TECHNICAL ASSISTANCE IN ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT

NILE NYABARONGO UPPER CATCHMENT INTEGRATED POLLUTION MANAGEMENT PLAN

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NILE NYABARONGO UPPER (NNYU) CATCHMENT INTEGRATED POLLUTION MANAGEMENT PLAN

UNIVERSITY of RWANDA

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ABBREVIATIONS AND ACRONYMS

BMPs	Best Management Practices
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DDS	District Development Strategy
DO	Dissolved Oxygen
DPSIR	Drivers, Pressure, States, Impacts and Responses
EAC	East African Community
Eb	Ecosystem-based Adaptation
EDCs	Endocrine Disrupting Chemicals
EDPRS-2	Economic Development Poverty Reduction Strategy - 2
EIP	Early Implementation Project
EUCL	Energy Utility Cooperation Ltd
FONERWA	Rwanda Green Fund
GEF	Global Environment Fund
GIS	Geographical Information System
GoR	Government of Rwanda
JMP	Joint Monitoring Programme
IPMP	Integrated Pollution Management Plan
IWRM	Integrated Water Resources Management
LODA	Local Administrative Development Authority
LULC	Land Use Land Cover
LVB	Lake Victoria Basin
LVEMP	Lake Victoria Environmental Management Project
LWH	Land Husbandry, Water Harvesting and Hillside Irrigation
M&E	Monitoring and Evaluation
MIDIMAR	Ministry of Disaster Management and Refugee Affairs
MIGEPROF	Ministry of Family and Gender Promotion
MINAFFET	Ministry of Foreign Affairs and Cooperation
MINAGRI	Ministry of Agriculture and Animal Resources
MINALOC	Ministry of Local Government
MINECOFIN	Ministry of Finance and economic Planning

MINEDUC	Ministry of Education
MINICOM	Ministry of Commerce
MININFRA	Ministry of Infrastructure
MINIRENA	Ministry of Natural Resources
MIS	Management Information System
MoE	Ministry of Environment
NGO	Non-Governmental Organization
NNYU	Nile Nyabarongo Upper
NWRMP	Water Resources Master Plan
PhACs	Pharmaceutically Active Compounds
PAREF	Reforestation Support Project (Projet d'Appui à la Reforestation)
POPs	Persistent Organic Pollutants
RDB	Rwanda Development Board
REMA	Rwanda Environment Management Authority
RHA	Rwanda Housing Authority
RLMUA	Rwanda Lands Management and Use Authority
RNRA	Rwanda Natural Resources Authority
RSSP	Rural Sector Support Project
RWB	Rwanda Water Board
RWFA	Rwanda Water and Forestry Authority
SDG	Sustainable Development Goals
SEA	Strategic Environmental Assessment
UNEP	United Nations Environment Programme
WASAC	Water and Sanitation Corporation
WHO	World Health Organisation
W4GR	Water for Growth Rwanda

0. EXECUTIVE SUMMARY

0.1. Introduction

The Government of Rwanda (GoR) through Rwanda Environment Management Authority (REMA) is implementing a pilot project of Least Developed Countries Fund (LCDF) II titled "Building resilience of communities living in degraded forests, savannahs and wetlands of Rwanda through an Ecosystem-based Adaptation (EbA) approach" funded by Global Environment Facility (GEF) through United National Environment Programme (UNEP) under climate change adaptation GEF focal rea. 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 wetlands ecosystems.

During the implementation, a need was identified to conduct a study on Wetland and Catchment Management Framework that will be used for upscaling of wetland ecosystem restoration activities under the project. The development of Integrated Pollution Management Plan for Nile Nyabarongo Upper is under Water Quality Management task undertaken as part of the above study. It provides a comprehensive analysis of pollution issues in the Nile Nyabarongo Upper catchment and proposes adequate interventions to sustainably tackle those issues identified.

0.2. Methodology

The Integrated Pollution Management Plan for Nile Nyabarongo Upper catchment was developed using various methods. Prior the development, a literature review was undertaken to familiarise the project team members with the catchment area under consideration and the historical pollution issues that have been documented. Thereafter, the team consulted the relevant district development plans, catchment management plan, and district sanitation master plans provided these were available at the time. Consultation with institutions at national level such as Rwanda Land Use and Management Authority (RLMUA), Rwanda Water Board (RWB) and Rwanda Housing Authority (RHA) provided data and information (shapefiles) that were used to delineate the catchment boundaries and generate different maps related to catchment. Field visits and interviews with district officials, community users and others with knowledge of pollution sources and concerns within the catchment allowed the team to identify pollution hotspots in their area, what the pollution concerns were and their impacts, the possible sources of pollution, and what is or could be done to manage it. At last, stakeholder workshops were organised to give officials and other delegates from the catchment the opportunity to confirm and prioritise the pollution issues in their area, to develop the key elements of an integrated pollution management vision for their area, and to develop initial goals, objectives and interventions to manage pollution in their catchment.

0.3. Situation analysis

Nile Nyabarongo Upper catchment has a total surface area of about 3,348 km^2 within the Nile basin and covers the following eight districts: Karongi, Ngororero, Rutsiro, Huye, Nyanza, Ruhango, Muhanga and Nyamagabe. Nyabarongo which is the main river in the catchment starts from the confluence of the Mwogo and Mbirurume rivers and runs to the confluence with the Mukungwa river from where it continues as the Lower Nyabarongo on its way to the Akagera River The catchment is renowned as Rwanda's 'water tower' and has a significant number of large tributaries, such as the Mwogo, Rukarara, Mbirurume River, Munzanga and Satinsyi Rivers. The rainfall pattern shows high annual rainfall arising at 1,200 mm/year with separate two rain seasons (long rains which spans from March, April and May, and short rains which spans from September, October, November and December) and two dry seasons (Jan-February and June-September). Water quality results show very high sediment loads and turbidity as a result of poor mining and traditional farming methods, high levels of E. coli and coliform bacteria resulting from discharge of untreated sewage as well as high organic loads with high biological and chemical oxygen demands (BOD/COD) which lower the dissolved oxygen concentrations (mg/L).

According to the 2012 population census, the total number of people who live within the catchment was estimated at 1.2 million inhabitants (7% urban, 93% rural) with highest density in Muhanga, Nyamagabe and Huye (900 – 1,500 inhabitants/km^2). The population is generally very young with over 40% less than 15 years-old and almost 52% of the population less than 20 years old (EICV4). Poverty rates within the catchment area are still very high, with approximately 41 % classified as poor and 16% as extremely poor.

Dominant socio-economic activities in Nile Nyabarongo Upper catchment include rainfed agriculture, traditional cash crops like coffee and tea, along with new ones, like honey and horticulture. Main food crops growing in the area are maize, beans, 'Irish' potato, wheat, cassava, banana, fruits and rice. Approximately 70% of households are also engaged in livestock rearing with the most commonly owned species being cattle, goats, pigs, rabbits and chickens. Fish farming is already practiced in Huye and Nyanza Districts. Agroforestry and forest plantations have been promoted as appropriate land use management systems in the catchment. Mining and quarrying for and of granite, tin, wolfram, colombo-tentalite (coltan) and cassiterite are important sources of revenue and employment. In Rutsiro, Ngororero, Nyamagabe, Muhanga, Karongi and in the Nyungwe forest. Non-regulated artisanal mining is commonly practiced. Other industrial activities include agro-processing of maize, rice, cassava, bananas, fruits, soybean, milk and honey. There are also four tea factories, one coffee factory, a soap industry, a tannery, and ceramics and handicrafts.

0.4. Main pollution issues

Analysis of emerging pollution issues in Nile Nyabarongo Upper Catchment led to the following prioritisation: (i) High to extremely high river sediment loads resulting from poor agricultural practices (hillside agriculture and encroachment of river banks and inadequate mining practices (artisanal mining) and deforestation. The former has adverse impact on high removal costs from drinking water intakes and infrastructure for hydropower production as well as efficiency reduction of water treatment and hydropower production machines, (ii) Water bodies' contamination by E.coli and other pollutants (TSS, BOD and COD) resulting from discharge of inadequately treated domestic, commercial and coffee washing stations wastewater as well as poor application of agro-chemicals, (iii) Littering of municipal solid wastes that impacts on aesthetic appearance and disturbance of stream flow following related accumulation of floating solid waste, dumping of building rubble, or dumping of large objects such as broken furniture, tyres, etc into river channels and (iv) Lack of data on pollution and low enforcement of laws and regulatory instruments resulting from low skills and awareness levels.

