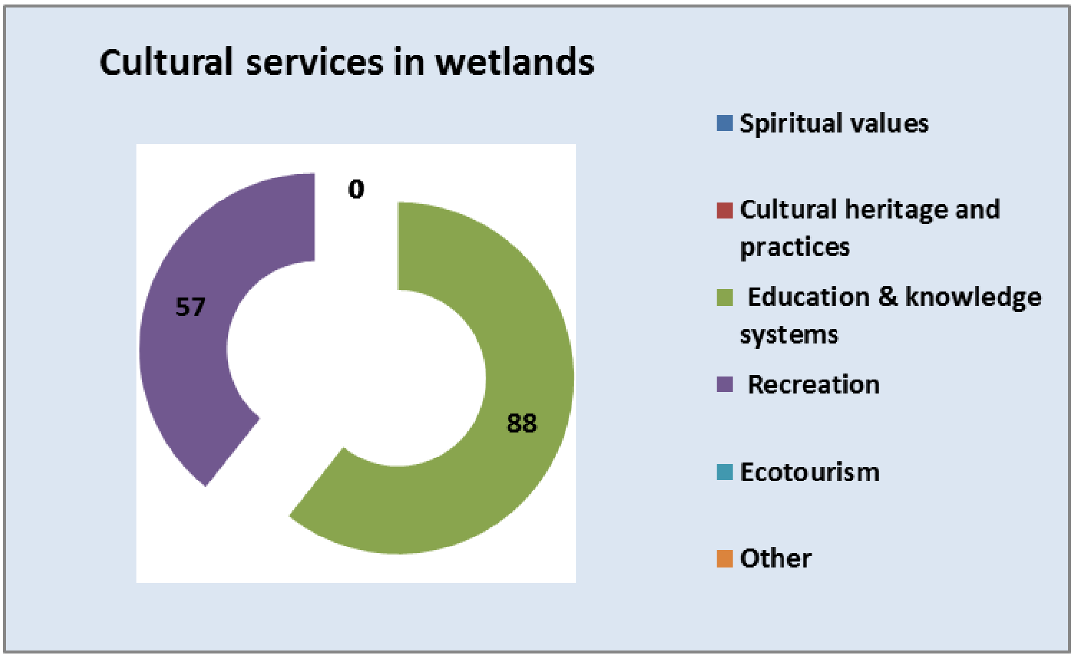



**Figure 3-39: Perception of culture services provided by wetlands in NNYU catchment**

### 3.3.2 Perception about importance of ecosystem services with different land uses

The aim of this section was to assess the importance of ecosystem services provided by wetlands in NNYU catchment and their contribution to the wellbeing of the local community. The ecosystem services considered in this section were provisioning services, regulating and supporting service and cultural services. As can be seen in Figure 3-40, all the respondents highlighted subsistence crops, cash crops and fresh water as very important and livestock feed as somehow important. Ornamental resources were highlighted by 42 out of 100 respondents as very important. In addition, wild foods and fuel were also mentioned not important with more than 50 respondents.

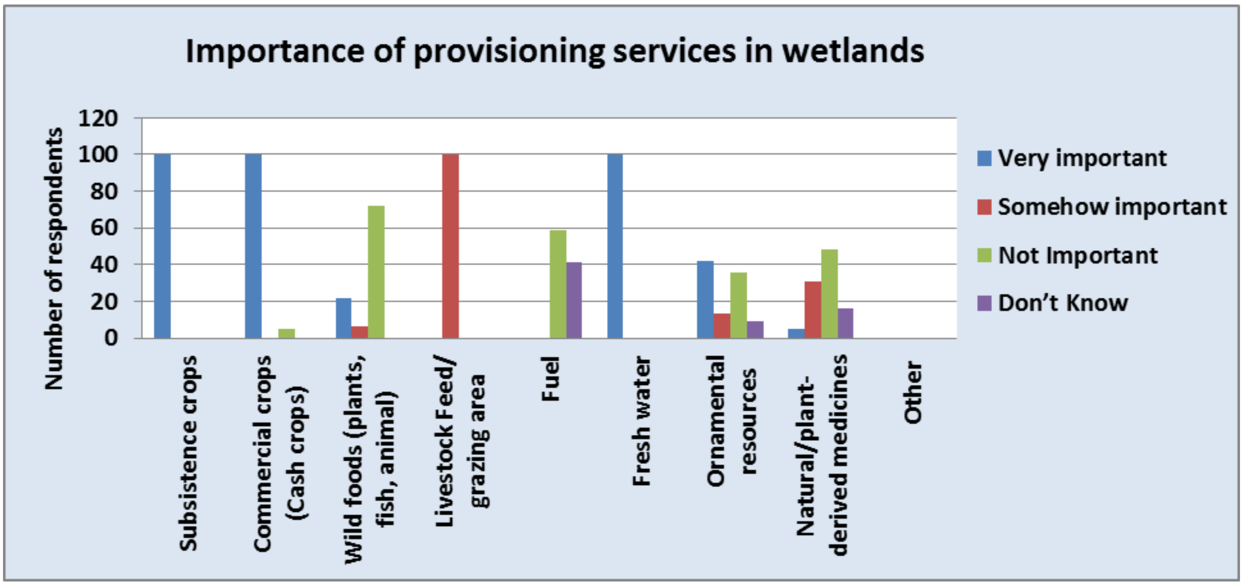



**Figure 3-40: Perception of importance of provisioning services provided by wetlands in NNYU catchment**

Regulating and supporting services considered in this section are regulation of air quality, water purification, regulation of disease and pests, flood regulation, erosion regulation, noise buffering and soil formation. As can be seen on Figure 3-41, all the respondents highlighted regulation of air quality, water purification and flood regulation as somehow important while soil formation was highlighted by 47 respondents as somehow important. Erosion regulation and regulation of disease and pests are indicated not important with 86 and 74 responses respectively. Most respondents seem to ignore noise buffering as one of regulating and supporting services provided by wetlands.

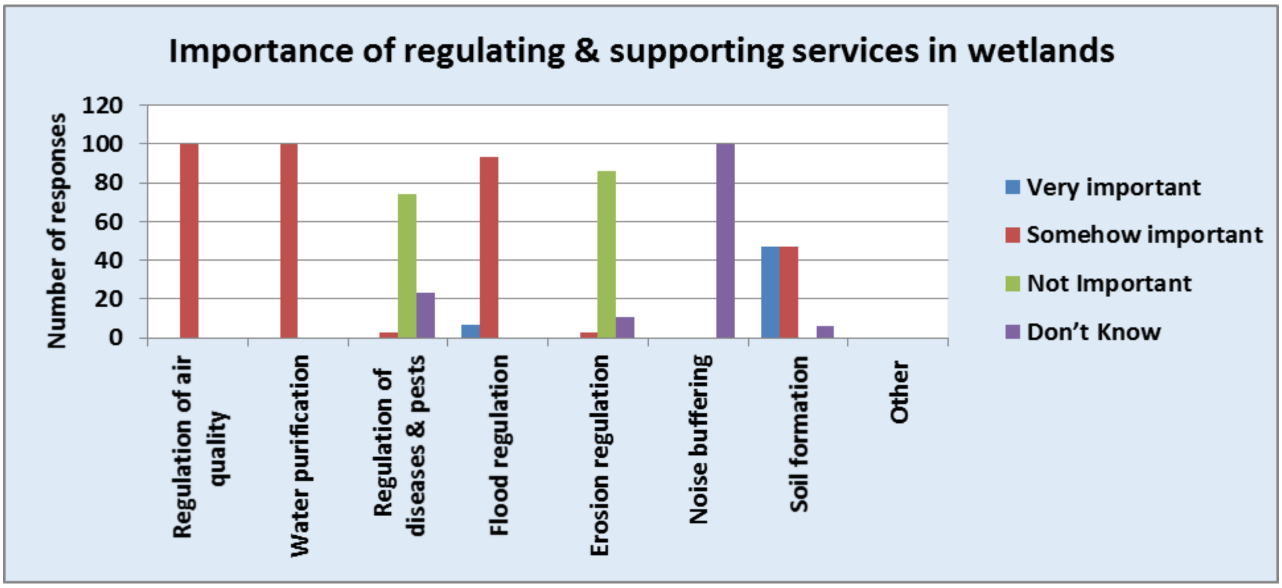



**Figure 3-41: Perception of regulation and supporting services provided by wetlands in NNYU catchment**

In addition, cultural services considered includes spiritual values, cultural heritage and practices, education and knowledge systems, recreation and ecotourism, as shown in Figure 3-38, none of these ecosystem services were highlighted as very important by the respondents. Ecosystem services highlighted as somehow important are education and knowledge systems and recreation with 68 and 60 responses respectively.

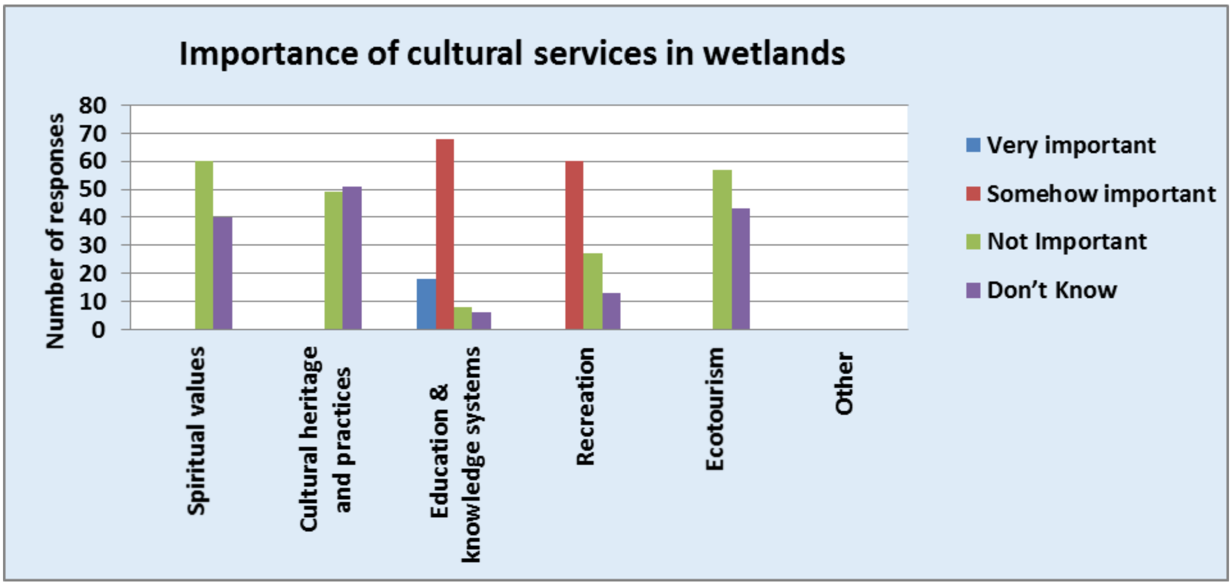



**Figure 3-42: Perception of importance of culture services provided by wetlands in NNYU catchment**

### 3.3.3 Economic and livelihood dependence on wetlands

The objective of this section is to assess the extent to which the local community depends on wetlands in NNYU catchment by considering only provisioning services. As can be seen in Figure 3-43, the ecosystem services highlighted as highly dependent in the visited wetlands are cash crops, subsistence crops, and fresh water each having more than 85 responses respectively. Livestock feed, ornamental resources and natural/plant derived medicines are highlighted as somehow dependent with 59, 34 and 31 responses respectively. Natural/plant derived medicines, wild foods and fuel are mentioned not dependent at all with 49, 71 and 100 responses each respectively.

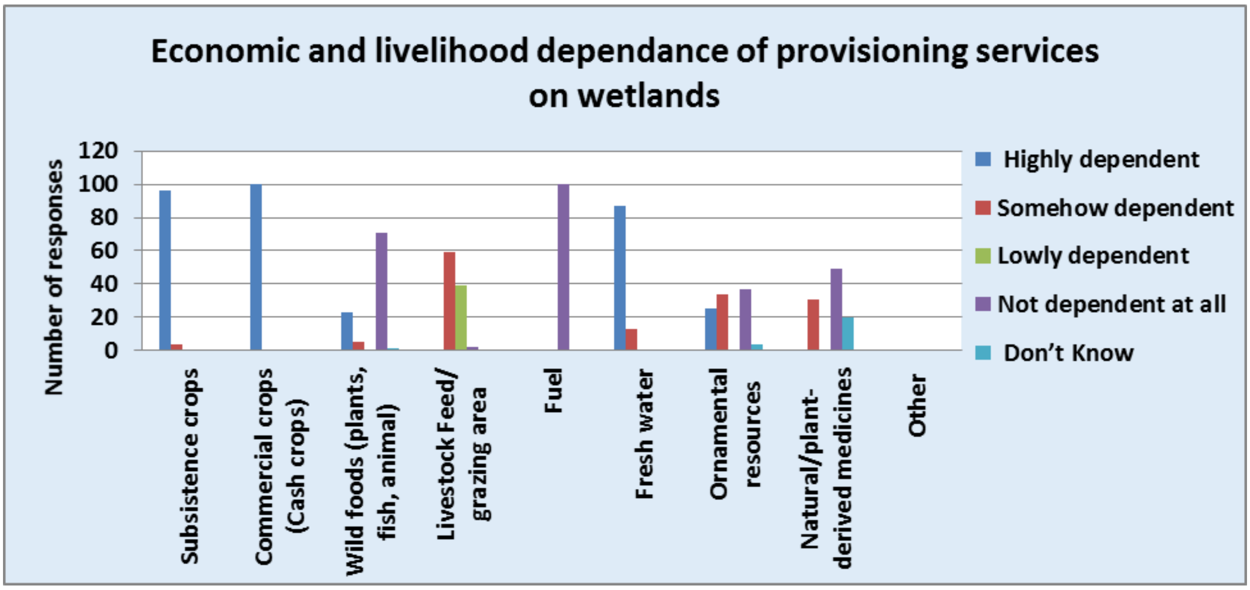



**Figure 3-43: Perception of economic dependence and livelihood of wetlands in NNYU catchment**

### 3.3.4 Trends of ecosystem services provision associated with wetlands in the past 5 years

The main objective of this section was to assess the trend of ecosystem services provided by the wetlands in NNYU catchment over the past five years. The considered ecosystem services under this category are provisioning services, regulating and supporting services as well as cultural services. As shown in Figure 3-44, all the respondents showed that fresh water, subsistence crops and cash crops have been increasing over the past five years with 100, 92 and 69 responses respectively. However, 23 respondents highlighted cash crops being declined over the past five years mainly due to the lack of other rice varieties. The livestock feed was highlighted as no change by all the respondents while many of the respondents don't know if other provisioning services were increasing or decreasing over the past five years.

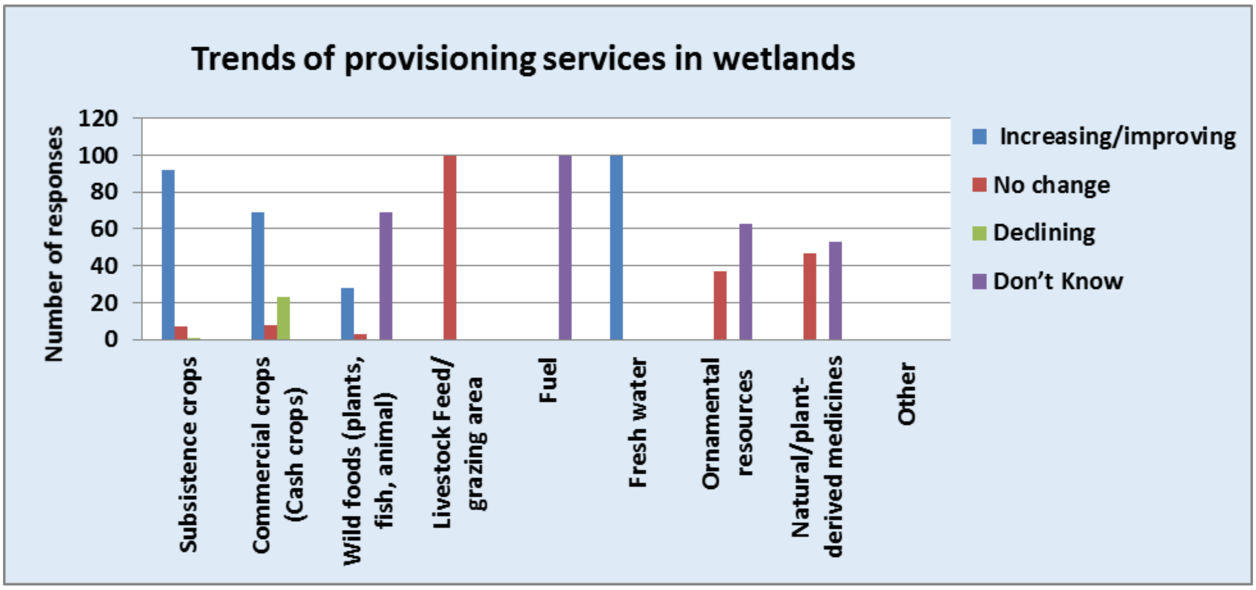



**Figure 3-44: Trends of provisioning services in NNYU catchment over the past 5 years**

### 3.3.5 Most important driver for the indicated trend of change

The main goal of this section was to analyse the drivers of ecosystem services identified as declining previously. All the ecosystem services under consideration are provisioning services, regulating and supporting services as well as cultural services. The trends of drivers over the past five years have been analysed in Figure 3-45 for the visited wetlands. According to the respondents, provisioning services notably cash crops are mentioned as declining in this catchment over a period of past five years. This is caused by the lack of other rice varieties (73%) and infrastructure development (27%) that caused flooding in the wetlands.

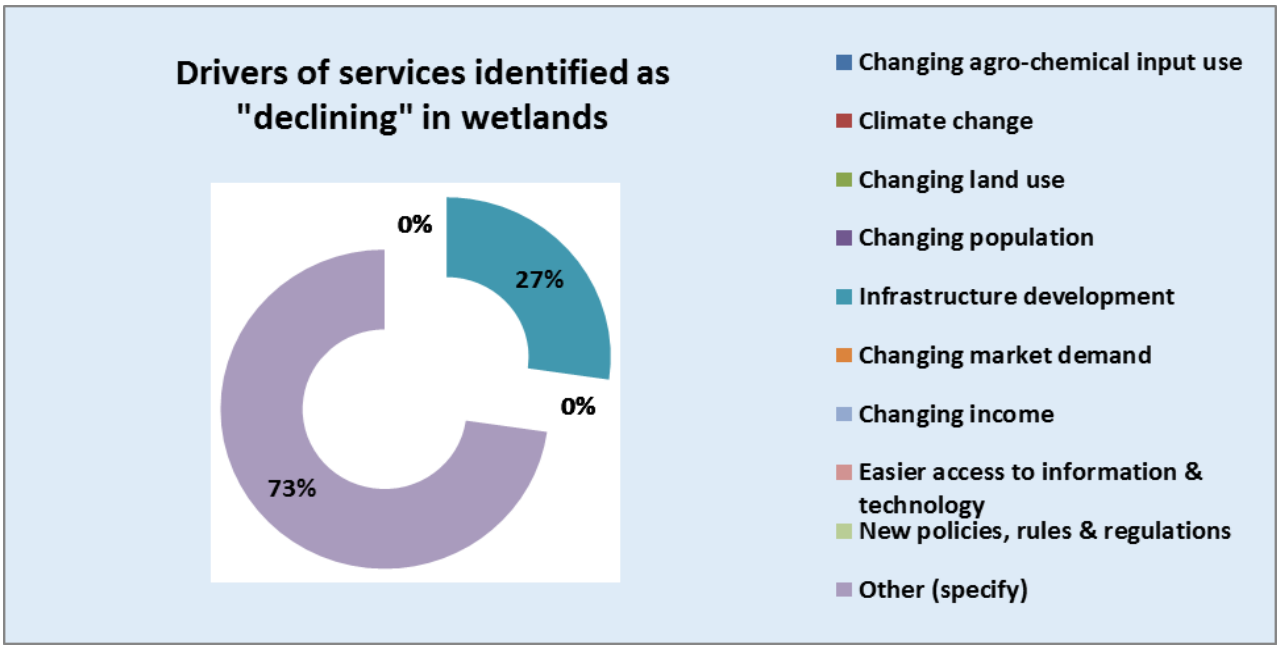



**Figure 3-45: Drivers for the trend of change of ecosystem services considering declining ecosystem services in NNYU catchment**

### 3.3.6 Natural hazards in the wetland area and surrounding

The main goal of this section was to assess the natural hazards currently occurring in wetlands and surrounding area within NNYU catchment. The natural hazards under consideration in this section as can be seen in Figure 3-46 are: flood events, mass movements, strong sedimentation coming from the water course, erosion of river banks, and disease caused by contaminated water. All the respondents showed that wetlands in this catchment are affected by flood events, erosion of river banks, and strong sedimentation coming from the water course. Landslides and diseases caused by contaminated water are not a main issue for interviewed farmers in the visited wetlands.

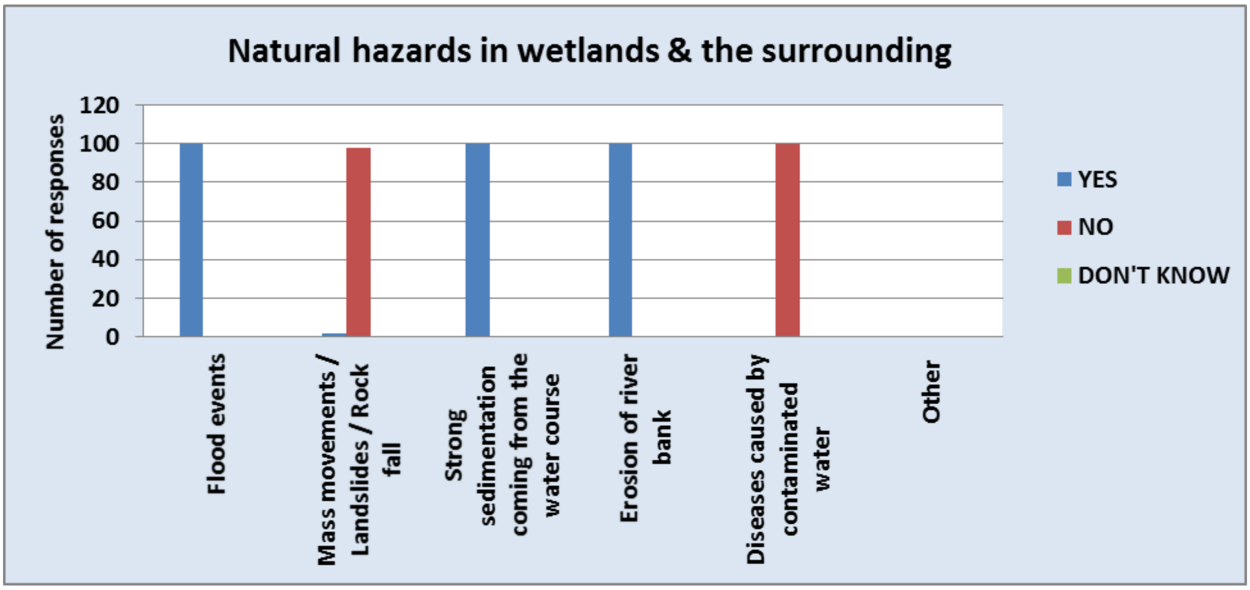



**Figure 3-46: Natural hazards in wetland area and surrounding in NNYU catchment**

### 3.3.7 Opinion concerning wetland restoration: Fears and Opportunities

The main goal of this part was to assess communities' interests and concerns regarding restoration of wetlands within NNYU catchment. As presented on Figure 3-47, all the respondents fear the loss of assets and livelihood if wetlands are restored. In contrast, the communities do not fear the "loss of neither land nor cultural heritage.

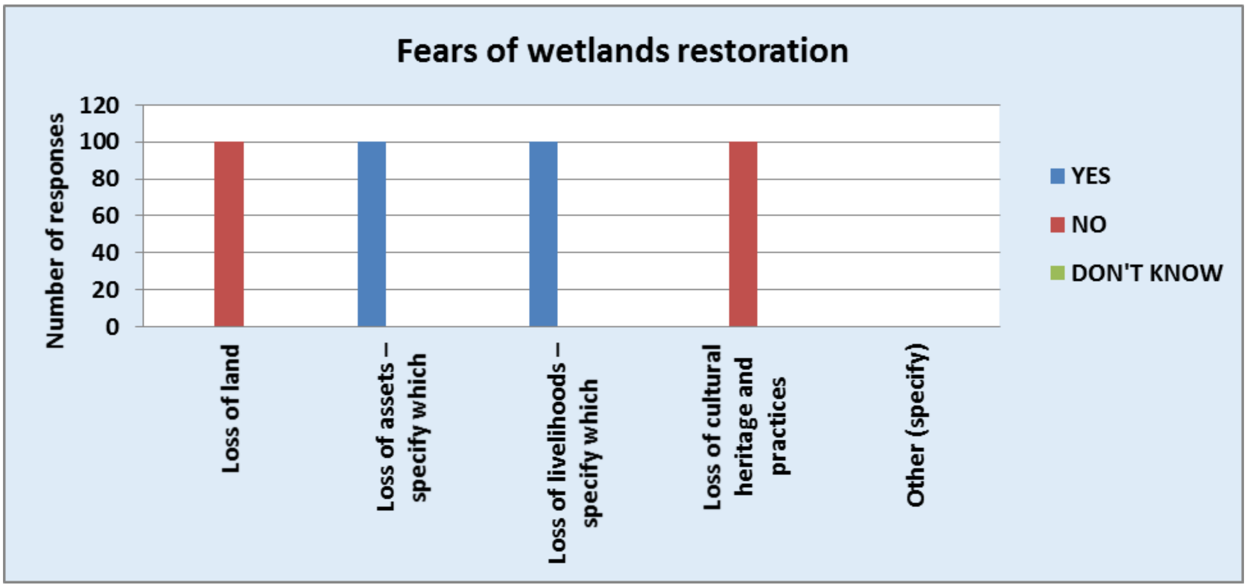



**Figure 3-47: Fears about the wetlands restoration in NNYU catchment**

For the opportunities associated with restoration of wetlands in NNYU catchment, as can be seen in Figure 3-48, all the respondents' highlighted regulation of air quality, water purification, regulation of disease and pests, flood regulation and erosion regulation. Education and knowledge systems, recreation, and noise buffering and ecotourism are not seen as good opportunities for restoration of wetlands in that area.

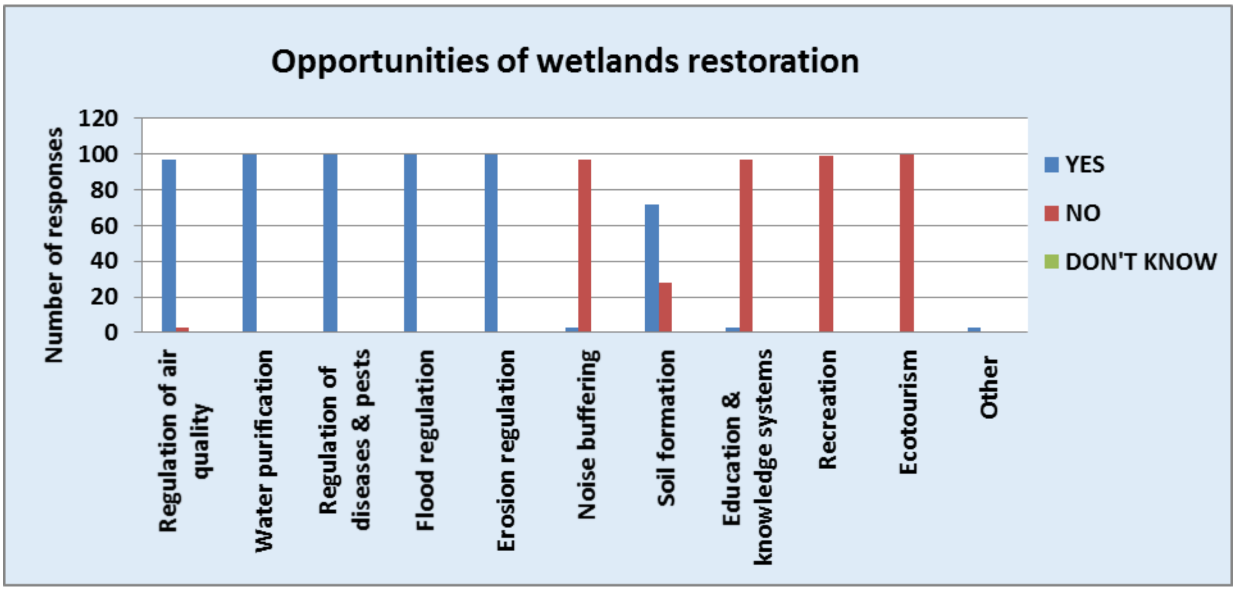



**Figure 3-48: Opportunities about the wetlands restoration in NNYU catchment**

### 3.3.8 Analysis of drivers of wetland degradation

The main goal of this section was to understand the drivers of change by assessing the extent at which the drivers of ecosystem degradation under consideration are practiced in the area. Figure 3-49 highlights the drivers considered in this category which were Agricultural activities, eutrophication and pollution, infrastructure development, wetland overharvesting, emergent invasive species, loss of indigenous species and alteration of biogeochemical cycles.

In line with the provided responses, the local community considers wetland overharvesting, eutrophication and infrastructure development as the main drivers of ecosystem degradation for the visited wetlands and neighbouring environment in NNYU catchment with 100, 69 and 69 responses for each respectively. Agricultural activities are not considered as a driver for ecosystem degradation. On the other hand, drivers like emergent invasive species, loss of indigenous species, and alteration of biogeochemical seem to be unknown to the community.

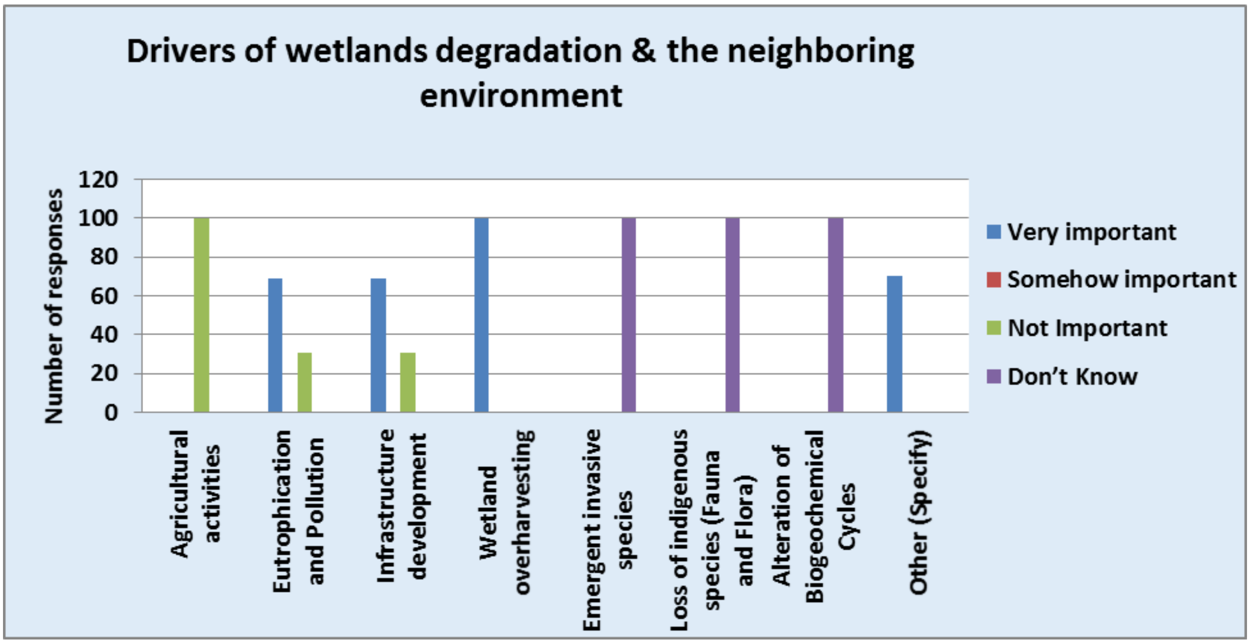



**Figure 3-49: Drivers change of wetland degradation in NNYU catchment**

#### 3.3.9 Conclusion and recommendations

The purpose of the survey in NNYU catchment was to develop a wetland management framework with Ecosystem Based Adaptation in Rwanda. The results provided an understanding of community perception on ecosystem services delivered by wetlands, the importance of ecosystem services, economic and livelihood dependence on wetlands, trends of ecosystem services in past five years, drivers of declining ecosystem services, natural hazards occurring in wetlands and neighbouring area, wetlands restoration opinions and wetlands degradation indicators.

In general, the main provisioning services provided by the visited wetlands within NNYU catchment notably, in Muhanga District, are subsistence crops, cash crops and fresh water. The wetlands are moderately managed but there is a need to improve the drainage and irrigation systems. In addition, for cash crops especially rice, farmers have claimed that there is a decrease in rice productivity due to the lack of other varieties of rice and this has negatively affects their socioeconomic livelihoods. The detailed analysis of key issues concerning wetlands management in this District are flooding, erosion particularly in Kiyumba, Kabacuzi, Nyabinoni, Kibangu and Rongi sectors, mining especially in Ndago mining site that leads to pollution of Nyabarongo river, waste management and wetland buffer zones violation. Due to these issues this report recommends the followings:

- Wetlands in this catchment are affected by flooding due to landslides and erosion from neighbouring environment. Developed measures to minimize the level of flooding and erosion should be implemented for a better management of wetlands in this catchment. This should be supported by sustainment and improvement of both radical and progressive terraces, protection of river banks by bamboo trees, reforestation with indigenous species and improvement on drainage systems in wetlands.
- Sustainable wastes management including the construction of modern landfills and composting is recommended at least at the District level to reduce the pollution hotspots in the area and for the benefit wetlands environment.
- Mining activities in this catchment should be legally authorized and controlled by the District. This should be supported by mining sites rehabilitation by planting bamboo trees and other local indigenous trees around the mining sites.

## 3.4 NMUK catchment

This sub-chapter provide information gathered related to the existing knowledge on status and health of wetlands in Nile Mukungwa catchment (NMUK). The guiding ways proposed by District Environment officers and Natural resources directors along with field works interventions including the utilisation of questionnaire helped in understanding the baseline information on ecosystem services provided by wetlands in this catchment. These include identification of wetlands degradation indicators, the extent to which wetlands are managed and to propose the interventions to address the existing problems concerning wetlands management. Figure 3-50 highlights the spatial distribution of land use/Land cover (LULC) in NMUK catchment.

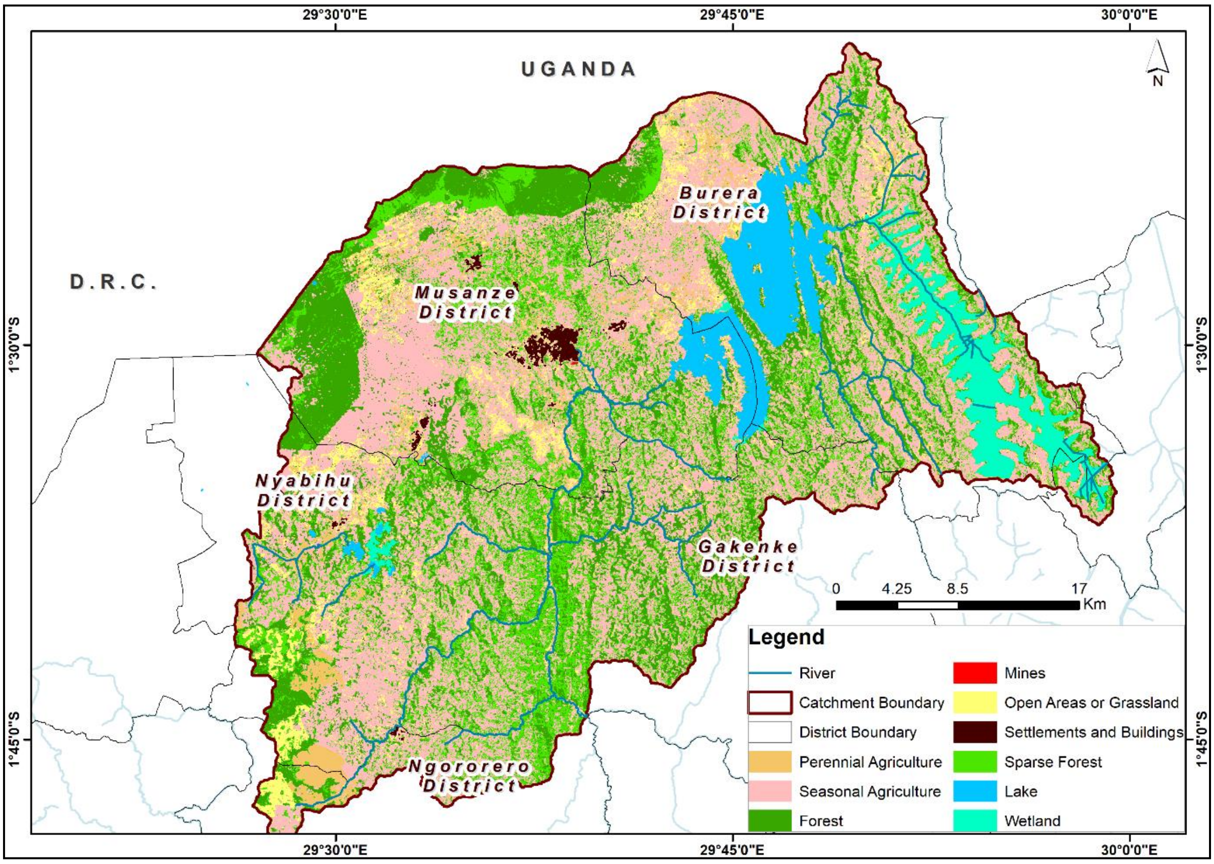



**Figure 3-50: Spatial Distribution of existing LULC in NMUK Catchment**

NMUK catchment include Ngororero, Gakenke, Musanze, and Burera Districts. The main activity in the wetlands within NMUK catchment is agriculture with subsistence crops. The wetlands are under management of the Districts in partnership with their respective key stakeholders and agricultural activities are done mainly through land use consolidation. Table 3-8 indicates area coverage of existing LULC in NMUK catchment. Generally, farmers in this catchment work under cooperatives which help in improving their social and economic status. However, most of the visited wetlands are not well managed and this affects wetland provisioning services notably subsistence crops produced in this wetlands.

**TABLE 3-8 Area coverage of existing LULC in NNYU catchment**

| S/N | LULC Category | Area (Ha) | Area (%) |
|---|---|---|---|
| 1 | Seasonal Agriculture | 80,148.1 | 43.8 |
| 2 | Perennial Agriculture | 7,020.8 | 3.8 |
| 3 | Dense Forest | 36,079.8 | 19.7 |
| 4 | Sparse Forest | 34,396.8 | 18.8 |
| 5 | Open Areas or Grassland | 8,911.7 | 4.9 |
| 6 | Settlements and Buildings | 1,078.0 | 0.6 |
| 7 | Waterbody | 8,676.5 | 4.7 |
| 8 | Wetland | 6,750.2 | 3.7 |
| 9 | Mines | 7.2 | 0.0 |

### 3.4.1 Perception about ecosystem services with different land uses

The purpose of this section was to understand the community perception on ecosystem services provided by different land uses in NMUK catchment. A total of 200 respondents were interviewed and only wetland land uses was evaluated taking into consideration provisioning services, regulating and supporting services and cultural services from the wetlands within this catchment.

Figure 3-51 present the provisioning services which include subsistence crops, commercial crops (cash crops), wild foods, livestock feed, fuel, fresh water, ornamental resources and natural plants-derived medicines. Considering the number of respondents interviewed, it is obvious that wetlands in this catchment are dominated by subsistence crops. These include mainly beans, maize and vegetables. All the respondents mentioned that wetlands in this catchment provide more subsistence crops, fresh water and livestock feed compared to other provisioning services. Other provisioning services provided by wetlands in this catchment are ornamental resources, notably clay, wild foods and plant-derived medicine. The wetlands do not provide neither commercial crops nor fuel.

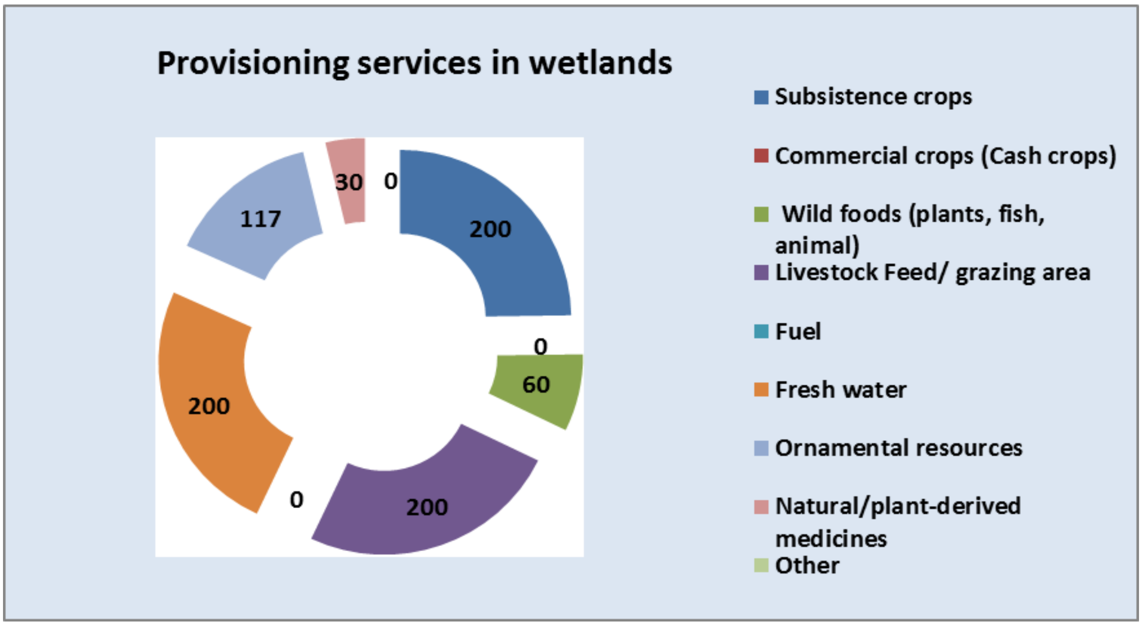



**Figure 3-51: Perception of provisioning services provided by wetlands in NMUK catchment**

Regulating and supporting services considered in this section are regulation of air quality, water purification, regulation of disease and pests, flood regulation, erosion regulation, noise buffering and soil formation. Figure 3-52 shows that higher number of respondents (more than 100) mentioned that regulating and supporting services provided by wetlands are regulation of air quality, water purification and flood regulation. Erosion regulation is considered to be provided at a low level. On the other hand, the local population seem to have no knowledge about the provision of regulating and supporting services like regulation of disease and pests, noise buffering and soil formation.

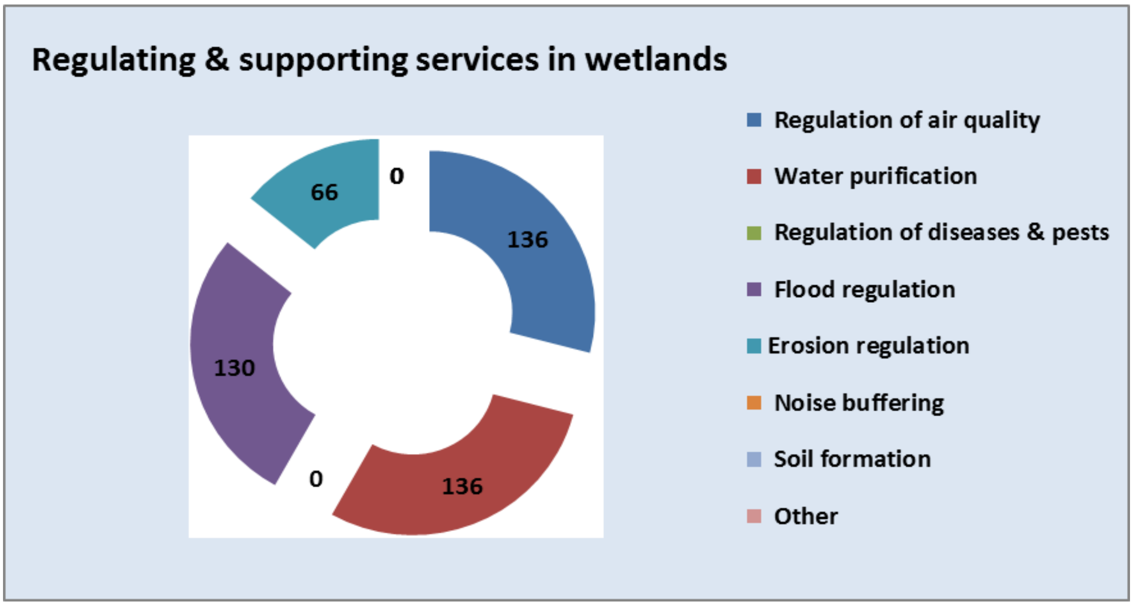


**Figure 3-52:** Perception of regulating and supporting services provided by wetlands in NMUK catchment

Cultural services considered in this category included spiritual values, cultural heritage and practices, education and knowledge systems, recreation and ecotourism. According to the respondents as highlighted in Figure 3-49, recreation is the main cultural service provided by this catchment, mainly due to football pitches observed in the visited wetlands. Education and knowledge systems are provided with a low frequency while other services such as spiritual values, cultural heritage and practices as well as ecotourism are not provided at all.

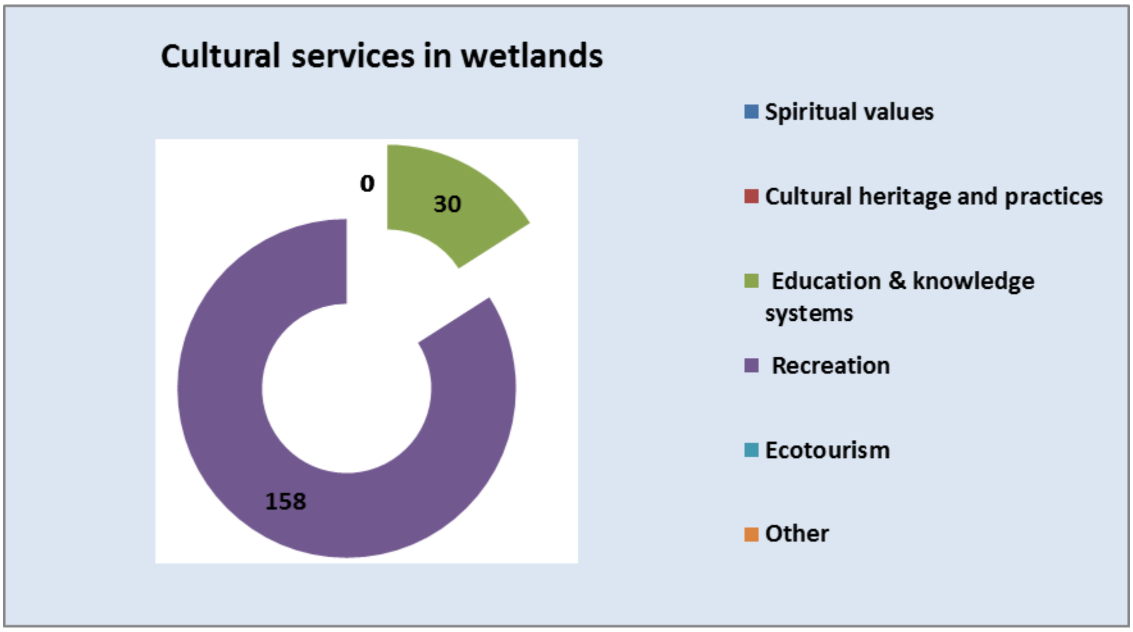



**Figure 3-53:** Perception of cultural services provided by wetlands in NMUK catchment

### 3.4.2 Perception about importance of ecosystem services with different land uses

The aim of this section was to assess the importance of ecosystem services and their contribution to the wellbeing of the community. The ecosystem services considered in this section were provisioning services, regulating and supporting service as well as cultural services. According to most respondents, as shown in Figure 3-54, the services provided by wetlands in this catchment highlighted as very important are subsistence crops and fresh water. Services highlighted as somehow important are livestock feeds and ornamental resources with more than 100 responses each respectively. Fuel, natural plant derived medicine and commercial crops are considered not important in this catchment with more than 120 responses each respectively.

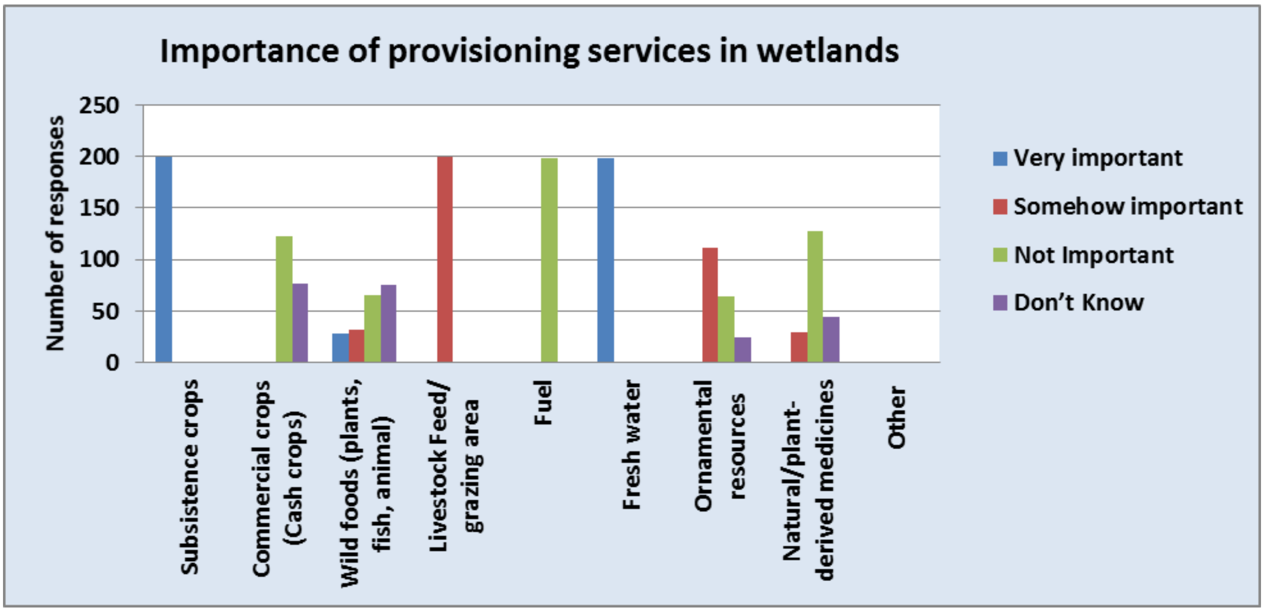



**Figure 3-54:** Perception of importance of provisioning services provided by wetlands in NMKU catchment

Regulating and supporting services considered in this section are regulation of air quality, water purification, regulation of disease and pests, flood regulation, erosion regulation, noise buffering and soil formation. According to the answers provided by the respondents as shown in Figure 3-55, there are no services highlighted as very important. Services highlighted as somehow important include flood regulation, regulation of air quality and water purification with more than 130 responses for each respectively. Regulation of disease and pests and erosion regulation are labelled not important with more than 110 responses respectively. The local population seems to not have much knowledge about the provisioning of noise buffering and soil formation by wetlands where the responses were more than 120 for these services.

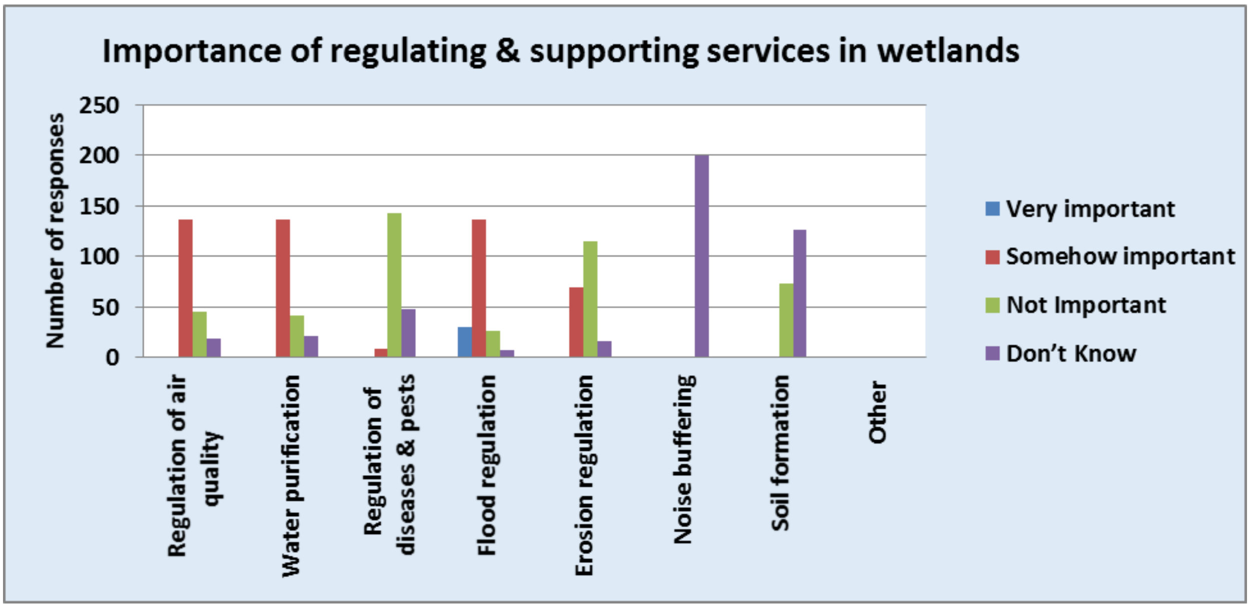



**Figure 3-55: Perception of importance of regulating and supporting services in NMKU catchment**

This section also considered cultural services that includes spiritual values, cultural heritage and practices, education and knowledge systems, recreation and ecotourism. As shown in Figure 3-56, no ecosystem services were highlighted as very important by the respondents. Ecosystem service highlighted as somehow important is recreation while ecotourism, spiritual values, education and knowledge systems, cultural heritage and practices are considered not important with more than 110 responses each. However, more than 60 respondents stated not being aware of any practice of spiritual values or cultural heritage and practices in the wetlands within NMUK catchment.

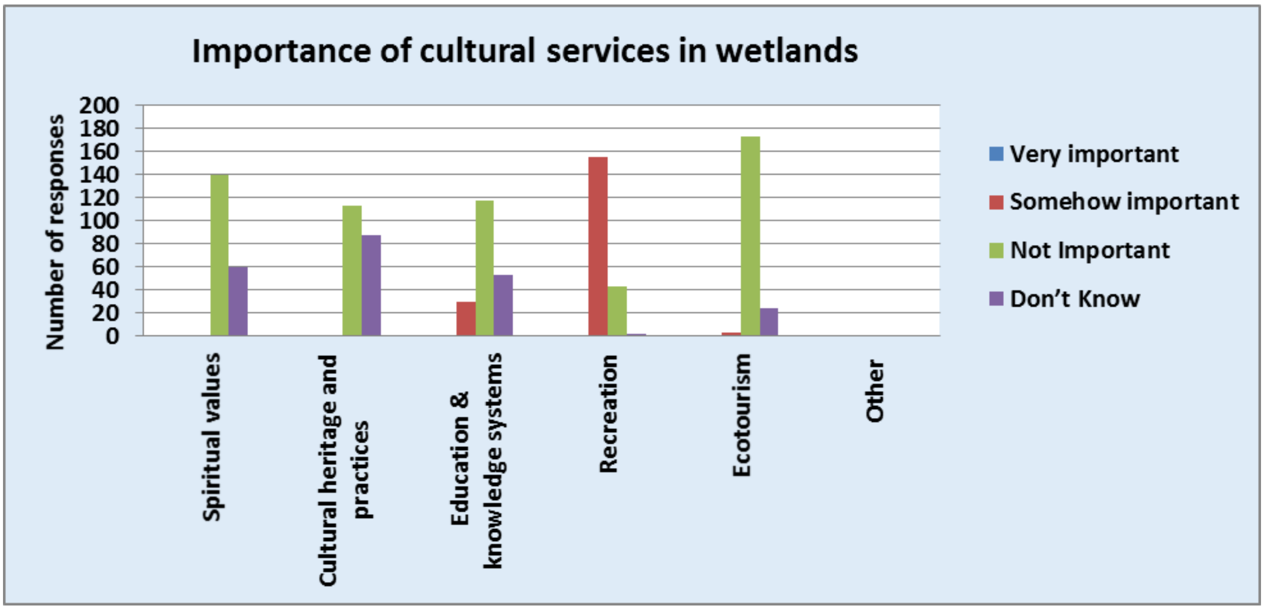


**Figure 3-56:** Perception of importance of cultural services provided by wetlands in NMKU catchment

### 3.4.3 Economic and livelihood dependence on wetlands

This section has the objective of assessing the extent to which the local community depends on wetlands in NMUK catchment by considering only provisioning services. As shown in Figure 3-53, the ecosystem services highlighted as highly dependent are subsistence crops and fresh water each having more than 150 respondents. Livestock feed and ornamental resources are shown to be somehow dependent with more than 60 responses each. Ecosystem services highlighted as not dependent at all are fuel, commercial crops, wild foods, and natural/plant derived medicines with more than 100 responses for each.

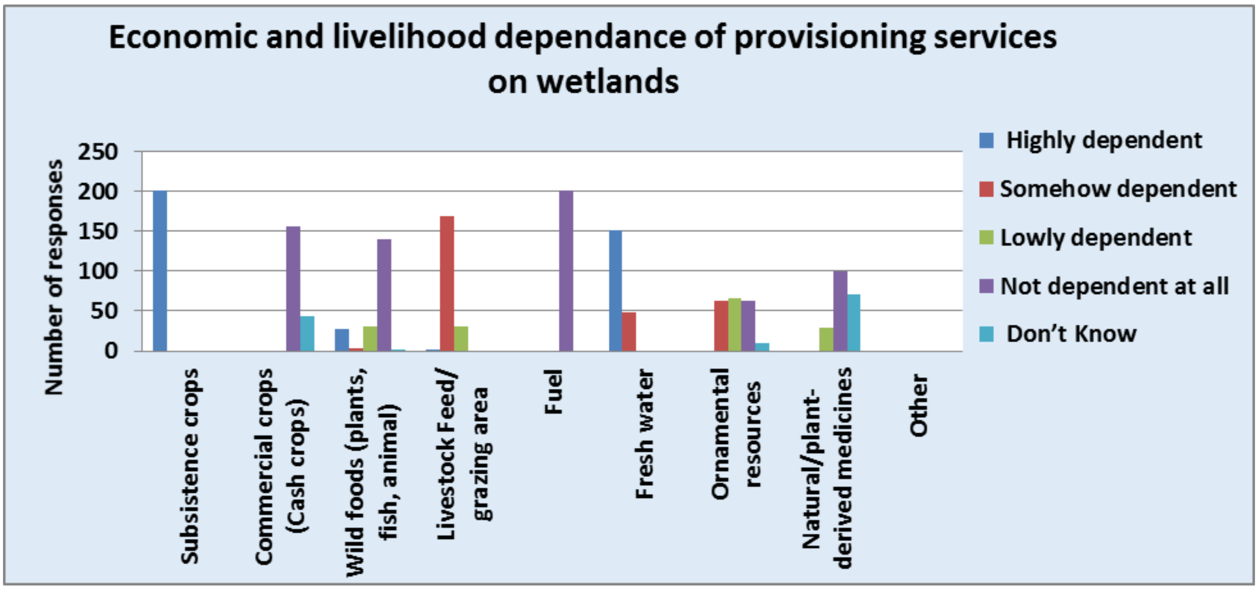



**Figure 3-57:** Economic dependence and livelihood on wetlands in NMUK catchment

### 3.4.4 Trends of ecosystem services provision associated with wetlands in the past 5 years

The main objective of this section was to assess the trend of ecosystem services provided by wetlands in NMUK catchment over the past five years. The considered ecosystem services under this category are provisioning services, regulating and supporting services and cultural services. As indicated in Figure 3-58, all the respondents showed that subsistence crops and fresh water have been increasing over the past five years. The ecosystem services like livestock feed and ornamental resources are highlighted as stable with more than 50 responses each respectively. However, 49 respondents have shown livestock feed to decline over the past five years mainly due agricultural practices in these wetlands. Almost all the respondents seemed to not know if provisioning services like commercial crops, fuel, wild foods and natural/derived medicines have increased or declined over the past five years.

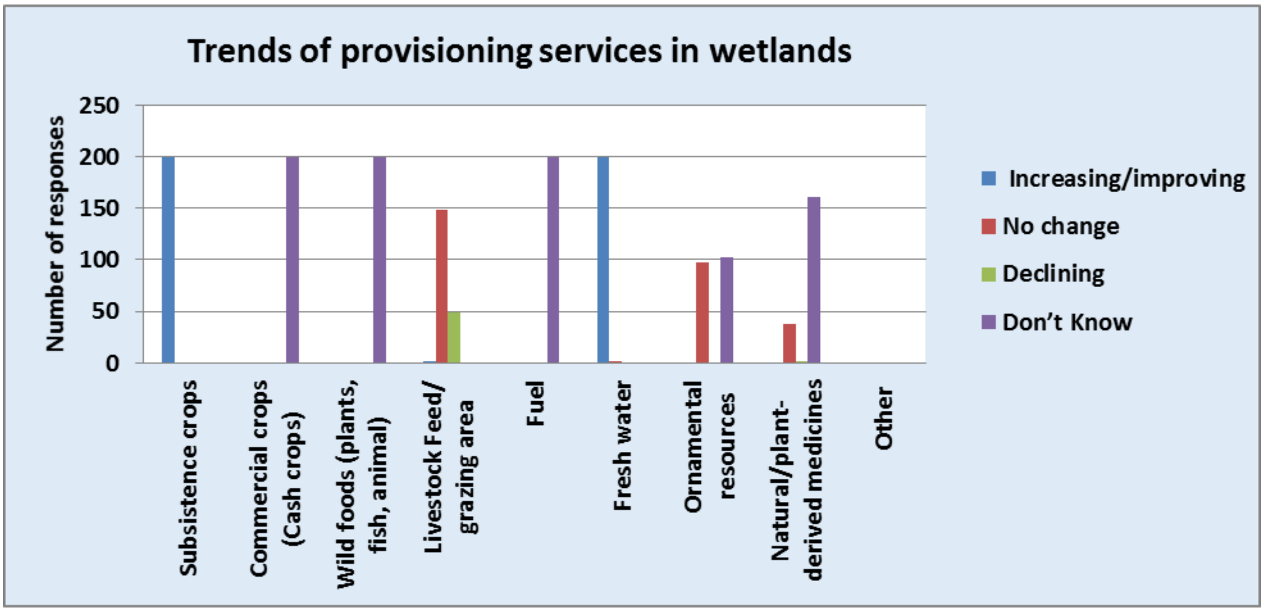


**Figure 3-58: Trends of provisioning services by wetlands in NMUK catchment over the past 5 years**

### 3.4.5 Most important driver for the indicated trend of change

The main goal of this section was to analyse the drivers of ecosystem services identified as declining previously. The ecosystem services under consideration are provisioning services, regulating and supporting services as well as cultural services. The trends of drivers over past five years have been analysed in Figure 3-55 for the whole NMUK catchment. According to the provided responses, provisioning services, regulating and supporting services, and also cultural services were mentioned as declining in this catchment over a period of past five years. The decline was indicated to be mostly driven by climate change (63%) and other drivers (37%) that include flooding and erosion.

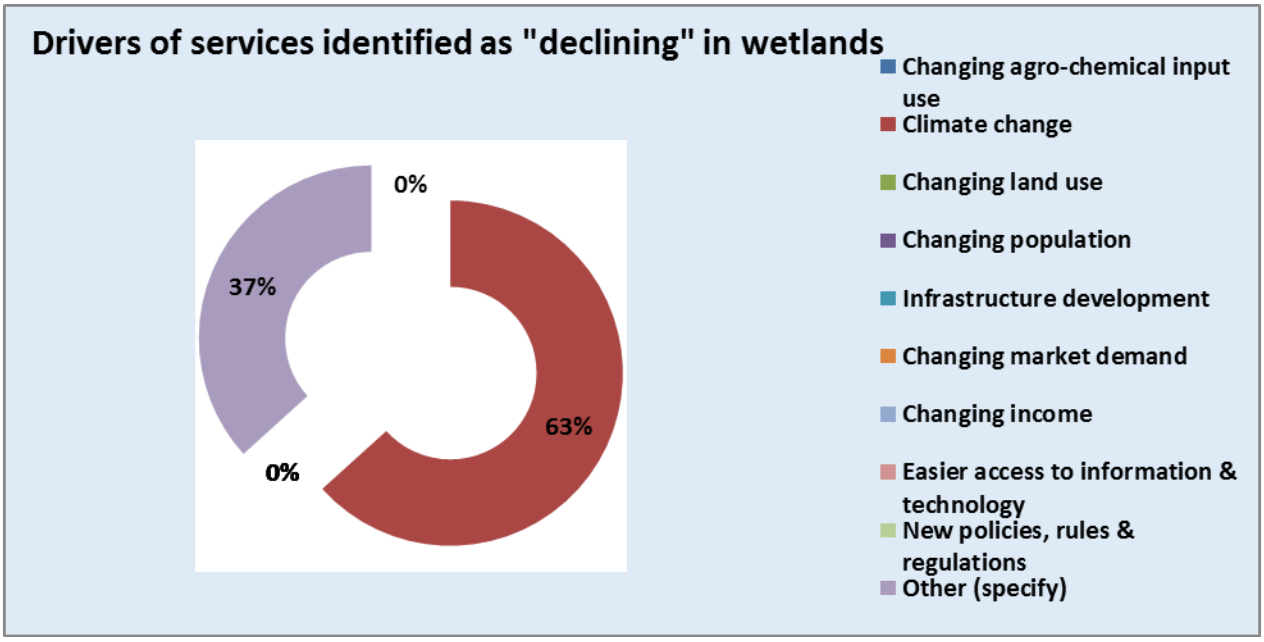



**Figure 3-59: Drivers for the trend of change of ecosystem services considering declining ecosystem services in NMUK catchment**

### 3.4.6 Natural hazards in the wetland area and surrounding

The main goal of this section was to assess the natural hazards currently occurring in wetlands and surrounding area within NMUK catchment. The natural hazards under consideration in this section as can be seen in Figure 3-60 are flood events, mass movements, strong sedimentation coming from the water course, erosion of river banks, and disease caused by contaminated water. All the respondents mentioned that wetlands in this catchment are affected by flood events, erosion of river banks, strong sedimentation coming from the water course while 130 of the respondents have highlighted landslides as the natural hazard affecting wetlands in this catchment.

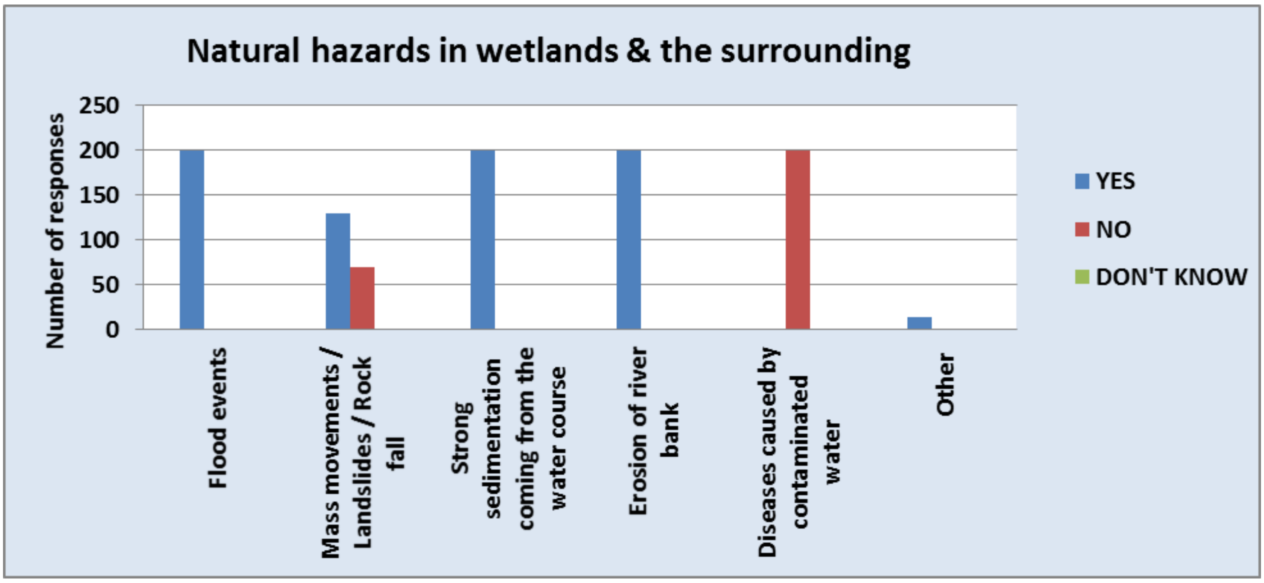


**Figure 3-60: Natural hazards in the wetland area and surrounding in NMUK catchment**

### 3.4.7 Opinion concerning wetland restoration: Fears and Opportunities

The main goal of this part was to assess communities' interests and concerns regarding wetlands restoration in NMUK catchment. Based on provided responses, the main fears for wetlands restoration include loss of livelihood, loss of assets and loss of land with 200,199 and 49 responses respectively. Right the contrary, the communities do not fear the "loss of cultural heritage and practices" as indicated in Figure 3-57.

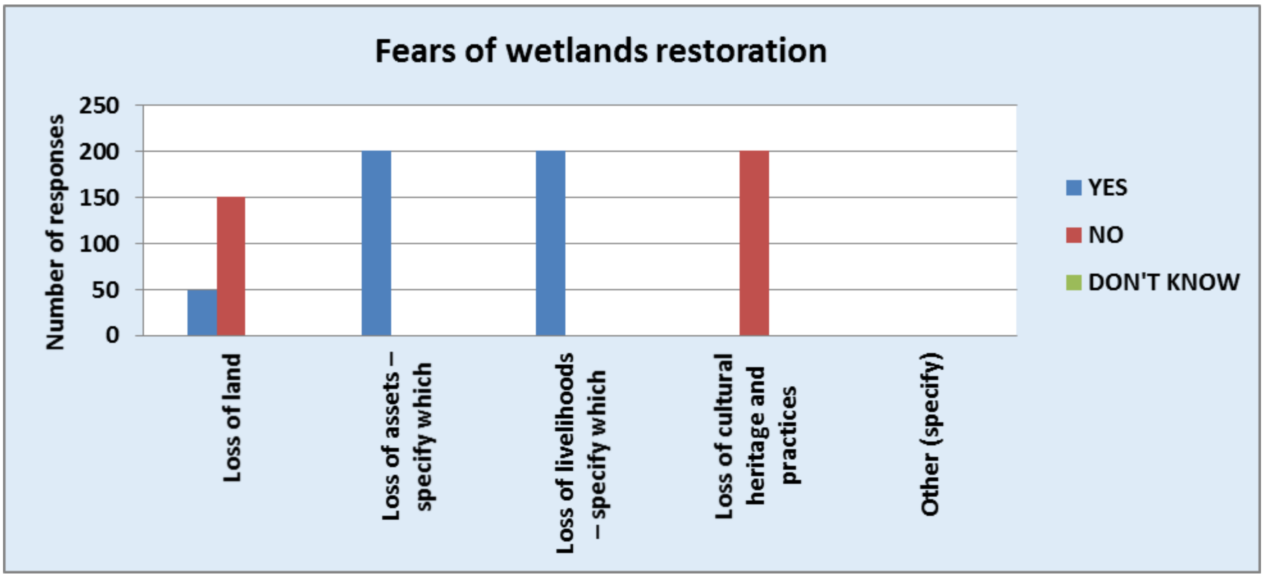



**Figure 3-61: Fears about wetlands restoration in NMUK catchment**

In line with opportunities for restoration of wetlands in NMUK catchment, all the respondents indicated that it can be a good opportunity for "water purification", "erosion regulation", "flood regulation", "regulation of disease and pests", and "regulation of air quality". Education and knowledge systems, recreation, and noise buffering and ecotourism are were not mentioned as good opportunities for wetlands restoration in NMUK catchment as indicated in Figure 3-62.

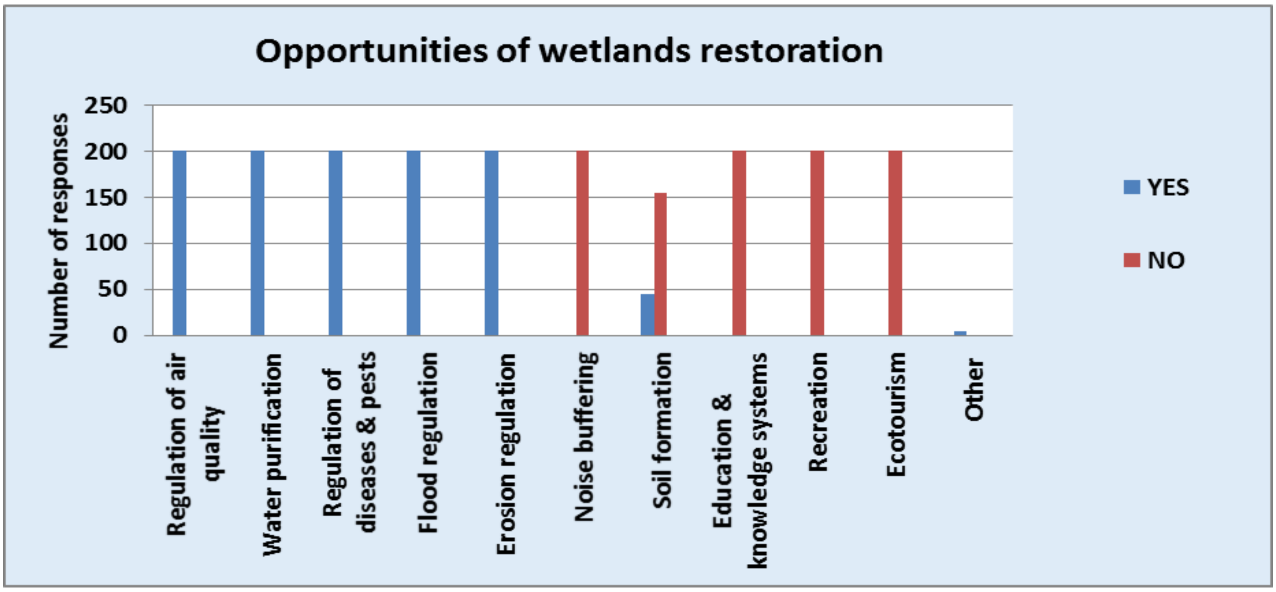



**Figure 3-62: Opportunities about wetlands restoration in NMUK catchment**

### 3.4.8 Analysis of drivers of wetland degradation

The main goal of this section was to understand the drivers of change by assessing the extent at which the drivers of ecosystem degradation under consideration are experience in the area. Figure 3-59 highlights the drivers considered in this category which are agricultural activities, eutrophication and pollution, infrastructure development, wetland overharvesting, emergent invasive species, loss of indigenous species, and alteration of biogeochemical cycles.

In line with the provided responses, the communities consider wetland overharvesting as the main driver of ecosystem degradation of wetlands and neighbouring environment in NMUK catchment while eutrophication and pollution is considered as somehow important with 49 responses. Agricultural activities and infrastructure development, are not considered as part of the root cause of ecosystem degradation and other drivers like emergent invasive species, loss of indigenous species and alteration of biogeochemical seem to be strange to the community for either causing or not causing ecosystem degradation.

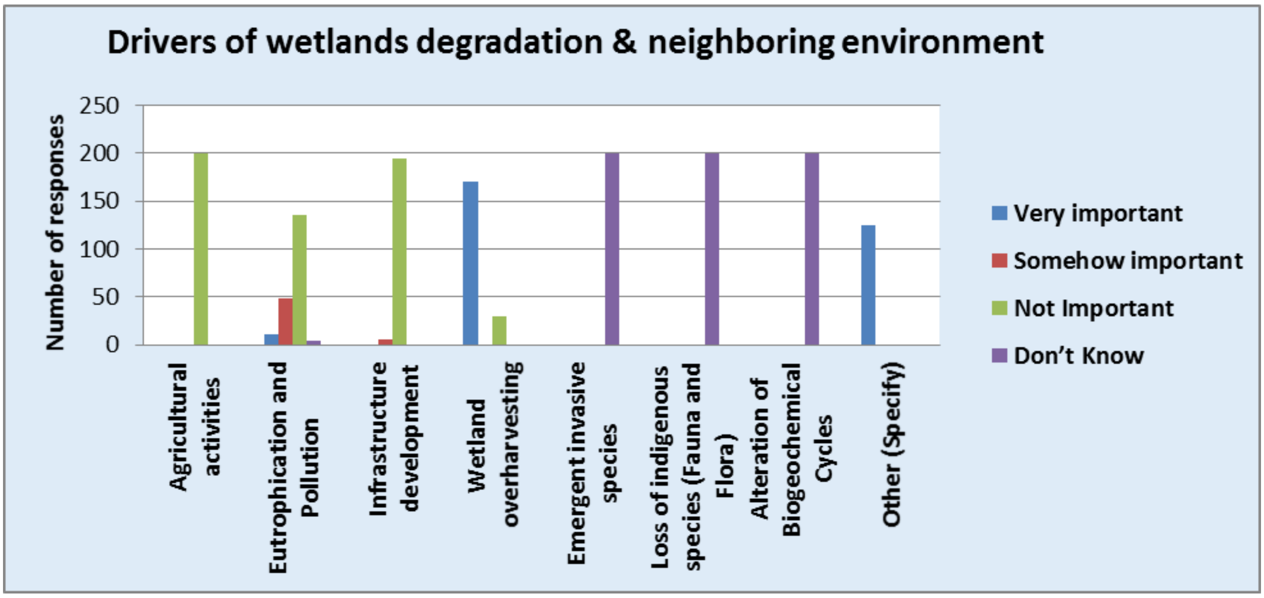



**Figure 3-63: Drivers of wetland degradation in NMUK catchment**

### 3.4.9 Conclusion and recommendations

This purpose of the survey in NMUK Catchment was to inform the wetland management framework in Rwanda with an Ecosystem Based Adaptation approach. A general picture of NMUK catchment showed that, the main provisioning services provided by the wetlands are subsistence crops and fresh water. Despite the fact that farmers work under cooperatives, most of the visited wetlands in this catchment are not well managed and this affects the socioeconomic livelihood of the community working in these wetlands.