0.5. Integrated Pollution Management Vision and objectives

The vision for the Nile Nyabarongo Upper catchment is:

"Nile Nyabarongo Upper is a well-managed catchment supporting the community to meet its socio-economic needs in a sustainable manner without compromising natural ecosystem to provide its services"

Achievement of the vision will be through the following strategic goals:
1. Strengthening pollution management planning at catchment level
2. Efficient and effective pollution management in Nile Nyabarongo Upper catchment
3. Effective information and knowledge management

0.6. Proposed interventions

Interventions proposed in this plan have focused on coordination of planning at catchment level, inadequate management of solid and liquid wastes; sub-standard farming & mining practices aggravating soil erosion and pollution and low skills and awareness levels on pollution issues.

- *Interventions for addressing uncoordinated planning processes at catchment levels*: (i) Operationalise catchment technical committee in NNYU (ii) Support integrated planning at catchment level and (iii) Support regular coordination meetings of water committee, environment committee and water user's organisations.

- *Interventions for addressing inadequate management of solid &liquid wastes*: (i) Promote eco-design of wastes treatment facilities (i.e wastewater treatment plants and landfills) (ii) Support the development of centralised wastewater and municipal solid wastes treatment plants (iii) Sensitisation & education of general

public on waste management techniques (iv)Training and agreement with industries on the use waste minimisation technologies, including cleaner production (v) Provide information to facilitate the use of up to date technologies in industries (vi) Multiply inspections for environmental compliance in mining sector (vii) Support rainwater harvesting on rooftops of settlement areas (viii) Construction of water drainage to capture road drainage & settlements and (ix) Support resettlement of population in high risk zones

- *Interventions for addressing sub-standard mining & agricultural practices* (i) Consistently enforce environmental regulation to stimulate operators to implement efficient and green techniques and technology, including model mining (ii) Facilitate the inclusion of local communities in the monitoring of environmental impacts during operations and after mine closure (iii) Support innovation in the mining sector through promoting sustainable and innovative infrastructure (iv) Build human capacity in technical and environmental skills and knowledge through education, training and work experience (v) Develop long-term programme to address abandoned mine sites, including holding responsible party's liable and incentivising investment in reprocessing waste (vi) Enforce water quality standards (vii) Develop mandatory best environmental management practices and restrictions on inputs (vi) Payment for ecosystem services (ix) Introduce farm advisory services and trainings on improved farming techniques to minimise negative impacts on water quality

- *Interventions for addressing low skills and awareness levels on pollution issues*: (i) Develop training package on urban and rural pollution and BMPs., (ii) Conduct trainings, awareness raising and capacity building among farmers on smart agriculture (iii) Conduct capacity building in sustainable mining approach/Model mining among mining operators (iv) Disseminate policies, laws and regulatory instruments on environment protection, sustainable mining and smart agriculture.

0.7. Implementation, Monitoring & Evaluation

The above plan goals, objectives and associated interventions can only be achieved with clear institutional arrangements. Institutions roles and responsibilities were defined in this plan. The plan will be implemented through the District Development Strategies (DDS) at District level as well as Imihigo targets and action plans at local levels. Local Administrative Entities Development Agency (LODA) and Rwanda Water Board will coordinate the integration of interventions proposed in this plan into Districts annual action plans and Imihigo. Nile Nyabarongo Upper catchment committee will also support the implementation of the plan. The overall success of implementation of the Nile Nyabarongo Upper Integrated Pollution Management Plan lies in strengthening the human and financial resources capacity of Districts and Rwanda Resources Board by sourcing for funds for the execution of the proposed interventions.

CHAPTER ONE: INTRODUCTION

1.1. Background and context

LDCF II Project entitled "Building resilience of communities living in degraded wetlands, forests and savannas of Rwanda through an ecosystem-based adaptation approach"

The Least Developed Countries Fund (LDCF) II Project titled "Building resilience of communities living in degraded forests, savannahs and wetlands of Rwanda through an Ecosystem-based Adaptation (EbA) approach" is funded by Global Environment Facility (GEF) through United Nations Environment Programme (UNEP) under climate change adaptation GEF focal area for total 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 wetlands ecosystems. The above objective will be achieved through

i) increasing the technical capacity to plan and implement E-bA at national and local levels;

ii) strengthening the national and local policies, strategies and plans to facilitate the national implementation of E-bA;

iii) restoring degraded savanna, forests and wetlands to provide proof-of-concept for the role of ecological infrastructure in increasing climate resilience and providing alternative livelihoods for local communities

The project has three components:

1. The National and local institutional capacity development for the use of an EbA approach.

2. Policies, strategies and plans for adaptation to climate change.

3. Ecosystem based Adaptation (EbA) interventions that reduce vulnerability and restore natural capital.

The LDCF II Project was designed to demonstrate The LDCF- demonstrates the benefits of EbA by using intervention sites in the most vulnerable areas in Rwanda. To maximise the sustainability and upscaling of the interventions, the project will:

(i) train national- and local-level authorities as well as local communities at intervention sites on the use of EbA;

(ii) increase scientific knowledge on the benefits of EbA and identify best practices for EbA;

(iii) provide guiding documents to mainstream EbA into policies, plans and strategies in Rwanda; and

(iv) increase local community awareness on the role of ecological infrastructure in increasing climate resilience.

Technical Assistance in Wetland and Catchment Management Framework Study (this project)

With aim to collate current knowledge on status and health of the environment within catchments that include forest, savannah, and wetland ecosystems in Rwanda, to develop systematic mapping and monitoring tools to identify basin management needs and track progress towards addressing them as well as to develop an understanding of the drivers of their degradation and to prepare a range of plans based on the results of the analyses and in response to climate threats, LDCF II/REMA

In accordance with the Term of References, the Wetland and Catchment Management Framework Study consists of a number of tasks:

Strategic Plan for Ecosystem Based Adaptation and Wetland Management which includes a status quo description, national wetland management plan, guidelines for wetland management, and technical support with implementation of the plan.

Water Quality Management which includes to identify pollution hotspots in Rwanda, develop water quality management guidelines, and develop water quality management plan for Rwanda, a water quality modelling tool, and integrated pollution management plans for four catchment areas.

Develop integrated catchment management for some catchments in Rwanda (Nile-Akagera upper, Nile-Nyabarongo lower and Nile-Nyabarongo upper including Nyiramuhondi watershed), and

Capacity building and training

This report is part of Water Quality Management task and presents the Integrated Pollution Management Plan for Nile-Nyabarongo Upper Catchment

Terms of Reference for Integrated Pollution Management Plan

According to the ToRs the development of the Integrated Pollution Management Plan will requires identification of key pollution indicators of interest (e.g. fecal coliforms, BOD, COD, DO, Nitrates, etc.), mapping of major sources of pollution (e.g. residential areas, schools, abattoirs, major industrial areas, etc.), existing pollution management facilities and their capacities, and loading estimates

for key pollutants, understanding of the transport and fate of these pollutants, key sensitive areas (e.g. water intakes, areas of ecological concern, etc.), appropriate standards/guidelines, and a longer-term plan of investments to help meet these standards/guidelines. To the extent possible, the plan should also survey economic costs and benefits to pollution and pollution management respectively.

In addition, the pollution management analysis and prioritization should consider the impacts and lessons from the current activities under the LDCF II and LVEMPII project and suggest improvements in the targeting or design of future activities, as appropriate

1. 2. Scope and purpose

In Rwanda, high population density, expanding industrialization and urbanization, inappropriate waste and wastewater management, high rainfall intensity on steep slope high elevation are putting pressure on natural environment leading pollution, particularly in urban areas. The potential pollutants that could arise from the above pollution drivers requires careful management to avoid negative impacts on human health, and environmental factors such as groundwater, soils, surface water and ecology.
Nile Nyabarongo Upper Integrated Pollution Management Plan provides identified key pollution indicators, mapped major sources of pollution in the catchment, provided appropriate standards and guidelines applicable to pollution management and proposed long term actions to tackle pollution in Nile Nyabarongo Upper catchment.

1.3. Layout of the report

Nile Nyabarongo Upper Integrated Pollution Management Plan consists of the following chapters:

Chapter 1: gives an introduction to the study through presenting the general background of the Integrated Pollution Management plan, scope of the plan as well as the layout of the report.

Chapter 2: is a description of the methodology followed in the preparation of the Integrated Pollution Management Plan

Chapter 3: provides a brief overview of the catchment description, its key geographic features, and the challenges that affect pollution.

Chapter4: provides an overview of the emerging pollution issues in the Nile Nyabarongo Upper catchment, their characteristics and related mapping

Chapter 5:describes an integrated pollution management plan to deal with the problems of pollution in the catchment, targets to achieve, indicators to be monitored as well as the resources required

Chapter 6: describes monitoring that should be undertaken to assess the situation and the success of intervention.