The detailed analysis of key issues concerning wetlands management in this catchment found that due to the landscape of the area and heavy rains especially in rainy season, this catchment is prone to landslides associated with erosion from mountains that lead to flooding in wetlands. The survey also notices other key issues that pollute wetlands like sub-standard and illegal mining and wastes management. Understanding the connection between these issues to allow an appropriate interventions, the report recommends the followings:

- Wetlands in this catchment are affected by flooding due to landslides and erosion from neighbouring environment. Measures to minimize the level of flooding and erosion should be implemented for a better management of wetlands in this catchment. This should be supported by sustainment and improvement of both radical and progressive terraces, protection of river banks by bamboo trees, reforestation with indigenous species and restoration and management of wetlands.
- Sustainable wastes management including the construction of modern landfills and composting for is recommended for the benefit of public health, the protection of environment including wetlands.
- Illegal mining activities in NMUK catchment should be stopped and the enforcement of the environmental law should be used for that purpose. This should be supported by rehabilitation of closed mining sites.

# Chapter 4 GUIDELINES FOR WETLAND BUFFER MANAGEMENT

## 4.1 Background

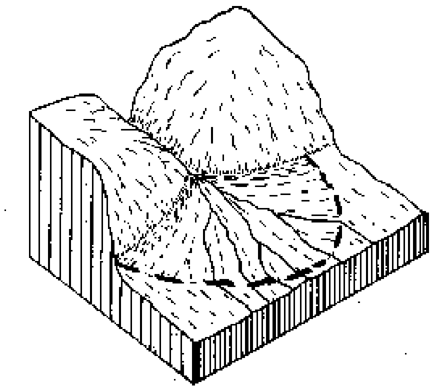
The sustainable management of wetlands should include the objectives of reasonable utilisation as well as conservation mechanisms to ensure continued ecosystem health and functioning. A wetland is an area that is in balance with both hydrology and sediment regimes. A change in either will result in a compensation/change in the other.

Of particular importance is the geomorphology of the wetland, or the balance between sediment and water. The deposition of sediment into a wetland could potentially result in the development of a raised sediment fan, which impedes flow through a wetland. This impediment results in increased flow velocity, potentially leading to channel incision and soil erosion, a drop in water table and ultimately desiccation ("drying up") of the wetland.

The "drying up" of a wetland has many impacts such as:

- Loss of aquatic biodiversity
- Loss of wetland functioning
- Loss of moisture from the soil
- Loss of agricultural productivity
- Silting up of reservoirs
- High turbidity
- Eutrophication

**Raised sediment fan:**



Changes to the Hydrology of a wetland may have a similar outcome. A change in catchment land-use may result in the introduction of an altered hydrological regime to which the wetland is not accustomed. The wetland responds, and elevated surface flows may result in head cut erosion and channel formation, resulting in a drop in base level; a drop in the water table and desiccation ("drying up") of the wetland.

This is the first in a set of guidelines proposing management and rehabilitation techniques for the use and/or conservation of wetlands (as identified in the National Framework), as well as for river buffer management. The guidelines will include best practice approaches, social environmental and economic benefits of these options, and indicative cost. Providing a fixed design is not feasible as there is not one solution for all situations. Wetland management is site-specific, and the implementation of such a design may have varying cost and technical requirements. Conditions at different sites, e.g. geotechnical, ecological or hydrological conditions, may vary at different localities within the same wetland.

In 2010 REMA prepared 11 practical technical tools intended to strengthen the environmental management capacities of districts, sectors and towns. These tools were intended to address capacity building needs of officers by providing practical guidelines and tools. The set of guidelines produced for this project intends to align with these existing guidelines, therefore broadening the capacity of officers and providing new practical tools for wetland management.

### 4.1.1 Purpose

The objective of this guide is to propose practical information on wetland buffer management. It is intended as a tool for integrating environmental considerations in planning rehabilitation initiatives. Although not intended to provide an exhaustive account of approaches and situations, this tool is intended to address capacity building needs of officers by providing information on wetland buffer zone management. This tool can be used as a field guide or as a checklist of elements for discussion during training and during implementation of rehabilitation initiatives.

### 4.1.2 Location in the landscape

The hydrogeomorphic (HGM) approach (Brinson, 1993) is a classification system that recognises the link between wetland types to water and their geomorphological position in the landscape. This approach is based on three fundamental factors that influence how wetlands function, namely:

- Position in the landscape (geomorphic setting);
- Water source (catchment hydrology); and
- The flow and fluctuation of the water once in the wetland (hydrodynamics).

The HGM approach classifies wetlands based on their differences in functioning, and importantly defines the functions that each class of wetland is likely to perform. The approach has been modified for use by a succession of authors, and most recently by Ollis et al. (2013) to form a consistent basis adopted for wetland specialist studies. It is considered applicable to Rwanda, since the local wetland systems identified fit into the classifications described. The individual hydrogeomorphic (HGM) unit is the smallest scale at which wetland assessments are undertaken.

The wetland systems of Rwanda are mostly divided into floodplain wetlands and valley-bottom wetlands. While both of these wetland types are found along valley floors in association with streams or rivers, their hydrological drivers differ. Consequently their ecological functions, their dynamism and sensitivity, their patterns of sediment transport and deposition, and their internal hydrological dynamics differ. This may influence the types of ecosystem services and functions that they support.

Regional variations in climate, geology, topography and catchment gradient generate a range of conditions for valley-bottom and floodplain wetland development and these were drawn on by the Integrated Management of Critical Ecosystems (IMCE) project (REMA, 2009) to understand the range of wetlands across the country. Topographic variability across the country has given rise to a diverse set of wetlands. In addition, wetlands may be broadly grouped according to their elevation, for example:

- below 1 400 m in elevation (mostly within Eastern province),
- those between 1 400-1 800 m, and
- a third group of high altitude wetlands which occur about 1 800 m in elevation (including wetlands in the North West)

There is a corresponding range in rainfall, being generally highest at high altitude areas in the west of the country, and lowest in the low-altitude, eastern savanna regions. High altitude wetlands occur in both the north and west of the country within Kigali city, Muhanga, Huye and a part of Southern province (REMA, 2009). Longitudinal gradient also exerts an influence on the type of wetland, with valley-bottom wetlands generally associated with steep-sided, narrow valleys and floodplains with large, flat and open valley floors.

Note that a further group of wetlands, hillslope seep wetlands, could potentially provide a further category. Due to the scale of this project these wetland have been grouped together with the valley-bottom wetlands of the country. They are likely to form smaller wetland HGM units in localised positions in the landscape. They are, however, worthy of individual consideration. Hillslope seepage wetlands are generally associated with shallow to deep, well-drained soils associated with an impeding horizon that limits deep infiltration. They typically reflect the presence of seasonal, shallow interflow. The dominant hydrological driver is lateral subsurface seepage across a semi-impermeable aquitard such as dense clay, soft or hard plinthite or parent material. The presence of hillslope seepage wetlands indicates the emergence of water that is retained in the landscape but which is moving in the subsurface, with the rate of flow being a function of head, slope, soil depth and porosity. Because of this relationship between interflow and its emergence at the soil surface, hillslope seepage wetlands are often associated with stream flow augmentation. Springs, where groundwater emanating from cracks in the underlying geology is expressed to the surface, are regarded similarly to seepage wetlands.

## 4.2 Wetland buffer zone principles

**Definition**
A wetland buffer zone is an ecotone located between human-disturbed lands and wetlands. The main functions of the riparian buffer zone is to protect wetland ecosystem through flooding control, water protection, soil conservation, habitat provision for wild species diversity, and the influence they have on ecosystem processes in wetlands. Width and vegetation composition of riparian buffer zone are the key features that enhance its functions essential to establishing and maintaining healthy wetlands.

**Designing buffer zones**
Width and vegetation composition of buffer zones are key features that enhance many functions essential to establishing and maintaining healthy wetlands.

**Width**
Width of buffer zone may be the most important factor in affecting buffering functions. Buffer zones are usually not wide enough to function in protecting water, especially in agricultural area. The recommended width of the buffer strip depends on many factors including slope, soil type, farming practices, size of crop fields, and the landowner's objectives. For instance, to remove chemicals and sediment from surface and subsurface runoff, buffer strips should be at least 20 m wide on each side of the waterway. "A buffer strip less than 20 m wide does not hold water in the root zone long enough for chemicals to be removed from the water, although it can trap most sediment moving in surface runoff "(Ma, 2016).

However, the weakness of a fixed-width approach is that the buffer widths are not necessarily tailored to the specific conditions of and around the individual wetlands. Variable-width buffer approaches allow buffer area widths to vary according to site-specific or reach-specific conditions for example slope, soil condition, vegetative condition of the stream, or intensity of the existing land use. Naturally with these approaches, a minimum buffer width is established that applies to all wetlands and then widths are widened based on site- or reach-specific conditions. The benefit of this approach is that the buffer area can incorporate protection for other sensitive natural features such as floodplains, wildlife habitat, and steep slopes.

**Vegetation Types**
The most effective riparian buffer zone normally has three zones of vegetation. This combination of trees, shrubs, and grasses helps protect the stream more than planting a single species. Trees and shrubs provide perennial root systems and long-term nutrient storage close to the stream. The warm season grass provides the highest density of stems to slow surface runoff from adjacent fields. The design can be modified to fit the landscape and the landowner's needs, for example, by replacing shrubs with more trees, substituting some of the trees with shrubs, or expanding the grass zone.

### 4.2.1 Current policies

Traditionally, management of wetlands and rivers in Rwanda has been based on local knowledge in order to meet small scale food production. Management has been based on the local knowledge of hydrology, soils and vegetation that has been gained over decades of working in and observation of the wetlands (Nabahungu, 2012). Community practices are mainly aimed at meeting immediate food and cash needs with little consideration for the environment. More recently, traditional management has been superseded by national interventions, the role players of which are both national and local government institutions.

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 favour dissolved oxygen (indirectly proportional to the water temperature).

In Rwanda, interventions aimed at improving the impacts associated with land-uses have taken the form of spatial buffer zones around wetland, riparian and lake systems. The law on environment No 48/2018 of 13/08/2018 limits agricultural and pastoral activities around bodies of water, while land-use activities need to be undertaken at a distance of 50 meters from the banks of lakes and 20 meters from the banks of a wetlands (excepts allowable activities within a specific wetlands) and 10 meters from the banks of streams and rivers.. In the case of rivers, the Ministerial Order N°007/16.01 Of 15/07/2010 Determining the length of land on shores of lakes and rivers transferred to public property clarifies that 10 m of buffer zones shall be enforced on shores of big rivers (listed in the same order) and 5 m buffer for small rivers, also listed in the order; all remaining streams / rivers not listed in the order, a buffer of 2 m shall be observed. Buffers are discussed further under Step 3 of the assessment steps.

The Article 4 of the water law, defines boundaries of natural water as follows:

a) *Lakes, rivers, streams:* boundaries are defined by the line attained by the highest waters before overflowing

b) *Wetland*: Boundaries are defined by the line attained by the highest water in normal circumstances (Republic of Rwanda, 2018).

However, the new land policy (2019) indicates the lack of clear policy guidance on the clear use and management of buffer zones (Republic of Rwanda, 2019).

### 4.2.2 Strategic approach to wetland management

It should be recognised that linear buffer zones as generally applied are unlikely to protect wetlands from changes in hydrology or water quality brought about by changes in land-use in the catchment, whether this be upstream or adjacent to a particular wetland zone. Hence effectively buffering wetlands from external impacts may require a more strategic approach depending on the land-use in question.

Linear buffers tend to be more effective against land-uses characterised by diffuse surface water discharges unto the receiving environment. For example a buffer zone separating agricultural land from a wetland or riparian system would generally intercept diffuse runoff or subsurface flows from the adjacent landscape. This would afford an opportunity for intercepting sediments (change in roughness) as well as for trapping and transforming nutrients.

However should the adjacent land use be transformed through, for example, urban development, the runoff characteristics will change from diffuse discharges in the undeveloped state to point source piped discharges in the transformed state. Additionally volumes and discharge rates change. Typically the runoff characteristics associated with urbanisation lead to increased peak discharges and runoff volumes due to more surfaces with less permeability (roofs, roads, parking lots, sidewalks, etc. (Konrad, 2016).

The effect of urbanisation is also larger for more common rainfall events, because under undeveloped conditions common events typically generate no to very little runoff. Following urbanisation the change in the behaviour of rainfall and runoff due to the increase in impervious surfaces is large. The much larger rare events lead to saturation of the pervious areas followed by significant runoff, so a change to impervious makes much less difference. Simulation modelling has shown that a highly urbanised catchment (60% impervious) increased peak flow by a factor of 5 for the 100 year average recurrence interval (ARI) event, but by a factor of 30 or more for the most common events (ARI < 1 year).

The net result is an increase in the volume and velocity of surface flows into the receiving environment. This is usually via point-source discharge (storm water drains, pipes, roads, pathways, intermittently flowing watercourses). These features, aimed specifically at disposing of runoff, traverse a linear buffer and will impact the wetland or riparian system irrespective of the width of the buffer.

Buffers are therefore site-specific (although there may be some generic features). The design of an effective buffer is dependent on the type of development, or land-use, taking place in the catchment and the impact on the receiving environment this is likely to have. Cultivation agriculture, horticulture, and forestry developments tend to generate diffuse surface discharge into the receiving environment, although cognizance should be taken of features such as contour banks and roads. In these cases a linear buffer may adequately ameliorating most of the impacts. Developments which imply an increase in hardened or impervious surfaces are generally associated with point-source discharges. Under these circumstances a strategic approach may be more appropriate, where a set of specific measures is implemented at a range of scales, each one aimed at mitigating a specific impact. Measures such as bio-retention features (removing contaminant and sediments from storm water), attenuation facilities (reduction of the force of water), grassed swales, and water storage features are examples of the suite of tools aimed at protecting wetlands and riparian systems from the impacts associated with changes in catchment land-use. A linear buffer is merely one of the tools available, depending on the stated objectives of the buffer.

For the purposes of this project, and the dominant land-uses in Rwanda, priority will be given to the maintenance and management of linear, or spatial, buffer zones.

#### 4.2.3 Buffer zone functions

A vegetation buffer zone is considered to be a protection intervention designed and managed to fulfil ecological objectives. Typical functions are: the stabilisation of river and wetland banks; erosion control; facilitating ecological connectivity; and maintaining water quality by trapping sediment and pollutants transported from source areas via diffuse surface runoff. Buffer zones act to absorb the edge effects from adjacent land-uses, shifting them away from core aquatic habitat. In Rwanda, activities with the goal of riparian or wetland rehabilitation are not only based in close proximity to the target area, but also extend into the upstream catchment as shown in Figure 4-1. This indicates that a catchment management approach is necessary for managing aquatic ecosystems. Buffer zones associated with water resources have been shown to perform a wide range of functions, and as such have been proposed as a method to protect water resources and associated biodiversity (MacFarlane and Bredin, 2017, Table 4.1).

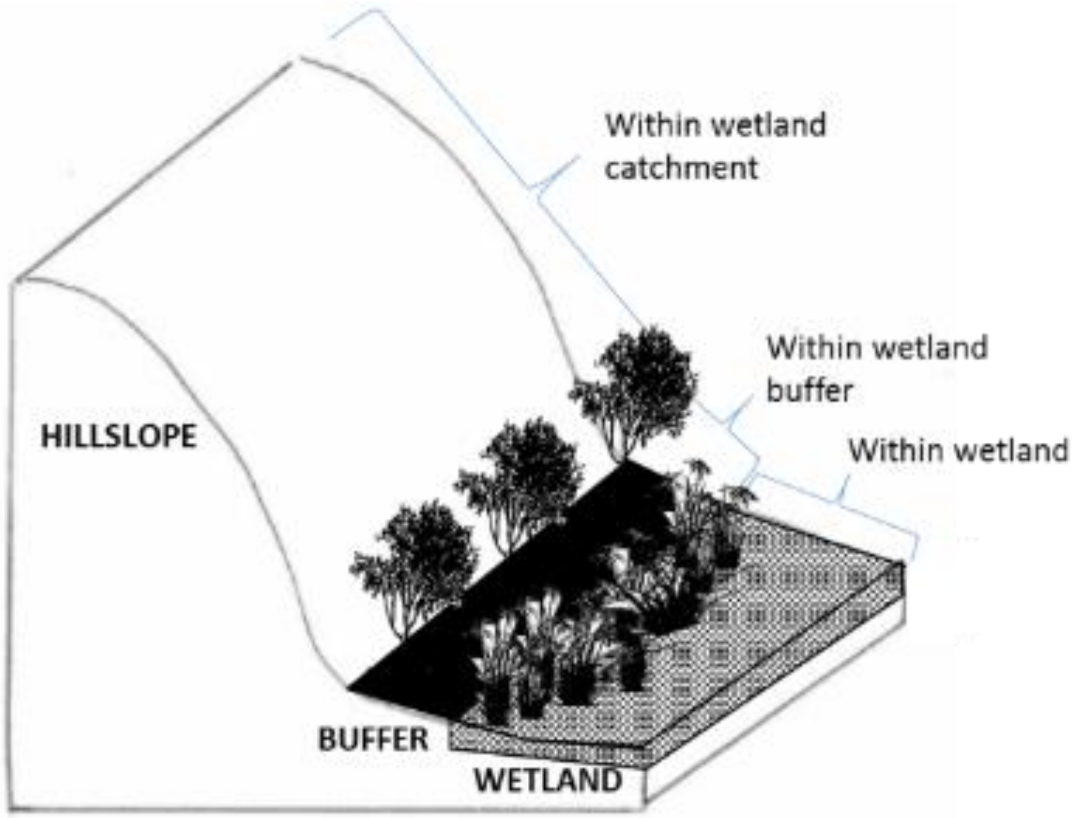


**FIGURE 4-1 CURRENT WETLAND REHABILITATION INTERVENTIONS OCCUR WITHIN WETLANDS, WETLAND BUFFERS OR WETLAND CATCHMENTS.**

**TABLE 4.1 THE LINK BETWEEN THE PROCESS AND THE GOAL OF ACTIVITY FOR VEGETATION BUFFERS**

| Process to be re-instated | Goal of activity |
|---|---|
| Hydrology and Geomorphology<br>Providing basic aquatic processes and reducing impacts from upstream activities and adjoining land uses | **Maintaining channel stability**<br>Riparian vegetation, particularly root systems, strengthens stream banks and groundcover increases erosion resistance. This is important during flood events, with erosion being reduced greatly by good vegetation cover along stream banks. Buffers also prevent direct access of livestock to watercourses, preventing physical damage and direct inputs of nutrients, organic matter and pathogens.<br>**Control of microclimate and water temperature.**<br>Riparian vegetation regulates water temperature, an important factor in the life-cycles of aquatic biota, and other water quality variables such as dissolved oxygen concentration (DO) important for invertebrates and fish population. Riparian forest also influences light levels, affecting the growth of aquatic plants and algae.<br>**Flood attenuation**<br>Well-developed riparian vegetation increases the roughness of stream margins, thus slowing down flows. This acts as a cost effective alternative to engineered structures.<br>**Storm water attenuation**<br>Flooding into the buffer zone increases the area and reduces the velocity of storm flow. Vegetation reduces velocity through increasing resistance to flow, which reduces erosion potential.<br>**Sediment removal**<br>Surface roughness provided by vegetation reduces the flow of runoff and aids the settling of particles.<br>**Removal of toxins, nutrients and pathogens**<br>Buffer zones also remove toxins, lower the level of nutrients and encourage deposition of pathogens (which soon die once exposed to the elements). |
| Biodiversity<br>Providing habitat for fauna and flora | **Provision of habitat for aquatic and semi-aquatic species**<br>Riparian vegetation along the stream line provides food and habitat for aquatic fauna. Semi-aquatic species rely on terrestrial habitats to recruit juveniles.<br>**Habitat connectivity**<br>Vegetation buffers along water resources provide corridors to allow for the connection of breeding, feeding and refuge |

| Process to be re-instated | Goal of activity |
|---|---|
| | sites which help maintain populations of semi-aquatic and terrestrial species.<br>**Provision of habitat for terrestrial species**<br>Vegetation buffers may provide the only remaining terrestrial habitat for species, especially in highly developed areas. |
| Livelihoods<br>Providing livelihood opportunities | **Reduced flood risk**<br>Vegetation buffers increase resistance to flow, and increase the residence time of floodwaters, reducing flow velocities, thus reducing flood peaks. This provides safety to people and property in the downstream catchment.<br>**Economic benefits**<br>The use of beneficial trees and vegetation provides economic benefits to the surrounding community. |

Additionally, buffers also provide space around the wetland or riparian system. In this way they serve as a “safety-valve” in the event that an unforeseen impact becomes evident after the development or land-use has been implemented. A buffer zone cannot attenuate surface flow, or promote infiltration. These functions require specifically designed interventions. The buffer zone does, however, provide space (within a developed landscape) in which to position these interventions. These interventions are also able to be designed in such a way that they augment the ecological services provided by the wetland or river.

In developing an approach for buffer zone determination it essential that the methodology is informed and focused on the underlying objective. Buffer widths should also be tailored according to risk. When the risk or uncertainty is high, ecologically conservative buffers should be established whereas less conservative buffers are appropriate for low risk (MacFarlane and Bredin, 2017). Risks include adjacent land uses, the importance or sensitivity of the water resource, the conservation status of the aquatic system, characteristics of the buffer affecting the functionality.

## 4.3 Steps for a buffer zone management

Wetland protection depends not only on managing wetlands themselves, but also on managing the surrounding water sources and landscape, above all in buffer areas. The assessment process for buffer-zone[11] determination from Macfarlane and Bredin (2017) was followed in order to have a defined methodology for the assessment of buffer zones. This produces a step-wise assessment process as follows:

[11] Buffer zone width should not be uniform, rather it should be set according to the site attributes (soil type, topography, slope, soil cover, type of biodiversity within the wetland/sensitivity and biodiversity, hydrology and other characteristics such as land use around wetlands (residential, forest, agriculture/perennial or seasonal, etc. It is not advisable to have same buffer width for different site conditions. As buffer zones are determined in Rwandan law as uniform, this would require to adjust the law, and where extension is needed, government may expropriate land owners or cooperatecoperate with the community on the proper private appropriate land use.

- STEP 1 • Define objectives and scope to determine the most appropriate level of assessment
- STEP 2 • Map and categorise water resources in the defined area
- STEP 3 • Refer to the Rwanda management objectives for buffers around lakes, wetlands, and rivers/streams
- STEP 4 • Assess the risks posed by surrounding land use and define management measures to protect the water resources
- STEP 5 • Assess risks posed by surrounding land use on biodiversity and identify management zones for biodiversity, include mitigation
- STEP 6 • Assess the socio-economic risks associated with wetlands management actions
- STEP 7 • Delineate and demarcate recommended final buffer zone requirements
- STEP 8 • Document management measures necessary to maintain the effectiveness of final buffer zone areas
- STEP 9 • Monitor implementation of buffer zones

These steps are discussed in detail below:

#### 4.3.1 STEP 1: Define project objectives and scope to determine the most appropriate level of assessment

The objectives for assessing the potential impacts and establishing a buffer, as well as establishing the scale of the buffer intervention needs to be determined during Step 1. This assessment may be at either the desktop (i.e. to note hot spots of issues at a broad scale) or site-based (i.e. to note detailed buffer zone requirements at a site) level.

#### 4.3.2 STEP 2: Map and categorise water resources in the defined area

The next step is to generate a map of the water resources associated with the development or land-use. This may be done at the desktop level, with infield verification, for landscape level studies that incorporate the most recent drainage line, aquatic land and wetland shapefiles through the use of GIS, or by reviewing the area with satellite imagery on Google Earth™. Local-level studies may involve the detailed field delineation of wetland and riparian systems. The edge of the aquatic system denotes the start of the buffer zone, and is determined by the outer boundary of the temporary wetland zone for wetlands, and the top of the macro-channel for riparian watercourses.

### Rivers and streams

The edge of the "active channel" is used as a starting point, although the active channel changes form as it moves from the headwaters to lower reaches of a drainage system. In the upper reaches the active channel is smaller than it would be in the lower reaches. Channel migration will also need to be considered in the mid to lower reaches, as this will impact the buffer zones. The edge of the macro-channel represents the outer edge of the watercourse, and incorporates the dynamics of the active-channel. The watercourses are further classified according to their association with base-flow. The transverse scale of the river, its ecological state and its contribution to catchment water resources are considerations when determining a rational width for the buffer zone.

**Lakes and Reservoirs**

A lake is considered to be a relatively large body of slow-moving or standing open water. The edge of the maximum height of standing open water, the visible high water mark, may be considered to be the edge of a lake.

**FIGURE 4-2 THE RWERU-AKAGERA LAKE SYSTEM**

**Wetlands**

Once the wetland habitat has been delineated, the wetland type (Hydrogeomorphic unit) should be defined (as described in Chapter 2). The description includes an analysis of the dominant ecological drivers for each wetland type. In Rwanda there are two main types of wetlands: floodplain wetlands and valley-bottom wetlands. It is important to obtain a reliable idea of the extent and distribution of the various zones of saturation within the wetlands. This will indicate the wetland's importance as a water resource, highlight important regulatory ecological services and, in conjunction with the type of land-use, guide the design of the buffer zone.

**Ecological Assessments of the Aquatic Systems**

Determine the Present Ecological State (PES) and the Ecological Importance and Sensitivity (EIS) of the wetland and riparian systems in question, using appropriate assessment tools. The wetland evaluation generally considers the three central components of wetland ecological integrity, namely hydrology, geomorphology and vegetation. An evaluation of the ecological services provided by the wetlands is also recommended.

Riparian assessment techniques, such as the Index of Habitat Integrity (IHI) consider the state of a suite of instream and riparian fringe criteria relative to a perceived benchmark, or reference state. Example criteria are water quality; flow modification; lateral and longitudinal connectivity; and intactness of native vegetation.

These assessments identify:

1. The importance of the aquatic systems at the landscape level, or their ecological value to the country;
2. The most important ecological services provided, and those that are either not as important, or are easily replaceable;

3. The level of disturbance sustained, and the ecological problems undermining the ecological integrity of each system.

It is also useful to consider the likely trajectory of ecological change should no remedial measures occur.

### 4.3.3 STEP 3: Refer to the Rwanda management objectives for buffers around lakes and rivers/streams

The law on environment No 48/2018 of 13/08/2018 determines modalities for protection, conservation and promotion of environment in Rwanda. It makes provision for Environmental Impact Assessment (EIA), strategic environmental assessment, environmental audits in Chapter V related to the obligations of the state, decentralized entities and local communities with regard to the protection, conservation and promotion of environment, particularly in its articles from 30 to 34. The law indicates in its article 30 that the list of project and activities to undergo environmental impact assessment before authorization are established by a ministerial order (currently No 001/2019 of 15/04/2019) which also describes the instructions, requirements and procedures for conducting Environmental impact assessment. The list includes projects in various sectors such as infrastructure, agriculture and animal husbandry, mines, works in parks and park buffer zones. The Article 31 of the law provides that every policy, strategy, plan, and programme must undergo SEA while the procedure shall be determined by a ministerial order. The article 32 of the law provides for an environmental audit and the list of projects subjects to environmental audit shall also be determined by a ministerial order.

The environmental Law also provides the strongest protection measures for Rwanda's natural resources and assets and includes specific measures to be implemented as well as sanctions in case of its violation. Through the law, the State is responsible for identifying reserved 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, the law on environment (Article 42) stipulates the Minister with environment under their responsibility will grant approval to build a structure. In protected wetlands, the law prohibits all uses, apart from scientific research. It should be noted that blanket buffer stipulations, while convenient and preferable to zero buffer implementation, are not entirely appropriate because they remove the site-specific variation in conditions from consideration. This increases the potential for a buffer to be ineffective in achieving its desired objectives. Ideally a buffer should be designed according to the aquatic system to be protected, the value it presents to society, the types of impacts likely to be sustained.

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:

- Article 12 stipulates that swamps[12] with permanent water shall be given special protection. Such protection shall consider their role and importance in the preservation of biodiversity.
- Article 42 prohibits dumping in wetlands: (1) waste water, except after treatment in accordance with instructions that govern it and (2) any hazardous waste before its treatment.
- Article 49 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

[12]Considered to be a synonym for wetland in this report.

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.

- Its 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 environmental impact assessments (EIAs).
- Article 42 prohibits to burn or eliminate waste in wetlands by 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 cemetery.

This law indicates that there is legislation in place to limit land use around rivers, lakes and wetlands, but in reality the enforcement of these measures is difficult. Several observations on the ground are noted:

- Demarcation lines were created along some rivers and lakes showing the buffer zones but agriculture activities are still operating within the buffer zone.
- Although the cattle kraals are constructed outside the 10m buffer zone of river and 50 m from lakes; the grazing activities still occur within the buffer zones.
- It is observed that where buffer zones are created, mostly agroforestry trees and bamboo are planted along the rivers and around the lakes for the purpose of bank protection rather than the recommended vegetation structure of grasses, shrubs and trees.
- The efficiency of bamboo river bank protection needs to be questioned. The bamboo stabilizes the river bank at the point of cluster, but it prevents understory growth leaving bare areas under its canopy, as well as clustering resulting in bare areas in between clusters that are prone to erosion. Similarly, the area of bank between the water’s edge and the bamboo cluster is still prone to erosion unless other vegetation e.g. reeds have colonized it. Therefore, the bamboo or other native trees could be used to stabilize river bank while another outer strip of vegetation shall be adopted to control sediments and overland flow (water bars can be created to divide channelized flow into sheet flow).
- When choosing buffer, the main criteria are the density, height and type of plants. These characteristics affect the capacity of vegetation to retain sediments on riparian land. The density of vegetation is important at ground level in order to reduce overland flow velocity and to trap sediments. However, having “clusters” of plants is also an issue as this could concentrate flow and cause erosion channels.
- Despite Article 42 of the Law prohibiting the burning of waste in wetlands, it has been observed that some farmers burn biomass & agriculture residues in wetland. This is of particular concern in peat wetlands, as peat is flammable and will continue to burn until there is no more peat mass left to burn.

The management objectives the water resources should also be evaluated, both at the national and the local level. This may be linked to any national natural resource management goals, as well as to the ecological condition of the aquatic systems.

The article 41 of the law on environment (2018) indicates that a committee responsible for conservation, protection and promotion of environment as well as climate change is established at the City of Kigali, District, Sector and Cell levels. The organisation, functioning and responsibilities of environmental protection committees as well as their members of are determined by a Prime Minister’s Order.

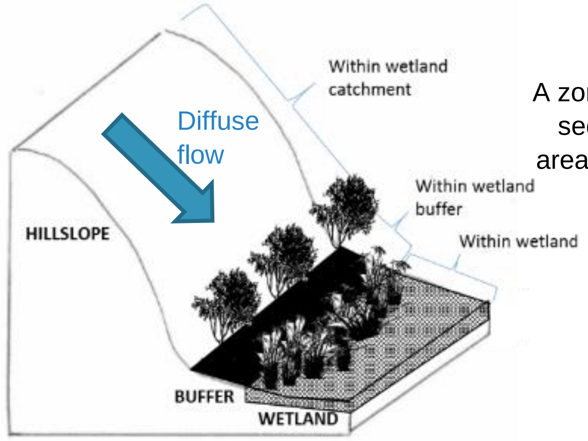
**FIGURE 4-3 Example of river bank collapse from erosion next Nyarububa wetland, Rulindo District**

### 4.3.4 STEP 4: Assess the risks posed by surrounding land use and define management measures to protect the water resources

**THE POTENTIAL RISKS AND IMPACTS OF THE PLANNED ACTIVITIES IN SURROUNDING CATCHMENT OF THE AQUATIC SYSTEMS SHOULD BE CAREFULLY EVALUATED. A RISK ASSESSMENT IS NECESSARY IN ORDER TO DETERMINE THE LEVEL OF INTERVENTION (INCLUDING BUFFER ZONE WIDTH) REQUIRED TO MITIGATE THE ANTICIPATED IMPACTS. A HIGH LEVEL RISK WILL REQUIRE A LARGER, MORE COMPLEX BUFFER STRATEGY THAN A LOW LEVEL RISK. A GENERAL OVERVIEW OF RISK ACTIVITIES POSED BY DIFFERENT SUB-SECTORS BASED ON THE LAND USE IS PROVIDED IN TABLE 4.1. A BUFFER ZONE FUNCTIONS TO REDUCE THE IMPACT OF POLLUTANTS ENTERING A WATER RESOURCE VIA DIFFUSE SURFACE FLOW (I.E. FLOW WITHOUT A CHANNEL, USUALLY FROM RUNOFF AFTER RAINS). THE COMMON DIFFUSE SURFACE FLOW THREATS WHICH MAY BE POSED BY ACTIVITIES/LAND USES ARE DEFINED IN**

Table 4.2. The main diffuse flow threats that vegetation buffers should be used to mitigate for are as follows:

- sedimentation and turbidity;
- increased nutrient/organic contaminants/heavy metal inputs, pesticides; and
- presence of pathogens,




**Aquatic Impact Buffer Zone:**

A zone of vegetated land designed and managed so that sediment and pollutant transport carried from source areas via diffuse surface runoff is reduced to acceptable levels.

Wetland buffers improve water quality by trapping and/or transforming pollutants such as sediments, nutrients, pathogens, and pesticides in surface water via biofiltration. The bendy curves along water ways, combined with vegetation and root systems, dissipate stream energy, which results in less soil erosion and a reduction in flood damage. Surface runoff is slowed by buffer vegetation (trees and shrubs), causing larger sediment particles and pollutants adsorbed to sediment particles to settle out

**TABLE 4.2 The potential risk activities associated with sub-sectors in Rwanda**

| Sub-Sector | Activity/land use |
|---|---|
| Agriculture | Informal subsistence farming |
| | Consolidated small farm plots |
| | Large monoculture projects |
| | Large commercially managed estates |
| Industry | Dairy industry |
| | Coffee washing station |
| | Butchery |
| | Chemical facilities |
| | Petroleum works |
| | Timber works |
| Residential | Village (low impact) |
| | Village (medium impact) |
| | Urban centres (high impact): uncontrolled wastewater and solid waste disposal, |
| | Informal settlement in urban centres (high impact) |
| Transportation | Paved roads: wetland fragmentation, compaction,.. |
| | Gravel roads: wetland fragmentation, compaction,.. |
| Service infrastructure | Service infrastructure |
| | Above ground electrical infrastructure |
| | Below ground electrical infrastructure |
| | Hazardous waste disposal: garages, refilling station and other oil services, etc. |
| | General waste disposal: landfilling, |
| | Sewerage treatment works |
| | Pipelines for transportation of water or sewerage |
| Mining | High risk mining and associated waste |
| | Medium risk mining and associated waste |
| | Low risk mining and associated waste |

**TABLE 4.3 COMMON THREATS POSED BY ADJOINING LAND USES ON WATER RESOURCES. THE THREATS THAT BUFFER ZONES CAN MITIGATE ARE HIGHLIGHTED IN BOLD.**

| Threat | Source of impact | Approach to address threats |
|---|---|---|
| Water quantity | Reduction or increase of water inputs; Increase in hardened surfaces; | Not vegetation buffer |
| Water quantity - patterns of flow | Concentrated or diffuse flow; increased runoff; | Not vegetation buffer |
| **Sedimentation and turbidity** | Concentrated flows | Not vegetation buffer |
| | **Diffuse runoff** | **Buffer zone can be used** |
| **Water quality - increased input of nutrients** | Concentrated flows | Not vegetation buffer |
| | **Diffuse runoff** | **Buffer zone can be used** |
| **Water quality - increased input of organic contaminants** | Concentrated flows | Not vegetation buffer |
| | **Diffuse runoff** | **Buffer zone can be used** |
| **Water quality - increased input of heavy metals** | Concentrated flows | Not vegetation buffer |
| | **Diffuse runoff** | **Buffer zone can be used** |
| Water quality - changes in pH | Concentrated or diffuse flow | Not vegetation buffer |
| Water quality - concentration of salts | Concentrated flows | Not vegetation buffer |
| Water quality - temperature | Concentrated flows | Not vegetation buffer |
| **Water quality - pathogens** | Concentrated flows | Not vegetation buffer |
| | **Diffuse runoff** | **Buffer zone can be used** |

Note: Those threats that will not be mitigated by vegetated buffer zones will require other designed measures to address. Examples would be waste water treatment works; attenuation features; bioretention features; storage facilities.

**Socio-economic aspects of buffer zone managements**

**Economic aspects**

Establishing buffer zones to better preserve wetland areas is by all means an economic activity whereby productive resources are put to use with the aim of creating incremental value to the society. Ideally, the economic feasibility of a buffer zone must be assumed by appraising the incremental costs and benefits of establishing buffer zones and comparing the result to the situation in which such a zone was not established. The latter scenario would be one in which conservation areas simply bordered areas with no specific restrictions on development activities, other than those applied elsewhere in the area.

Three aspects are to be considered: Costs of buffer zones, Benefits of buffer zones, and actual appraisal (cost-benefit analysis, time frame, discount rate). Translating resource use into economic terms means establishing the cost of buffer zones, including both explicit costs, the monetary expenses of establishing and managing buffer zones, such as the cost of infrastructure works and implicit costs, the value of any associated non-monetary impacts of establishing buffer zones that negatively affect the well-being of society.

**Social aspects**

Land tenure is a key issue in the success or failure of buffer zone management. In general, it will usually be more difficult to manage buffer zones on privately owned land. Land-use restrictions may be difficult to enforce, especially as people become aware of potential alternative uses with apparently more favourable financial returns from investment. On the other hand, buffer zones on state-owned land, while allowing uniform management regimes, may also lead to the management problems usually associated with the 'tragedy of the commons'. In the latter case, informal management agreements would be a requirement for ensuring sustainable productive use by local communities.

Community tenure of land is difficult to manage. For a buffer zone to succeed, there must be a recognition of the role of all stakeholders and why and how they interact, or ought to interact. Stakeholders must communicate intensely and participate in all stages of buffer zone establishment and management. In order to achieve true and meaningful participation, in particular from the local population, local users must appreciate the real benefits of buffer zones in order to adopt them as a long-term survival strategy. Although there will be obvious benefits from the appreciation of the value of nature conservation and preservation of the natural resource base for their own livelihood, planning must also include direct short-term economic benefits or a fair compensation for the lack of them. Collaborative management and co-management of the buffer zone is basically a process of collaboration between local communities and state agencies over the use and management of natural resources or other assets, whether state or privately owned, through a negotiation process which includes all stakeholders, recognizes the contribution of each, and results in a mutually acceptable and adaptable management agreement.