CHAPTER 2. METHODOLOGY

The process of developing strategies and plans to address the problems associated with pollution is known as integrated pollution management planning. The Integrated Pollution Management Plan (IPMP) is the main output of the planning process. The IPMP records a vision for the catchment area and formalises the key current and future trends of the various pollution categories such as water, land, air and noise pollution. The IPMP also provides additional details with regard to the specific implementation of options for improved catchment pollution management while still promoting green growth and development objectives.

The IPMP states how issues and concerns will be addressed through management strategies within a specified time period, and outlines an associated procedural and technical framework for implementation.

The first step of the planning process, is to determine the current pollution state of the catchment area. The steps followed for the catchment integrated pollution management planning process are outlined in Figure 1.

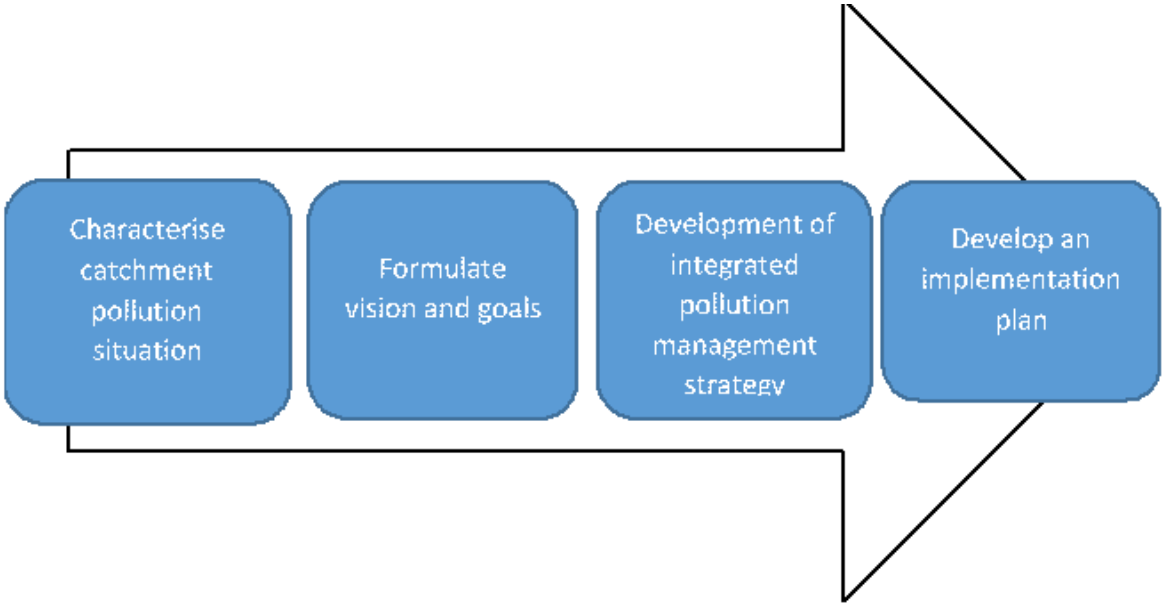

Figure 1: Steps in developing the Catchment Integrated Pollution Management Plan

Step 1: Characterise the catchment pollution situation

This step provides for gaining an understanding of current characterization of pollution issues and sources in the catchment area. It also identifies and prioritize the key pollution challenges and opportunities.

1. A review of relevant literature was undertaken to familiarise the project team members with the catchment area under consideration, and the historical pollution issues that have been documented. In this task the team also consulted the relevant district development plans, urban management plans, and district sanitation master plans provided these were available at the time.

2. The project team generated maps of the relevant catchment areas. The data and information (shapefiles) provided by the Rwanda Land Use and Management Authority (RLMUA), Rwanda Water Board (RWB) and Rwanda Housing Authority (RHA) were used to delineate the catchment boundaries and urban areas in the catchment. .
3. The team then met with district officials which included the District Environmental officers and others with knowledge of pollution sources and concerns. The objectives of the meetings were to identify pollution hotspots in their area, what the pollution concerns were and their impacts, the possible sources of pollution, and what is or could be done to manage it.

In order to guide the discussion, the officials were requested to consider beforehand the following aspects and whether it is relevant in their area:

(i) Examples of sensitive catchment areas which should be protected against pollution

- Important water abstraction points (surface or groundwater) for domestic or catchment agricultural use
- Cultural areas at or near streams and rivers
- Important parks or conservation areas
- Stormwater drainage network

(ii) Examples of types of pollutants

- Sediments and erosion
- Nutrients (nitrogen, phosphates) and excessive algae in streams and dams (fertilisers)
- Hydrocarbon pollution from fuels, oils, and grease
- Agrochemicals such as pesticides and herbicides
- Microbiological pollution (pathogens) that cause diseases such as diarrhoea, cholera, etc.
- Organic pollutants that consume oxygen in the water when it breaks down leading to fish kills
- Trace metals from solid waste dumps, landfills, and industries
- Solid waste and litter in streams

(iii) Possible point sources of pollution

- Wastewater Treatment Systems and their effluents
- Industrial effluents
- Hotels, hospitals, etc.
- Formal and informal abattoirs
- Landfills and solid waste dumps
- Fish farm outflows

(iv) Nonpoint or diffuse sources of pollution

- Stormwater drainage system
- Grey water disposal into stormwater system
- Informal sewage disposal into urban canals, stormwater drains and urban streams
- agriculture and wetland agriculture, aquaculture
- Garages, vehicle workshops, vehicle service centres
- Fresh produce markets with no or poor solid waste management
- Unpaved and poorly maintained urban roads, construction sites
- Seepage from septic tanks

(v) Existing pollution management options

- Regulations and bylaws that control certain activities and discharges into the stormwater drainage system
- Riparian buffer zones
- Stormwater detention dams, natural and artificial wetlands

Where possible, coordinates for issues were captured and integrated into the maps developed by the project team or directly in Google Earth as place marks with a title and description. These were then summarised in this report along with other issues stemming from the literature review

4. Some of the pollution hotspots that were identified during the discussions were visited to visually inspect the situation at the selected hotspots, to take photographs at the sites, and to undertake some water sample collection for measurement of temperature, pH, electrical conductivity, and turbidity.

Step 2: Formulating a vision and goals

This involves describing the desired state of the catchment area over the long term with respect to pollution, together with goals (preliminary objectives) and targets to achieve this over time. This should be developed in a participatory approach with stakeholders from the catchment area.

A stakeholder workshop was held on the 3rd of October 2017 in Kigali where officials were given the opportunity to confirm and prioritise the pollution issues in their area, to develop the key elements of an integrated pollution management vision for their catchment area, and to develop initial goals, objectives and interventions to manage pollution in their catchment area.

Step 3: Developing an integrated pollution management strategy

This includes specifying a coherent suite of strategic objectives and outcomes related to pollution management, designed to achieve the vision.

Incorporating the vision, goals and objectives determined through the stakeholder engagement process, as well as the information provided from the catchment pollution characterisation, a catchment pollution management strategy is proposed.

Step 4: Detailing an implementation plan

The main activity at this point is defining the actions needed to give effect to the catchment pollution management strategy and that should ultimately achieve the vision and objectives, as well as who is responsible for the actions, the indicative phasing and cost estimates for the actions.

To give effect to the proposed strategy, and for the achievement of the goals, objectives and ultimately the vision of the Nile Nyabarongo Upper area, an implementation plan is included in this IPMP.

CHAPTER 3. CHARACTERISTICS OF NILE-NYABARONGO UPPER CATCHMENT

The purpose of this chapter is to provide a brief summary of the main characteristics of the Nile Nyabarongo Upper catchment, with a focus on those features that would affect both rural and urban pollution. Key pollution issues identified during the project are described in the chapters that follow on this descriptive chapter.

3.1. Administrative boundaries

The Nile- Nyabarongo upper catchment covers significant areas of eight districts (Karongi, Ngororero, Rutsiro, Huye, Nyanza, Ruhango, Muhanga and Nyamagabe) with very small pieces of Nyamasheke and Nyaruguru districts. The overlay of the catchment and the districts is presented in Figure 2.

Figure 2: Nile Nyabarongo Upper catchment, sub-catchments and district boundaries.

3.2. Population distribution and poverty rates

According to the national census of 2012, the total number of people who lived within the catchment was around 1.2 million with 6.7% living in urban areas and 93.3% living in rural areas. The medium projection scenario estimated that in 2020, population in Nile Nyabarongo Upper catchment would stand at 1,976,208 with about 377,595 (19.1%) being urban and 1,598,613 (80.9%) rural population (RWRMP, 2014).

Sectors with the highest population densities are located in urban areas in Muhanga, Nyamagabe and Huye. In these areas, the population density ranges from 900 - 1500 habitants/km2. Other areas that are densely populated lie in the northern part of the catchment in Ngororero where the population density is 600 – 900 habitants/km2. Previously, human settlement was encroaching on Nyungwe forest area, but recently these communities have been resettled. The high population densities exert a lot of pressure on water and land resources which manifests itself

in the high rate of land and wetland degradation and pollution of water sources.