#### 4.3.5 STEP 5: Assess risks posed by surrounding land use on biodiversity and identify management zones for biodiversity

Aquatic and semi-aquatic species that rely on terrestrial vegetation will require a larger buffer distance. It is important to assess whether there are any threatened vegetation types, animal or plant species or any important species in large numbers. As Rwanda has legislation which defines protected and non-protected (with or without specific conditions) wetlands, these should be consulted to determine if the river/wetland in question has any conservation priorities.

There are a number of important considerations in designing an appropriate buffer zone with the intention of conserving biodiversity. These are:

- The extent of the aquatic system that constitutes critical habitat for species of conservation concern. For a small patch of habitat, it may not be necessary to apply a uniform large buffer to the entire HGM unit.
- The specific terrestrial habitat requirements for semi-aquatic species. Some species may breed in wetlands, but use terrestrial areas to forage. An effective buffer zone needs to accommodate this;
- It is also important to consider the wider landscape, and the proximity of the wetland or river to any large tracts of intact vegetation.

A rational approach is required that determines whether any important biodiversity elements are likely to be present. Potential species or species assemblages' habitat requirements should be identified and mapped, ensuring that core areas are included. The designed buffer should also incorporate other significant biodiversity features, processes or requirements that may be relevant. In areas of significant conservation importance a larger biodiversity buffer area, or a biodiversity corridor buffer may be required.

#### 4.3.6 STEP 6: Assess the socio-economic risks associated with wetlands management actions

As discussed earlier in wetlands provides different ecosystem services including provisioning services, regulating services, supporting services, and cultural. However, most of these services are not well known by the surrounding community which may hinder wetland wise use.  In most cases, according to the findings from interviews, the communities are basically aware of some provisioning services: livestock rearing, agriculture production, fuel, fishing, mining, etc. But other supporting services, regulatory services and cultural services are know well understood by the community: flood attenuation, water purification, biodiversity maintenance, nutrients cycling, climate change mitigation and adaptation, biogeochemical cycle, soil formation, cultural and recreational services, etc. are among those services which re not well known to the community. Consequently, the community has been negatively affecting the ecological character of wetlands (building, livestock rearing, unsustainable cropping, wetland vegetation removal for different activities, etc.).

When the organic environmental law No 04/2005 of 08/04/2005 (currently law on environment No 48/2018 of 13/08/2018) was adopted in 2005 with establishment of buffers zones for rivers, wetlands and lakes, many farmers and other land owners who were used to use land up to the banks of water bodies lose their land that was officially put in the state land as per the Ministerial Order No 007/16.01 of 15/07/2010 determining length of land on shores of lakes and rivers transferred to public property. This affected livelihood of the affected community which had to struggle in search of alternative sources of livelihood. Conservation activities gave jobs to the nearby community but, more incentives may be needed to ensure ownership and sustainability of wetland management. This incentives may include approved sustainable use of buffer zones and additional setback where needed, assistance in the recommended use of buffers and setbacks and compensation in case of any difficulty following the sustainable use of buffers ad setback (e.g. in case of floods, lack of market, etc.). In case of sustainable and productive use of wetlands buffer zones or other setbacks, where possible, priority should be given to those who occupied the land before establishment of buffers zones.

#### 4.3.7 Delineate and demarcate recommended final buffer zone requirements

Wetland buffers should be designed to achieve specific objectives. Once the objectives, surrounding risk activities and threats associated with the risk activities that a vegetation buffer can mitigate have been defined, as well as the biodiversity requirements, then the final buffer zone requirements should be developed. The water resource boundary should be used to define the “no-go zone” in terms of the active channel or core lake or wetland. Then the extent of the buffer zone as depicted by legislation must be mapped. When it has been identified that there are high risk activities or conservation priority areas then this buffer distance or composition should be reviewed, and modified where necessary.

***Different researchers recommended the following criteria for the determination of buffer width:***

- *the functions and values of the water resource to be protected by the buffer*
- *the characteristics of the buffer itself and of the adjacent catchment*
- *the intensity of the land use (or proposed land use)in the adjacent catchment and the expected impacts that result from that land use*
- *the specific functions that the buffer is intended to provide, including the targeted species to be managed and requirements of their habitat needs.*

In addition, the type of buffer shall also be assessed in terms of the intended purpose. E.g. if the purpose is to improve water quality, the following shall be assessed: type of soil (porosity), slope, source of water, land use in the surroundings, etc. If the buffer is intended to provide habitat for a targeted biological species, it shall conform to the species requirements (some may need few meters of buffer with (10m-30m), while others may need up to up to 300m buffer width. In general, buffers for species protection (habitat) are wider than those intended to protect water quality (Hruby, 2013.

The buffer width should extend horizontally from the edge of the aquatic system, as opposed to extending along the ground. This negates to some extent the steepness of the adjacent slopes, and consequent faster surface water influx. Table 4.4 provides an indication of the kind of buffer widths required to achieve specific objectives. The slope and runoff conditions of the adjacent catchment are likely to dictate the width of the buffer. Steeper slopes and more impervious surfaces would favour the adoption of the wider range of buffer widths for each objective. In contrast, a relatively flat catchment with sandy soils and good vegetation cover is likely to warrant a buffer width situated towards the narrower end of the range.

**TABLE 4.4 Indication of buffer widths aimed at achieving specific objectives**

| | **Recommended buffer (in meters)** |
|---|---|

| Buffer ecological function | 50 | 30 | 20 | 10 | 2 |
|---|---|---|---|---|---|
| Storm water attenuation | ✓ | x | x | x | x |
| Fecal coliform attenuation | ✓ | x | x | x | x |
| Nitrogen attenuation | ✓ | x | x | x | x |
| Phosphorus attenuation | x | ✓ | x | x | x |
| Pathogen attenuation | x | x | x | ✓ | x |
| Pesticide attenuation | x | x | x | ✓ | x |
| Sediment attenuation | ✓ | x | x | x | x |
| Protection of core wildlife habitat | ✓ | x | x | x | x |
| Stream temperature moderation | x | ✓ | x | x | x |

**Note**: **x:** not recommended width; **✓:** recommended width

*Source: Adapted from: Beacon Environmental Ltd (2012).*

To be effective, a buffer zone should ideally consist of dense stratified vegetation, with the herbaceous cover being arguably the most important in ameliorating the impacts of agriculture and forestry. This is because it provides:

- Surface roughness against diffuse surface flow, slowing down runoff and allowing sediment to settle out;
- The underground portion of herbaceous plants usually mirrors the above ground components. Hens et all, dense and vigorous grass plants also have dense, robust root systems which stabilise the soil and secure it against erosion;
- Tall vegetation cover provides cover for fauna to move through the landscape;

Trees and shrubs have root systems that extend into the subsoil layers, binding and anchoring soil deeper down the profile. The stratified vegetation supports greater biodiversity movement, essentially constituting a modified ecotone. The robust stems and trunks serve to further break up and dissipate surface flow prior to entry into the aquatic system. They are particularly effective in stabilising potential concentration points for surface flow.

If the main objective of the buffer is biodiversity related, the buffer should be composed of native plant species, with management primarily aimed at preventing the establishment of alien invasive plants. In areas where biodiversity is not an important consideration, then opportunity exists to incorporate tree crops into the buffer since they are likely to fill a similar ecological role to native trees. Therefore, in urban areas, ornamental trees can also be adopted to create recreational urban parks, but specific species might be determined according to different factors including, but not limited to: climate adaptability, economic and other uses at harvest, ecological function and interaction with existing species, accessibility and cost effectiveness. An indicative list of native plant species potentially to be planted in buffer zones was given in the Wetland Master Plan for Kigali City (Ministry of Environment, 2019) as follows: *Albizia gummifera, Anthocleista grandiflora, Bersama abyssinica, Blighi unijugata, Borassus aethiopium, Bridelia micantha, Celtis Africana, Chaetachme aristate, Clausena anisate, Combretum umbricola, Cordia africana, Croton macrostachyus, Croton megalocarpus, Ekebergia capensis, Erythrina abyssinica, Euphorbia candelabrum, Euphorbia tirucalli, Ficus lutea, Ficus natalensis, Ficus sycomorus, Podocarpus latifolius, Ficus thonningii, Ficus vallis-choudae, Kigelia africana, Maesa lanceolata, Maesopsis eminii, Phoenix reclinata, Prunus africana, Pterygota mildbraedii, Sapium ellipticum, Senegalia (formerly Acacia) polyacantha, Spathoda campanulata, Symphonia globulifera, Teclea nobilis, Trimeria grandiflora, Vachellia* *(formerly Acacia) kirkii, Vachellia (formerly Acacia) hockii, Vachellia (formerly Acacia) tortilis, Vachellia (formerly Acacia) sieberiana*. Fruit trees, such as avocado, mango, papaya, may also be included.

Furthermore, where buffers serves for pollution control, it is recommended to systematically and sustainably harvest buffer vegetation (plant & trees) to withdraw the pollutants from the system. After needful assessment, this can also be done inside the wetlands while the harvest cab used for economic activities like handcraft, wood & timber for various purposes, etc. An important proviso is that dense herbaceous cover is maintained around the trees to facilitate buffer functioning.

According to the Rwanda Environment Management Authority (REMA), the vegetation types and other activities used in particular buffer zones should be as follows (; REMA, 2016; REMA, 2013; REMA 2012):

- Buffer (i.e. 10m on either side of active channel)
  - Site clearing
  - Bamboo seedlings – production, plantation, maintenance and guarding
  - Reeds
  - Agroforestry trees as required
    - Grafted mangoes
    - Papaya trees
    - Grafter orange
    - Gravellia robusta
    - Calliandra calothyrosus
    - Avocado tree
    - Plum tree
    - Pineapple(may not be applicable)
  - Establishment of demarcation line
  - Planting trees
  - Maintenance and materials
    - Bamboo: quarterly through community work
    - Picks
    - Hand hoe
    - Trident
    - Rope
    - Niveau d'eau
    - Decametre
    - Panel
    - Grass slashers

- Wetland buffers zones would be similar, applied over a 20m width.
- Lake buffer (i.e. 50m on either side of permanent waters edge made up of 15m grass belt, 15m shrub belt and 20m tree belt)
  - Grass
    - African star grass (*Cynodon nemfluensis; Pennisetum clandistinum; Paspalum spp*)
    - Elephant grass
    - Andropogon (also *Panicum maximum; Digitaria spp; Paspalum urvellei*)
  - Shrubs
    - Fruit value shrubs
  - Trees
    - Agroforestry trees as defined above

For the restoration of degraded wetland ecosystems using indigenous trees, the following table describes recommended protocol for each aspect.

**Table 4.5:** Recommended protocol for EbA restoration of degraded wetland ecosystems

| No | Aspect | Description |
|---|---|---|
| 1 | Scope | Aim to cover the whole degraded sections, starting with the highly degraded zones or the most vulnerable to the current climatic and non-climatic stressors |
| 2 | Ecological adaptability | Each plant should be chosen according to its ecological requirements, and only ecologically adapted indigenous tree species should be planted.<br>• Anatomical and physiological characteristics of identified plant species should be considered during the plantation (waterlogged areas, riparian zone, buffer zone...)<br>• No exotic plant should be used, except in rare cases after careful judgment of the inevitability. |
| 3 | Climate change adaptation/mitigation | Species should be identified based on their potential contribution to climate change adaptation/mitigation |
| 4 | Benefits to local communities | Identify suitable climate-resilient but also beneficial indigenous species to local community's needs. |
| 5 | Local knowledge and practices | • Take into consideration local knowledge and traditional practices in terms of preferred plant species and planting/maintenance practices<br>• Technical/scientific methods for planting/maintenance should supplement local knowledge/practices |
| 6 | Care and maintenance | • It is advised to avoid the use of fertilizers in wet places to prevent them from leaching<br>• Take appropriate measures for the management to remove invasive species and prevent further propagation.<br>• Protect the plants from damages (e.g. encroachment, uprooting...)<br>• Regularly monitor the health status of the plants and take appropriate action |

Source: REMA, 2019.

#### 4.3.8 STEP 7: Document management measures necessary to maintain the effectiveness of final buffer zone areas

The demarcation of the buffer zone is a critical step in ensuring that it is not degraded over time. This demarcation can take the form of trenches (grassed swales with multiple discharge points), which have the added benefit of trapping sediment and reducing the velocity of runoff. When the objective is biodiversity protection extra effort needs to make to ensure that there is less disturbance in the defined buffer area.

Signs indicating the presence of the buffer zone, and educating the community about the function, importance and value to them of the buffer should be erected at prominent places on the edge of the buffer. In instances where stakeholders may be motivated to continue using the wetland area (such as drought prone areas) there should be extra effort to engage with stakeholders and ensure that communities know about the buffer and are aware of activities that are allowed.

This comes with a relevant issue to buffer zone management "sustainability". Buffer zone management is seen as a long-term intervention aimed at bringing about a transition to sustainability.

Four dimensions of sustainability can be distinguished:
**Ecological sustainability**, which concerns using natural resources in a way which does not reduce their future use potential, or impair the long-term viability of the species.
**Social sustainability**, which concerns the ability of contracting communities to sustain their obligations as set

out in collaborative agreements. Social acceptability is an important criterion in this aspect.
**Institutional sustainability**, which concerns the managing authority's ability to meet conservation obligations, etc.
**Financial and economic sustainability**: a state in which resources are managed so as to maintain productive opportunities for the future and whereby natural capital stock is not declining through time. The latter concept is interesting as it bridges the gap between ecology and economics by demanding minimum conditions of ecosystem stability and resilience through time as a prerequisite for sustainability. Sustainability is promoted by institutionalisation of activities and programmes, and capacity building at the government, private sector and community level. In order to create support and general awareness among the local population, these people have to be involved in the process of buffer zone development and management. The population has to indicate what they expect and what they were or will be using the buffer zone for. Without their consent and understanding of the importance of a buffer zone, the approach will not be sustainable.

Typical management measures that should be considered once the buffer zone is demarcated are as follows:

- Access and use of the buffer zone and buffer zone vegetation by community members
- Overgrazing and trampling of buffer vegetation by livestock
- Management and use of vegetation (tree crops; groundcover) within the buffer
- Removal of trees and shrubs by the local community;
- Burning for agriculture or other purposes within the buffer (especially in peat wetlands)
- Encroachment of alien invasive plants in the buffer
- Dominance of one plant within the buffer (i.e. the dominance of bamboo is not preferable, and should grow in unison with natural reeds)
- The maintenance of vigorous herbaceous vegetation within the buffer;
- Monitor occurrence of species of concern if buffer is within a conservation area

#### 4.3.9 STEP 8: Monitor implementation of buffer zones

Monitoring the effectiveness of the final buffer zone area and associated management practices should include developing monitoring objectives and indicators of buffer zone effectiveness as well as developing a monitoring programme to achieve monitoring objectives.
Such indicators could be as follows (Macfarlane & Bredin, 2017):

- Has the buffer zone been demarcated effectively?
- Are disturbances being managed effectively?
- Is there dominance of one type of vegetation in the buffer area?
- Are riverbanks stable?
- Are there incidents when livestock have overgrazed or tramped the buffer area?
- Is there still unsustainable use of the buffer area or river/lake/wetland area?
- Is there evidence of environmental degradation in the buffer or wetland (soil erosion, sediment deposition, high nutrient status)
- Is there evidence of increased use of the buffer by fauna;
- Is the community aware of the benefits of the buffer?
- Is the community aware of when they can use the agroforestry trees/vegetation?

It will be necessary to have a monitoring point before, within and after the buffer zone in order to monitor the effectiveness of the buffer in mitigating diffuse flow. These should be catered towards the particular threat associated with the surrounding land use.

## 4.4 Management of urban and peri-urban wetlands

Urban wetlands are those which lie within the boundaries of a city or town. Peri-urban wetlands are located in areas adjacent to cities and towns. These ecosystems provide a variety of benefits and services to the community. In addition to providing habitat for plants and animals, wetlands provide water storage, improve water quality and reduce pollution. Wetlands also protect against natural hazards, slowing floodwaters, reducing the risk of fire and protecting against erosion of river banks and coastlines. Wetlands and associated vegetation can provide a cooling effect to surrounding areas in summer and also moderate strong winds. Wetlands can also contribute to the wellbeing of the community by acting as urban green spaces which provide aesthetic appeal, landscape diversity and recreational opportunities. They can also contribute to cultural heritage, spiritual values. Additionally, wetlands provide easily accessible educational opportunities to learn about the environment

Potential impacts of urban development on wetlands
Urban and peri-urban wetlands are potentially at risk of:

- direct habitat loss (from development, land reclamation, roads, in-stream dredging, etc.)
- altered water regime (from dams/barriers, stream redirection, hard surfacing, water extraction, etc.)
- pollution (from garbage, sewage, oil and chemical spills, pesticides, airborne toxins, etc.)
- biodiversity loss due to the introduction of exotic species (weeds, pests and domestic pets)
- other ecosystem modifications (for example, altered fire regimes, dieback and changes in salinity).

Decision-makers developing policies and planning for urban and peri-urban development that may impact on wetlands should:

- Maintain wetlands and the range of services they provide as essential elements of the supporting infrastructure of Rwanda towns and cities.
- Promote the wise use of wetlands as a means of achieving sustainable urban and peri-urban communities.
- Where possible, avoid further degradation or loss of wetlands as a result of urban development or mitigate the impacts.
- Involve local communities including Traditional Owners, in urban and peri-urban spatial planning and wetland management decisions.

Urban developers and wetland managers should:

- Conserve wetlands – where possible, urban development should avoid destroying or degrading wetlands through drainage, infill, water diversion, pollution or the introduction of invasive species.
- Restore and create wetlands – wetlands should be restored and/or created within urban areas as part of water management infrastructure.
- Include the value of wetlands – the costs of wetland loss and degradation and the value wetlands can add should be taken into account when considering urban and infrastructure development.
- Educate the community on wetland management
- Engage stakeholders – decisions on urban planning and wetland management should involve local communities, including Indigenous people.
- Undertake integrated planning – wetland management should be integrated into the wider elements of urban spatial planning

## 4.5 Case studies: some ecosystem based adaptation activities under LDCF II project

In order to understand the existing initiatives on catchment restoration and their impacts on wetland management, an evaluation of some intentions was conducted on a four years pilot project of LDCF II titled “Building resilience of communities living in degraded forests, savannas and wetlands of Rwanda through an ecosystem-based Adaptation (EbA) approach”. The project interventions include i) strengthening the technical capacity of Rwandans to plan and implement EbA; ii) strengthening the policy and strategy framework in Rwanda to promote ecosystem restoration and management; iii) restoring ecosystem to increase their resilience to effects of climate change; and iv) promoting sustainable and climate resilient livelihood.

The purpose of the evaluation was to find out the best practices from the project by comparing the planned versus ongoing and implemented activities in order to point out the gaps as well as understanding the underlying causes. The next phase of evaluation was then to take into consideration lessons learnt and recommendations for improvements in the next implementation phase. The EbA activities are currently being implemented for restoration of Nyiramuhondi watershed in Ngororero District; Murago wetland and lake Cyohoha north in Bugesera District; Kibare Lakeshores in Kayonza district and Nyandungu wetland in Gasabo and Kicukiro Districts; and lake Ruhondo in Musanze District.

The evaluation of EbA activities will provide technical assistance in the implementation of the ecosystem-based adaptation management activities of wetland and riparian area under LDCF II and to associate the implemented activities with livelihood improvement. This includes reviewing the activities underway by the time this Project is initiated and suggesting improvements in the approach in line with project objectives and national good practices. At the end of the evaluation of EbA activities, lessons from these and other reviewed activities were used to inform the guidelines for the National Wetland Management Framework. The case studies below focus on Nyiramuhondi watershed, Sanza forest and Lake Ruhondo and are presented respectively in Table 4.6 , Table 4.7 and Table 4.8. In general, the stakeholders' engagement process, sensitization of the community on EbA initiatives and the continuous monitoring of the field interventions should be given a high priority for the sustainability and local community appropriation/ownership of the EbA interventions. For instance, it was noted that most of the population in the buffer zone of Nyiramuhondi River cultivate their land up to the river bank and without maintaining the planted bamboos as shown in Figure 4.4. Consequently the river bank become fragile and exposed to erosion and landslides which in turn pollute the Nyabarongo River.

**FIGURE 4.4 ILLUSTRATION OF CULTIVATION ACTIVITIES IN THE BUFFER ZONE OF NYIRAMUHONDI RIVER (LEFT) AND ITS DISCHARGE WITH SEDIMENTS INTO NYABARONGO RIVER (RIGHT)**

**TABLE 4.6 EVALUATION OF FIELD INTERVENTIONS ON RESTORATION OF NYIRAMUHONDI WATERSHED**

| Planned | Executed | Gaps/Deviations | Lessons Learnt | Suggested Improvement/way forward |
|---|---|---|---|---|
| **Protection of river banks** | River banks were protected by bamboo | Lack of follow up, maintenance in some buffer zones. The erosion of liver banks has taken away some of the planted bamboo and also, it is difficult to differentiate allowed cultivation area and river banks | The community still has personal plots within river banks area | Involve the community for protection of river banks with clear fences and plantation of livestock grass and/or bamboo on river banks |
| **Construction of Radical terraces (100 ha)** | Terraces were constructed | Lack of regular maintenance for the constructed terraces | Some community members do not understand the importance of terraces | Rehabilitation of existing terraces and the construction of new ones |
| **Plantation of agroforestry trees on 100 ha** | Agroforestry trees were planted | Some of the trees planted on terraces are not well maintained | The community still consider agroforestry as a key approach for EbA | Introduction of indigenous plants species in agroforestry |
| **Plantation of Bamboo trees on 10 ha** | Bamboo were planted | The planted bamboos are not well maintained by the local population, some were dried and others no longer exist | Bamboo plant are not appreciated by the community because bamboo species are invasive species in their land | The community propose introduction of indigenous species to replace bamboo like Urubingo and sugar canes. Regular monitoring should be considered. |
| **Restoration of GIHE forest (5 ha)** | 5 ha of forest restored | There is a need of fences and monitoring for planted trees | Eucalyptus was tree species planted in GIHE forest | Establishment of clear fences to protect the forest |
| **Sensitization of local communities around Nyiramuhondi river on river banks and watershed protection** | Most of the villages around Nyiramuhondi were sensitized | Some people have admitted not to have been sensitized on protection of river banks and watershed | Some people still don't understand the importance of liver bank protection | Increase the awareness of local people on the protection of watershed and river banks |
| **Regular monitoring and maintenance** | Monitoring is done on an ad hoc basis by agronomist | Monitoring and maintenance by local stakeholders / beneficiaries not done on a regular basis | Local people are not involved in the maintenance | Establishment of monitoring and maintenance procedures and make them available to the community around Nyiramuhondi watershed. Regular reporting should be considered |

**TABLE 4.7 EVALUATION OF FIELD INTERVENTIONS ON SANZA NATURAL FOREST RESTORATION (NGORORERO)**

| Planned | Executed | Gaps/Deviations | Lessons Learnt | Suggested Improvement/way forward |
|---|---|---|---|---|
| **Sensitization of local communities on forest restoration, maintenance and protection** | Sensitization and mobilization were conducted | Sensitization was not a continual process | There is a need of community sensitization and training on forest protection | Provision of training and mobilization campaign on protection of Sanza forest |
| **Restoration of mining sites (1.5 ha)** | All planned mining sites have been restored | Restoration was not sustainable in some mining sites because of landslides | The restoration of mining sites contributed at the same time to the restoration of entire forest | A proper planning is needed to reduce the mining site vulnerability to the landslides |
| **Restoration of Sanza degraded forest areas using indigenous species (6.1 ha)** | Degraded area was restored using indigenous species | Some indigenous species have been degraded | Misconception of introducing indigenous species | Protect the introduced indigenous species and prevent from degradation |
| **Restoration of buffer zone by planting indigenous species** | Buffer zone restored (1km) | Some of the planted species were damaged due to the lack of fences | Misconception of introducing indigenous species | Introduce fences for the protection of the planted indigenous species |
| **Removal of exotic species from the natural forest** | 1 ha of exotic species (eucalyptus)has been removed | few exotic species plants are still in the forest | Though the exotic species have been removed, they adapt more than indigenous species | Regular forest maintenance by removal of exotic species |
| **Development of guarding scheme of Sanza Natural forest by local community around Sanza forest** | The community is involved in guarding activities around Sanza forest | Guarding schemes are based on voluntary attitude | There is a positive and a voluntary motivation of the community to guard the forest | Strengthening guarding schemes to attract the community for protection of the forest |
| **Regular monitoring and maintenance** | Monitoring is done by the local community | Lack of skills in maintenance and monitoring of forests | Monitoring and maintenance activities are decentralized | Establishment of monitoring and maintenance procedures and make them available to the community around Sanza forest |

**TABLE 4.8 EVALUATION OF FIELD EBA INTERVENTIONS FOR LAKE RUHONDO RESTORATION**

| Planned | Executed | Gaps/Deviations | Lessons Learnt | Suggested Improvement/way forward |
|---|---|---|---|---|
| **Relocation of the community living in Islands of Lake Ruhondo** | Around 112 households were relocated | 48 households remaining on some islands | Relocated families still come back to cultivate on islands | Provision of lands to the relocated families to sustain their life. |
| **Provision of basic settlement for relocated people** | Preliminary settlements were provided at the time of relocation | Provided settlements were destroyed by some relocated families | Relocated families did not want to start new life in a new environment different from island life | Identification of needs of relocated families by local governance and put them in place. Introduce other living alternatives apart from farming and fishing. |
| **Compensation** | Some families were not compensated | A great number of relocated families did not receive their compensation | The compensation should not be in terms of money only. There is also a possibility to be compensated with equivalent land or properties. | Accelerate compensation process to free relocated families from heading back to the islands.<br><br>Allow the owners of the land at the islands (mostly in the buffer zones) to sell their lands to investors. |
| **Protection of buffer zone (lake shores)** | Lakeshores are well protected | Road leading to circumference of lake shore have been damaged | Planted bamboo on the lakeshores are well maintained | Continual improvement in lakeshore protection |
| **Identification of touristic projects** | Some relevant projects have been identified | Identified projects are not known by the local community | Most of identified projects favour the cultivation of fruit trees on Islands within Lake Ruhondo | Suggestion of projects that promote EbA |

## 4.6 Concluding remarks

Buffer zones are one of the tools available for meeting the stated objective of mitigating the impacts of adjacent land-uses on wetland areas. They are, however, unlikely to fully protect these ecosystems on their own. Effective protection entails the integration of the buffer into catchment management practices. For example, one of the objectives is to trap sediment before it enters the receiving environment. This should be coupled with catchment measures such as maintaining good vegetation cover, managing runoff from preferential flow paths, and incorporating measures that break up and dissipate surface flow in the land-use design. Likewise the effectiveness of the buffer zone in trapping nutrients and toxicants will be enhanced by the application of fertilizers and agrochemicals in the catchment. Buffers will not protect the wetland from changes to catchment hydrology, this will require the implementation of designed interventions within the catchment.
In fact, additional measures shall supplement buffers function by ensuring domestic and industrial wastewater treatment before discharge into the environment. Therefore, as stated in the environmental law specific activities around wetlands shall be given additional conditions to fulfil to ensure full protection of wetlands and water resources. These additional measures shall be clarified with the environmental impact assessment of specific projects in consideration of all applicable laws and regulations before their implementations and effective monitoring will be needed to ensure enforcement of mitigation measures throughout the project life cycle.

For example, in this regards, the law on environment precise that cattle kraal shall be built beyond 60 m from the banks of rivers and stream (though official buffer is 10 m) and 200 m away from the bank of lakes (instead of just the regular 50 m buffer zone). These can be considered as setbacks or required distance between water bodies and specific activities.  Grazing shall also be prohibited within buffer zones limits to avoid soil compaction and vegetation removal.

# CHAPTER 5 GUIDELINES FOR AGRICULTURAL PRACTICES IN NON-PROTECTED WETLANDS

## 5.1 Background

Agriculture is the main economic activity for the people of Rwanda, providing employment to about 62.8% of the total population (NISR, 2018). The agriculture sector contributed 24% of Rwanda's Gross Domestic Product in 2019, while the services sector contributed 49% of GDP, the industry sector contributed 18% of GDP while 9% was attributed to adjustment for taxes less subsidies on products. The agricultural sector has therefore been given a high priority in the government's planning for development. The current national thrust is for the sector to move from subsistence to commercial mode of production. With its projected contribution to economic growth, modernisation of agriculture is seen as one of the six pillars of Vision 2020, along with sustainable land-use management and basic infrastructure. Wetland agriculture is seen as an integral part of that development thrust.

The estimated total area of wetlands in Rwanda is 276,477 ha of which 204,592.98 ha are non-protected with limitations, while 16,588.62 ha are non-protected without limitations. The latter two categories add up to 221,181.6 ha which are mostly already cultivated and, in terms of the Irrigation Master Plan, have been targeted for irrigation development (if not already developed) (REMA, 2019).

Cultivated wetlands provide a critically important ecosystem service within the country. However, this use is largely incompatible with biodiversity support and, to some extent, with water quality ecosystem service support. As the wetlands are drained for cultivation, the natural storage of the wetland is reduced, and the tilling of the soil results in the gradual oxidation of organic matter and silt removal from the wetland. Mining is another activity with direct threat for wetlands in Rwanda mainly with sand, gravel, clay and peat extraction. Mine exploitation is often illegal and rarely organized. It disturbs the wetlands ecological balance and often brings about water pollution and diversion of the river through silting, watercourse drying up and results in landscape disturbance in general.

International research has identified a direct link between increased occurrence of malaria (and other vector illnesses) and paddy rice. While the objective of the paddy-rice-project may be food security, the resultant impact on health detracts from developing community wealth building, as households are spending more of their income on health care and medicine as a result. The increased occurrence of Malaria was confirmed by the District officials during the Catchment Management Planning workshops in September 2017.

In addition to the extensive irrigation there are further pressures on the wetlands from the land-use types described in chapter 3. Accordingly, these wetlands should fall under a very different management regime and be used within a different set of limits. They can be further divided according to whether they meet the Ramsar threshold for maintenance of wetland ecological character. Limits of use for all wetlands should be forward-looking, and ensure that they can be farmed, for example, for the next 20-40 years

Subsequently the Prime Minister's Order No. 006/03 of 30 January 2017 draws up a list of swamp lands, their characteristics and boundaries and determining modalities of their use, development and management; as per the requirements of the Law Governing Land in Rwanda N° 43/2013. Furthermore, the order also provides for a buffer zone for each wetland/swamp, as the requirements of the Environmental Law N° 48/2018 of 13/08/2018, determining the modalities of protection, conservation and promotion of Environment in Rwanda.

## 5.2 Purpose

The objective of this chapter is to provide guidelines for agricultural practices in non-protected wetlands in Rwanda. This guideline is intended to address capacity building needs of officers by providing information on agricultural practices in non-protected wetlands. The guideline can be used as a field guide or as a checklist of elements for discussion during training and during implementation of rehabilitation initiatives.

## 5.3 Present agricultural use of wetlands

The overwhelming majority of Rwandans rely primarily on agriculture for livelihoods. 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. Consequently, the use of wetlands (marshlands[13]) has become a food security imperative which is clearly confirmed by the existing intensive agricultural production in many of the country's valley bottom and floodplain wetlands.

Historical management of wetlands in Rwanda, has been based on local wetland knowledge to meet small-scale food production, are mainly aimed at meeting immediate food and financial needs. Local community practice in wetlands has been based on local knowledge of hydrology, soils and vegetation, gained over decades of working and observation (Nabahungu, 2012). The small scale of these systems generally means that the impact on ecosystem services is low.

More recently, traditional management has been superseded by national interventions, the role players of which are both national and local government institutions and private-sector donors, developers and managing agents. This has increased the scale of the impact within wetlands.

The Irrigation Master Plan and District Development Plans highlight the considerable extent of planned wetland development. For example, the entire Nyaborongo floodplain wetland within Kamonyi District is proposed for irrigation development, extending from the confluence with the Akanyaru River to the border of Gakenke District and the proposed Shyorongi dam. This is an area of approximately 3,000 ha. .

### 5.3.1 Crops and fodder types in wetlands

The main climatic variables of temperature, rainfall and altitude have been used to divide Rwanda into 10 agro-climatic zones (ACZs) (Verdoodt and Van Ranst, 2003). The ACZs can be used to classify the country according to agricultural suitability. The ACZs are further subdivided into 38 agro-ecological zones (AEZs). AEZs are characterised according to pedological and climatic criteria. The basic information for this classification was taken from the PNUD/FAO/RWA/006 database.

For the purposes of these guidelines, agricultural suitability has been consolidated from the agro-climatic zones into the three broad regions of Rwanda, namely the Western Highlands, Central Plateau and Eastern Lowland regions. The economically important crops suited to and grown on a significant scale in each region, are summarised in Table 5.1.

**TABLE 5.1 ECONOMICALLY IMPORTANT CROPS SUITED TO AND GROWN IN THE THREE MAIN REGIONS OF RWANDA**

| Region | Perennial crops | Seasonal crops |
|---|---|---|
| Western Highlands | Tea, coffee, pyrethrum, banana, avocado. | Potato (Irish), dry bean, maize, soybean, sweet potato, vegetables. |
| Central Plateau | Tea (northern areas only), coffee, pineapple, banana, sugarcane | Potato (Irish), dry bean, maize, sorghum, wheat, soybean, sweet potato, vegetables, rice, wheat, cassava. |
| Eastern Lowlands | Sugarcane, banana, mango, papaya. | Rice, maize, sorghum, potato (Irish), dry bean, soybean, sweet potato, cassava, vegetables. |

### 5.3.2 Soil types associated with crop production in wetlands

The potential of a wetland soil for agriculture is determined by inherent soil properties, which may be limiting to production within an environment, and for a given crop.

In the higher altitude areas (more than 2,000 m), where the climate is isomeric, peat predominates over mineral soils. All the soils are in general acid and very poor in exchangeable bases. The agricultural potential is low to average and the altitude limits the variety of crops. Physical properties are good and the risk of acute dryness is limited by the climate.

[13] Marshland is used as a synonym for wetlands in Rwanda

In the area of plateaus and hills (1,400 m to 2,000 m altitude) is a high density of small wetlands. Many wetlands have organic soils which are fairly to very acid and relatively poor in exchangeable bases, as well as mineral soils. The agricultural potential of these wetlands is variable. In rain fed situations the risks of extreme and sometimes irreversible dryness exists for both organic soils and clayey soils.

In the east of the country, and in the south-west in Bugarama, where there is a hot climate, wetland mineral soils are generally rich in exchangeable bases and are often vertisolic. Their pH is at least 5 or more, and their colour is dark. In general, the agricultural potential of these soils is considered to be very high, but the vertic character found in some areas makes their development difficult.

## 5.4 Agricultural land-use types in wetlands

Agricultural land use, in wetlands, includes both irrigated and rain-fed production, and consists of five broad types:

Firstly, **informal subsistence farming** on small units of less than 0.5 ha with a wide range of food crops such as maize, potato, sweet potato, beans and vegetables which are grown with minimal inputs. These may be either irrigated or rain-fed.

Secondly, **consolidated small plots farmed cooperatively** and with intensive, synchronised production of up to three crops per year, with improved inputs. These may be either irrigated or rain-fed.

Thirdly, **large monoculture, perennial crop projects farmed cooperatively,** such as the extensive tea projects. Although mainly under irrigation, this category can also be rain-fed.

Fourthly, **large monoculture, seasonal crop projects farmed cooperatively,** such as the extensive rice projects. Although mainly under irrigation, this category can also be rain-fed.

The fifth type is the **large private-sector managed estates,** which mainly produce sugarcane, either irrigated or rain-fed. The different types of agricultural land use in wetlands are summarised in Figure 5.2.

**TABLE 5.2 AGRICULTURAL LAND-USE TYPES IN WETLANDS**

| Type | Ownership | Production area | Cropping system | Crop example |
|---|---|---|---|---|
| Estate Project | Private sector | Very Large (>500ha) | Monoculture (rain-fed) | Sugar cane |
| Cooperative projects (Community-based) | Community | Large (>100ha) | Monoculture Annual crops (irrigated or rain-fed) | Rice |
| Cooperative projects (Community-based) | Community | Moderate to large (>50ha) | Monoculture Perennial crops (irrigated or rain-fed) | Tea |
| Cooperative projects (Community-based) | Community | Moderate (>5ha) | Synchronized crops in rotations (irrigated or rain-fed) | Maize/potato/beans |
| Informal cropping (subsistence farming) | Household | Small (<1.0ha) | Multi-cropping (irrigated or rain-fed) | Vegetables, Potato, Sweet potato, Maize, beans etc. |

The types of wetland agriculture are illustrated in Figures 5.1, 5.2, 5.3 and 5.4 below.

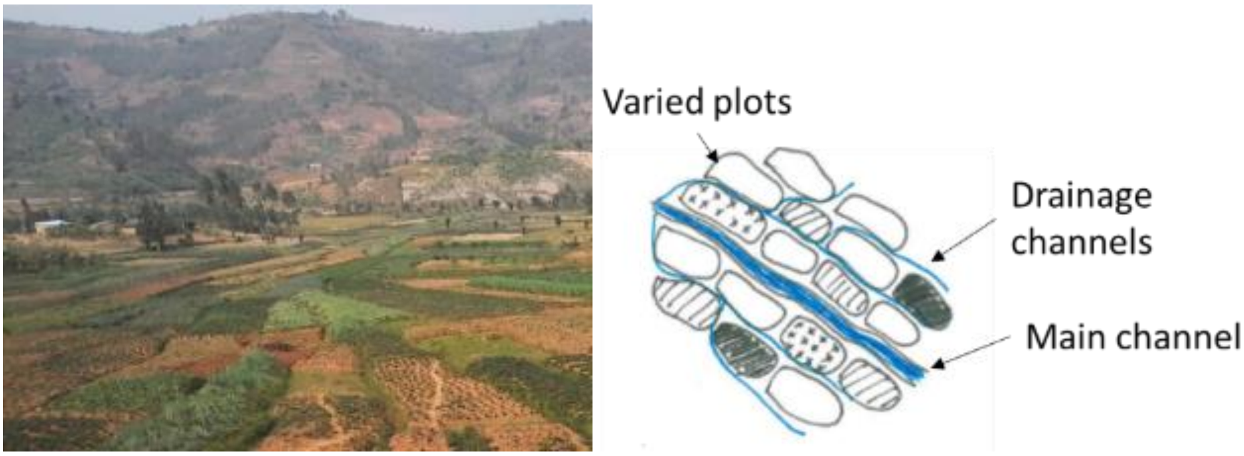



**FIGURE 5.1 EXAMPLE OF INFORMAL SUBSISTENCE FARMING ON SMALL UNITS OF LESS THAN 0.5 HA WITH A WIDE RANGE OF FOOD CROPS SUCH AS MAIZE, POTATO, SWEET POTATO, BEANS AND VEGETABLES WHICH ARE GROWN WITH MINIMAL INPUTS AND EITHER IRRIGATED OR RAIN-FED.**


**FIGURE 5.2 EXAMPLE OF CONSOLIDATED SMALL PLOTS FARMED COOPERATIVELY AND WITH INTENSIVE, SYNCHRONIZED PRODUCTION OF UP TO THREE CROPS PER YEAR WITH IMPROVED INPUTS AND EITHER IRRIGATED OR RAIN-FED.**

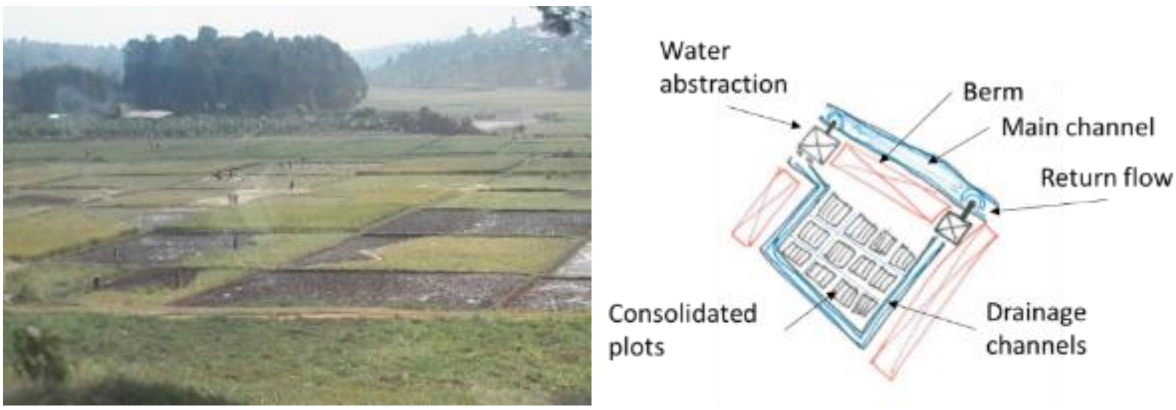



**FIGURE 5.3 EXAMPLE OF LARGE MONOCULTURE PROJECTS SUCH AS THE EXTENSIVE RICE PROJECTS WHICH ARE ALSO MANAGED INTENSIVELY ON A COOPERATIVE BASIS. ALTHOUGH MAINLY UNDER IRRIGATION, THIS CATEGORY CAN ALSO BE RAIN-FED WITH RICE OR MAIZE.**

FIGURE 5.4 EXAMPLE OF LARGE PRIVATE-SECTOR MANAGED ESTATES WHICH MAINLY PRODUCE RICE

**Impacts of agricultural practices on wetlands in each land-use type**

The agricultural practices in each of the land-use types impact in the vital function of wetlands in various ways, some more severe than others. These impacts are summarised in Table 5.3.

**TABLE 5.3 Impacts of agricultural practices in each of the land-use types**

| Informal subsistence agriculture | |
|---|---|
| ***Negative impacts*** | ***Positive impacts*** |
| Forming of small raised beds and earth canals/drainage lines between beds which causes soil disturbance and erosion and lowers the water table. | Creation of an artificial network of "pathways" for vertical and lateral water connectivity, which to some extent simulates the natural wetland function of river flow buffering (water storage and peak flow delay) |
| Hand cultivation for seedbed preparation and weed control exposes soil to erosion. | Low levels of fertilization (organic or inorganic) which limits eutrophication potential |
| Regular cultivation results in gradual reduction (oxidation) of soil organic matter. | |
| Random cropping patterns which create a "patchwork" effect of different crops and fallow beds | |
| **Consolidated small plots farmed cooperatively with synchronized seasonal crops** | |
| Forming of small raised beds and earth canals/drainage lines between beds which causes soil disturbance and erosion and lowers the water table. | Creation of an artificial network of "pathways" for vertical and lateral water connectivity, which to some extent simulates the natural wetland function of river flow buffering (water storage and peak flow delay) |
| Hand cultivation for seedbed preparation and weed control exposes soil to erosion. | Synchronized cropping with enhanced productivity (three crops in one year and improved yields) which may reduce the periods of exposed soil (between crops) when the soil is vulnerable to erosion and runoff |
| Regular cultivation results in gradual reduction (oxidation) of soil organic matter. | |
| Modest applications of fertilizer (organic or inorganic) | |

#### 5.4.1 Large monoculture projects (both cooperative and estate managed)

Under this category, the land-use impacts from agricultural practices are summarised as follows:

- Construction of diversion berms; diversion of natural flow of water through the wetland into lined canals and the controlled channelling of water into and out of the wetland for irrigation. This artificial control of water movement compromises the ability of the wetland to fulfil its function of river flow buffering.
- The monocropping of perennial crops such as sugarcane and tea has a positive impact by ensuring limited soil cultivation and exposure to erosion because of their full-canopy.
- The mono-cropping of seasonal crops such as rice also has a positive impact by limiting soil exposure to erosion during the growing season. However annual land cultivation for planting does expose the soil to erosion for a limited period and results in gradual reduction (oxidation) in soil organic matter.
- Applications of fertilizer (organic or inorganic) help to reduce the rate of soil fertility depletion in wetland soils. However, misuse of fertilizers can cause downstream nitrification of water resources.

### 5.5 Assessing the sustainability of land-use in wetlands

Sustainable development comprises three mutually reinforcing pillars: economic development, social development and environmental protection at the local, national, regional and global levels (UN, 2002). In broad terms, the concept of sustainable development is an attempt to combine concerns about environmental issues with socio-economic issues (Hopwood *et al.,* 2005).

Sustainable development can also be defined as 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. However the term sustainable development is open to misuse in situations where the economic dimension predominates over the social and environmental dimensions. Given the conflicting interpretations that are likely to arise around sustainable development and the need for greater clarity of meaning, more specific guidance and criteria are required to measure attainment of sustainable development (Sunderlin, 1995; Lawrence, 1997).

“WET-SustainableUse” (Kotze, 2010) is an environmental management tool that has been developed in South Africa to assist in assessing the ecological sustainability of wetland use. This system can also be used for wetlands in Rwanda to assess the environmental impacts of both current and possible future uses of a particular wetland resource. It focuses on grazing of wetlands by livestock, cultivation of wetlands and harvesting of wetland plants for crafts and thatching. “WET-SustainableUse” 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), are expanded in Table 5..

**TABLE 5.4 THE FIVE KEY ENVIRONMENTAL COMPONENTS CONSIDERED IN ASSESSING THE EXTENT TO WHICH USE OF A WETLAND ALTERS THE ENVIRONMENTAL CONDITION OF THE WETLAND.**

| Example picture | Key components | Rationale |
|---|---|---|
|  | **1.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. |
|  | **2. 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. |
|  | **3.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 uptake by plants. |

| Example picture | Key components | Rationale |
|---|---|---|
|  | **4. 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). |
|  | **5. 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). |

Table 5. 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.

**TABLE 5.5 CHARACTERISTIC LIVELIHOOD IMPACTS RESULTING FROM ALTERATIONS TO THE FIVE KEY ELEMENTS DETERMINING THE ENVIRONMENTAL CONDITION OF A WETLAND.**

| Key elements considered | Likely impact on the livelihoods of local people using the wetland |
|---|---|
| 1. Hydrology (the distribution and retention of water in the wetland) | The reduced extent and duration of flooding/saturation in the wetland potentially allows for greater opportunities for the cultivation of wetland areas that were naturally too wet for cultivation. From a livelihoods perspective, this is positive. However, these alterations may also have negative effects on local livelihoods, particularly where important resources (e.g. the fish of the floodplain or the reeds) are dependent on a close-to-natural flooding regime. An artificial drying out of the wetland is also likely to reduce the value of the wetland as a source of water for domestic and livestock use and small-scale irrigation, particularly during dry years. Over-drainage of a wetland may also directly reduce the crop production potential of a wetland during dry years by subjecting crops to desiccation[1]. |
| 2. The retention (or erosion) of sediment in the wetland | Reduced retention of mineral sediment (usually as a result of erosion) will almost always have a negative impact on wetland productivity, which in turn will impact negatively on the supply of provisioning services and the livelihoods that these sustain. This might be expressed rapidly (e.g. if soils are inherently shallow or the intensity of erosion is very high) or slowly (e.g. if erosion intensity is low).<br>Erosion may also impact on water quality downstream, by increasing sediment and nutrient loads. |
| 3. The accumulation of soil organic matter (SOM) in the wetland | Reduced organic matter leads to both reduced nutrient retention and water-holding capacities, which in turn result in reduced productivity and provisioning services.<br>In the short term, increased mineralization of SOM (e.g. as a result of desiccation from artificial drainage) is likely to increase nutrient availability for crops, which is potentially positive for livelihoods. However, as the SOM store is depleted, this release of nutrients will come to an end and the soil will often be left both depleted of nutrients and with a poor capacity to hold any nutrients that may enter the system. This in turn will impact negatively on the capacity of the wetland for producing crops The time taken for this point to be reached may vary greatly from one wetland to the next, and will depend on the size of the SOM store, which may be very large in peatlands with deep peat deposits or very small in some seasonally saturated mineral soils. |
| 4. The retention and internal cycling of nutrients in the wetland | As in the case of erosion, reduced nutrient retention and internal cycling will almost always have a negative impact on wetland productivity, which in turn will impact negatively on the supply of provisioning services and the livelihoods that these sustain.<br>A reduction in this capacity is also likely to impact negatively on the water quality of downstream areas, thereby affecting those that depend on this water. |
| 5. The natural composition of the wetland vegetation | A decline in the richness of native species reduces the resource base of wild plants, including medicinal plants and plants for crafts and thatching. Plants of value for grazing livestock may also potentially be lost. |

## 5.6 Assessing the impact and sustainability of the agricultural land-use types in wetlands

In order to assess the sustainability of the five types of agricultural land use in Rwanda's non-protected wetlands, as described above, and using the "WET-Sustainable Use" principles, each of the above levels of impact were given an empirical value from 1-5 (1= low impact; 5 = high impact) which provides an impact intensity score. This mean that a project with low impact will have high sustainability for land uses and vice versa. In this simple application of the concept, there was no weighting of the environmental components. Weighting will be necessary when considering wetlands with high levels of importance or sensitivity.

### 5.6.1 Impact rating

Table 5.6 shows the relative intensity of impact of the six wetland agricultural land-use types on the five environmental components with empirical values from 1-5 (1= low impact; 5 = high impact).

**TABLE 5.6 RELATIVE INTENSITY OF IMPACT OF EACH OF THE WETLAND AGRICULTURAL LAND-USE TYPES ON THE FIVE ENVIRONMENTAL COMPONENTS (INDICATORS).**

| Type | 1. Estate Projects *Private sector* *Monoculture* *(Sugar cane)* | 2.Cooperative projects *Monoculture* *(perennial crops –Tea)* | 3.Cooperative projects *Monoculture* *(annual crop – rice)* | 4.Cooperative projects *Synchronized crop rotation* *(annual crops - maize, potato, beans)* | 5. Informal cropping *Multi-cropping* *(seasonal crops – veges., sweet potato, maize, beans* |
|---|---|---|---|---|---|
| 1. Hydrology - Distribution and retention of water | 3 | 3 | 3 | 3 | 4 |
| 2. Retention of sediment | 2 | 3 | 3 | 4 | 5 |
| 3.Accumulation of soil organic matter (SOM) | 2 | 2 | 3 | 4 | 5 |
| 4.Retention and internal cycling of nutrients | 2 | 2 | 3 | 4 | 5 |
| 5. Retention of the natural composition of wetland vegetation | 5 | 5 | 5 | 5 | 5 |

### 5.6.2 Factors contributing to impact rating

| Impact intensity (Average) | 2.8 | 3.0 | 3.4 | 4.0 | 4.8 |
|---|---|---|---|---|---|

The main factors contributing to the impact rating of the land-use types are summarized in Table 5.7.

**TABLE 5.7 MAIN FACTORS CONTRIBUTING TO THE IMPACT RATING OF THE LAND-USE TYPES.**

| Type | Impact rating | Main factors affecting rating |
|---|---|---|
| 1. Estate Projects<br>*Private sector*<br>*Monoculture*<br>*(Sugar cane)* | 2.8 | Sugarcane is a perennial crop with minimal soil disturbance in the production cycle (7 years). The full canopy cover of this grass species and the dense shallow rooting system simulates the natural vegetation of a wetland reasonably well.<br>Soil nutrient levels are replenished with fertilizers.<br>Excessive fertilization can cause downstream water quality reduction |

| Type | Impact rating | Main factors affecting rating |
|---|---|---|
| | | The natural composition of the wetland vegetation is completely replaced. |
| 2.Cooperative projects<br>*Monoculture*<br>*(perennial crops – Tea)* | 3.0 | Tea and coffee are perennial crops with minimal soil disturbance in the production cycle.<br>However, unlike sugarcane, the canopy is not as dense close to the ground and the rooting system is not as shallow and dense.<br>Access paths between rows are required for harvesting which enhances runoff.<br>Soil nutrient levels are replenished with fertilizers.<br>Excessive fertilization can cause downstream water quality reduction<br>The natural composition of the wetland vegetation is completely replaced. |
| 3.Cooperative projects<br>*Monoculture*<br>*(annual crop – rice)* | 3.4 | The full canopy cover and dense shallow rooting system of rice simulates the natural vegetation of a wetland reasonably well. However annual cultivation exposes the soil to oxidation of organic matter and erosion into drainage canals.<br>Soil nutrient levels are partly replenished with fertilizers.<br>The natural composition of the wetland vegetation is completely replaced. |
| 4.Cooperative projects<br>*Synchronized crop rotation*<br>*(annual crops- maize, potato, beans)* | 4.0 | With up to three crops grown in one year (under irrigation) the regular cultivation exposes the soil to oxidation of organic matter and erosion into drainage canals.<br>Soil nutrient levels are partly replenished with fertilizers.<br>The natural composition of the wetland vegetation is completely replaced. |
| 5. Informal cropping<br>*Multi-cropping*<br>*Seasonal crops – veges., sweet potato, maize, bean s* | 4.8 | The unsynchronized cropping patterns are likely to result in a high level of soil exposure for oxidation, runoff and downstream sedimentation.<br>Very low levels of fertilizer application depletes the natural soil fertility levels in the wetland soils.<br>The natural composition of the wetland vegetation is completely replaced. |

Note: A project with high impact will result in low sustainability for the wetland use

## 5.7 Recommendations to enhance sustainable agricultural use of wetlands

### 5.7.1 Cultivation methods

With one of the key elements in the definition of a wetland being its effect as a “sediment sink”, any cropping practices that maintain that effect will be more appropriate than those that promote erosion, soil loss and soil break-down (oxidation of organic matter). The common method of cultivation in most wetlands throughout Rwanda is hand hoeing. Though very labour intensive, the ancient method is far less destructive than mechanical (tractor) ploughing. The land use Intensification programme promotes the gradual increase in tractor use to improve agricultural productivity. The promotion and introduction of mechanical cultivation in wetland agriculture must be carefully considered in terms of the potential negative impacts.  The possible use of hand-driven motorized small cultivators should be investigated and tested as an alternative.

The principles of conservation in agriculture which embrace the concept of conservation tillage methods should also be tested and expanded in wetland cropping areas. Conservation tillage methods are designed to minimise soil disturbance and maximise mulching of the soil surface. This reduces erosion and maintains organic matter levels. However, conservation tillage is not an easy system to adapt to and will not be adopted readily by farmers without a well-supported programme of trial and demonstration. It is proposed that the Crop Intensification Programme[14] is the appropriate vehicle for this purpose.

### 5.7.2 Crop selection

**Crop selection within existing wetland cropping areas**

The production of "seasonal" crops (up to three crops a year in terms of the land use consolidation and intensification programmes) results in multiple cultivation and soil disturbance activities. This level of soil disturbance inevitably leads to soil erosion and loss of organic matter. The growing of perennial crops such as tea has the benefit of having very little soil cultivation/disturbance once the plants are established. The full-canopy of these crops ensures that the soil is protected from rain-drop action (which promotes soil erosion) and simulates the natural vegetative cover in a wetland to some extent.

Tea and coffee are suited to specific climatic conditions and their expansion is therefore restricted to suitable areas and to market constraints. From a livelihoods perspective, the other widely grown food crops cannot all be replaced by "industrial" type crops. However the expansion of the tea and coffee industry in climatically suitable wetland areas should be promoted as preferred crops (where climatically and economically viable) in preference to other crops, but with due consideration to food security needs.

**Alternatives to rice production expansion in prioritized wetlands**

Where prioritized and vulnerable wetlands have been "earmarked" for the expansion of rice production, serious consideration should be given to finding alternative and compensatory agricultural production options outside of those wetlands and preferably to the benefit of the same communities that would be involved in the wetland rice projects.

Finding an alternative to paddy rice production is a challenge because of the Rwandan government's concerted drive to promote and support wetland rice production as guided by the National Rice Development Strategy and most other policy documents relating to agricultural development. This programme has been successful for a number of reasons including:

- The suitable agro-climatic conditions for wetland rice production (national average yields are close to 6.0 t/ha).
- Rapidly escalating Rwandan consumer preference for rice over other staples and the government's initiative to effect rice import substitution by stimulating local production.
- Proliferation of private-sector rice milling operations which provide guaranteed markets and production financing support.
- Higher financial returns from rice compared with other annual crops.
- Relatively low capital and operating costs of irrigation in wetlands compared to areas outside wetlands.
- High labour requirement and related job creation.

Any alternative crop will have to show the equivalent level of productive land use, income generation, job creation, and import substitution for it to be successfully adopted.

The one crop that might meet these requirements is Upland rice. This crop, which has similar growth habits to other traditional field crops like maize, does not need the saturated growing environment of rice paddies.

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[14] Under MINAGRI, the crop intensification program (CIP) is responsible for the overall planning of land area that needs to be consolidated for growing priority food crops. One of the key components of CIP includes consolidated use of farm lands in the production areas.

The Rwanda Agriculture Board (RAB), in partnership with the Chinese Agricultural Technology Centre, is researching Upland rice production. New variety trials have been conducted for five years at the RAB-owned research stations of Mututu, Nyanza and Rubona, in Huye District.

Yields, under trial conditions, of up to 7.5 t/ha have been achieved. This indicates the Upland rice may be competitive with wetland rice under good rainfall conditions or under irrigation. The Upland rice varieties tend to have a growing season about a month shorter than paddy rice and have lower water requirements. The trials are also testing the adaptability of the new varieties to different soil types and conditions.

While the main purpose of the Dryland rice programme is to increase rice production in Rwanda there is an opportunity to promote this crop as an alternative to paddy rice production in priority wetlands.

Upland rice will require “radical” terracing to create flat cultivation beds on the hill slopes surrounding the wetlands.

Although irrigation of Upland rice is not imperative to produce a crop, to compete with the yields of paddy rice, irrigation of Upland rice projects will have to be considered. The capital development costs of irrigation infrastructure for upland rice and the operating costs are likely to be higher than for wetland rice irrigation. However the major advantage of protecting priority wetlands and reducing the risk of human diseases associated with paddy rice, should justify the additional expenditure on irrigation.

### 5.7.3 Cropping systems

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…”

### 5.7.4 Soil fertility

Continuous intensive cropping is depleting the soil fertility of Rwanda´s non-protected wetlands.

Declining fertility of wetland soils for crop production results in the demand for larger cropping areas, resulting in a downward spiral of wetland productivity and sustainability and increasing degradation. A way of reducing soil degradation in wetlands is therefore to raise soil fertility to sustainable levels of productivity.

Very low fertilizer application rates in Rwanda do not match nutrient removal by crops. At present, average fertilizer applications in the country are about 45 kg/ha of a fertilizer mix such as 17:17:17 (Nitrogen (N): Phosphate (P): Potassium (K)). This is equivalent to 7.6 kg N; 3.3 kg P; 6.3 kg K. Now 1.0 t/ha of maize grain contains (extracts from the soil) 16.0 kg N; 2.9 kg P and 4.3 kg K.

A long-term strategy should be to apply fertilizers at rates adequate to replace nutrient removal by crops. At present, nutrient ratios in applied fertilizers are not matched to crop requirements. This can lead to fertilizer wastage and nutrient imbalances. To avoid any overuse of fertilizers, soils analysis should be done to know the gaps in needed nutrients according to the crop. In addition, timing shall be done to ensure optimum uptake by crops.

There is high variability in soil types in Rwanda which results in a wide range of soil fertility conditions. Acid soils, which are common in the high rainfall areas of Rwanda, lead to phosphate (P) fixing in the soils (i.e. restricts the availability of P to crops) and aluminium toxicity (which stunts root growth). Application of agricultural lime or dolomitic lime reduces Aluminium toxicity and improves Phosphate availability – making less fertilizer more effective.

Inadequate facilities exist for farmers to assess soil fertility status and obtain fertilizer recommendations that consider the soil nutrient status and target crop yields. Standard soil fertility analysis shows pH and related lime requirement and N, P and K requirements to achieve a target yield.

Organic fertilizers (manure or compost) have a natural balance of readily available nutrients but the concentration of nutrients in organic fertilizers is low. To meet crop requirements, large quantities of organic fertilizer are therefore required (up to 3 t/ha). The challenge of availability and transporting such quantities of organic matter makes adequate fertilization of crops with organic fertilizers not feasible on a large scale. A combination of organic fertilizers and inorganic (granular) fertilizers is therefore becoming a more common and sustainable recommendation in Rwanda. The approach is recommended in the concept of Integrated Soil Fertility Management (ISFM).

Increased fertilizer use in Rwanda is limited by financial constraints. It is recommended that the GoR should continue and possibly enhance the fertilizer subsidy programme. In 2014, the GoR revised its program to subsidize fertilizers in an effort to move fertilizer import and distribution to a competitive private sector.

Raising soil nutrient levels in wetland soils increases the risk of leaching and nutrification of downstream water resources. Therefore, any initiative to improve soil fertility in wetlands must be accompanied by thorough training and monitoring within the sector to avoid misuse of fertilizers. The training and monitoring would include:

- application methods,
- soil testing for quantity and type of fertilizer use,
- state monitoring of imported fertilizer quality,
- Appropriate timing of fertilizers application (season and growth stage of crop) to ensure optimum uptake

It is recommended that the CIP programme would be the most appropriate vehicle for the implementation of these innovations. The CIP is already involved in creating awareness of the benefits of using fertilizer among small farmers; using subsidy vouchers to promote and stimulate fertilizer markets; refining outdated technical recommendations; implementing regular quality control; and providing credit facilities for fertilizer and seed buyers.

### 5.7.5 Summary of recommendations

The recommendations to enhance the sustainability of agricultural use of wetlands are briefly summarised in Table 5.4.

**TABLE 5.4 SUMMARY OF RECOMMENDATIONS TO ENHANCE THE SUSTAINABILITY OF AGRICULTURAL USE OF WETLANDS.**

| Item | Recommendation |
|---|---|
| Cultivation method | Avoid or reduce tractor cultivation[15] |
| | If mechanization is essential consider and test hand-driven motorised cultivators. |
| | Test and demonstrate conservation tillage options to minimize soil disturbance and maximize mulching. |
| | CIP to facilitate for the implementation of these innovations as an extension of their existing services. |
| Crop selection | Examples of tea as more sustainable forms of cropping in wetlands than seasonal crops, where climatic conditions are suitable |
| | Upland rice as an alternative to paddy rice where prioritized and vulnerable wetlands have been “earmarked” for the expansion of rice production. |
| Cropping systems | Using the Synchronised Crop Rotation Programme (as driven by the CIP) as a vehicle to introduce and promote the recommendations. |

[15] Tractors enhances soil compaction and affects the flow and water availability

| Item | Recommendation |
|---|---|
| Soil fertility | Enhance soil fertility (quantity and quality) by:<br>• Improving /expanding facilities for soil fertility testing and fertilizer recommendations – based on soil type, selected crop and yield target - for more discerning application of fertilizers.<br>• Apply Integrated Soil Fertility Management practices which recommends the combined application of both organic manure/compost and inorganic, granular fertilizers.<br>• Improve/expand GoR fertilizer subsidy programme.<br>• Thorough training and monitoring within the sector to avoid misuse of fertilizers. The training and monitoring would include:<br>- application methods,<br>- soil testing for quantity and type of fertilizer used,<br>- state monitoring of imported fertilizer quality,<br>- proper timing of fertilizer application for optimum uptake |

# Chapter 6 . WETLAND MANAGEMENT FRAMEWORK

The strategic orientation of wetland management framework in Rwanda is **sustainable utilization of wetlands for livelihood support while ensuring sustainable protection of wetlands with high conservation potential**.

## 6.1 Vision, goal and objectives

Based on the stakeholder workshop held on 10 and 11 October 2017 (summarised in Appendix A), as well as the results of the assessment of wetland management in Rwanda undertaken by the project specialists, the vision for wetlands management is:

### *Sustainable and productive wetlands for the socio-economic welfare of Rwanda*

Goals, objectives and targets are drawn from the suggestions made by stakeholders, guided by the expertise of the project team.

**Goal 1:** To rehabilitate 30% of national wetlands by 2030 in order to support livelihoods[16]

*(Achievement of this will contribute towards national food security targets)*

Objective 1.1: Update the National Inventory

*Target 1.1.1: Update the wetland inventory attribute data*

*Target 1.1.2: Identify wetlands for categories of utilisation (commercial, subsistence, etc.)*

*Target 1.1.3: Provide clear guidance on appropriate utilisation of categories of wetlands*

Objective 1.2: Improve farming practices in wetlands

*Target 1.2.1: Establish wetland management committees[17] at different administrative levels*

*Target 1.2.2: Reduce sedimentation of wetlands (by considering catchment committees, that include wetlands, issues of wetland sedimentation can easily be managed)*

*Target1.2.3: Improve water storage of wetlands*

*Target 1.2.4: Improve ecosystem functions of wetlands*

*Target 1.2.5: Provide clear guidance on appropriate farming techniques for farming in wetlands, including fish farming and fisheries*

**Goal 2:** To ensure implementation of a framework for sustainable wetland utilisation and management by 2030

Objective 2.1: Strengthen the enabling environment to implement sustainable wetland management

*Target 2.1.1: Strengthen institutional capability (structures, functions, roles and responsibilities, staffing)*

*Target 2.1.2: Establish an inter-sectoral national committee for wetland management (REMA, RWB, RFA, MINAGRI)*

[16] Which would be around 53,356.66 ha against the current level of protection of 17% equalling to 31000 ha.

[17] It can also be aligned with catchment management committees or simply the Environmental protection committees. The article 41 of the law on Environment (2018) provides for the Establishment of environment protection committees, indicating that a committee responsible for conservation, protection and promotion of environment as well as climate change is established at the City of Kigali, District, Sector and Cell levels. The organisation, functioning and responsibilities of environmental protection committees as well as their members are determined by a Prime Minister's Order.

*Target 2.1.3: Develop a National Wetland Policy and strategy*

Objective 2.2: Implement a National Wetland Resources Management Strategy

*Target 2.2.1: Implement compliance monitoring and enforcement of wetland utilisation*

*Target 2.2.2: Establish a "permit for use" system for wetland utilisation*

*Target 2.2.3: Develop a framework for Payment for ecosystems services (PES)*

*Target 2.2.4: Develop a National Monitoring and Evaluation Framework*

*Target 2.2.5: Implement MIS system for data collection and monitoring.*

Objective: 2.3 Increased communication, awareness and education about wetland systems

*Target 2.3.1:* Awareness about wetland functions and goods and services

*Target 2.3.2: Research and Education*

*Target 2.3.3: Develop citizen science for monitoring and reporting on bird diversity*

**Goal 3:** To ensure the sustainable protection of those wetlands with high conservation potential by 2030.

Objective 3.1: Proclaim wetlands that are proposed for Ramsar status

*Target 3.1.1: Identify vulnerable and important wetlands for restoration and protection*

*Target 3.1.2: Develop and implement Rehabilitation and management detailed plans*

Objective 3.2: Develop ecotourism opportunities

*Target 3.2.1: Build local capacity and develop a brand to support avitourism (e.g. birding watching and guiding)*

*Target 3.2.2: Build local capacity and develop a brand to support sports (e.g. canoeing, catch-and-release angling, hiking along boardwalks, etc.)*

*Target 3.2.2: Build local capacity and develop a brand to support eco-holidays (e.g. cleaning of wetlands, removal of invasive species, collecting data for wetland research, etc.)*

## 6.2 Tables of actions

The Implementation Framework is presented in **Table 6-2** for each Strategic Goal, similar / related activities were integrated into one or more Target/Aims. The Activities outline the key actions to achieve the Targets/Aims. Indicators/Outputs were identified for each Activity, against which to monitor progress made in implementing the wetland management. Indicative phasing provides a timeframe for implementing the activities, with Responsibilities assigned to lead role-player's, and where applicable specific District/Sectors are identified and an indicative costing for activities requiring funding that is not part of daily operations. These headings are summarised below.

**TABLE 6-1 Table of actions**

| Target / Aim | Activities | Indicators/Outputs | Indicative timeframe | Responsible Authority | Applicable District / Sectors | Indicative costing |
|---|---|---|---|---|---|---|
| *What action needs to be achieved to meet the objective* | *Specific activities to be carried out to meet the Target/Aim* | *For monitoring / Links to limits set by Districts* | *Short = 1-2 years*<br>*Medium = 2-5 years*<br>*Long = 5-10 years* | *Who should be responsible to ensure this action is implemented* | *If actions are specific/ prioritised to a District or Sector area* | *1 FRW= 950 USD (June, 2020)*<br>*n/a =part of routine operational costs* |

**TABLE 6-2 WETLAND MANAGEMENT FRAMEWORK**

**Goal 1:** To rehabilitate 30% of national wetlands by 2030 in order to support livelihoods**.**
Whilst the below implementation framework has been provided as a guideline upon which to set and base the achievement of the defined goals, it is recommended that a Pilot Study/Project be initiated at the outset (over a 3 year cycle), in which the various activities are applied, monitored and evaluated. The objective of a pilot project is to test and refine the proposed approach for the follow-on years. In doing so, potential problems can be resolved on a smaller scale prior to being implemented at a larger national scale. This further encourages the documentation of lessons learnt over the course of the period etc. An example of a successful national wetland programme is the South African National Working for Wetlands programme. On an annual basis the programme not only compiles a suite of rehabilitation plans for wetlands nationally, but also ensures that these plans are implemented subject to authorisation by the relevant government bodies. The successful implementation of the programme has ensured that the budget allocated for these activities has increased over the years in conjunction with the capacity of the programme personnel. Implementing a suitable pilot-project on a limited budget, and documenting the successes and lessons learnt, may provide useful motivation for national/international funding allocated to the rehabilitation, monitoring and evaluation of the wetlands at a national level.

**Goal 1:** To rehabilitate 30% of national wetlands by 2030 in order to support livelihoods

**Objective 1.1:** Verify and update the National Inventory

| Target / Aim | Activities | Indicators/ Outputs | Indicative timeframe | Responsible Authority | Indicative costing |
|---|---|---|---|---|---|
| *Target: Update the wetland inventory attribute data* | 1. Include the HGM unit in the classification of wetlands. | All wetlands assigned HGM unit | Short | RLMUA | n/a |
| | 2. Include ecosystem services provided by wetlands in the classification of wetlands. | All wetlands assigned potential ecosystem services | Short | RLMUA | n/a |
| | 3. Include wetland condition in the classification of wetlands. | All wetlands have a baseline condition in which to monitor health status | Medium | RLMUA | n/a |
| | 4. Update the shapefiles for wetland boundaries | All wetland boundaries reflect the current extent | Medium | RLMUA | n/a |
| *Target: Identify wetlands for categories of utilisation (commercial, subsistence, etc.)* | 1. Using inventory status, potential ecosystem function, environment policy, biodiversity policy, IWRM policy and land use policy, classify all wetlands with a management objective - conservation, cultivation, etc. | All wetlands assigned a management objective | Short | RLMUA | n/a |
| | 2. Develop a management plan for each wetland setting out clear objective, acceptable use practice to which it can be monitored. | All wetlands have a management plan | Short | RLMUA | n/a |
| *Target: Provide clear guidance on appropriate utilisation of categories of wetlands* | 1. Develop guidelines for all wetland use types. | Guidelines for wetland use | Short | RLMUA, REMA, RAB | 80 M FRW |
| | 2. Capacity building and training through the wetland committees on appropriate use | No. of people trained | Short | RLMUA, REMA, RAB | 100 M FRW |

**Goal 1:** To rehabilitate 30% of national wetlands by 2030 in order to support livelihoods

**Objective 1.2:** Improve farming practices in wetlands

| Target / Aim | Activities | Indicators/ Outputs | Indicative phasing | Responsible Authority | Indicative costing |
|---|---|---|---|---|---|
| *Target: Establish (wetland)/catchment management committees at different administrative levels* | 1. Determine structure, objectives and functions of committees at different administrative levels. | A generic structure, objectives and functions, appropriate for each administrative level, agreed by all stakeholders. | Short | REMA, MINALOC/Districts | n/a |
| | 2. Establish committees at different administrative levels | Committee establishment completed. | Short | REMA, MINALOC/Districts, involvement of RLMUA, and RAB /MINAGRI | n/a |
| | 3. Implement regular meeting and reporting by committees. | Committees meet regularly with full documentation of minutes, progress monitoring reports and action schedules. | Medium | REMA, MINALOC/Districts | 90 M FRW |
| *Target: Reduce sedimentation of wetlands* | 1. Continued implementation of progressive and radical terracing in upstream areas. | Progressive increase in terracing of priority upstream areas. | Short - medium | MINAGRI, RAB | 1.6 M FRW/ha |
| | 2. Repair and implement wetland and buffers | Progressive increase in extent of priority wetland and buffers. | Short-medium | RLMUA | 500k-1M/ FRW /ha |
| | 3. Implement soil erosion and runoff reduction measures in upstream catchments | Progressive increase in areal extent of priority soil erosion and runoff reduction measure implementation. | Medium-long | MINAGRI, RAB | 500k-1M FRW / ha |
| *Target: Improve water storage/ retention of wetlands* | 1. Assess the potential of natural storage of wetlands, especially in areas in drought-prone areas. | Progressive increase in priority wetland water storage assessments. | Medium | RWB, REMA | 50 M FRW |
| | 2. Include management of the storage capacity within the management plan of these identified wetlands. | Progressive sign-off of management plans for priority wetlands that include management of storage capacity. | Medium | REMA, RLMUA | n/a |
| *Target: Improve ecosystem functions of wetlands* | 1. As part of the management plan for each wetland, assess the ecosystem functions provided by the wetland and include management options to preserve these functions for the ongoing sustainability of the wetland for utilisation. | Progressive sign-off of management plans for priority wetlands that include assessment of ecosystem functions provided by those wetlands, as well as management options for preserving ecosystem functions. | Short | REMA, RLMUA | 100M FRW |

| | | | | | |
|---|---|---|---|---|---|
| *Target: Provide clear guidance on appropriate farming techniques for farming in wetlands* | 1. Provide training and capacity building through catchment committees on appropriate farming practices and techniques (extensive guidelines provide this information). | Degree of progress with training and capacity-building in relevant farming techniques detailed in each wetland committee's minutes, progress report and action schedule. | Short | REMA, RAB, RLMUA | 60M FRW |

**Goal 2:** To ensure implementation of a framework for sustainable wetland utilisation and management by 2030

**Objective 2.1:** Strengthen the enabling environment to implement sustainable wetland management

| Target / Aim | Activities | Indicators/ Outputs | Indicative phasing | Responsible Authority | Indicative costing |
|---|---|---|---|---|---|
| *Target: Develop a National Wetland Policy and strategy* | 1. Review, consolidation and integration of all wetland related policies, integrating all aspects of wetland utilisation, management and conservation into a single policy document. | Integrated Wetland Policy | Medium | REMA | 19M FRW |
| *Target: Strengthen institutional capability (structures, functions, roles and responsibilities, staffing)* | Each institution involved in wetland management must include a clear function and responsibility and towards the implementation of wetland management and sustainable use. | Institutional structures strengthened to provide wetland management functions | Short | REMA with RWB, RLMUA, MINAGRI, RAB, Districts | n/a |
| *Target: Establish an intersectoral national committee for wetland management (REMA, RWB, RLMUA, MINAGRI, RAB, Districts)* | *1. To provide more integrated approach to wetland management, establish committee to address coordination and integration of wetland management functions* | Quarterly meetings and minutes of committee meetings | Short | REMA with RWB, RLMUA, MINAGRI, RAB, Districts | 30M FRW |

**Objective 2.2:** Implement a National Wetland Resources Management Strategy

| Target / Aim | Activities | Indicators/ Outputs | Indicative phasing | Responsible Authority | Indicative costing |
|---|---|---|---|---|---|
| *Target: Establish a "permit for use"* | 1. Establish statutory regulations for permitting wetland utilisation. | Regulations promulgated. | Short | REMA with RWB, RLMUA, MINAGRI, RAB | 20M FRW |

| | | | | | |
|---|---|---|---|---|---|
| *system for wetland utilisation* | 2. Establish a permitting administration system and database. | Functioning permitting administration system. | | | |
| *Target: Develop a framework for Payment for ecosystems services (PES)* | 1. Conduct a review of PES systems and experiences established internationally. | Review recommendations accepted by national catchment committee. | Medium | REMA with RWB, RLMUA, MINAGRI, RAB | 100M FRW |
| | 2. Conduct a technical workshop for drafting the PES framework with suitable experts and stakeholders. | Workshop minutes and draft framework completed. | | | |
| | 3. Publish the final framework for PES after processing the draft framework through relevant affected government departments. | Final framework published. | | | |
| *Target: Implement compliance monitoring and enforcement of wetland utilisation* | 1. Develop training courses for wetland monitoring officers. | Training curriculum and schedules finalised. | Medium | REMA, REB/HLI | 50M FRW |
| | 2. Recruit and provide training for wetland monitors. | Fully trained wetland monitors. | | | |
| | 3. Delegate authority to and deploy wetland monitors. | Wetland monitors deployed and functioning. | | | |
| *Target: Develop a National Monitoring and Evaluation Framework* | Update the national framework with outputs of activities from this implementation plan | National M&E Framework finalised. | Short | REMA with RWB, RLMUA, MINAGRI, RAB | 100M FRW |
| *Target: Implement MIS system for data collection and monitoring.* | Ensure monitoring, data collection and input into the national MIS is happening | Fully functioning MIS in place. | Short | REMA with RWB, RLMUA, MINAGRI, RAB | 200M FRW |

**Goal 2:** To ensure implementation of a framework for sustainable wetland utilisation and management by 2030

**Objective: 2.3** Increased communication, awareness and education about wetland systems

| Target / Aim | Activities | Indicators/ Outputs | Indicative phasing | Responsible Authority | Indicative costing |
|---|---|---|---|---|---|
| *Target: Awareness about wetland functions and goods and services* | Public communication campaign to raise awareness | Raised awareness among the public. | Short | REMA | 50M FRW |
| *Target: Research* | Support research activities in wetlands and incorporate into the wetland management structure | Increased wetland research outputs. | Short | REMA, HLI | 250M FRW |

| | | | | | |
|---|---|---|---|---|---|
| *Target: Develop citizen science for monitoring and reporting on bird diversity* | Using local communities to report on bird sightings | Increased reports of bird sightings. | Short | RDB, REMA | 60M FRW |

**Goal 3:** To ensure the sustainable protection of those wetlands with high conservation potential by 2030.

**Objective 3.1:** Proclaim wetlands that are proposed for Ramsar status

| Target / Aim | Activities | Indicators/ Outputs | Indicative phasing | Responsible Authority | Indicative costing |
|---|---|---|---|---|---|
| *Target: Identify vulnerable and important wetlands for restoration and protection* | 1. Using the classification in G1,O1,T1 above, identify the vulnerable wetlands and wetlands for conservation. | Detailed list of vulnerable and wetlands for protection | Short | **REMA**, RDB | 40M FRW |
| | 2. Declare by order the protection of these wetlands within Rwanda. | Conservation status of identified wetlands established nationally within Rwanda | Short | RDB | n/a |
| | 3. Submit documents for final proclamation of wetlands proposed for Ramsar status | Ramsar status proclaimed on all conservation wetlands | medium | RDB | 20M FRW |
| *Target: Develop and implement Rehabilitation and management detailed plans* | 1. Develop and implement rehabilitation plans for each wetland. | Detailed rehabilitation and management plans for each wetland | medium | **REMA**, RWB | 100M FRW / catchment |
| | 2. Monitor compliance with rehabilitation and management plans. | bi-annual reporting on compliance with plans | Short | **REMA**, RWB | 60M FRW |

**Objective 3.2:** Develop ecotourism opportunities

| Target / Aim | Activities | Indicators/ Outputs | Indicative phasing | Responsible Authority | Indicative costing |
|---|---|---|---|---|---|
| *Target: Build local capacity and develop a brand to support avitourism (e.g. birding watching and guiding)* | 1. Develop avitourism sector training programmes for the public to build capacity in local communities. Tourism service industry includes *inter alia* drivers, chefs, driving, guiding, waitrons, conference centres, corporate gifting, beauty and spa, laundry, etc. | Formal training programme established | Short | **RDB**, REMA, Districts | 100M FRW |

| | | | | | |
|---|---|---|---|---|---|
| | 2. Develop a guiding accreditation system for birding guides throughout Rwanda | Accreditation / certification established | Short | RDB | 20M FRW |
| | 3. Implement training and accreditation programmes | Number of. accredited guides per year | Medium | RDB | 20M FRW |
| | 4. Implement a small grant fund to help promote entrepreneurs in the avitourism industry. | Number of community based ecotourism businesses established per year. | Medium | RDB | 200M FRW |
| | 5. Develop a marketing strategy for avitourism in Rwanda - bird route, cultural experiences, logo, branding, materials | Clear avitourism marketing strategy | Short | RDB | 25M FRW |
| | 6. Promote and implement the brand through international marketing and tourism industry. | Number of avitourists per year. | Medium | RDB | 100M FRW |
| *Target: Build local capacity and develop a brand to support sports (e.g. canoeing, catch-and-release angling, hiking along boardwalks, etc.)* | 1. Develop a marketing strategy for sport focussed tourism in Rwanda – logo, branding, materials | Clear sport marketing strategy | Short | RDB | 25M RWF |
| | 2. Promote and implement the brand through international marketing and tourism industry. | Number of sport focussed tourists per year. | Medium | RDB | 100M FRW |
| | 3. Develop training programmes for local communities to become involved in sports and tourism. | Formal training programme established | Short | RDB | 25M FRW |
| *Target: Build local capacity and develop a brand to support "eco-holidays" (e.g. cleaning of wetlands, removal of invasive species, collecting data for wetland research, etc.)* | 1. Develop a marketing strategy for environmentally focussed holiday packages in Rwanda –logo, branding, materials, and project research. | Clear sport marketing strategy | Short | RDB | 25M FRW |
| | 2. Promote and implement the brand through international marketing and tourism industry. | No. sport focussed tourists per year. | Medium | RDB | 100M FRW |
| | 3. Develop a database for conservation projects within Rwanda, focussed on wetland restoration, rehabilitation and research. | Formal database of proposed projects | Medium | RDB | 15 FRW |

Costing source, adapted from:

*UNEP, 2015. Building resilience of communities living in degraded wetlands, forests and savannas of Rwanda through an ecosystem-based adaptation approach.*

*EMD, 2019.Technical note on Conceptual framework for the methodology and tool for wetland ecosystem functions, assets and services assessment and management and assessment of potential indicators (including wetland biodiversity indicator assessment).*

## 6.3 Institutions for implementation

Formal institutional structures and arrangements are required for the implementation and monitoring of the National Wetland Management Framework (NWMF) to ensure it effective implementation and achievement of its vision, goals and objectives. The legislative framework for wetland management assigns different functions of wetland management to different institutions. Therefore, the implementation of this National Wetland Management Framework will be tasked to the institution responsible to coordinate all the institutions involved in wetland management, REMA.