The catchment has a very young population; over 40% of the population is younger than 15 and almost 52% of the population is below 20. The total female population exceeds the male population by about 10%.

Poverty rates within the catchment area are still very high with approximately 40.8% of the population classified as poor while 15.6% are regarded as extremely poor. The statistics relating to poverty are derived from the Household Living Surveys (EICV4) and are defined on the basis of consumption figures. The 'poor' poverty classification is related to a consumption level of a basket of food and non-food items defined as 159,375 RWF per capita per year for the EICV4 survey (January 2014 prices). The 'extreme poor' poverty level classification is defined on the basis of consumption related to the cost of the basket of food items at 105,064 RWF per capita per year.

Nyamagabe, Karongi, Rutsiro, Ngororero and Ruhango have the highest poverty rates (Table 1), with Nyamagabe district having the highest poverty and extreme poverty rates of all Rwandan districts. The cause of poverty has often been linked to high population growth and declining soil fertility in a largely agrarian economy.

Table 1: Population % identified as poor and extreme poor for the Upper Nyabarongo catchment

District	% poor (district population)	% extreme poor (district population)
Karongi	45.30%	21.30%
Ngororero	49.60%	23.50%
Rutsiro	51.40%	23.60%
Huye	32.50%	5.70%
Nyanza	38%	17.60%
Ruhango	37.80%	23.60%
Muhanga	30.50%	7.80%
Nyamagabe	41.50%	13%
Average	**40.80%**	**15.60%**

3.3. Climate

Temperature observation data within the Nile Nyabarongo Upper catchment shows a maximum daily temperature of almost 25.3°C and minimum of 14.6°C in the western part of the catchment. The southern part of the catchment has a maximum daily temperature of 23.6 °C and a minimum daily temperature of 14.0°C.

3.4. Land use

The Nile Nyabarongo Upper map was developed based on CROM data developed by Rwanda Water Board using remote sensing technology combining radar and optical imagery from 2016- 2018, and ground truthing in the field. Figure 3 below presents existing characteristics of Land Use and/or Land Cover (LULC) in NNYU

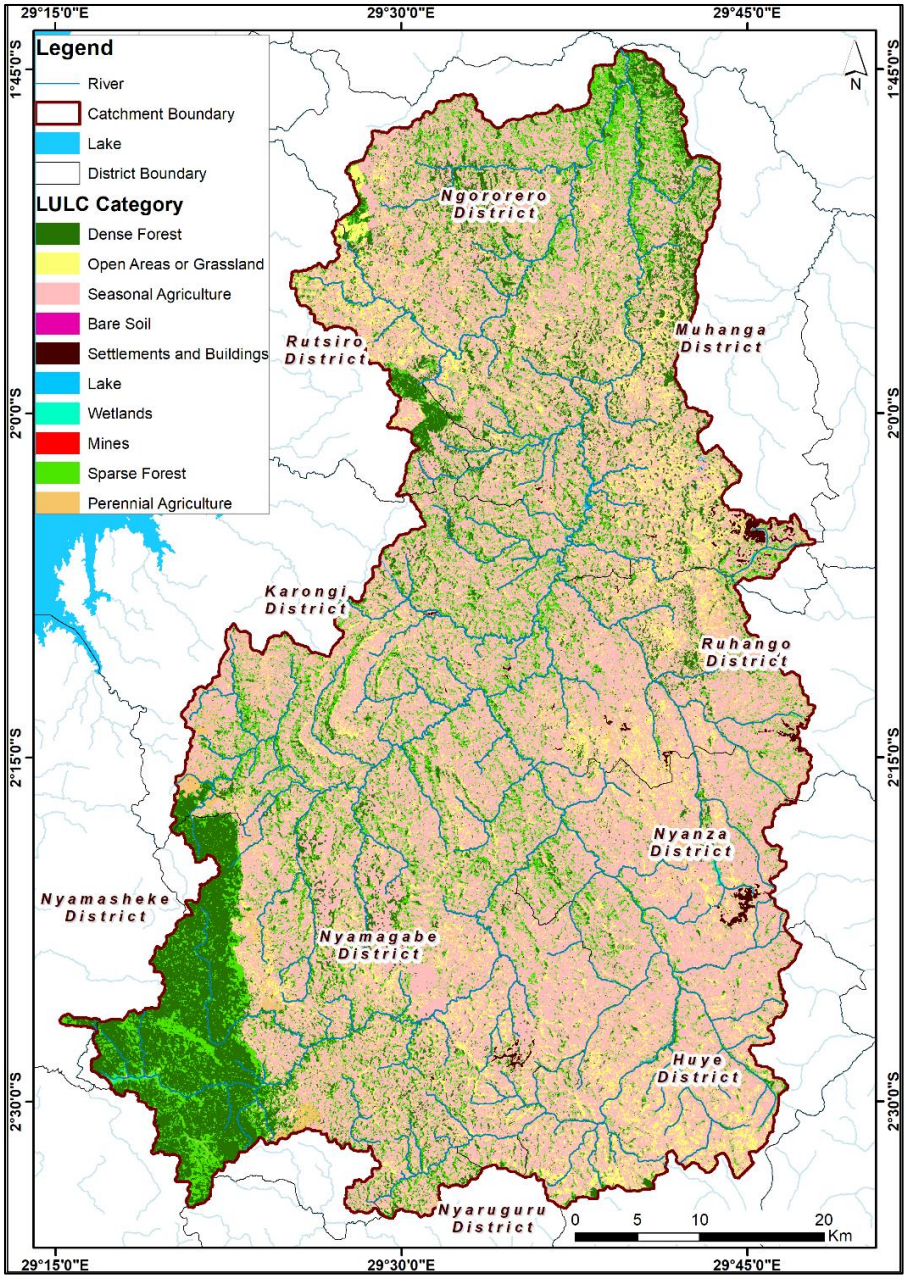

Figure 3: Existing Land Use and/or Land Cover (LULC) in NNYU

The area and relative proportion of each LULC class for the Upper Nyabarongo catchment is presented in Table2.

Despite the presence of parts of two national parks (Nyungwe and Mukura Forests), the total forested area covers only about 10% of the catchment area and from this, about 10% is considered sparse, i.e. shows signs of tree felling or other forms of degradation. The influence of pressure resulting from a high population is very clear with agriculture the prominent land use, comprising the classes 'agriculture (seasonal)', 'agriculture (perennial)' and 'open areas or grass', jointly adding up to 85%. The predominance of this class therefore also reflects the enormous impact of agriculture on land cover and, combined with the high soil erosion risks on steep slopes, contributes strongly to sediment ingress from such land into rivers.

Settlements and buildings, water, and wetlands occupy very limited areas of the catchment. The table 2 below presents land cover classification in Nile Nyabarongo Upper.

Table 2: Land use / land cover classification Upper Nyabarongo (W4GR, 2018)

Class	Area (ha)	Percentage (%)
Forest	14,347	9%
Sparse Forest	1,212	1%
Open areas or grass	37,914	23%
Agriculture (seasonal)	83,462	50%
Agriculture (perennial)	20,710	12%
Settlements and buildings	4,338	3%
Water	3,816	2%
Wetlands	337	0%
Total	166,135	100%

3.5. Economic activities and basic services infrastructure

Rain-fed agriculture is the predominant socio-economic activity in Nile Nyabarongo Upper catchment with both cash crops (coffee, tea, honey and horticulture) and food crops (maize, beans, irish potato, wheat, cassava, banana, fruits and rice). Agroforestry and forest plantations have also been promoted as appropriate land use management systems in the catchment, e.g. in the catchment rehabilitation plan for the catchment. Exotic species such as eucalyptus, pines, cypress, acacia and alnus have also been promoted. However, despite these initiatives, forests cover has been declining due to the high pressure exerted by demands for agricultural expansion, human settlement and use of firewood for cooking.

Livestock rearing is also another predominant socio-economic activity in Nile Nyabarongo catchment with approximately 70% of the households engaged in livestock rearing. The most commonly owned types of livestock are: cattle, goats, pigs, rabbits and chicken. The one cow per poor family program known as ‘GIRINKA” has increased the number of cows producing milk countrywide. Fish farming is widely practiced in Huye and Nyanza districts where productivity is sought to be increased through construction of dams and fish ponds.