### 6.3.1 Ministry of environment (MoE)

At the Ministerial level, MoE is tasked with the implementation of this framework. As the framework sets out several objectives, targets and actions, that require a variety of institutions to implement, the implementation of this plan is proposed to be coordinated by REMA. REMA is tasked:

1. To implement Government environmental policy;
2. To advise the Government on policies, strategies and legislation related to the management of the environment as well as the implementation of environment related international conventions, whenever deemed necessary;
3. To conduct thorough inspection of environmental management in order to prepare a report on the status of environment in Rwanda that shall be published every two (2) years;
4. To put in place measures designed to prevent climate change and cope with its impacts;
5. To conduct studies, research, investigations and other relevant activities in the field of environment and publish the findings;
6. To closely monitor and assess development programs to ensure compliance with the laws on environment during their preparation and implementation;
7. To participate in the preparation of activities strategies designed to prevent risks and other phenomena which may cause environmental degradation and propose remedial measures;
8. To provide, where it is necessary, advice and technical support to individuals or entities engaged in natural resources management and environmental conservation;
9. To prepare, publish and disseminate education materials relating to guidelines and laws relating to environmental management and protection and reduce environmental degradation risks;
10. To monitor and supervise impact assessment, environmental audit, strategic environmental assessment and any other environmental study. REMA may authorize in writing, any other person to analyse and approve these studies.
11. To establish relationships and cooperate with national and international institutions and organizations in charge of environment and any other bodies that may help REMA to fulfil its mission.

Therefore, as REMA is tasked with coordination, monitoring and supervising activities for the management of the environment, REMA is therefore, tasked with coordinating, monitoring and supervising the implementation of this plan. Other stakeholders include: RLMUA, RWB, RFA, RHA, Districts, etc.

## 6.4 Information and monitoring

Monitoring, evaluation and review processes are essential to ensure that management plans are effectively implemented. The National Monitoring and Evaluation Framework developed in another part of this study has included monitoring and evaluation of the National Wetland Management Framework.

It should be borne in mind that monitoring and evaluation can be undertaken at a variety of levels, ranging from a national level all the way down to a site-specific framework. The defined aims and objectives greatly influence the level at which M&E will need to be undertaken. National M&E generally considers broad indicators of change, such as those adopted for State of the Environment (SoE) reporting, and thus predominantly utilises GIS and desktop-based assessment methods e.g. hectares of wetlands influenced. Following on from this is the more refined M&E of wetlands/wetland complexes, which entails the rapid monitoring of prioritised wetland systems. This level of M&E is reliant on a rapid field-based assessment of the identified systems, thereby being able to verify the collated desktop information. Even though there is a fieldwork component to this level of M&E, it is still considered to be relatively coarse in nature, and may not provide site-specific information e.g. landscape level integrity / functionality assessments. Following on from this, are the site-specific M&E plans. These plans have been refined to a wetland cluster or wetland specific level. The degree of data collected is based on the available resources and the objectives of the project. Meanwhile, the following is an indicative list of the proposed monitoring indicators that can be considered during wetland monitoring (they can be assessed all or some of them may be considered depending on the available resources):

i. Indicators of wetland degradation as discussed in paragraph 3.1.9. These are: Erosion, Flood, Eutrophication, Wetland overharvesting, Infrastructure development, Agricultural activities, Mass movements / landslides and Sedimentation.

ii. Wetland area survey: this can be done either with GIS/satellite based assessment & mapping or aerial survey using drones for examples

iii. Evolution of number of birds or other aquatic species diversity (vertebrates & invertebrates)

iv. Rwanda Dragonfly Biotic Index (RDBI), a metric of biotic integrity calculated based on the following three sub-indices of species: Distribution-Based Score, Threat-Based Score, and Sensitivity-Based Score.

v. Water quality sampling and testing (testing of water or soils samples for analysis of nutrients, heavy metals pollution, soil organic matter, etc.).

vi. Environmental DNA[18] monitoring: non-destructive nor isolating technic of biodiversity assessment through analysis of environmental samples (soil, water, or air.).

vii. Interview with local community and their engagement (citizen science): Effort shall be made to maximize citizen engagement in wetland management and monitoring.

viii. Etc.

The monitoring of wetlands shall be coordinated with competent authority (REMA) in collaboration with stakeholders under different funding mechanisms: Rwanda Green Fund, research funding for student thesis, during environmental assessment conducted prior to the use of unprotected wetlands (to be covered by the user applicant), etc. The monitoring frequency of once every three years can be recommended and the monitoring results should be published in the State of the Environment report which is usually published once every two years.

## 6.5 Case studies for wetland management in other countries

**Framework for Sustainable Management of Lake Nakivale Wetland System in Isingiro District, Uganda.**

**November, 2015**

The study focused on a local and on-site framework for sustainable management of Lake Nakivale wetland system which is hinged on good land use practices, regulated human activities and good wetland resources management. The formulation of the framework was based on the results of the community based assessment of the effects of threats to the wetland conservation and the weaknesses embodied in the existing interventions to address problems emanating from the effects of poor land use practices.

The wetland was experiencing unprecedented interrelated and intertwined environmental problems emanating from the effects of poor land use practices such as deforestation, overgrazing, human settlement on the fringes of the wetland system, encroachment and wetland reclamation. It was clear that if nothing is done to address the prescribed environment problems; the capacity of Lake Nakivale Wetland to provide ecological, economic, social and cultural benefits to neighbouring local communities was likely to be compromised.

The cumulative effects and outcome of poor land use practices were identified, categorized and ranked as land degradation, siltation of Lake Nakivale, loss of some of the wetland resources such as medicinal plants, forest cover, wildlife habitats and biodiversity as well as water pollution. The results showed that forests and bush land on the edge of the wetland were converted into crop fields of mainly banana and maize.

[18] DNA: Deoxyribonucleic Acid

The wetland regulations provide for a 200 meters strip around Lake Nakivale Wetland as protected zone but it was not being respected by the residents. Makeshift homesteads with no proper waste management facilities were found on the fringes of the wetland. The poor disposal of human waste in areas very close to wetland water system was posing a danger to human health and was likely to contaminate water sources used by the residents for domestic purposes and watering animals. It was also observed that overdependence on fuel wood by the residents as a key source of energy was also encouraging deforestation in the area.

Based on the existing poor land use practices, the threats to the conservation of the wetlands and with the input of the focused resource use groups, a three layered onsite framework for sustainable management of Lake Nakivale Wetland was developed. The first layer covers sustainable land use management which would be achieved by restoring the degraded parts of the wetland, promoting the culture of land use planning and implementing soil and water conservation interventions.

The second layer focused on the improved wetland resource management which is backed up by strong law enforcement and regulation of human activities, monitoring of wetland resources as well as regular assessment of wetland vulnerability, sensitivity and adaptive capacity. This feeds into the third layer that enhances the culture of planned and well-regulated exploitation of wetland resources.

It was important for the management to mobilize stakeholders to actively participate in the restoration and conservation of the wetland and adjacent landscape. The framework provided guidance to stakeholders on how human activities within the wetland system are regulated, threats to the conservation of the wetland minimized, local people empowered to actively participate in the management of the wetland and the utilization of wetland resources monitored. It was emphasized that the use of wetland resources should be based on the predetermined sustainable wetland resource off-take levels, backed by effective monitoring system.

In order for the framework to be effective, well trained and skilled law enforcement staff were put in place, mandated to collaborate with local community leaders and resource use groups to ensure that residents comply with the set wetland and lake shores management guidelines as well as environment management laws. The designed framework became handy in guiding local people, wetland managers and local government leaders to undertake initiative interventions and actions to sustainably manage Lake Nakivale Wetland.

For the framework to be effective and efficient at the initial stage, the management took prudent and crucial consideration for the implementation of the following listed interventions.

a. Development and implementation of land use plan for the entire landscape
b. Management and control of the human settlement in Nakivale.
c. Build the capacity of local people to adopt good land use practices
d. Support natural resources department to conserve lake Nakivale wetland
e. Strengthen the capacity of existing community based associations to manage lake Nakivale wetland
f. Establishment of a community based law enforcement team
g. Development and promotion of lake Nakivale wetland as ecotourism attraction
h. Development and implementation of a monitoring and evaluation plan
i. Promotion of an on farm tree planting and alternative sources of energy
j. Formulation of wetland management ordinance and by laws

Source: Adonia Kamukasa Kakurungu Bintoora[1], Faustino Orach – Meza[2] & Eric Edroma[3].

School of Sciences, Nkumba University, P. O. Box 237, Entebbe, Uganda. *Savant Journal of Research in Environmental Studies Vol 1(2) pp. 019-029 November, 2015.* https://www.ugandawildlife.org/download/category/7-research?download=26:framework_for_conservation_of_lake_nakivale_wetland

**Trans-boundary wetland management plan for the Semliki wetland between the Democratic Republic of Congo and the Republic of Uganda.**

**June, 2020**

The contents of the document provide the Trans-boundary Wetland Management Plan for the Semliki Delta wetland in the border of DRC and Uganda. It details a consensus strategy and common framework to support stakeholders of the wetland landscape in their planning towards wise use of wetland resources and achieving long term sustainable development by advancing a concept for balancing growing demands with limited resources.

The Semliki Trans-boundary wetland landscape provides essential goods and services which supports the vast population of the basin alongside acting as an effective sink for carbon, playing a key role in buffering the effects of climate change, thereby supporting climate adaptation and resilience. The wetland supports a considerable biodiversity of flora and fauna with endemic mammals, birds, amphibians, and plants. Therefore, there is a need for Trans-boundary wetland management planning.

The wetland faces several threats and challenges which include unsustainable land use practices that enhance river bank, lakeshore and wetland degradation and soil erosion resulting in a high sediment load of rivers and siltation of Lake Albert. High population growth exacerbates environmental problems, mismanagement of the land, natural resource depletion and environmental degradation. Other threats include wetland encroachment, lack of demarcation, unclear and shifting wetland boundary, and reduction in fish stock and destruction of fish breeding areas.

The Semliki trans-boundary wetland management plan was built on three processes namely: wetland monograph, investment project plan and early investment projects. The methodology used in the development of the Semliki Trans-boundary Wetland Management Plan was derived from the Ramsar resolution VIII.14: New Guidelines for Management Planning for Ramsar Sites and Other Wetlands.

Using a participatory approach of key stakeholders within the wetland landscape, the following vision was formulated and adopted. “A sustainably conserved Semliki wetland for enhanced biodiversity and community livelihoods”. The overall objective of the Semliki Trans-boundary wetland management plan was “to restore and protect the Semliki Delta and Wetland resources and functions through participatory approaches”.

The Semliki Trans-boundary wetland management plan had the following strategic objectives.

- To promote ecological restoration of the Semliki Delta wetland for enhanced wetland integrity.
- To promote and support adoption of sustainable sources of livelihoods for the communities’ dependent on the Semliki Delta wetland landscape.
- To support the establishment and strengthening of governance structures for the management of the Semliki Delta wetland landscape.

The Trans-boundary Wetland Management Plan has identified key result areas under strategic objectives which will be implemented over a period of ten years (2020-2030). The following targets will address conservation of the wetland landscape.

a. Enhance the protection and conservation of Semliki Delta wetland water resources for improved water quality and quantity.
b. Integrate wetland wise-use into Semliki river basin development planning.
c. Promote sustainable land use practices for improved livelihoods and reduced degradation
d. Increase the Semliki Delta fisheries resource base (diversity and abundance) by 10% annually through adoption of sustainable fishing practices.
e. Rehabilitate and restore 5 ha of degraded wetland biodiversity annually

f. Promote conservation of birds and wild animals within the wetland landscape for ecotourism development and socio-economic benefits.
g. Promote adoption of sustainable agricultural practices including climate smart agriculture and paludiculture for improved livelihoods and food security.
h. Promote adoption of sustainable capture fisheries and aquaculture to improve the fisheries resource base and incomes.
i. Enhance coordination and cooperation of trans-boundary wetland institutions
j. Enhance communication, education and public participation and awareness

Source: http://nelsap.nilebasin.org/index.php/en/information-hub/technical-documents/55-semliki-delta-transboundary-wetlands-management-plan-july-2020/file

## 6.6 Concluding remarks

Wetlands form an integral part of the country's landscape and economy, and management and coordination of all users is required in order to ensure their ongoing sustainable existence and use. The management of Rwanda's wetlands is the responsibility of all users, not only that of the mandated government institutions. Though environmental policy is commonly a balancing act between protection and use, wetland policies should be specific enough so that administrators working to achieve national energy, agriculture, mining or urbanisation goals do not approve unsustainable uses that risk wetland degradation. Implementation of the recommendation actions contained in this framework will contribute towards the sustainable management and use of the country's wetlands. The review and updating of this framework in five to ten years is recommended.

# CHAPTER 7 . CONCEPTUAL GUIDELINES FOR WETLAND REHABILITATION PLANNING FOR RWANDA

## 7.1 Introduction

Freshwater ecosystem **rehabilitation / restoration** has been highlighted as important to assist in securing vital ecosystem goods and services, referred to as our natural capital. The destruction of natural freshwater ecosystems is a result of anthropogenic activities of varying degrees. It has been demonstrated that ecosystems provide a suite of benefits to human society, while offering an equally compelling social imperative for rehabilitation: maintaining intact and resilient ecosystems enhances human health and well-being.

The ecosystems/natural capital supplying these services are rapidly being depleted and thus rehabilitation / restoration activities are considered to be critical, so as to secure these services and livelihoods into the future. It has been estimated that almost two-thirds of the globe's ecosystems have been degraded due to anthropogenic impacts, mismanagement and failure to invest / reinvest in the overall functioning and integrity of these systems.

**Restoration versus Rehabilitation**

1. **Restoration** – the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed to a pre-existing condition, or as close to that condition as possible
2. **Rehabilitation** – direct or indirect actions with the aim of reinstating a level of ecosystem functionality where ecological restoration is not sought, but rather renewed and ongoing provision of ecosystem goods and services

A globally accepted response to ecosystem degradation is ecological rehabilitation. This is defined as the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed, thereby ensuring the ecosystems are sustainably managed and utilised. The rehabilitation of degraded ecosystems further promotes some degree of resilience within these systems. This provides the systems with a degree of buffering which allows them to endure periodic stresses and climate change.

Rehabilitation planning, implementation and associated management is considered to be a long-term commitment to the natural resource. The successful rehabilitation of ecosystems, and thus the overall resilience and sustainability of the system, can only be achieved through collective and thorough engagement of all of the stakeholders reliant on the natural capital, i.e. the stakeholder engagement process should be all-inclusive from the land user to the regulating officials.

The level and type of rehabilitation adopted is considered to be case/site specific, as rehabilitation planning is largely dependent on the extent and duration of historical and current disturbances, the cultural landscape in which the ecosystem is located and the opportunities available for rehabilitation. Understanding the overall functioning of the system, particularly in a landscape where the community is dependent on the natural resource, is key for the success of any rehabilitation project. This is further supported by ensuring that an adaptive management approach is incorporated into the planning and aftercare of the system, thus ensuring the ecosystem is maintained at a desirable level and offering it resilience to stressors.

**Adaptive management** is a structured, iterative process of robust decision making in the face of uncertainty, with an aim of reducing uncertainty over time via system monitoring.

In 2010 REMA prepared the following 12 practical technical tools[19] intended to strengthen the environmental management capacities of districts, sectors and towns.

1. Practical Tools for Sectoral Environmental Planning.

[19] https://www.rema.gov.rw/index.php?id=38

2. Practical Tools on Land Management - GPS, Mapping and GIS.
3. Practical Tools on Restoration and Conservation of Protected Wetlands.
4. Practical Tools on Sustainable Agriculture.
5. Practical Tools on Soil and Water Conservation Measures.
6. Practical Tools on Agroforestry.
7. Practical Tools on Irrigated Agriculture on Non-protected Wetlands.
8. Practical Tools on Soil Productivity and Crop Protection _Final Version.
9. Practical Technical Information on Low-cost Technologies - Composting Latrines & Rainwater Harvesting Infrastructure.
10. Practical Tools on Water Monitoring Methods and Instrumentation.
11. Practical Tools on Small-scale Incinerators for Biomedical waste management.
12. Practical Tools on Solid Waste Management of Imidugudu, Towns and Cities.

These tools were intended to address capacity building needs of officers by providing practical guidelines and tools. The set of guidelines produced for this project intends to align with relevant existing guidelines, therefore broadening the capacity of officers and providing new practical tools for wetland management.

### 7.1.1 Purpose

The purpose of these guidelines is to provide the user, including inter alia government officials, local communities, and the private/NGO sector; with a conceptual framework on which to base freshwater ecosystem / wetland rehabilitation planning and monitoring. It should be noted that the framework is considered to be a guide only and may be subject to change depending on the site context and nature of the rehabilitation activities.

### 7.1.2 Wetland use in Rwanda

As detailed in chapter 2 and according to the current legislation, wetlands can be categorised into two classes, namely (1) wetlands receiving total protection and (2) non-protected wetlands. The latter category can be further subdivided into wetlands 'with status of use under specific conditions' and 'without conditions'. Even though there is some degree of legislation / policies that dictate the use, management and/or potential development of these systems, it is not necessarily explicitly defined in a single legislature or policy. Details pertaining to the overarching legislative and institutional situations have been described in detail in the overarching National Wetlands Management Framework for Rwanda of 2020 (**NWMF**), and therefore, have not been repeated in this guideline document. Nonetheless, it is essential to understand the categories under which wetlands have been classified and the legal implications associated with the destruction/use of these systems.

> **Definition of a WETLAND:**
>
> For the purpose of these guidelines the Ramsar definition of a wetland has been adopted:
>
> "*Areas of marsh, fen, peatland or water, whether 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*".

Protected wetlands ideally should receive total protection from activities that may detrimentally impact on the overall functioning and integrity of the system, whilst the wetlands classified under the '*non-protected category*', are or may be subjected to some degree of modification and should be subjected to a rigorous Environmental and Social Impact Assessment (ESIA) study. The wetlands identified under the '*without conditions'* category have been identified as systems that have been entirely transformed. These systems fall under the size threshold of wetlands included under the 'specific conditions' category. The use of the wetlands within the 'specific conditions' category, requires explicit consideration in terms of the overall 'ecosystem approach'. Special

> **Resilience** is the ability of an ecosystem to regain structural and functional attributes that have suffered harm from stress or disturbance

consideration in terms of the use, management and/or destruction of these systems is essential, particularly in a country where development and the associated upliftment is encouraged.

The abundance of wetlands, and the ecosystem goods and services provided by these systems should be maintained in order to provide the country with some degree of **resilience** in an ever changing environment, particularly associated with climate change. In order to achieve this, the wetlands identified for rehabilitation should follow a defined procedure to not only ensure an all-encompassing process has been adopted, but to ensure that process followed is documented. This is essential as the rehabilitation of a system is a long-term commitment and thus, the 'thinking' that has gone into the rehabilitation should be available for the future ambassadors of the ecosystem. However, prior to undertaking any form of rehabilitation planning it is essential to understand the predominant types of wetlands and the general problems associated with these systems.

### 7.1.3 Wetland types in Rwanda

Wetlands can be classified into a variety of hydrogeomorphic (HGM) unit types. As described in chapter 2, three types of HGM units have been identified in Rwanda including floodplain wetlands, valley-bottom wetlands and seepage wetlands. Seepage wetlands however, are grouped together with valley-bottom wetlands. Understanding the types of HGM units is crucial for wetland rehabilitation planning and ecosystem based adaptation, as understanding the drivers, especially hydrology, of the system and the impacts on these are key when trying to reinstate natural processes. Table 7.1 provides an overview of the HGM unit types identified and the potential ecosystem services these types of systems may supply, whilst Figure 7.2 graphically illustrates the various types of HGM units and their typical landscape setting. It should be noted that the table does not provide an overview of the cultural and provisioning services that may be supplied.

A wetland that is relatively intact may be capable of supplying some degree of cultural and provisioning services, such as the harvesting of plant material. Securing the hydrology, geomorphology and vegetation components within the socio-ecological environment will allow for the sustainable utilisation of the wetland. Figure 7.1 provides a graphic overview of how the physiological driving forces of a wetland (hydrology, geomorphology and vegetation) are interlinked with a sustainably managed socio-ecological environment (three pillars of sustainability). It should be noted that rehabilitation activities within a system that has strong socio-ecological connections, does not necessarily mean reinstating near-natural conditions, but rather encouraging the wise use of the wetland so that the underlying drivers are still functioning.

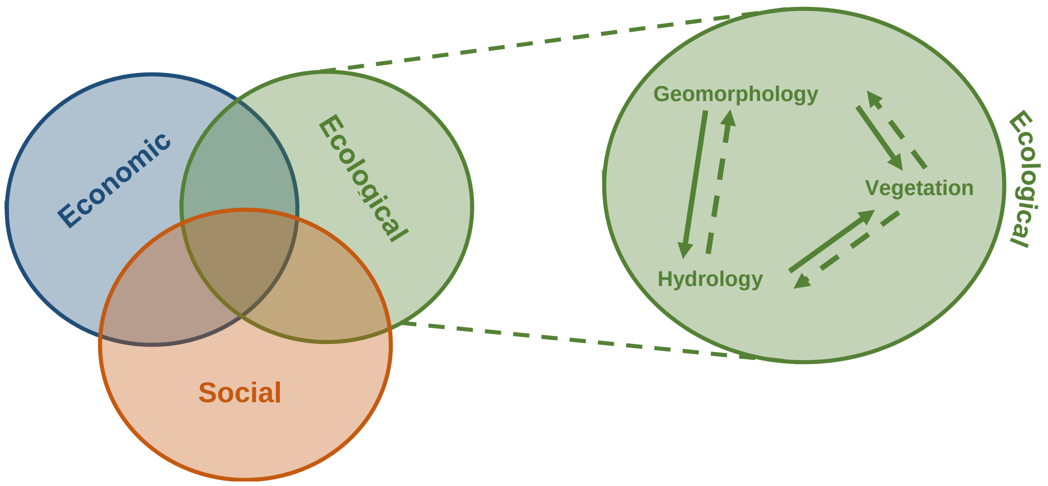



**FIGURE 7.1 GRAPHICAL PRESENTATION OF THE HOW THE PHYSIOLOGICAL DRIVING FORCES OF A WETLAND ARE INTERWOVEN WITH A SUSTAINABLY MANAGED SOCIO-ECOLOGICAL ENVIRONMENT**

The chapter 2 makes further reference to the additional information about the wetland classification of Rwanda, particularly relating to the wetland soil type, vegetation community type and regional type. These classifications need to all be considered when describing the characteristics of the particular system identified for rehabilitation, not only in terms of the benchmark of the system, but also as certain types of rehabilitation activities may not be suited to certain characteristics of the system due to the overall origin/formation of the process.

**TABLE 7.1 DESCRIPTION OF THE HGM TYPE, THE GENERAL RATING OF THE HYDROLOGICAL BENEFITS LIKELY TO BE PROVIDED BY A WETLAND BASED ON ITS HYDROGEOMORPHIC TYPE**

| Wetland HGM Type | Description of the HGM unite type | Regulatory Benefits Potentially Provided | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Flood attenuation | | Stream flow regulation | Enhancement of water quality | | | | |
| | | Early wet season | Late wet season | | Erosion control | Sediment trapping | Phos-phates | Nitrates | Toxicants |
| **Floodplain**  | Valley bottom areas with a well-defined stream channel, gently sloped and characterised by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes. | ++ | + | 0 | ++ | ++ | ++ | + | + |
| **Channelled valley-bottom**  | Valley-bottom areas with a well-defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterised by the nett accumulation of alluvial deposits or may have steeper slopes and be characterised by the nett loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes | + | 0 | 0 | ++ | + | + | + | + |
| **Unchannelled valley-bottom**  | Valley-bottom areas with no clearly defined stream channel, usually gently sloped and characterized by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes. | + | + | + | ++ | ++ | + | + | ++ |

*0 – benefit unlikely to be provided to a significant extent,*

*+ - benefit likely to be present to some degree,*

*++ - benefit very likely to be present*

*Source: adapted from Ollis et al. 2013; Kotze et al. 2007, p.17 and p.22.*

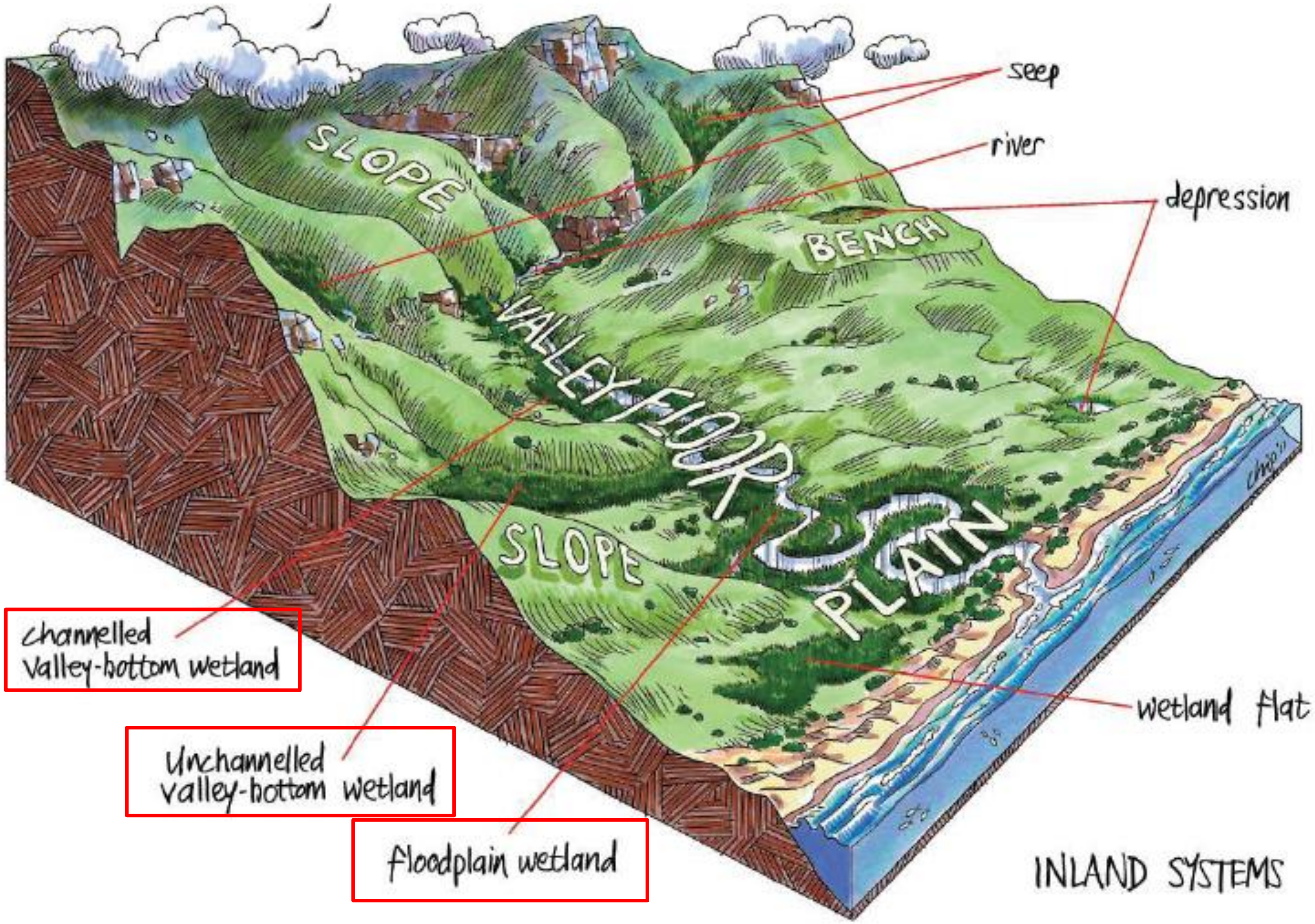



**FIGURE 7.2 ILLUSTRATION OF THE SEVEN PRIMARY HGM UNITS AND THEIR TYPICAL LANDSCAPE SETTING, WITH THE TYPICAL RWANDAN WETLANDS INDICATED IN RED BLOCKS**

Source: Ollis et al. 2013, p. 17

### 7.1.4 Catchment and in-system wetland impacts

Understanding the overall functioning / operations of a HGM unit type, and the manner in which water enters, passes through and leaves a wetland system are important considerations when reviewing/assessing a wetland for rehabilitation purposes. Understanding the general functioning of a wetland allows for judgement to be passed in terms of the impacts on the system and the degree to which the system has been altered with regards to the overall functioning and integrity of the system. The **historic condition / reference state** should ideally be the starting point from which rehabilitation initiatives are inferred. While the reference state is key to understanding the system, it should be noted that the implementation of a rehabilitation plan may not result in the system recovering to its reference state, as existing constraints and conditions may greatly influence the path of trajectory of the system e.g. the rehabilitation activities may encourage a wise-use approach to the utilisation of the wetland system.

> **Reference state / ecosystem**
>
> A community of organisms and abiotic components able to act as a model or benchmark for restoration. A reference ecosystem usually represents a non-degraded version of the ecosystem complete with its flora, fauna, abiotic elements, functions, processes and successional states that would have existed on the restoration site had degradation, damage or destruction not occurred – but should be adjusted to accommodate changed or predicted environmental conditions. (SER 2016)

Understanding the conditions and proximity of the impacts that have led to the degradation of the wetland habitat is crucial. Thus, not only do the in-system impacts need to be identified but impacts originating from the catchment or watershed, too. The formation/origin of wetlands are as a result of catchment characteristics, therefore changes in the catchment characteristics could greatly influence the condition of the wetland.

> **Wise use approach**
>
> Adopting a *wise use* approach refers to an approach which aims to achieve the long-term success of a rehabilitation project. Success of the project is reliant on research and monitoring of the system in order to allow for a responsive adaptive management process to be adopted.

Catchment impacts are often associated with urbanisation, which includes (amongst others) increased hardened surfaces which influence the flood peak characteristics within the catchment; damming of rivers for water provisioning, changes in vegetation characteristics from well-vegetated landscapes to agricultural landscapes, which may lay barren for extended periods thus increasing the sediment loads into wetlands. It should be noted that sometimes wetland degradation is a symptom of catchment activities and rehabilitation activities in the wetlands themselves may not improve the situation. In many instances, the catchment impacts are irreversible but need to be acknowledged and, where possible, sustainable land management practices adopted.

The most common in-system impacts, as identified in chapter 2 and 3, include among others the following:

- Agricultural activities
  - Informal subsistence agriculture
  - Consolidated small plots farmed cooperatively with synchronised annual crops
  - Large monoculture projects (both cooperative and estate managed)
- Mining
  - Brick making and associated quarries
  - Mining for peat
- Pollution (in-system and catchment related)
  - Point source
  - Nonpoint source.
- Urbanization: wetland compaction
- etc.

Chapter 5 provides a detailed approach within which to assess the extent of the impact, particularly associated with agricultural activities, and the degree of modification to the system and the associated functioning, e.g. hydrology, these activities may have on the system. When considering the impacts on a wetland, these descriptions should be read and taken into consideration.

### 7.1.5 SWOT analysis for wetland rehabilitation

SWOT analysis is a strategic planning tool standing for Strengths, Weaknesses, Opportunities, and Threats. Strengths and weaknesses represents respectively internal positive and negative factors that may affect a business or activity while opportunities and threats represents respectively external positive and negative factors that may favour or jeopardize the success of a plan, activity or business. It is a tool designed to be used in the preliminary stages of decision-making and as a precursor to strategic management planning. During the preparation of the wetland rehabilitation guidelines, it was considered that local community participation and stakeholders' involvement are key elements for the successful implementation the guideline and therefore as detailed in chapter 3, the SWOT analysis was based on local community perception on wetland rehabilitation, information from district officials, field observation and literature review.

**Strengths**

- Political and legal framework that favours wetlands conservation and sustainable use: Rwandan planning tools favours sustainable development, including wise use of natural resources as well as consideration of climate change mitigation and adaptation. These include but are not limited to: the vision 2020, currently turning into vision 2050; Green Growth and climate resilience National Strategy for Climate Change and Low Carbon Development, Land Policy, Environment and Climate Change Policy, Biodiversity Policy, Biodiversity Policy and Strategy, land use master plan, Environmental low, land law, water resources law, forestry law, Biodiversity law, etc. Furthermore, a number of orders and regulations have been adopted for the implementation of laws including ministerial orders on Environmental Impact Assessment, its requirements, procedures, and list of projects and activities that are subject to it; prime Minister's order drawing a list of all swamp lands, their characteristics, boundaries and determining modalities of their use, development and management, ministerial order on shores of lakes, wetlands and rivers transferred to public property, etc.
- Presence of different institutions with the mandate on wetlands usage and protection including Ministry of Environment (MoE), Rwanda Environment Management Authority (REMA), Rwanda Agriculture Board (RAB), Rwanda Water Resources Board (RWB), Rwanda Land Management and Use Authority (RALMUA), Rwanda Forestry Authority (RFA), Rwanda Green Fund (FONERWA), Districts, etc. Furthermore, in different institutions not directly mandated for wetlands conservations, environmental specialists and officers are supporting the implementations of environmental laws and policies including wetland management.

**Weakness**

- Lack of awareness and recognition of the multi-functionality of wetlands at different levels. In many cases communities around wetlands do not have enough information or knowledge on wetlands ecosystem services which may hamper their sustainable management and wise use. For example, out of 200 interviewees in the Nile Akagera Upper catchment more than 100 did not know about the role of wetland in regulation of air quality, noise buffering, water purification, regulation of disease and pests, and soil formation. Furthermore, most of the respondent did not know about drivers of emergent invasive species, loss of indigenous species, and alteration of biogeochemical cycle.
- 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.

- Increased pressure of agriculture activities on wetlands: Agriculture is the main economic activity for the people of Rwanda, providing employment to about 62.8% (NISR, 2018) of the total population. These agriculture activities and associated environmental aspects have direct and indirect impact on depletion and degradation of forest, land, and wetland.
- Lack of wetland policy and strategy: A specific policy, strategy and law regulating wetland management, conservation and wise use is still a gap for sustainable management of Rwandan wetlands.
- Insufficient stakeholder and local community participation in the decision process of wetland rehabilitation/restoration and management
- Lack of an integrated approach for wetland development and management
- Lack of a clear definition of prohibited, permitted and conditional uses of wetland buffer zones
- Lack of coordination at catchment level

**Opportunities**

- International commitment in wetland conservation: e.g. RAMSAR Convention, Paris Agreement to fight climate change, etc. Funding opportunities may include: World Wildlife Fund (WWF), Green Climate Fund (GCF) which if funding for example the Green Gicumbi Project, etc.
- International Funding Partners: UNDP, WB, AfDB, GEF, Etc.

**Threats**

The following are key factors that may negatively affect wetland rehabilitation:

- Lack of necessary measures that should be taken by neighbouring countries for transboundary wetlands. In fact, Rwanda has many transboundary wetlands that should be managed collectively by all concerned countries. This is for example, the case of Akanyaru Wetland, Akagera wetlands, Muvumba wetland, and Rusizi wetlands.
- Climate Change and associated impacts: floods, droughts, erosion and siltation of water bodies, etc.