In addition, mining and quarrying are considered as important sources of revenue and employment. The main precious mineral resources exploited are: granite, tin, tungsten, colombo-tantalite (*coltan*) and cassiterite. The sites where extraction takes place are in Rutsiro, Ngororero, Nyamagabe, Muhanga, and Karongi and in the Nyungwe forest. Non-regulated artisanal mining is commonly practiced. Other industrial activities include agro- processing of maize, rice, cassava, bananas, fruits, soybean, milk and honey. There are also four tea factories, one coffee factory, a soap industry, a tannery, and ceramics and handicrafts for Agaseke.

At last, there are many tourism opportunities, but these still remain largely under-exploited. The opportunities are around the natural forests in Nyungwe, Mukura, Gishwati and Busaga. Nyanza is home to the traditional royal palaces of the ancient

kingdoms, hence there is opportunity to further develop cultural tourism. Figure 4 presents key socio-economic activities in Nile Nyabarongo upper

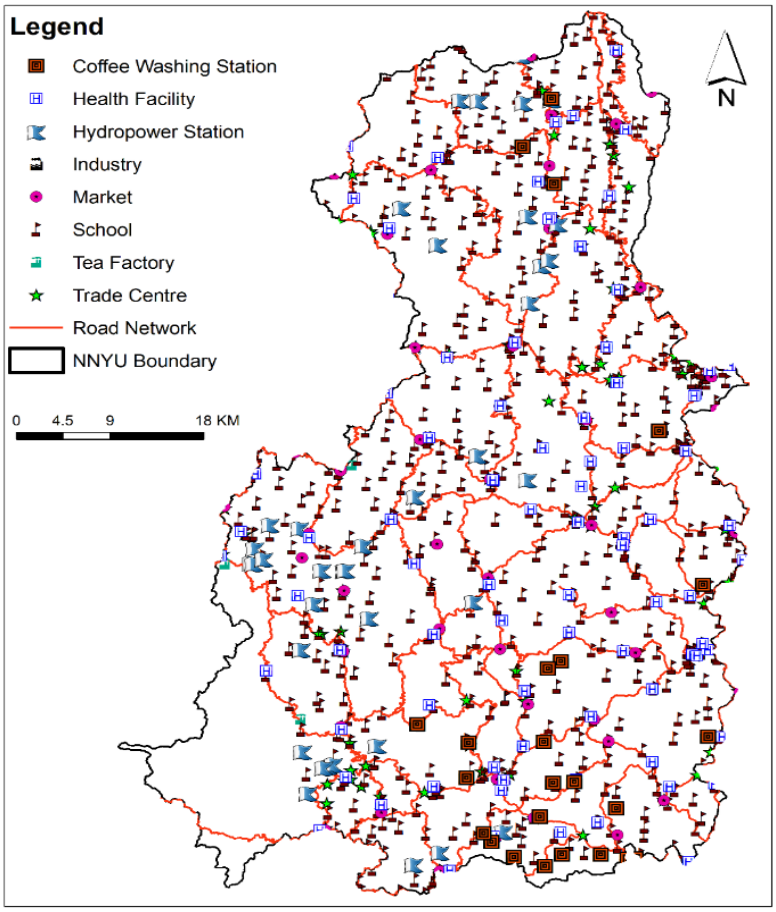

Figure 4: Key socio-economic activities in NNYU

3.6. Access to basic services

Access to safe drinking water and improved sanitation and hygiene practises is low. 60% of the population in the catchment has access to a public tap or a protected spring for water supply and 15% of the households make use of unprotected springs for water supply. In comparison with the national data (76% of the Rwandan population has access to a public tap or protected spring), the Upper Nyabarongo catchment shows a lower percentage of access to improved sources of drinking water. Sanitation figures show more than 80% of the households use a private pit latrine albeit only about two- thirds comply with the international standard definitions of an improved sanitation facility. Very few Rwandan households have installed flush toilets (which require a house connection to a public water supply network). The prevailing practice remains that water is used for cooking and washing only (its 'grey' wastewater is discharged mostly on surface) while the excreta are disposed of in waterless latrines16. According to the latest WHO/UNICEF (JMP) report 2015 17, the percentage of Rwanda's population with a hand washing facility at home, consisting of soap and running water, is estimated at only 6% in urban and 1% in rural areas.).

The primary road network is well developed with good tarmac road access from Kigali to Muhanga, and subsequently from Muhanga to Nyabihu, Muhanga to Karongi, Muhanga to Nyanza and Huye, and Huye to Nyamasheke and further to Rusizi. However, road travel outside the primary road network is challenging. Access to electricity is limited, only a low percentage of households uses electricity for lighting. Energy consumed is in the form of traditional biomass burning, particularly firewood and charcoal. Cooking with firewood is practised by more than 92% of the population. Alternative sources of energy like biogas and improved cooking stoves are still limited.

3.7. Hydrology

The Nile Upper Nyabarongo Nyabarongo springs from the confluence of the Mwogo and Mbirurume rivers and runs to the confluence with the Nyabarongo Upper River from where the Nyabarongo continues as the Lower Nyabarongo on its way to the Akagera River and Lake Victoria. The catchment is also reputed to be the water tower of Rwanda and boosts a significant number of tributaries, of which the most important are from south to north:

- Mwogo River with a length of 81.1 km;
- Rukarara River (length of 47.4 km) springing from the Rubyiro and the Nyarubugoyi rivers;
- Mbirurume River (51.6 km);
- Mashyiga River (12.2 km);
- Kiryango River (10.4 km);
- Munzanga River (24.4 km);
- Miguramo River (15.0 km);
- Satinsyi River (59.7 km).

The land morphology of a catchment is a crucial characteristic that determines a significant part of its hydrological response to rainfall. A significant portion of the area (particularly in the west of the catchment) is of high altitude (above 2000 m) with steep slopes, peaking at 2950 m. The outflow of the catchment is at 1410 masl altitude, at the confluence of the Upper Nyabarongo and the Nyabarongo Upper Rivers.

The Upper Nyabarongo has a sustained flow during the dry season months (July and August) and a moderate hydrological response i.e. with receding flow prior to the rainy season from the months of September up to December. The large rainy season from February up to May shows a more robust increase of monthly flow levels, which indicates that groundwater reserves are replenished in these months. This kind of hydrological response is typically caused by significant infiltration and groundwater storage of rainfall along the Nyabarongo River and its tributaries.

In 2018, Rwanda Water and Forestry Authority developed a water balance and allocation model for Nile Nyabarongo Upper catchment. The results from the model showed that in all sub-catchments, the largest amount of allocated water is

dedicated to environmental flow; irrigation comes second, followed by minimal domestic, livestock and industry use. Surplus water is currently discharged to downstream users (on top of the environmental flow), but also offers potential for use within the catchment or (via inter-catchment transfers) in neighbouring catchments, by different categories of water users, and thus offers a resource for growth and development. Figure 5 below shows the annual water allocation per water use sector in Nile Nyabarongo Upper

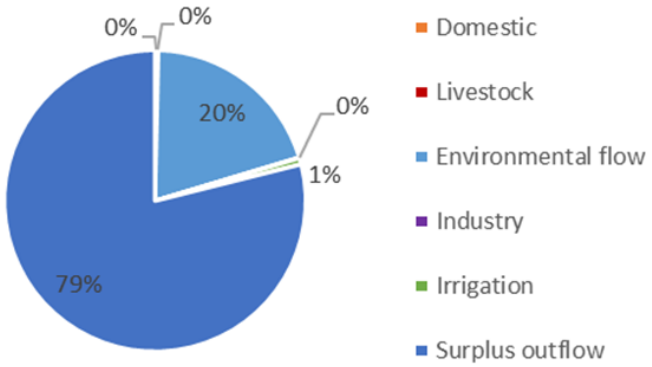

Figure 5: Annual water allocation per water use sector, baseline scenario (source: WEAP model, WRMD, 2018)

3.8. Water Quality

3.8.1. Surface water quality

The status of water quality in Upper Nyabarongo catchment is regularly monitored at 6 permanent locations: upstream on Rukarara river at gauging station, Mwogo before its confluence with Mwogo, Mbirurume before its confluence with Mwogo, on Nyabarongo before its confluence with Nyabarongo Upper and Nyabarongo after its confluence with Nyabarongo Upper.

Data analysed from these measurements and findings corroborated from the NWRMP indicate that there are:

- Very high sediment loads and turbidity, due to mining and to traditional farming methods;
- High loads of E. coli and coliform bacteria (and others not measured) from untreated sewage;
- High organic loads and high biological oxygen demands (BOD) and chemical oxygen demands and resulting low concentrations of oxygen (mg/L).

According to Table 3 below, the dissolved oxygen (DO) is generally in acceptable range. Dissolved oxygen is considered as one of the most important aspect of aquatic environment. It is needed by species to respire and perform metabolic activities. Thus low levels of dissolved oxygen are often linked to species death incidents. On the other hand, optimum levels can result to good growth, thus result to high production yield. In general, a saturation level of at least 5 mg/l is required. Values

lower this can put undue stress on the aquatic species and levels reaching less than 2 mg/L to death of species.

Similarly, other water parameters such as Dissolved Inorganic Nitrogen (DIP), Dissolved Inorganic Phosphorus (DIP), BOD, COD and heavy metals (Pb &Zn) were found in acceptable range. The presence of total suspended solids (TSS) above acceptable limits is attributed to the soil erosion that contribute to water pollution by sediments transport and extraction of sand by local People. Most of rivers are surrounded by a steep slopes resulting from the presence of hills and mountains. The soil moves to the valleys and reach the surface water. In addition, mining in the catchment is still using artisanal methods which trigger landslides and leaves behind barren waste rock dumps. The topsoil is exposed to erosion when it rains; rivers near receive a lot of soils carried by erosion.

Table 3: Water quality characteristics of Nile Nyabarongo Upper

Sampling sites	D.O	pH	TSS	COD	BOD	DIN	DIP	Pb	Zn	E.Coli
Mwogo upstream	7.43	6.8	896	14.11	6.45	3.620	0.828	ND	0.357	$2.2x10^2$
Rukarara upstream	7.95	7.67	21	10.24	5.25	3.211	0.310	ND	0.228	$3.1x10^3$
Mwogo before Rukarara	4.54	6.81	2804	14.94	31.80	4.421	0.879	ND	0.512	$4.1x10^2$
Rukarara downstream	7.42	7.04	600	12.46	5.55	3.674	0.483	ND	0.276	$2.2x10^3$
Mbirurume downstream	6.9	7.19	724	13.1	7.20	3.772	0.638	ND	0.188	$6.1x10^2$
Mwogo before Mbirurume	5.5	7.48	940	12.75	6.75	4.820	1.552	ND	0.681	$3.0x10^2$
Nyabarongo at Kirinda	6.04	7.01	796	15.23	6.45	5.773	0.936	ND	0.306	$2.0 x 10^2$
Nyabarongo at mwaka	6.24	6.34	2964	16.4	7.65	5.670	0.948	0.007	0.420	$3.1x10^3$
Nyabarongo before mukungwa	6.87	7.1	2712	13.5	7.9	6.009	1.241	ND	0.184	$6.1.x 10^2$
Standards (industrial discharge)	0-12	5-7	**50**	**250**	**50**	**20**	**5**	0.1	5.0	**400**

3.8.2. Groundwater quality

Groundwater quality in Nile Nyabarongo Upper is not well known since there is no regular monitoring network for groundwater However, few studies carried out in the catchment (Wondatir Nigatu et al., 2015; Nsengimana.H et al.; 2012) found the presence of heavy metals and E.coli above drinking water acceptable limits in groundwater wells sampled in Muhanga and Huye Districts The presence of E.Coli in

samples is an indicator that other pathogenic microorganisms such as Salmonella spp., Klebsiella spp., Serratia spp., Shigella spp., M. morganii, and Proteus spp are also present in the ground water wells.

The above studies revealed that the presence of coliforms in groundwater were more pronounced during the rainy season than in the dry season. This implies the transport of pollutants by runoff and infiltration of contaminated water. The utilization of such water may cause diseases like dysentery, diarrhoea, typhoid, cholera, jaundice, gastroenteritis, shigellosis, enteric fevers, and other ailments, therefore there is a need to treat water before utilisation. Faecal coliforms like other bacteria can usually be killed by boiling water or by treating with chlorine. This also shows a need of continuous water quality monitoring to ensure that it meets the standards of drinking water.

CHAPTER 4. EMERGING POLLUTION ISSUES IN NILE NYABARONGO UPPER

4.1. Introduction

Emerging pollution issues discussed in this chapter are pressures and threats to environment (with focus on water quality) that are assumed to be those things resulting from human actions (past, current and future), which have potential to impact water quality, along with natural phenomena and environmental factors. These include natural phenomena exacerbated by human interaction, inappropriate land management practices, and low enforcement of laws or misdirected policy settings. These key problems, together with their underlying causes and opportunities, are discussed in detail below.

4.2. Analysis of Policy, Legal and Regulatory Frameworks

An enabling policy, legal and institutional framework is key to the development and subsequent implementation of the Integrated Pollution Management Plan for Nile Nyabarongo Upper catchment. These issues are explored in the sections below:

4.2.1. Policy Framework

a) Vision 2050

Vision 2050 is about ensuring high standards of living for all Rwandans and is aimed to shift Rwandan's from the current livelihood to the society everyone wants and proud to belong. In order to realize this Vision, the country will embark on economic transformation, social transformation and governance and justice. The country will increase momentum towards reaching upper middle income by 2030 and high income by 2050. This will require average annual growth of above 10% per cent. Therefore, the Vision 2050 provides the policy context for the plan. Nile Nyabarongo Upper Integrated Pollution Management Plan will contribute to this country ambition by progressively achieving pollution management to ensure high standard of living and environmental welfare

b) National Strategy for Transformation

The National Strategy for Transformation (NST1) which is also the Seven Year Government Programme (7 YRGM) is an implementation instrument for the remainder of Vision 2020 and for the first years of the journey under vision 2050. In order to achieve the high-level targets of Economic Transformation and prosperity, the contribution of Nile Nyabarongo Upper Integrated Pollution Management Plan to the targets of NSTP is included in the following **NST1 5.16** statement "*Additional emphasis will be put on strengthening monitoring and evaluation. High impact areas selected include implementation of:* ***Environmental and social Impact Assessments****, biodiversity and ecosystem management,* ***pollution and waste management*** *"*

c) National Environment and Climate Change Policy, 2018

The National Environment and Climate Change Policy provides strategic direction and responses to the emerging issues and critical challenges in environmental management and climate change adaptation and mitigation. The policy goal is for

“Rwanda to have a clean and healthy environment resilient to climate variability and change that supports a high quality of life for its society.”

It sets up two key principles related to pollution management:

- Polluter Pays Principle according to which those responsible for environmental damage must be held liable for the repair caused to both the physical and human environments. They must also be held responsible for the costs of preventive measures to reduce or prevent further pollution and environmental damage.
- The Pollution Prevention Principle which anticipates problems and prevents negative impacts on the environment and people’s environmental rights

Nile Nyabarongo Upper Integrated Pollution Management Plan will contribute to achieving the National Environment and Climate targets through the following key policy statements related to pollution management

- Prevent and promote integrated pollution control and waste management
- Promote the circular economy to advance sustainable consumption and production patterns:
- Promote green technologies and procurement: and
- Promote sustainable management of wetlands.

d) National Water Resources Management Policy, 2011

The overall goal pursued in this water policy is to manage and develop the water resources of Rwanda in an integrated and sustainable manner, so as to secure and provide water of adequate quantity and quality for all social and economic needs of the present and future generations, and ensure full participation of all stakeholders in decisions affecting water resources management. This plan will contribute to achieving the policy targets through the following strategic policy actions:

- Monitor and assess water resources to understand the water balance and to support water accounting, identify the spatial and temporal occurrence and distribution in the country;
- Formulate a water resources management strategy addressing, inter alia, watershed protection and provides mechanisms for the designation of special conservation and or protection zones; and
- Promote water conservation techniques and technologies, including rainwater harvesting, water recycling and other appropriate technologies.

e) National Sanitation Policy

The vision of National Sanitation Policy is to ensure sustainable, equitable and affordable access to safe sanitation and waste management services for all Rwandans, as a contribution to poverty reduction, public health, economic development and environmental protection while the mission is to promote, plan, build and operate services in a sustainable, efficient and equitable manner. This plan will contribute to achieving the policy targets through the following policy objectives:

- Raise and sustain household sanitation coverage to 100 per cent by 2020, and promote hygiene behaviour change;
- Implement improved sanitation for schools, health facilities and other public institutions and locations;
- Develop safe, well-regulated and affordable off site sanitation services (sewerage and sludge collection, treatment and reuse/disposal) for densely populated areas;
- Enhance storm water management in urban areas to mitigate impacts on properties, infrastructure, human health and the environment5. Implement integrated solid waste management in ways that are protective to human health and the environment; and
- Ensure safe management of e-waste, industrial wastes, nuclear waste and health care waste.

f) Mining Policy, 2010

The Mining Policy covers wider aspects of regulation, institutional and investment framework for the mining industry, value addition and capacity building strategies as well as providing a clear plan of action to support the sub sector's growth.