## 7.2 GUIDING PRINCIPLES AND KEY CONCEPTS

The Society for Ecological Restoration (SER) has developed a suite of documents associated with the restoration of all ecosystems types, i.e. drylands, forests, wetlands, etc. These documents are considered to be international best-practice and should ideally be adopted as far as possible at regional levels.

Even though this principal document exists and is considered to be best-practice in terms of ecological restoration, it is also understood that in many instances restoration may be idealistic and thus rehabilitation is often considered to be a more realistic approach. Nonetheless, the general guiding principles and key concepts have briefly been summarised in the following sections, so as to guide the thinking of the wetland rehabilitation teams towards international best-practice.

### 7.2.1 Guiding principles

In order to achieve some level of success in terms wetland rehabilitation, it is recommended that the overall process should be effective, efficient and engaging. These are defined as follows (adapted from SER 2016, p.9):

- Effective wetland rehabilitation establishes and maintains an ecosystem's values.
- Efficient wetland rehabilitation maximises beneficial outcomes while minimising costs in time, resources and effort.
- Engaging wetland rehabilitation collaborates with partners and stakeholders, promotes participation and enhances experience of ecosystems (ecosystem based adaptation).

### 7.2.2 Key concepts

While wetland rehabilitation planning should ensure that the afore-mentioned guiding principles are adopted throughout the planning, implementation and management processes, consideration should be given to the six key concepts as outlined by the SER. The key concepts have been summarised as follows:

1. Reference conditions should be based on regional / local conditions and should take natural ecological variances into consideration.
   a. Describing the foreseen reference conditions (historic conditions prior to the era of industrialisation and encroachment), allows for a shared vision to be developed and from which realistic aims and objectives can be established. This further assists in the adaptive management of the overall system.
   b. It should be noted that a reference condition does not necessarily eliminate human relations to these systems as cultural values / dependence to certain systems may have been fundamental in the overall functioning and integrity of the system.
2. Identifying the key **attributes** of the system is required at the outset of any rehabilitation planning project. The identification of these attributes is considered essential prior to any objectives being set.
   a. The attributes include: (1) absence of threats; (2) physical conditions; (3) species composition; (4) structural diversity; (5) ecosystem functionality; and (6) external exchanges.
   b. Once the key attributes have been defined, specific and measurable indicators may be set to monitor and evaluate the success of the rehabilitation activities thus allowing for an adaptive management approach to be adopted.

**Attribute examples**

(1) Cessation of threats such as overutilization and contamination; elimination or control of invasive species
(2) Reinstatement of hydrological and substrate conditions
(3) Presence of desirable plant and animal species and absence of undesirable species
(4) Reinstatement of layers, faunal food webs, and spatial habitat diversity
(5) Appropriate levels of growth and productivity, reinstatement of nutrient cycling, decomposition, habitat elements, plant-animal interactions, normal stressors, on-going reproduction and regeneration of the ecosystem's species
(6) Reinstatement of linkages and connectivity for migration and gene flow; and for flows including hydrology, fire, or other landscape-scale processes

3. The most ideal form of intervention is to encourage and/or establish natural recovery processes within the system.

   a. Through encouraging conditions to establish in which natural processes can commence provides the systems with some degree of resilience to future stressors, especially climate change, which is particularly important in an ever-changing environment.
   b. This also allows some degree of flexibility within the rehabilitation process, as natural environments are unpredictable and thus the precise outcomes cannot always be accurately predicted.
4. The principal goal to rehabilitation, ideally should be to secure a full recovery of the system in comparison to the local reference state.
   a. The recovery of a system to external stressors may be a long process, and thus recognition should be given to this. Understanding that the set results / objectives may only be achieved over an extended period should encourage managers of these systems to adopt an adaptive management approach. This is particularly true if a catchment-based approach has been considered and adopted.
5. Success of a rehabilitation plan is primarily based on an all-inclusive consultative process, in which knowledge from all the stakeholders is obtained. The incorporation of knowledge at a grass-roots level may provide insight into the overall functioning of the wetland system.
   a. The inclusion of stakeholders at a grass-roots level at the outset allows for an appropriate wetland rehabilitation plan to be formulated which is most likely to improve the overall outcomes and social benefits of the rehabilitation plan.
6. All-inclusive engagement with the various stakeholders should be undertaken from the outset of the project and be genuine.
   a. Rehabilitation of wetland systems, particularly in areas where communities are largely dependent on the natural resource, should ensure that all stakeholders are included in the planning process. The inclusion of all stakeholders would contribute to the overall success of the project as ownership of these systems may be encouraged.
   b. The engagement process can be a powerful tool to instil positive attitudes towards the wetland systems and the associated surrounding landscape. This approach allows for a symbiotic relationship to develop in which both the stakeholders and environment reap the success of the rehabilitation activities.
   c. It further allows for a citizen-science approach to be adopted post-implementation. This allows for an inexpensive and effective manner to collect and monitor these wetland systems. The collection of data thus ensures that informed decisions in terms of an adaptive management approach can be adopted.

The majority of the afore-mentioned key concepts are relatively broad and may need to be refined at a pre-project level. Nonetheless, the most important concept that must be adopted for every project, is the stakeholder engagement process. The success of any rehabilitation project is strongly linked to the buy-in, support and input from the broader community, but especially those persons reliant on the wetland ecosystem. These concepts have been incorporated into the overall wetland rehabilitation planning approach, as described in the following sections.

## 7.3 CONCEPTUAL WETLAND REHABILITATION PLANNING FRAMEWORK

Wetland rehabilitation planning is a complex undertaking and aims to address all facets of sustainability, as wetlands are considered to be socio-ecological ecosystems. As described in chapter 3, wetlands in Rwanda provide a suite of ecosystem goods and services. In the majority of the identified wetlands, the adjacent communities are largely dependent on these systems for their livelihoods. Based on this, the sustainable utilisation of these systems should be promoted to ensure the systems resilience in an ever-changing environment, especially climate change.

This conceptual framework is aimed at all types of rehabilitation projects, including (1) the rehabilitation of wetlands within protected areas, and (2) the rehabilitation of wetlands in heavily modified landscapes in both urban and rural communities. Due to the wide variety / possibilities for wetland rehabilitation projects, the framework is only considered to be a guide to wetland rehabilitation planning and thus should be adapted / amended to suit the specific site / landscape requirements. This however, does not exempt the rehabilitation planning team from adhering to the country's legislative requirements. Chapter 2 provides an overview of the national legislative, policies and institutional requirements.

### 7.3.1 Wetland rehabilitation planning at various scales

Wetland rehabilitation planning is one component of overall catchment management, which should consider the full range of ecosystem types and characteristics. Within the catchment approach, management of each of the ecosystem types is embedded. Wetland rehabilitation activities are considered to be an integral component of the management function. Figure 7.3 provides an overview of wetland rehabilitation planning within the broader landscape context.

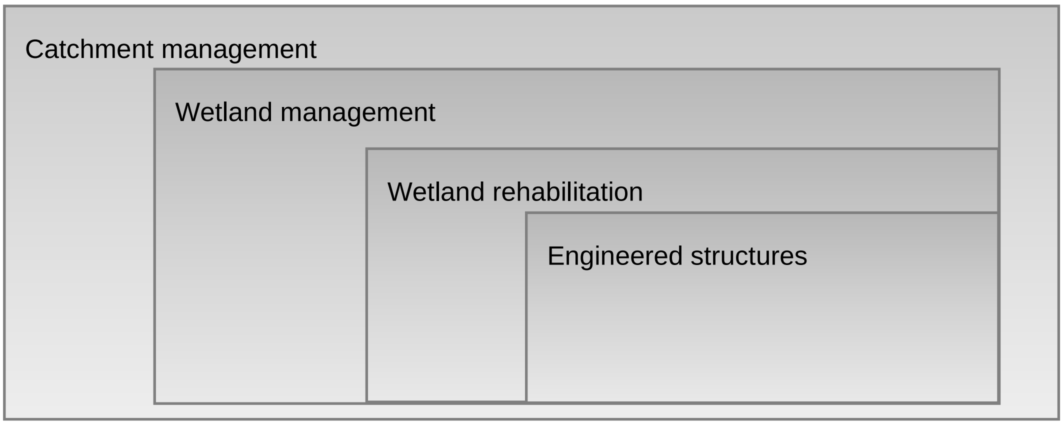



**FIGURE 7.3 OVERVIEW OF WETLAND REHABILITATION PLANNING WITHIN THE BROADER LANDSCAPE**

(adapted from Kotze et al. 2009)

Within wetland rehabilitation, varying levels of wetland rehabilitation planning may be undertaken, from broad-scale landscape rehabilitation planning to system specific rehabilitation planning. Each of these levels is based on the same conceptual approach however, at varying levels of detail and/or intervention. It should be noted that even though a broad-scale planning process may be undertaken, the intensity of the stakeholder engagement process should not necessarily be reduced and / or excluded. If a desktop planning process is being undertaken to flag or prioritise potential areas for rehabilitation, the stakeholder engagement process would still be applicable for the next stage. Based on this, the following principles are considered to be an integral component of wetland rehabilitation planning at the various scales. It should be noted that the legislative requirements in which the planning is undertaken are applicable, particularly if the rehabilitation planning is a requirement associated with an ESIA. A good understanding of these principles is necessary, even though the circumstances surrounding each wetland system may vary.

1. **Identify wetland ecosystem of concern and categorise the impacts on the system**. As highlighted in the Society for Ecological Restoration (SER) Key Concepts (Concept 2), all attributes associated with the system should be clearly defined. Document the attributes of the system including the ecological (biotic and abiotic) and the social. It is imperative that the current scenario / landscape in which the wetland is located is clearly depicted and understood.
2. **Identify the relevant stakeholders and commence with the engagement process** (SER Key Concepts 5 and 6). The stakeholders may include *inter alia* the regulatory authorities, community members, landowners, users, etc. The stakeholder engagement process is often considered to be an expensive undertaking and thus is often excluded from the wetland rehabilitation planning process.

However, the exclusion of all of the relevant stakeholders from the outset may lead to the failure of the rehabilitation activities. An all-inclusive consensus-based planning process will assist in the future management of the system and overall success of this long-term undertaking.

3. **Protection of intact systems should be considered a priority**, as the cost of protecting these systems may be less expensive than undertaking rehabilitation planning for degraded systems.

4. **Management of the rehabilitated wetland** is considered crucial in securing the overall longevity of the ecosystem. The success of the rehabilitation project is predominantly dictated by the level and degree of management of the system following the implementation of the rehabilitation plan. In many instances, particularly the systems located within community areas, the management of the wetland is dictated by the success of the stakeholder engagement process, *i.e*. the greater the level of ownership/stewardship, the greater the chance the system will be appropriately managed and maintained. Behaviour and practices are largely influenced based on the consultative process, which influences the overall resilience of the system. It should be noted that roles and responsibilities of the system following the rehabilitation activities should be established at the outset.

5. **Commitment to the overall management and maintenance of the rehabilitated system** needs to be proven by the stakeholders/persons responsible for the system. Depending on the landscape setting, an incentives-based approach may encourage the “affected” community to manage the system efficiently and appropriately (Key Concepts 5 and 6). Only once the commitment has been established should the rehabilitation activities commence. And only then can the sustainability and resilience of the system into the future be secured.

6. **The rehabilitation planning should always be undertaken in alignment with the applicable legislative frameworks, by-laws and rules.** These laws and rules should be discussed with the various stakeholders to ensure the wetland is utilised and managed sustainably.

7. **The overall functioning of the wetland at a local and catchment scale needs to be established**. Understanding the natural fluctuations of the system and the key driving forces is essential. The functioning and integrity of the wetland is largely influenced by aspects beyond the control of the rehabilitation planning team, such as climatic conditions, but may greatly influence the nature of the rehabilitation measures recommended (refer to Section 1.1.2). In addition, the historical conditions of the system should also be understood as this also influences the type of interventions proposed (Key Concept 1). These findings should all be clearly documented and would further influence the type of planning that will be undertaken, *i.e.* whether the planning is attempting to achieve restoration or rehabilitation.

8. The National Wetland Management Framework makes reference to a variety of national initiatives that have been undertaken in terms of wetland mapping and planning. **Any rehabilitation planning should take these existing initiatives into consideration.**

9. **Clear and attainable aims and objectives should be defined at the outset.** Realistic aims and objectives are based on an in-depth understanding of the overall functioning of the system, which includes catchment and in-system characteristics. The natural fluctuations of the system must be incorporated into the planning process, as only then can a self-maintaining and sustainable rehabilitated system be obtained. Even though a system’s response to particular rehabilitation measures may take an extended period of time, an indication of when the set aims and objectives may be achieved should be documented. It should be noted, that a wetland system’s response to the rehabilitation activities may not necessarily be as anticipated, and thus an adaptive management process should be included in the planning process.

10. **A clear conceptual model of the proposed rehabilitation should be developed.** The rehabilitation plan should include a suite of information, including:

    a) Site identification (selection of the targeted site for rehabilitation action(s)

    b) Stakeholder analysis and engagement (identification and engagement)

c) The set aims and objectives;

d) The proposed rehabilitation strategy (ideally a graphical representation should also be included);

e) The key ecological elements to be addressed *e.g.* raising the water table of the wetland;

f) The current and post-rehabilitation scenarios including the anticipated changes in functioning and integrity of the system;

g) The associated costs of the proposed implementation of the rehabilitation strategy;

h) The phasing of the rehabilitation activities, *i.e*. implementation order;

i) Management and maintenance requirements; and

j) The monitoring and evaluation requirements.

11. **Detailed wetland rehabilitation planning should be undertaken by a multidisciplinary team** (*e.g.* wetland ecologist, environmental engineer and social specialist) with due consideration of stakeholder consultation and engagement. A multidisciplinary team would ensure that all of the objectives are appropriately addressed and that all components of the system are carefully considered.

12. **A well-defined management, maintenance and monitoring plan needs to be developed and suitably adopted**. The plan should allow for an adaptive management approach to be adopted, whereby criteria/indicators are identified for monitoring or measures and / or activities can be implemented in response to these data / information. The plan should further assist in gaining necessary insights concerning the ecological variability of the system and thus the overall resilience of the system to changes, *e.g.* climate change.

13. **An adaptive management approach can only be undertaken if suitable data is regularly collected, *i.e.* monitoring of the system**. Depending on the location of the system, the monitoring and potentially the evaluation, should be executed by the stakeholders most closely linked to the wetland. This would generally further improve the success of the project and secure the rehabilitation activities in the long term.

### 7.3.2 Steps to be taken during wetland rehabilitation planning

The steps provided in this section of the proposed framework, are based on the afore-mentioned rehabilitation planning principles. Figure 7.4 provides a simplistic overview of the steps to be taken during the rehabilitation planning process. It should be noted that each of these steps comprises of a suite of activities/interactions which have not been included in the diagram. In addition, the management of the system in conjunction with the monitoring and evaluation is a continuous process and is considered to a long-term commitment to the rehabilitated wetland.

For the purpose of these guidelines a hypothetical example has been provided in which key components / aspects of the wetland rehabilitation process have been highlighted. These hypothetical examples are provided in the various boxes throughout the remainder of the guidelines. It should be noted that circumstances/images pertaining to specific wetlands have been included for illustrative purposes.

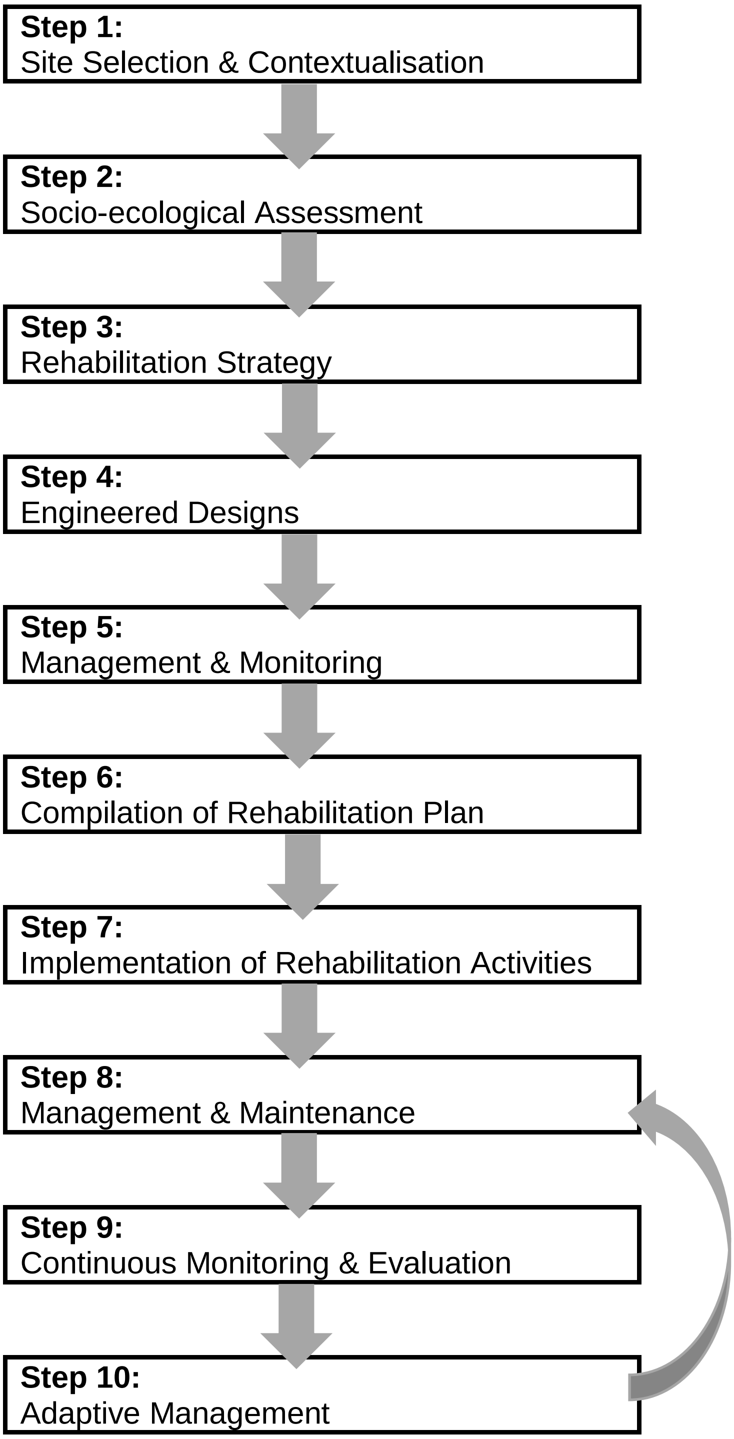
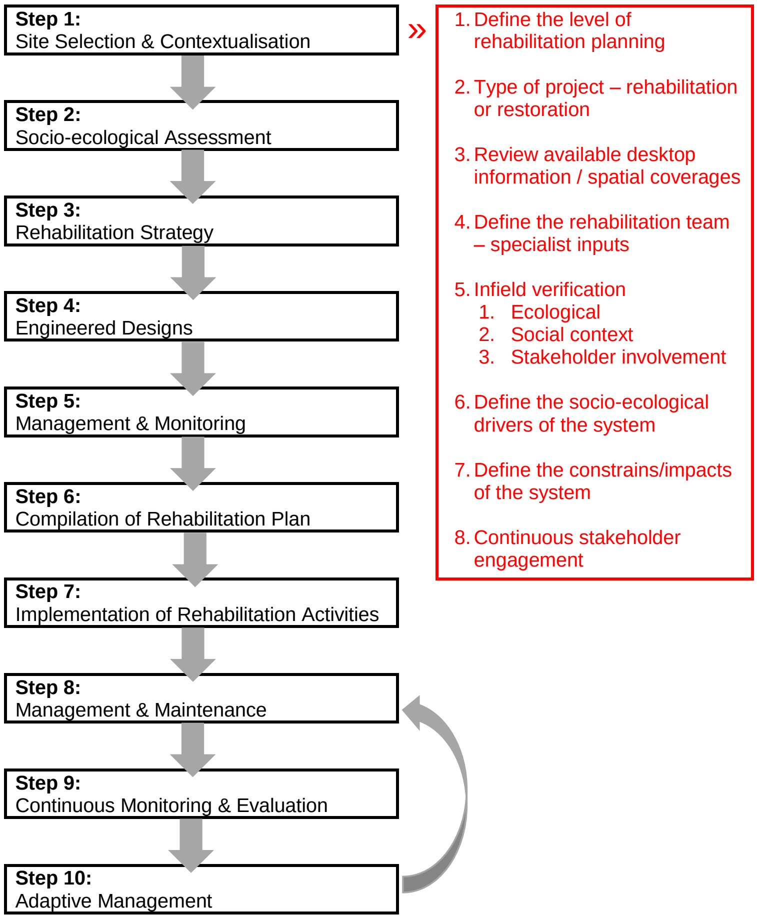



**FIGURE 7.4 SIMPLISTIC OVERVIEW OF THE WETLAND REHABILITATION PROCESS. NOTE: THE INTRICACIES INVOLVED IN EACH STEP HAVE BEEN EXCLUDED FROM THIS DIAGRAM**

#### 7.3.2.1 Site selection and contextualisation

The selection of a site/s for wetland rehabilitation purposes is largely dependent on the type of rehabilitation planning being undertaken, *i.e.* broad landscape level planning versus system-specific planning. Regardless of the level of planning, the context within which the system/s are located needs to be clearly ascertained, which includes identifying any particular catchment management related objectives and / or priorities. The selection of an appropriate site is further influenced by the type of project to be undertaken, *i.e.* restoration versus rehabilitation. These overarching details need to be clearly articulated and documented at the outset. Detailing such information may greatly influence the overall success of the project, particularly relating to being able to evaluate the rehabilitation activities against the defined aims of the project.




The context in which the system is located needs to be ascertained. This can be undertaken in a phased approach in which the available desktop data is initially interrogated followed by infield verification of the findings. Infield verification is considered essential as not all aspects of the site can be obtained through the interrogation of desktop data, especially the social component of the system.

The contextualisation of the site within the broader and local landscape is considered to be one of the most crucial steps in wetland rehabilitation planning. This step encourages the planning team to determine the impacts influencing the system both at an ecological and social level. This assessment of the system for the current scenario allows for a clear understanding of the impacts and challenges associated with the system to be developed. It should be noted that influences on the system are not only limited to activities currently taking place within the system or catchment but also historical activities. Any major historical events, be they natural or artificial *e.g.* politically driven, also need to be documented as the integrity of the system may have been greatly influenced by such events. The natural fluctuations associated with the wetland system should also be documented, and thus potentially assist in being able to predict the trajectory of change associated with the rehabilitation activities more readily. This further provides an overview as to whether engineered rehabilitation may be required or whether preventative measures should be considered (based on the Drivers Pressures State Impacts Response (DPSIR) framework), e.g. reducing livestock grazing pressures. All of these components need to be documented, but more so that the possible link between these is understood. These linkages may greatly influence the success of the rehabilitation planning process.

Again, the intensity of the site contextualisation process is largely dependent on the level of study being undertaken. This further dictates the types of tools / available data that is used during the planning process. In addition, the location of the site influences the required resources for the site contextualisation process, *i.e.* wetlands located within private landholdings are anticipated to be less complex in terms of the social context in comparison to a wetland located within a community that is heavily reliant on the wetland for their livelihood.

The site contextualisation process may become onerous, but can prove beneficial during the planning and subsequent management and monitoring of the system within the post-rehabilitation landscape. It provides a detailed overview of the site in terms of social, ecological and economic components, thus highlighting any potential causes for concern and/or risk associated with the rehabilitation planning. Identifying drivers/indicators of change in terms of the three spheres of sustainability, can highlight the viability of the proposed rehabilitation initiatives. This is essential to ascertain at the outset. Should it be recognised at the outset that the proposed site for rehabilitation is unsuitable, the site selection and contextualisation process has to be repeated until a suitable site have been selected.

Should however, the site selection and contextualisation process identify a suitable system for rehabilitation but there are a variety of constraints associated with the site, then these constraints/impacts need to be clearly discussed back to the various stakeholders. This first step would be considered as establishing some degree of trust amongst the stakeholders and provide a platform from which learning for all stakeholders engaged, can take place. Open channels of communication, learning and collaboration from the outset can ensure that a common set of aims and objectives can be established. This common vision may be one of the crucial components in making the overall wetland rehabilitation process and subsequent management a success.

**Box 1: Site selection / Site contextualisation**

**General description of the wetland:**

A valley-bottom wetland has been identified for rehabilitation purposes, as the ecosystem functions the system may provide at a local and broader scale are considered to be valuable in the ever-changing environment. The wetland is located within a rural community, who are largely reliant on the wetland for their livelihoods, and as a result a large portion of the wetland has been converted to subsistence agricultural practices.

**Desktop analysis:**

Review of all of the available spatial information which may include:

- Climate data,
- National priority planning coverages;
- Areas of conservation priority e.g. catchment considered important in terms of crane breeding habitat;
- Catchment characteristics (derived from aerial imagery);
    - Land use changes e.g. agricultural activities, damming of rivers etc.;
    - Extent and intensity of the land use changes e.g. size of the activities in relation to the wetland's catchment area;
- Topography of the overall landscape.
- In-system characteristics:
    - Land use changes e.g. agricultural activities etc.;
    - Identification of potential threats / impacts e.g. erosional features;
    - Extent and intensity of the land use changes e.g. size of the activities in relation to the overall wetland area;
    - Types of land use practices e.g. raised beds agriculture
    - Extent of remaining intact wetland habitat.

**Infield analysis:**

A review of the desktop findings in field is considered to be essential in terms of the rehabilitation planning process. This is particularly true in terms of the social-ecological aspect of the study, as the challenges and social reliance on the system (if applicable), cannot be ascertained through the desktop verification process. The infield verification would include:

- Ecological review of the wetland and its associated catchment
    - Confirm the extent to which the ecological driving forces of the system have changed, e.g. has the overall hydrology changed and is it predominantly associated with catchment related activities or in-system activities, e.g. damming of a river within the catchment versus agriculture within the system. It is essential to understand the reason for the change in the ecological driving forces. If the change is mostly associated with in-system activities these may be more readily addressed through incorporating a wise-use approach to the rehabilitation activities. Should the impacts be beyond the control of the rehabilitation team, e.g. damming of river, then these constraints and overall changes to the functioning of the system have to be clearly understood and documented.
- Social review of the site

- This component of the study is particularly important but is also reliant on a person with experience in the field of social / stakeholder engagement. Approaching this component incorrectly at the outset may have detrimental effects on the overall success of the proposed rehabilitation project.
- The socio-ecological driving forces of the community reliant on the wetland has to be carefully unpacked. This may provide context as to why certain activities have been undertaken within the system, and whether there is the option of introducing a wise-use approach to the utilisation of the wetland.

View of the some of the community members harvesting reeds from the wetland for household use.

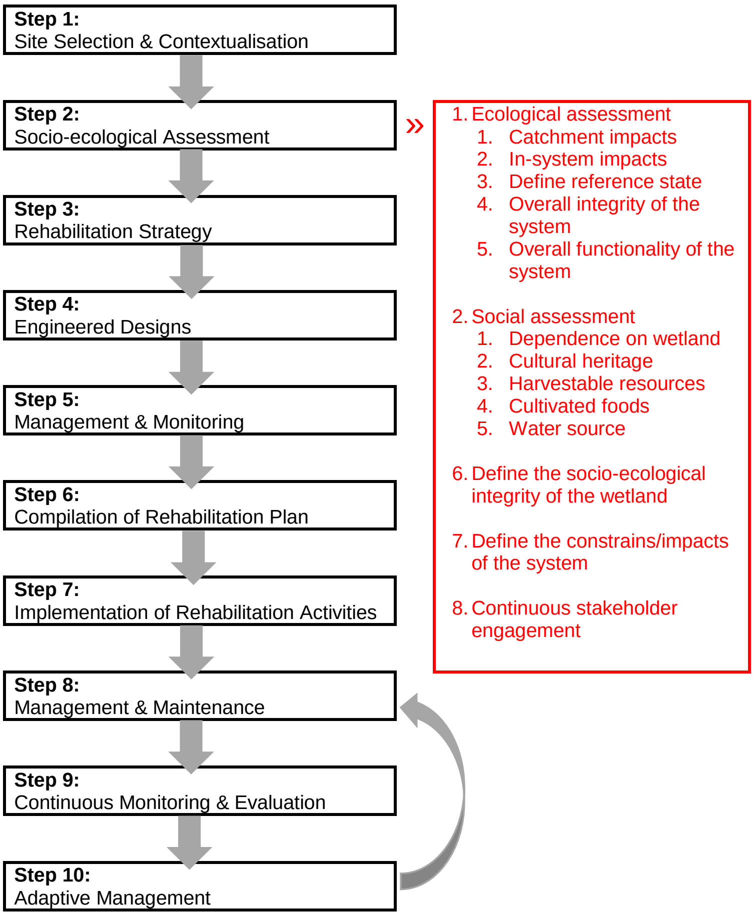
All of these findings need to be documented and evaluated following the infield verification process. The results of the evaluation invariably would highlight whether commencing with additional rehabilitation planning activities within the system is considered to be a futile exercise or not.

Examples of subsistence agricultural within the wetland system. Left: Some remaining wetland habitat has been retained. Right: Extensive agricultural activities practices across the wetland

#### 7.3.2.2 Ecological and social assessment of the system

The chapter 2 makes reference to the fact that there are limited ecological and social assessment techniques available in Rwanda. Nonetheless, chapter 5 provides some degree of guidance in terms of assessing the degree of impact on the wetland, particularly relating to agricultural practices, and wise-use approaches that may be adopted.

As there are no formal assessment techniques available, it is recommended that the site contextualisation process forms part of the assessment of the system, in conjunction with the criteria described in chapter 6. In-depth and detailed descriptions of the system at a local and catchment level would allow for trends to be established and in such ascertain with some degree of confidence the overall integrity and functionality of the identified system, *i.e.* a conceptual 'model' of how the particular wetland has been shaped and functions, and how some of the drivers of the system have been impacted. Establishing these impacts and changes to the system, will allow one to ascertain how the rehabilitation of the system may assist in halting, slowing down or changing these impacts. These detailed descriptions of the systems would further serve as baseline data from which the rehabilitation success can be measured.




In addition to describing the system in great detail, the engagement of the stakeholders is essential. The degree of stakeholder engagement at this stage is largely dependent on the engagement initiated during the site selection/contextualisation phase. In the event that the engagement was superficial, it is essential that all respective stakeholders are consulted. It should be noted though, that even if an in-depth consultative process was adopted at the outset, it is essential that it continues throughout the project, and is not neglected further along the rehabilitation planning process as it is assumed that it was already undertaken and therefore, does not need to be undertaken again. The stakeholder engagement process is a continuous consultative process.

**Box 2: Socio-ecological assessment**

Following the thorough review of the catchment and in-system conditions, the identified wetland can be assessed in terms of its socio-ecological condition. The assessment of the system is undertaken for the current scenario, however, is compared to the reference state.

**Reference state:**

The identified wetland was historically considered to be an unchannelled valley-bottom wetland. Based on an understanding of the wetland systems and in comparison to a unchannelled valley-bottom wetland in close proximity that is relatively intact, the following ecological characteristics about the system can be assumed:

- Wetness regime: The majority of the system would have been dominated by permanent wetness conditions, with limited temporary/seasonal conditions along the outskirts of the system. The wetness regime of the wetland is primarily driven by rainfall events and surface flows.

- Hydrology: Under natural conditions, the unchannelled valley-bottom would be inundated for extended periods. Historically, the loss of water from the system would mostly be via evapotranspiration, rather than through the efficient ridge and furrow agriculture, and extensive drainage network.
- Geomorphology: Little to no erosion or transport of sediments out of the wetland would have occurred due to the very shallow gradient (<0.03%).
- Vegetation: the vegetation composition would have been *Cyperus papyrus* and *Phoenix reclinata.*

Subsequent catchment and in-system activities have led to the formation of a channel and extensive drainage networks including raised bed practices.

The agricultural practices within the system would have resulted in channelled flows through the wetland, instead of diffuse flows across the width of the system. In confining the flows through the system, some of the ecosystem services would have been impaired / reduced. The regulating services that invariably would have been altered through the current land use practices include flood attenuation, erosion control, sediment trapping and toxicant removal. These services are considered to be some of the main services that may be supplied by unchannelled valley-bottom wetlands. Identifying which of the drivers have altered, e.g. the hydrology of the system, will contribute towards the formulation of the rehabilitation strategy. In addition to the loss of ecosystem services, impacts would reduce the overall resilience of the system to change in stressors. By substantially altering the overall functioning and integrity of the system, the chances of the system being able to respond to stressors is limited.

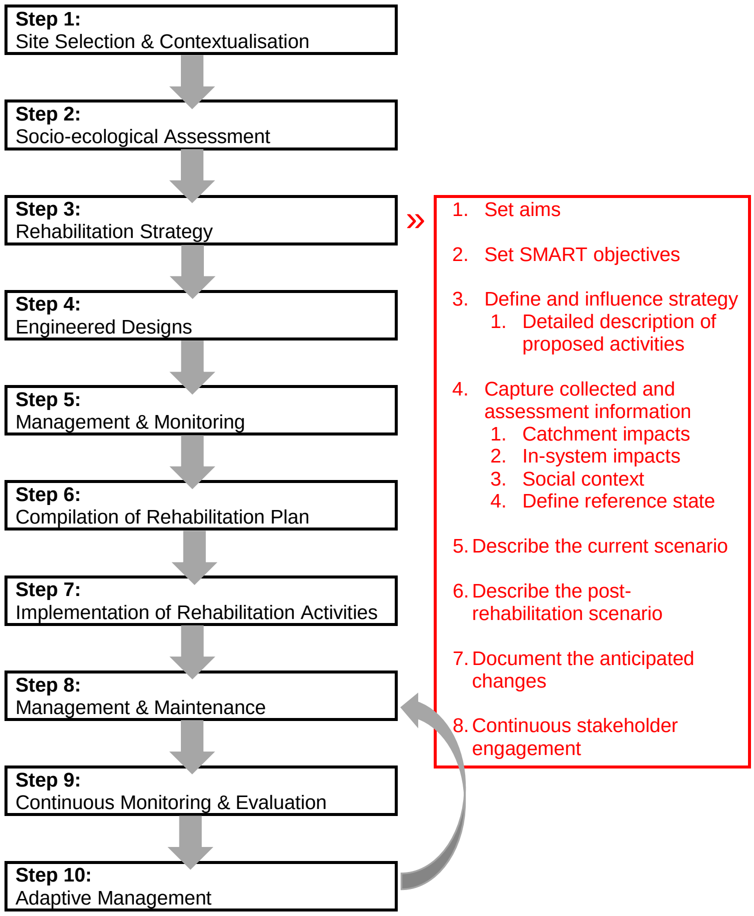
Impacts on the system have to be documented to assess the integrity and functionality of the wetland. Chapter 5 provides some guidance in terms of the assessment of the agricultural practices within the system. These should be adopted to ascertain how the movement of water entering, moving through and leaving the system has been modified.

The assessment of the land use practices within the wetland in conjunction with the data obtained from the engagement process would provide a detailed description of the social context of the community and the community's reliance of the system for their livelihood. Ascertaining the social drivers of the system allows for the potential to evaluate whether change in the view of the system and land use practices may be implemented. Positive, continuous, engaging and trusting environments for communication pave the pathway for change within the system. Change in terms of moving the overall system towards a sustainable system, and thus in return a more resilient system.

The importance of documenting all of the findings of the assessments, allows for reflection and evaluation on the success of the rehabilitation project at a later stage. This data would contribute towards the baseline data of the system, which is crucial should one want to monitor and evaluate the change of a system post-implementation.

#### 7.3.2.3 Wetland rehabilitation strategy

The above-mentioned steps would have highlighted the impacts (social and ecological) associated with the system identified for rehabilitation. The in-depth analysis of the system would allow for clear (possibly refined) aims and objectives to be set.




**Aims versus Objectives**

1. Aim – Specifying exactly what the rehabilitation strategy is setting out to achieve
2. Objective – describing the anticipated outcomes that will contribute to the aim being achieved

**Objectives = SMART**

<u>S</u>pecific

<u>M</u>easureable

<u>A</u>chievable

<u>R</u>elevant

<u>T</u>ime-bound

Setting attainable and realistic aims and objectives will greatly define and influence the proposed rehabilitation strategy. The proposed strategy is a detailed description of the proposed rehabilitation activities for the system, but does not include engineered structures or designs, if adopted. The strategy will capture all of the information collected and assessed during the site contextualisation process and assessment of the wetland habitat, *i.e.* in-system and catchment related impacts, driving forces, climatic conditions, regional context, defining the reference state (which would have largely been ascertained during the assessment phase). Additionally, the strategy should document the anticipated changes associated with the proposed rehabilitation activities, such as the redistribution of flows across the system. Providing these detailed descriptions of the current and anticipated post-rehabilitation scenarios will provide a basis against which the success of the rehabilitation interventions can be assessed.

**<u>Box 3: Aims and Objectives</u>**

Following the assessment of the socio-ecological state of the system, areas of concern can be established, and thus the aims and objectives of the rehabilitation project can be set. It is essential that the setting of the aims and objectives is undertaken at a grass-roots level. This will ensure buy-in from all of the stakeholders involved and increase the longevity and resilience of the system. This is particularly important when the proposed rehabilitation strategy aims to differently manage the land use activities within the system, i.e. in the incorporation of a wise-use approach. The assessment of the system, including the infield verification of the system, would have highlighted areas in which agricultural practices may be excluded from, reduced, modified and /or improved in the post-rehabilitation context.

In consultation with the stakeholders, the proposed rehabilitation strategy would have to be discussed especially if drastic changes in the land use practices are envisaged. These types of changes can only be achieved through an open and trustworthy channels of communication.

Example of a stakeholder engagement process, in which the local community is consulted regarding the rehabilitation of the wetland

In instances where the current land use activities are considered to be severely altering the functionality of the system, sustainable practices may be suggested and / or exclusion zones across the system identified with the stakeholders. These exclusion zones would allow for near-natural conditions to be established and other areas to be more intensively utilised. Rehabilitation activities may also include creating buffer zones or revegetation of portions of the systems. These sorts of practices are described in more detail from chapter 3 to 6.

Thus assuming a successful consultative process was undertaken and there is buy-in from a grass-roots level, the specific aims and objectives for the rehabilitation strategy may be set.