This plan will contribute to the policy targets on improving the mining sector knowledge, skills and use of best use of best practices, especially the implementation of Model mining.

g) Urbanisation and Human Settlements Policy, 2015

This policy provides opportunities for alleviating pressure on rural land and biodiversity resources because increased urbanization raises challenges of utility supplies (water, energy, and housing) as well as waste disposal. This plan will contribute to this policy targets through addressing challenges related to waste minimization and promotion of green cities.

h) Industrial policy and Investment code, 2011

Environmental compliance advisory (especially relating to Environmental Impact Assessment), has been included among the services provided by the RDB, which is an opportunity to promote sustainable Environment and Natural Resources management. This plan will contribute to this policy targets through promoting resource efficient and cleaner production in industry sector.

i) Health Policy 2014 and Health Sector Strategic Plan

This objective of the Health Policy is centred on the reduction of burden of disease of the most important health problems in Rwanda – i.e., maternal and child health problems, infectious diseases and non-communicable diseases through access to primary health care. Both prevention and treatment and care services are included in these programmes, as well as interventions aimed at improving important health-determining factors, such as behaviour change communication, promotion of adequate nutrition, environmental health and sanitation, and access to safe water.

Policy directions with relevance to pollution management include:

- Environmental health interventions will be strengthened from the national to the village levels. Hygiene inspections will be decentralized to empower districts and sectors and the Community-Based Environmental Health Promotion Programme will be scaled up to be implemented country-wide.

Inter-sectoral collaboration between non-health departments and the MoH is essential for interventions targeting health determinants: water distribution and sanitation systems to meet essential health needs, public hygiene activities (domestic and health-care waste management, health inspections

4.2.2 Legal Framework

Table 2 below includes a summary of the relevant legislation related to pollution management.

Table 4: Summary of relevant pollution management legislation

Legislation	# and date	Relevance to pollution
The National Constitution	2003 (Amended in 2015)	The constitution of Rwanda guarantees the right to a clean environment for every citizen and other people living in Rwanda, and imposes on the state and population, the responsibility for keeping the environment clean and pollution-free. Article 23 states that everyone has the right to live in a clean and healthy environment while Article 53 of the amended Constitution states that everyone has the duty to protect, safeguard and promote the environment, that the State should ensure that the protection of the environment, and do so by means of a law that determines the modalities for the protecting, conserving and promoting the environment.
Law determining the use and management of water resources in Rwanda	Law N°49/2018 of 13/08/2018	This Law determines the use and management of water resources in Rwanda. It defines 'water' as a good belonging to the state public domain, recognizing the right to water for all. The Water Law provides a clear framework for the principles of integrated water resources management, including the prevention of pollution, and the principle of "user pays" and "polluter pays. It also provide that polluting water bodies by dumping, spilling or depositing chemicals

		of any nature above tolerable limit for human health or aquatic life, commits an offence (art.37) and set penalties for the defaulters
Law on environment	Law No 48/2018 of 13/08/2018	This Law determines modalities for protecting, conserving and promoting the environment. The law on environment gives effect to the National Environment and Climate Change Policy, which sets out how to transform into a nation that has a clean and healthy environment, resilient to climate variability and change that supports a high quality of life for its society. It defines the responsibilities of citizen and state and set principles for exploiting natural resources such as land, water, forests and air as well as protecting biodiversity, among others. The law requires all project developers whose projects may have harmful effects on the environment to carry out environmental impact assessment (EIA) before launching them. Articles 17, 18, 19 and 20 provide guidance on conservation and protection of built environment, focusing on the management of liquid and solid wastes, management of hazardous and toxic wastes and the management of electronic wastes. Article 42, 43, and 45 provide for prohibited acts, including prohibited acts in wetlands and protected areas, prohibited emission of noise, prohibited acts in protection of biodiversity and prohibitions related to chemicals and wastes At last the law provides for administrative sanctions for all defaulters (from art.46 to art.60)

Law relating to the prohibition of manufacturing, importation, use and sale of plastic carry bags and single-use plastic items	Law N° 17/2019 of 10/08/2019	This Law prohibits the manufacturing, importation, use and sale of plastic carry bags and single-use plastic items. The law is expected to check the increasing habit of unnecessary consumption and disposal of single use plastic items which becomes a burden to the environment.
Law governing the preservation of air quality and prevention of air pollution in Rwanda	No. 18/2016 of 18/05/2016	This Law applies to all measures aimed at the preservation of air quality as well as all elements or activities likely to affect air quality or pollute the atmosphere. The law sets, amongst other, air quality standards, and describes compliance with minimum air quality standards, emission limits, specific tolerance limit of pollutants from industries, inspection of air pollutants from the transport sector, air pollutants from construction works, air pollutants from the storage of objects, air pollutants from waste incineration, and air pollutants from other sources. The law also makes provision for administrative sanctions.
Ministerial Order establishing the list of projects that must undergo environmental impact assessment, instructions, requirements and procedures to conduct environmental impact assessment	No 001/2019 of 15/04/2019	This Order establishes: 1° the list of projects that must undergo an environmental impact assessment before they obtain authorisation for their implementation; 2° instructions, requirements and procedures for conducting environmental impact assessment.
Ministerial Order **Determining the list of Water Pollutants**	No. 004/16.01 of 24/05/2013	This order defines a water pollutant and then provides a list of: Physico-chemical pollutants, organoleptic pollutants & Organic Pollutants; radionuclides; and Biological Pollutants.
Ministerial Order	N° 006/2008	This ministerial order describes the modalities of inspecting companies or

Establishing Modalities of Inspecting Companies or Activities that Pollute the Environment	of 15/08/2008	activities that pollute the environment. It describes, amongst other, the responsibilities of inspectors, search and seizure of pollution products, analysis of suspected products, and decisions that REMA can take.
The Code of Criminal Procedure	No. 30/2013 of 24/5/2013	The Code of Criminal Procedure currently in force has been enacted in 2013. It governs the procedures by which authorities investigate, prosecute, and adjudicate crimes which includes environment offences.

4.2.3. Standards and guidelines related to pollution management

4.2.3.1. Standards relevant to effluent discharges

Dischargers of domestic and industrial effluents must comply with Rwandan standards as specified by the Rwanda Standards Board.

Rwanda Standard RS 110 of 2016 provides the limits for the discharge of treated domestic wastewater effluent into the environment as well as the test methods that should be employed for the individual constituents.

Rwanda Standard RS 109 of 2009 specifies the limits for the discharge of treated industrial wastewater effluent into the environment as well as the test methods that should be employed for the individual constituents.

According to the EAC website, the EAC Secretariat is working to harmonise effluent discharge standards, strengthen the capacity of EAC Partner States in enforcement of pollution control laws and establish pollution monitoring system in the EAC, and urges Partner States to allocate more resources for the implementation of conventions to which they are party such as Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, and the Stockholm Convention on Persistent Organic Pollutants.

At EAC regional RECP meeting held in Nairobi in July 2016 for harmonizing GIS mapping report, all EAC countries represented by Directors of National cleaner production centres and RECP Experts agreed to apply regional EAC standards in order to harmonize limits used to assess industrial pollution levels (Niyonzima, 2017). The EAC standards "East African Industrial and Municipal Effluents Standards" was published in January 2016 (EAC Gazette, 2016. The Table3 below provides the Regional EAC standards used to assess industrial wastewater effluents.

Table 5: Regional EAC standards used to assess industrial wastewater effluents (MINICOM, 2017)

Minimum pollution load (Green)	Medium pollution load (Blue)	High pollution load (Red)
BOD < 30 mg/l	BOD between 31 – 250 mg/l	BOD > 500 mg/l
COD < 60 mg/l	COD between 61 – 500 mg/l	COD > 500 mg/l
TN < 10 mg/l	TN between 10 – 20 mg/l	TN > 20 mg/l
NO_3 < 5 mg/l	NO_3 between 5 – 10 mg/l	NO_3 > 10 mg/l
TP < 5 mg/l	TP between 5 – 10 mg/l	TP >10 mg/l

4.2.3.2. Standards relevant to air emissions

Emitters of air pollution in Nile Nyabarongo Upper catchment must comply with air emission standards set by Rwanda Standards Board. The Rwanda air quality law was promulgated in May 2016 and it is supported by the Rwanda Standards Board who has developed emission standards and air quality specifications that are applicable for Rwanda and aligned with East African Community standards. These include:

- *RS EAS 750 Air quality* – emissions to the air by cement factories – guidelines. This Rwanda Standard published in 2011 is identical to the first edition 2010 Regional Standard EAS 750/2010 Air quality - Emissions to the air by cement factories - Guidelines.
- *RS EAS 751 Air quality Air quality – specifications.* This Rwanda Standard published in 2011 is identical to the first edition 2010 of Regional Standard EAS 751/2010 Air quality - Specification.
- *RS EAS 752 Air Quality* – Tolerance limits of emission discharges to the air by factories. This Rwanda Standard published in 2011 is identical to the first edition 2010 of regional Standard EAS 752/2010 Air quality – Tolerance limits of emission discharged to the air by factories.
- *RS407-1 Emission limits* — Specification: Road Vehicles

The publication of these air quality guidelines and standards, aligned with EAC standards, demonstrates the good collaboration of the Rwanda Government with its East African Community partners.