**AIM**

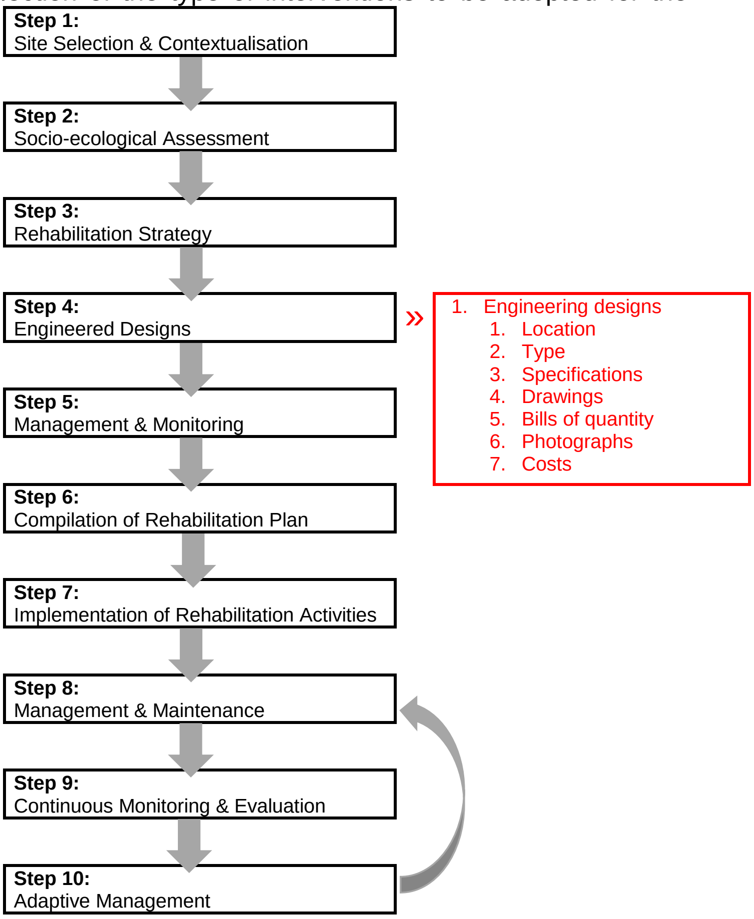
Due to the high level of utilisation of the remaining natural habitat and particularly the wetland by the surrounding community for subsistence living, maintaining and/or improving on these systems is considered to be an important undertaking. The local community are heavily reliant on the wetland for crop production and as a source of drinking water. The substitutability of this resource is considered to be scarce, therefore, the system should be maintained/improved.

**OBJECTIVES**

1. Reinstating hydrological conditions across portions of the wetland through the deactivation of the drainage networks and ridge and furrow agricultural practices.
2. Buffering the identified rehabilitation areas from the land use practices through the revegetation of fringe vegetation.
3. Modifying the land use practices in the allocated areas to ensure the practices do not threaten the overall functioning of the system.
4. Revegetation, with indigenous vegetation, of the portions of the wetland that have been set aside from production.
5. The anticipated system response to the rehabilitation activities is 5 years.

### 7.3.2.4 Engineered designs

Should engineered interventions be required, the selection of the type of interventions to be adopted for the system, is largely dependent on having a comprehensive understanding of the system before any interventions are introduced. Without attempting to understand the system, its origins and its natural functioning state, the introduction of poorly designed interventions has the ability to negatively influence the system and do more harm than good.



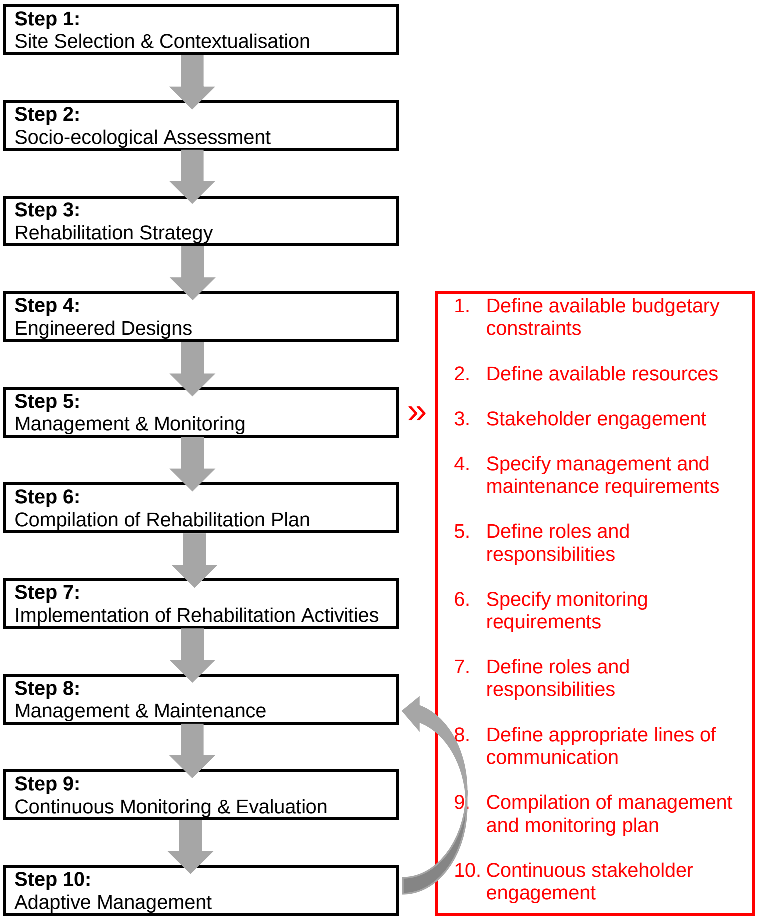

There are two broad means to actively encourage ecosystem rehabilitation namely using 'soft' rehabilitation approaches, *e.g.* manually removing alien invasive vegetation; or using 'hard' engineered interventions, *e.g*. concrete drop inlet weirs to halt erosion and raise the water table within the system. Should the latter of the options be the most suited to the site, specific details pertaining to the proposed engineered structures would be required.

The types of details that would have to be included are as follows:

- Location of the proposed intervention (Latitude and Longitude),
- Type of engineered intervention *i.e.* concrete weir, earthen plug, etc.
- Specifications of the intervention, *i.e.* size/measurements etc.;
- Design drawings of the specific intervention;
- Bills of quantity associated with the intervention;
- Photograph reference, *i.e*. photographs of the system upstream and downstream of the proposed intervention; and
- Costs associated with the proposed interventions.

Including these details in the wetland rehabilitation plan, allows for the overall plan to be reviewed and implemented. All the necessary details relating to the site are documented. In addition, all of the information is available and thus eliminating any possible queries/misunderstandings due to an incomplete "data set".

### 7.3.2.5 Management and Monitoring




As highlighted above, the longevity of the rehabilitation activities is predominantly nestled in the post-rehabilitation landscape, *i.e*. adaptive management of the system. To be able to achieve an adaptive management approach key long-term monitoring requirements should be incorporated into the overall plan. A monitoring plan and or a section of the rehabilitation plan should articulate the baseline and on-going monitoring requirements associated with the proposed intervention/s.

The details of the management and monitoring plan are largely dependent on the available resources to undertake the management and monitoring, and the actual nature of the system. In terms of the latter, the nature of the system in combination with the proposed rehabilitation activities, would largely determine the types of on-going management required. Should the system be retained as a working wetland, *i.e*. include sustainable agricultural practices, then the management of the wetland vegetation would only be limited to the buffer zones within the system, whilst should the wetland be rehabilitated back to near-natural conditions the management of the wetland vegetation may be key to maintaining the overall integrity of the system, *e.g.* removal of alien invasive vegetation or regular defoliation of the wetland vegetation. These management implications are thus substantially variable and therefore, details have not been included in this report.

In addition to the management of the system, regular monitoring is considered to be essential particularly in an adaptive management approach. Again, the level of monitoring to be adopted at a per system level, is largely dependent on the nature and location of the system within the broader landscape. Should the system be located within a rural community, access to high-tech equipment and detailed scientific research techniques may be limited, and thus simple monitoring using visual monitoring (fixed point photography) or broad vegetation community descriptions may be sufficient. In contrast, should the wetland be located within a protected area and access to resources increased, a more detailed approach to monitoring the changes of the system to the rehabilitation activities may be undertaken. Therefore, prescriptive monitoring activities cannot be described.

**Box 4: Management and Monitoring Requirements**

Following the compilation of the proposed rehabilitation strategy, it crucial to establish the roles and responsibilities for the system following the implementation of the rehabilitation plan. Only a system that is appropriately managed and monitored can develop a degree of resilience and attain the set aims and objectives. Again, these aspects are subject to a consultative approach with the stakeholders.

Due to the location of the rehabilitated wetland within a rural community the prescribed / recommended management and monitoring activities are considered to be accessible to community members and repeatable. Monitoring changes in a system can be a complex undertaking but this is not necessarily always applicable. Therefore, the proposed management and monitoring activities are prescribed:

- **Management**
  - Burning and grazing within the wetland habitat. The productivity of a system is increased with the regular defoliation of the vegetation. Ideally, fire would be used as a means to achieving this, however, since the communities are located in close proximity of the wetland, this is not considered to be a viable option and it is against the environmental law of Rwanda. Therefore, harvesting grazing material may be the least risky activity.
  - Alien vegetation removal is considered essential in maintaining near-natural conditions in the rehabilitated portions of the wetland. The initial removal of the alien vegetation would have been undertaken in conjunction with rehabilitation interventions. Follow-up activities are required to eradicate emerging species. Through the regular removal of the alien vegetation maintenance levels may be attained.
- **Monitoring**
  - Fixed point-photographs should be taken both prior to and following the rehabilitation activities. Regularly taking photos at the same position of the same portion of the wetland allows for photographic evidence to be gathered in terms of the response of the system to the rehabilitation activities. This in combination with open channels of communication can allow for an adaptive management approach to be adopted.

### 7.3.3 Wetland rehabilitation plan

The detailed rehabilitation plan is a combination of the strategy and the detailed engineered designs. The detailed plan would in most instances be used as supporting documentation to the ESIA process. The detailed rehabilitation plan must be compiled by a multidisciplinary team to ensure that the afore-mentioned components are suitably addressed. The adoption of a team that has the skill-set to address all components of the system will more likely achieve the set aims and objectives of the rehabilitation plan, in addition be able to establish suitable management, maintenance and monitoring requirements, to encourage the longevity of the project.

Ideally, a standard rehabilitation plan template should be developed. This would ensure all of the necessary details are included in the plans. Additionally, it would assist the authorities during the review of the authorisation application. Table 7.2 below provides an example of headings that may be incorporated into the detailed wetland rehabilitation plan. It should be noted that this is only a guide and should be adapted at a project level.

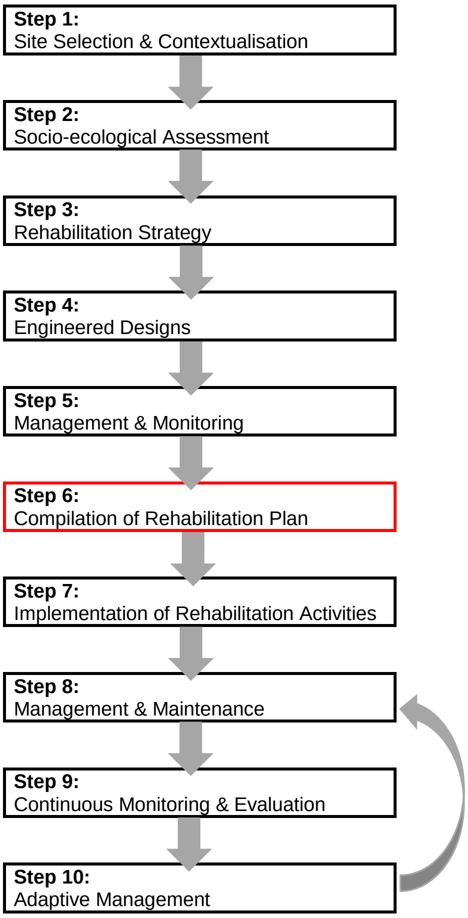



**TABLE 7.2 EXAMPLE OF A TABLE OF CONTENTS OF A DETAILED WETLAND REHABILITATION PLAN**

| | |
|---|---|
| 1 | INTRODUCTION |
| 2 | BACKGROUND TO THE STUDY |
| 3 | STUDY SITE |
| 3.1 | Regional context |
| 3.2 | Climate |
| 3.3 | Vegetation types |
| 3.4. | Hydrogeomorphic classification |
| 3.5 | Other wetland classification |
| 4 | Project Team |
| 5 | Methodology |
| 5.1 | Desktop analysis |
| 5.2 | Site selection |
| 5.3 | Ecological drivers of the system |
| 5.4 | Ecological impacts on the system |
| 5.5 | Social drivers of the system |

| | |
|---|---|
| 5.6 | Social impacts on the system |
| 5.7 | Catchment impacts |
| 5.8. | Integrity and functionality of the system / Assessment of the system |
| 5.9 | Rehabilitation planning |
| 6 | Assumptions and limitations |
| 7 | Study results |
| 7.1 | Wetland characteristics |
| 7.2 | Ecological context |
| 7.3 | Social context |
| 7.4 | Overall assessment of the system |
| 8 | Wetland rehabilitation plan |
| 8.1 | Wetland problems |
| 8.2 | Wetland rehabilitation aims and objectives |
| 8.3 | Wetland rehabilitation strategy |
| 8.3.1. | *Feasibility* |
| 8.3.2 | *Proposed interventions* |
| 8.3.3. | *Timing* |
| 8.3.4 | *Wetland rehabilitation prioritisation* |
| 8.4. | Mitigation measures |
| 8.5 | Detailed engineered interventions |
| 9 | Wetland rehabilitation monitoring and evaluation |
| 10 | Wetland management and maintenance |
| 11 | Appendix |
| 11.1 | Proposed intervention details |
| 11.1 | Intervention drawings |

## 7.4 CONCLUSION

The process of wetland rehabilitation planning can be a complex undertaking depending on the site identified for rehabilitation. The complexity contained within the planning process is understanding the socio-ecological context in which the wetland is situated. For Rwanda, in order to ascertain this a detailed review of the site is required – site contextualisation. The contextualisation of the site allows an overview of the overall driving forces and impacts on the system to be established. The wetland is not only reviewed in isolation but in its entirety which includes the surrounding catchment. But most importantly is also the social component of the site – the dependence of the community on the wetland, the associated impacts and the commitment to cooperative management of the system.

The detailed analysis of the system allows for a deeper understanding to be developed and thus the functionality and integrity of the system may potentially be established in the absence of wetland assessment tools. The interconnectedness of the system is crucial in understanding, and thus a multidisciplinary team is essential during the planning phases but especially at the outset in which the stakeholder engagement process is considered to be crucial.

Understanding the connections and how all of the components are interwoven allows for a suitable rehabilitation strategy to be developed. The strategy would ensure that the most suited interventions (‘soft’ or ‘hard’) are selected, and that these are closely aligned with the set aims and objectives of the rehabilitation strategy. The identification of suitable interventions then can dictate the type of management, maintenance and monitoring requirements can be prescribed for the system. The establishment of these allows for an adaptive management approach to be adopted. This essentially improves the resilience of the system.

# REFERENCES

Amler, E., Schmidt, M. and Menz., G. 2015. Definitions and mapping of East African wetlands: a review. Remote Sensing. 7:5256-5282.

Beuel, S., Gabiri, G., Heiss, L., Stumpp, C., and Reichert. B. 2016. Linkages between groundwater and agricultural production in an Ugandan wetland. Poster presentation. IAH Congress, Montpellier, France.

Beacon Environmental Ltd (2012). Ecological Buffer Guideline Review, Ottawa

Bintoora, A, K, K, Meza, F, O, & Edroma, E. 2015. Framework for Sustainable Management of Lake Nakivale Wetland System in Isingiro District, Uganda

Birdlife International. 2002. Important Bird Areas and potential Ramsar sites in Africa. Cambridge, U.K.

Boar, R.R., 2006. Responses of a fringing Cyperus papyrus L. swamp to changes in water level. Aquat. Bot. 84, 85–92. http://dx.doi.org/10.1016/j.aquabot.2005.07.008.

Brinson, M.M., 1993. A hydrogeomorphic classification for wetlands. EAST CAROLINA UNIV GREENVILLE NC.

Brooke, R and Matthew, R. 2016. Environmental Governance in Post-Conflict Situations: Lessons from Rwanda, In: Governance, Natural Resources, and Post-Conflict Peacebuilding. (eds) C. Bruch, C. Muffett, and S. S. Nichols. London: Earthscan.

Bugesera District Development Plan 2013-2018

Byers, B., Nsengimana, S., Hakizimana, E., Rutagarama, E., Granier, L., and Deeks, P. 2014. Rwanda Environmental Threats and Opportunities Assessment. Prepared for USAID/Rwanda under the Restoring the Environment through Prosperity, Livelihoods and Conserving Ecosystems (REPLACE) contract OAA-1-14-00016.

Cantón, Y., Solé-Benet, A., de Vente, J., Boix-Fayos, C., Calvo-Cases, A., Asensio, C., and Puigdefábregas, J. 2011. A review of runoff generation and soil erosion across scales in semiarid south-eastern Spain. Journal of Arid Environments, 75: 1254-1261.

Climate Service Centre. 2013. Climate Change Scenarios for the Congo Basin. Haensler A., Jacob D., Kabat P., Ludwig F. (eds.). Climate Service Centre Report No. 11, Hamburg, Germany.

Donaldson, L., Woodhead, A.J., Wilson, R.J. and Maclean, I.M., 2016. Subsistence use of papyrus is compatible with wetland bird conservation. Biological Conservation, 201, pp.414-422.

Ellery, W., Grenfell, M., Grenfell, S., Kotze, D., McCarthy, T.S., Tooth, S., Grundling, P.L., Beckedahl, H., Maitre, D.L. and Ramsay, L., 2009. WET-origins: controls on the distribution and dynamics of wetlands in South Africa. WRC Report, (334/09).

Ellery, W.N., Humphries, M., Barnes, K., Grenfell, M.C., Grenfell, S., Fischer, D., Kindness, A., and Hughes, G. 2012. Peat formation in the context of landscape evolution of the Mkuze Wetland on the coastal plain of Maputaland, South Africa. Geomorphology. 141-142:11-20.

EMD, 2019.Technical note on Conceptual framework for the methodology and tool for wetland ecosystem functions, assets and services assessment and management and assessment of potential indicators (including wetland biodiversity indicator assessment).

Energy Development Corporation Limited (EDCL). 2016. Feasibility Study for Nyabarongo II Multipurpose Development Project, Rwanda. Part E: Irrigation Design.

EPA, 2020. Classification and Types of Wetlands. (Available at: https://www.epa.gov/wetlands/classification-and-types-wetlands#marshes, accessed in December 2020).

Fischer, E., Dumbo, B., Dehling, M., Lebel, J-P., and Killmann, D. 2011. Biodiversity Inventory for Key Wetlands in Rwanda: Final Report. University of Koblenz-Landau, Germany.

Frenken, K., and Mharapara, I. (eds). 2002. Wetland development and management in SADC countries. Proceedings of a sub-regional workshop. Harare, Zimbabwe. Food and Agriculture Organisation of the United Nations (FAO).

Fryirs, K. A. 2013. (Dis)Connectivity in catchment sediment cascades: a fresh look at the sediment delivery problem. Earth Surface Processes and Landforms, 38: 30–46.

Gordon, N.D., McMahon, T.A., Finlayson, B.L., Gippel, C.J., and Nathan, R.J. 2004. Stream hydrology: an introduction for ecologists. 2nd Edition. Wiley and Sons. Chichester.

Grenfell, M.C., Ellery, W.N. and Grenfell, S.E. (2008). Tributary valley impoundment by trunk river floodplain development: a case study from the Drakensberg foothills, eastern South Africa. Earth Surface Processes and Landforms, 33:2029–2044.

Grenfell, S.E., Ellery, W.N., Grenfell, M.C., Ramsay, L.F. and Flugel, T.J. (2010). Sedimentary facies and geomorphic evolution of a blocked-valley lake: Lake Futululu, northern KwazuluNatal, South Africa. Sedimentology. 57(5):1159-1174.

Heermans, J and Ikirezi, M. 2015. Wetland Policies in Rwanda: Balancing Sustainable Use and Protection Through Policy. Kigali, Rwanda: USAID | LAND Project.

HELPAGE-Rwanda. 2009. Plan D'amenagement Du Bassin Versant Et Plans De Gestion A Base Communautaire Des Ecosystemes Critiques De Marais. Volume 3. Complexe Rweru-Mugesera. 2009-2023. Rapport Provisoire

Hope Magazine. 2012. Rwanda, Abundant Energy Opportunities. Available at: http://www.hope-mag.com/index.php?com=news&option=read&ca=6&a=196

Hopwood, B., Mellor, M. and O'Brien, G., 2005. Sustainable development: mapping different approaches. Sustainable development, 13(1), pp.38-52.

Hruby, T. 2013. Update on Wetland Buffers: The State of the Science, Final Report. Washington State Department of Ecology Publication #13-06-11

Hughes, R.H., and Hughes, J.S. 1992. A Directory of African Wetlands. IUCN, Gland, Switzerland and Cambridge, U.K; UNEP, Niarobi, Kenya; World Conservation Monitoring Centre, Cambridge, U.K.

IPCC, 2012: Glossary of terms. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 555-564.

Joosten, H & Couwenberg, J. 2009. Are emission reductions from peatlands MRV-able?

Kicukiro District Development Plan 2013-2018

Kiptum, C.K., Hatangimana, V., Niyonagira, D., and Nyirahabimana, S. 2014. Physical Properties of Clay and Bricks in Nyagatare, Rwanda. Journal of Mechanical and Civil Engineering. 11: 2: 97-100.

Konrad, C.P. 2016. Effects of Urban Development on Floods. Available at: https://pubs.usgs.gov/fs/fs07603/

Kotze, D., 2010. WET-Sustainable use: A system for assessing the sustainability of wetland use. Pretoria: Water Research Commission. WET-Management Series. WRC Report No. TT 343/10. Water Research Commission, Pretoria, South Africa.

Kotze, D.C., Ellery, W.N., Rountree, M., Grenfell, M.C., Marneweck, G.C., Nxele, S.I., Breen, C., Dini, J., Batchelor, A.L. and Sieben, E. 2008. WET-RehabPlan: Guidelines for Planning Wetland Rehabilitation in South Africa. WET-Management Series. WRC Report No. TT 336/08. Water Research Commission, Pretoria, South Africa.

Kotze, D., Collins, N., Lindley, D., Marneweck, G., and Batchelor, A., 2007. WET-EcoServices: a technique for rapidly assessing ecosystem services supplied by wetlands. WET-Management Series. WRC Report No. TT 339/09. Water Research Commission, Pretoria, South Africa.

Lal, R. 2001. Soil degradation by erosion. Land Degradation and Development. 12, 519-539.

Linström, A., and Van Rooyen, L. 2016. Report on peatlands and the impacts of peat to power, both globally and in Rwanda. Prepared for the International Crane Foundation, Endangered Wildlife Trust and MacArthur Foundation.

LVEMP II Rwanda Newsletter 1, 2013

LVEMP II Rwanda Newsletter 3, 2015

LVEMP II Rwanda Newsletter 4, 2015

Maclean, I.M.D., Tinch, R., Hassall, M., Boar, R., 2003c. Towards Optimal Use of Tropical Wetlands: An Economic Valuation of Goods Derived from Papyrus Swamps in Southwest Uganda. CSERGE Working Paper ECM 03–10, Norwich.

Macfarlane, D. and Bredin, I. 2017. Buffer zone guidelines for wetlands, rivers and estuaries. Part 1: Technical Manual. Water Research Commission: TT 715/1/17.

Macfarlane, D., Goodman, P., Koopman, V., Goge, M., Ellery, W., Kotze, D. and Walters, D., 2009. WET-Health: a technique for rapidly assessing wetland health. WET-Management Series. WRC Report No. TT 340/09. Water Research Commission, Pretoria, South Africa.

Ma M. 2016. Riparian Buffer Zone for Wetlands. In: Finlayson C. et al. (eds) The Wetland Book. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-6172-8_53-7

McCartney, M.P. Kashaigili, J.J., Lankford B.A., Mahoo, H. F. 2008. Hydrological modelling to assist water management in the Usangu wetlands, Tanzania

Millennium Assessment. 2005. Global assessment reports. World Resources Institute, Washington, DC.

MINALOC (no date) Institutional review of local governments. Republic of Rwanda.

MINECOFIN. Your Guide to the Sustainable Development Goals (SDGs) in Rwanda (available at: http://www.minecofin.gov.rw/fileadmin/user_upload/Guide_to_SDGs_in_Rwanda_ENG.pdf)

Ministerial Order Nº 001/11.30 of 23/11/2011 establishing irrigation water users associations in irrigation schemes.

Ministry of Environment, 2019. Wetland Master Plan for Kigali City, Kigali

Ministry of Infrastructure. 2015, National Urbanization Policy, Kigali, Rwanda

Ministry of Infrastructure. 2015. Rwanda Energy Policy

Ministry of Trade and Industry (2011), National Industrial Policy, Kigali, Rwanda

Mitsch, W.J. and Gosselink, J.G. 2000. Wetlands. 3rd Ed. John Wiley and Sons, Inc., USA.

Muthuri, F., Jones, M., Imbamba, S., 1989. Primary productivity of papyrus (Cyperus papyrus) in a tropical swamp; Lake Naivasha, Kenya. Biomass 18, 1–14.

Nabahungu, N. 2012. Problems and opportunities of wetland management in Rwanda. Doctoral thesis Wageningen.

Ngoma District Development Plan 2013-2018

Line Basin Initiative, 2020. Transboundary Wetland Management plan for the Semliki Wetland between the Democratic Republic of the Congo nd the Republic of Uganda, 2020-2030. Available at: http://nelsap.nilebasin.org/index.php/en/information-hub/technical-documents/55-semliki-delta-transboundary-wetlands-management-plan-july-2020/file

NISR, 2019. Rwanda Natural Capital Account-Minerals Resource Flow

NISR, 2018. Rwanda Natural Capital Account-Land.

NRC (National Research Council). 1995. Wetlands: Characteristics and boundaries. Washington, DC: National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418; (800) 624-6242.

Nsabagasani, C., Nsengimana, S. and Hakizimana, E. 2009. Biodiversity Survey in Akanyaru Wetlands, Unprotected Important Bird Areas in Rwanda

OECD, 1993. Guidelines for Aid Agencies for Improved Conservation and Sustainable Use of Tropical and Sub-Tropical Wetlands.

Ollis, D.J., Snaddon, C.D., Job, N.M. and Mbona, N. 2013. Classification system for wetlands and other aquatic ecosystems in South Africa. User Manual: Inland Systems. SANBI Biodiversity Series 22. South African National Biodiversity Institute, Pretoria, South Africa.

Pratt, J., Palerm, J., and Gakuba, A. 2012. Strategic Environmental Assessment of the Agriculture sector in Rwanda. Prepared for Ministry of Agriculture and Animal Resources (MINAGRI) and the European Union. Consortium SAFEGE., Belgium.

Prime Minister's Order No006/03 of 30/01/2017 drawing up a list of swamp lands, their characteristics and boundaries and determining modalities of their use, development and management.

Prime Minister's Office. 2017. Gahunda ya Guverinoma y'imyaka 7 (2017-2024) (National Strategy for Transformation, NST 1), Kigali 26 September 2017.Projet de Gestion Integree des Ecosystemes Critiques (MINITERE/REMA/IMCE). 2008. Etablissement d'un inventaire national rapide des maraiset élaboration de 5 avant-projets d'arrêtés ministériels relatifs aux marais. Modules 1 et 4. Crédit de la Banque Mondiale N° : GEF TF 055471-RW.

Ramsar Convention Secretariat. 2016. Ramsar Information Sheet Rwanda Rugezi-Burera-Ruhondo. https://rsis.ramsar.org/ris/1589

Ramsar Convention Secretariat. 2010. Wise use of wetlands: concepts and approaches for the wise use of wetlands. Ramsar handbooks for the wise use of wetlands, 4th edition, volume 1. Ramsar Convention Secretariat. Gland, Switzerland.

Ramsar Convention Secretariat. 2008. Strategic framework and guidelines for the future development of the list of wetlands of international importance.

REMA, 2011. Environmental and Social Management Framework for Rwanda under LVEMP II. Lake Victoria Environmental Management Project Phase II.

REMA. 2002. Practical Tools on Land Management - GPS, Mapping and GIS.

REMA. 2006. General Guidelines and Procedure for Environmental Impact Assessment.

REMA. 2009. Guidelines for Environmental Impact Assessment for Wetland Management in Rwanda.

REMA. 2009. Rwanda state of the Environment and Outlook Report; Rwanda Environment Management Authority (REMA), Kigali, Rwanda.

REMA, 2019. Ecosystem-Based Adaptation Guidelines for Climate Resilient Restoration of Savannah, Wetland and Forest Ecosystems of Rwanda

REMA (2017) http://rema.gov.rw/fileadmin/templates/Documents/REMA_Structure.pdf

REMA, 2016. Rehabilitation of Nyabarongo Catchment (Mwogo River) in Huye District. REMA.

REMA. 2015. Draft Environmental Assessment and Management Guidelines for Peat Extraction and Use.

REMA. 2014. Sector specific environmental audit guideline for agriculture projects.

REMA. 2014. Sector specific environmental audit guideline for industry projects.

REMA. 2014. Sector specific environmental audit guideline for mining projects.

REMA, 2013. Rehabilitation of Nyabarongo Catchment (Base River) in Gakenke District. REMA.

REMA, 2012. Rweru-Akagera Wetland Complex Rehabilitation Project. REMA.

REMA. 2012. Draft Guidelines for Environmental Impact Assessment (EIA) For Mining Projects in Rwanda.

REMA. 2010. Practical Tools on Irrigated Agriculture on Non-Protected Wetlands.

REMA. 2010. Practical Tools on Restoration and Conservation of Protected Wetlands.

REMA. 2010. Practical Tools on Soil and Water Conservation Measures.

REMA. 2010. Practical Tools on Sustainable Agriculture.

REMA. 2009. Integrated Management of Critical Ecosystems (IMCE) project. (unpublished)

Republic of Rwanda (2019), Official Gazette No 5 of 15/04/2019. Ministerial Order No 001/2019 of 15/04/2019 establishing the list projects that have to undertake environmental impact assessment, instructions, requirements, and procedures to conduct environmental impact assessment

Republic of Rwanda (2020). Official Gazette No 04 of 03/02/2020. Law No 72/2019 establishing Rwanda Forestry Authority.

Republic of Rwanda (2020). Updated Nationally Determined Contributions of Rwanda, Kigali, Rwanda

Republic of Rwanda. 2019. Ministry of Environment. (2019). National Land Policy, Efficient Land Management for Sustainable Development.

Republic of Rwanda. 2019. Ministry of Environment. (2019). National Environment and Climate Change Policy.

Republic of Rwanda (2019). Official Gazette No 15 of 15/04/2019. Ministerial Order **No 001/ 2019 of 15/04/2019** establishing the list of projects that must undergo environmental impact assessment, instructions, requirements and procedures to conduct environmental impact assessment…

Republic of Rwanda. 2018. National Agriculture Policy

Republic of Rwanda (2018), Official gazette no. special of 21/09/2018. Law on Environment No 48/2018 of 13/08/2018

Republic of Rwanda, Ministry of Land and Forestry. 2018. Rwanda National Forestry Authority

Republic of Rwanda. 7 Years Government Programme: National Strategy for Transformation 2017-2024, final

Republic of Rwanda. 2017. Official gazette No 7 of 13/02/2017. Prime Minister's Order No 006/03 of 30/01/2017 Drawing up a List of Swamp Lands, Their Characteristics and Boundaries and Determining Modalities of Their Use, Development and Management

Republic of Rwanda. 2016. National Biodiversity Strategy and Action Plan

Republic of Rwanda. 2015. Intended Nationally Determined Contributions of Rwanda, Kigali, Rwanda

Republic of Rwanda (2014). Official Gazette nº 33 bis of 18/08/0214. Prime Minister's Order Nº 87/03 of 16/08/2014 determining modalities of transfer of responsibilities and property of Energy, Water and Sanitation Authority (EWSA)

Republic of Rwanda (2013). Official gazette no 38 of 23/09/2013. Law No 70/2013 of 02/09/2013, Kigali, Rwanda

Republic of Rwanda. 2013. Official gazette no Special of 16/06/2013. Law No 43/2013 of 16/06/2013 Governing Land in Rwanda

Republic of Rwanda. 2012. Rwanda Vision 2020, Revised 2012.

Republic of Rwanda. 2011. Official Gazette No 50 of 12/12/2011. Ministerial Order No001/11.30 of 23/11/2011 establishing irrigation water users associations in irrigation schemes.

Republic of Rwanda. Ministry of Natural Resources (2011). National Policy for Water Resources Management

Republic of Rwanda. 2011. Official gazette n° Special of 12/07/2011. Law N°20/2011 Of 21/06/2011 Governing Human Habitation in Rwanda

Republic of Rwanda. 2011. Rwanda Biodiversity Policy

Republic of Rwanda (2011), Green Growth and Climate Resilience National Strategy for Climate Change and Low Carbon Development, Kigali.

Republic of Rwanda. 2010. Official gazette No 37 of 13/09/2010, Ministerial order No 007/16.01 of 15/07/2010 determining the length of land on shores of lakes and rivers transferred to public property

Republic of Rwanda. 2010. Official gazette no 35 bis of 30/08/2010. Ministerial Order No. 005/16.01 of 15/07/2010 determining the list of prohibited plains for construction Russell W; Sieben E; Braack M; Ellery W; Kotze D; Mitchell S; Brooker C; Breen C. 2010. WET-RehabMethods national guidelines and methods for wetland rehabilitation. Water Research Commission. K5/1408.

Rwamagana District Development Plan 2013-2018

RLMUA. 2017. Rwanda National Land Use Planning Guidelines

SOTER. 2006. van Engelen V.W.P., Verdoodt, A., Dijkshoorn, J.A. and Van Ranst, E. 2006. Soil and Terrain Database of Central Africa (DR Congo, Burundi and Rwanda). Report 2006/07

Seburanga, J.L., Kaplin, B.A., Bizuru, E., Mwavu, E.N. and Gatesire, T. 2014. Control of water hyacinth (Eichhornia crassipes) in Rwanda: a survey of local residents' perceptions. Nineteenth Australasian Weed Conference Proceedings.

Sekomo, B, C., Nkuranga, E. Rousseau, D, P.L., Lens, P.L.N. (2010). Fate of Heavy Metals in an Urban Natural Wetland : The Nyabugogo Swamp (Rwanda).

SER (Society for Ecological Restoration International Science and Policy Working Group) 2004. The SER International Primer on Ecological Restoration. Available online at http://www.ser.org. Society for Ecological Restoration International, Tucson, Arizona. (Accessed on 04 /07/2012).

Sunderlin, W.D., 1995. Global environmental change, sociology, and paradigm isolation. Global Environmental Change, 5(3), pp.211-220.

UNEP. 2016. UNEP Frontiers 2016 Report: Emerging Issues of Environmental Concern. United Nations Environment Programme, Nairobi.

UNEP, 2015. Building resilience of communities living in degraded wetlands, forests and savannas of Rwanda through an ecosystem-based adaptation approach.

UNEP/ UNDP/ GOR Poverty and Environment Initiative Project (PEI). 2007. Pilot Integrated Ecosystem Assessment of Bugesera.

Verdoodt, A. and Van Ranst, E., 2003. Land evaluation for agricultural production in the tropics. A large-scale land suitability classification for Rwanda. Ghent University. Laboratory of Soil Science.

Wingqvist, G.O., Drakenberg, O., Slunge, D., Sjöstedt, M, and Ekbom, A. 2012. The role of governance for improved environmental outcomes. Swedish Environmental Protection Agency (SEPA). Report 6154.

Wingqvist, G.O., Drakenberg, O., Slunge, D., Sjöstedt, M, and Ekbom, A. 2012. The role of governance for improved environmental outcomes. Swedish Environmental Protection Agency (SEPA). Report 6154.

Wood, A., and van Halsema, G. E. (eds). 2008. Scoping agriculture–wetland interactions. United Nations Food and Agriculture Organisation (FAO) Rome, Italy.

World Bank, 2016. Implementation Status and Results Report. AFCC2/RI-Lake Victoria Environmental Management Project (Burundi and Rwanda) (P118316)

WOCAT database reference: T_RWA003en

WOCAT database reference: T_CHN053en

# APPENDIX A: SUMMARY OF STAKEHOLDER WORKSHOP

## Summary of results

A stakeholder engagement meeting was held in Rwanda on 10 and 11 October 2017.

Stakeholders were given an opportunity to raise all the issues affecting wetlands in a group session of several districts plus range of expertise of people including some working in the relevant areas then feedback and discussion in a plenary forum.

The stakeholders were grouped according to District and mandated to discuss the problems in detail, their causes and possible mitigation measures that would help resolve the conflicts. They were also mandated to deliberate on management objectives. Each group also deliberated on what vision they wished to set for wetland management that encompassed both national goals and the goals of their district. Several issues were raised that contribute to the problems being experienced in the wetland.

The stakeholders communicated clearly that the management plan must be about people, economy and biodiversity. Not just about conservation, wetlands are critical ecological infrastructure.

### Vision for wetland management

Three different sets of visions were drafted by the three groups during group discussions.

BUGESERA, RWAMAGANA & GASABO DISTRICTS:

- All marshlands have to be productive and sustainable
- To ensure that Rwandan wetlands are conserved in a way that reduces biodiversity loss and promotes sustainable use to serve communities around the wetlands
- By 2030, all wetlands are demarcated and sustainably used
- All wetlands need to contribute to national economy

BURERA-MUHANGA DISTRICTS: To manage and use wetlands in sustainable way

NYAMASHEKE and RUSIZI DISTRICTS: Sustainable and well managed wetlands that are useful for ecological aspects and socioeconomic development for today and future generation.

### Goals and objectives for wetland management

GOALS

BUGESERA, RWAMAGANA & GASABO DISTRICTS:

- Increase livelihood of communities around wetlands
- Protection of vulnerable wetlands
- Proper law enforcement in designated wetland areas
- Biodiversity (flora and fauna) increase in wetlands
- Increase water quality and quantity
- Increase food security of communities
- Create intersectoral national wetland committee (REMA, Districts, Companies, NGO’s, stakeholders)
- Integration of payments for ecosystem services (PES) in wetlands

NYAMASHEKE and RUSIZI DISTRICTS:

- •• To protect and improve the wetlands status within good management,
- •• To ensure that wetlands are optimally used and sustainably,
- •• To secure the wetlands that are vulnerable.

BURERA and MUHANGA DISTRICTS:

- •• Enhance functionality and productivity of wetlands;
- •• To restore degraded wetlands;
- •• To promote the use of wetlands based on their natural condition;
- •• To increase the level of monitoring of wetland use

OBJECTIVES

BUGESERA, RWAMAGANA & GASABO DISTRICTS:

1• To determine wetland boundaries

2• To increase livelihood of communities around wetlands

3• To increase Biodiversity in wetlands

4• To Increase water quality and quantity

5• To increase food security

6• To develop national wetland education and research framework on conservation, wetland services and sustainable wetland use

7• To develop a national Monitoring and Evaluation framework

8• To establish a permit applying procedure for sustainable use of wetland resources

9• To formulate benefit sharing system for local communities

NYAMASHEKE and RUSIZI DISTRICTS:

- •• To control the healthy aquatic systems
- •• To involve local community in wetland management by setting wetland management committee for each hierarchical structure,
- •• To improve the social welfare of people around wetlands

BURERA and MUHANGA DISTRICTS:

- •• To reduce the sedimentation of wetlands;
- •• To protect and/or restore a minimum of area of wetlands;
- •• Identify rare, vulnerable, or important wetlands and prioritize for restoration /protection;
- •• Provide clear guidance on appropriate wetland restoration and management techniques and success measures.
- •• Establish and institutionalize long term protection, using mechanisms such as incentives, purchase of land title or easements to protect wetlands.
- •• To identify and prioritize restorable wetlands.

To achieve the vision and intended objectives of wetland management across the country, the objectives formulated by the stakeholders have been further unpacked into draft actions/interventions at a national level for the Wetland Management Framework.