4.2.3.3. Water quality guidelines

In order to assess the fitness for use of the rivers and streams in Nile Nyabarongo Upper catchment, it is recommended that a combination of guidelines be adopted based on full contact recreation and key aquatic ecosystem guidelines. Full contact recreation guidelines would be protective to children who play in streams and rivers, and farmers who get in contact with streams when they work their agricultural fields. Aquatic ecosystem guidelines would be protective to fish and aquatic organisms in streams. The following guidelines are recommended for assessing the

water quality status of rivers. Only a limited set of constituents was selected to keep the index simple.

Table 6: Guidelines for assessing the status of rivers.

Constituent	Units	Ideal	Good	Fair	Poor
Physical requirements					
Water clarity	Secchi disk (m)	>3	2	1	<1
Turbidity	NTU	<10	80	150	>150
Dissolved oxygen	mg/l	>8	6	4	<4
Chemical requirements					
Chloride	mg/l	<2	6	10	>10
pH	pH units	6.5 - 8.5	5.75 - 8.75	5 - 9	<5 or >9
Electrical conductivity	mS/m	<70	85	100	>100
Microbial requirements					
Faecal coliforms	cfu/100ml	<130	165	200	>200
E coli	cfu/100ml	<130	165	200	>200

From the above analysis, it can be concluded that there exists an enabling policy and legal and regulatory framework for developing and implementing the Integrated Pollution Management Plan for the Nile Nyabarongo Upper catchment of Rwanda. Emerging issues are discussed in the paragraph below.

4.2.4. Issues in current policy, legal and regulatory framework

4.2.4.1. Planning processes that are not aligned with catchment governance

The Law determining the use and management of water resources in Rwanda (LAW N°49/2018 OF 13/08/2018) provides for establishment of permanent catchment committees. The exact composition and mandate of catchment committees will be laid down in the Ministerial Orders (which are currently under development). Meanwhile, the Integrated Pollution Management Plan for NMUK catchment has been using temporary arrangements where a Catchment Task Force composed of officials from the Districts, Water Users, Civil Society Organizations and private operators was set up to facilitated the development of this plan. In addition, current planning processes are district based where each district develop its own DDS, annual action plan and Imihigo without consultation with other districts within the catchment.

However, cross cutting nature of catchment management plan strategic objectives makes it difficult for districts to provide effective cross-sectoral co-ordination of catchment management interventions in particular, to integrate pollution management interventions into District Development Strategies (DDS), District Annual Action Plans and Imihigo. This is due to a lack of ownership of planning processes by Heads of technical Units at District level who are insufficiently engaged in planning with the Planning (M&E) Unit. Planning, monitoring and reporting are also inconsistent across departments. Moreover, existing planning and reporting platforms are not used effectively and hence are not responsive to strategic and

policy actions due to inadequate preparation which results in weak participation and low quality reports. This leads to disconnection between catchment management strategies and the District Development Strategies (DDPs) due to inclusion of district stakeholders in consultation processes only during the implementation stage

4.2.4.2. Lack of coordination

There are many committees in various sectors, including environmental committees, water committees, agricultural water user committees, forestry management committees, Disaster Management Committees, health and hygiene committees etc. often with similar or overlapping roles and responsibilities for natural resources management.

In addition, the analysis of the existing policy and legal framework found some conflicting objectives in the programs for transformation of agriculture (e.g. objectives related to intensification in use of pesticides and fertilizers which conflict with objectives on improving water quality; as well, objectives for marshland reclamation which are potentially in conflict with objectives on wetlands protection) These soil intensive mechanisation measures are prioritised in agricultural mechanization strategies for Rwanda and in the national agriculture policy at the expense of the protection environment and natural resources management. Similarly, the national Environment and climate change policy seeks to aggressively promote protection of environment which may be at odds with agriculture transformation and economic development. These potential conflicts have to be carefully examined at local catchment level and interventions coordinated.

4.2.4.3. Inadequate measures by District authorities to enforce pollution control guidelines and standards

Whilst the legal framework is to a great extent in place, there is inadequate enforcement of environmental laws and regulations especially at the local level. This results from the strong individual and institutional interests and the low importance assigned to environmental and pollution issues at the decentralised levels as well as low accountability at different decision making levels.

4.2.4.4. Insufficient skills to implement integrated pollution management strategies

The capacity assessments need assessment in ENR sector (UNDP,2012) found a lack of ownership of a lack of clarity of roles, responsibilities and information as constraints to the effective management and protection of natural resources both at national and decentralized level.

The shortage of skilled technical personnel across the sector stems from insufficient resources dedicated to developing capacity and retaining skilled personnel. The skills gap in the pollution management sector has not been routinely assessed and addressed. Decision makers therefore, lack the information needed to effectively plug skills gaps. At the same time, while there is a strong desire to strengthen technical competencies, there is also a need for a wider skills set particularly among

managers to improve professional and managerial skills (management of multi-stakeholder processes, effective time management etc.). Organizational capacity is constrained by an insufficient of professional development, high turnover in key positions and limited information and knowledge sharing mechanisms.

4.2.4.5. Limited ownership of environmental and pollution issues

There is limited ownership of environmental sustainability and pollution issues particularly in the productive sectors. The complexity of the sector, characterized by divergent sub-sectors and diverse stakeholders with differing objectives, tends to result in diffused ownership. The inadequate mainstreaming of pollution issues in delivering Rwanda's sustainable development goals has, to a certain extent, been driven by sector specific performance contracts with individuals and institutions adopting a short-term, un-integrated approach to deliver the development objectives of key sectors. Although joint performance contracts – imihigos, have recently been introduced for some key sectors such as agriculture, weaknesses remain in coordination and joint working between sectors at catchment level.

4.2.5. Recommendation on strategic measures

If the current situation where sector ministries, agencies and districts are implementing their own plans in isolation, there will be a limited implementation of proposed measures and no specific integrated pollution management measures implemented. There is a need to move for a catchment based planning where plans are developed in participative and vertically and horizontally integrated manner, resulting in a coherent program of measures for each sub-catchment.

The catchment plans are developed in a participative and vertically and horizontally integrated manner, resulting in a coherent program of measures for each sub-catchment. Nile Nyabarongo Upper Catchment Committee need to be established and tasked with the implementation and monitoring of the IPMP and must ensure that there is coordination and cooperation between all role-players and engagement with stakeholders for the effective implementation of the plan. The Implementation Plan identifies lead institutions for various activities of the IPMP. The Catchment Committee's task will be to ensure these institutions integrate their responsibilities into their development plans, and monitor that the activities are implemented. At a minimum, Catchment committees will need to be supported technically and organizationally, by some form of a permanent secretariat (or Technical Committee) together with technical support from Rwanda Water Board.

4.3. Emerging urban and rural diffuse pollution issues

4.3.1. Urban pollution issues

Key urban areas in Nile Nyabarongo Upper include headquarters for Muhanga, Ruhango, Nyanza and Huye Districts. Different types of pollution featuring in the above city centres include water pollution, air pollution, solid waste pollution and

noise pollution. The main sources of pollution are household activities, factories, agriculture and transport.

4.3.1.1. Inadequate wastewater management

Field visits and visual inspections of selected hotspots in two key urban areas of the Nile Nyabugo Upper catchment, namely in Huye and Muhanga districts recorded the following key issues associated with urban water pollution:

- Improper management of municipal solid wastes and liquid wastes that end up into water bodies causing pollution
- Clogging of urban drainage as consequence of plastic litter
- Slaughter house without adequate wastewater treatment system where mixed solid matters and liquid wastes are discharged into water bodies;
- Domestic wastewater (prison, schools, etc) discharged into natural environment

Figure 6: Grey water sampled in the storm water drain from Huye Market (left) and Waste water flowing from Huye Slaughter house

The drain (left) on the Figure 8 above collects stomwater from Huye market and surrounding commercial houses as well as liquid wastes from those facilities and the last ones stagnate in it where they produce bad smells before being carried downstream in the valley when it is raining. Also, the Huye slaughterhouse does not have a modern wastewater system for treatment or disposal of solid waste. The outlet channel from the slaughterhouse carries the wastewater to a first pond where the waste water mixed with solid waste is left for drying (for dung and urines). The second pond (right on Figure 8) receives waste water from the first pond where it is left and infiltrates in the groundwater, this water was dark and smells like rotten eggs. And they said that sometimes with heavy rains, it can be flooded discharging into the environment. There was almost no dissolved oxygen in the wastewater.

The issue inappropriate wastewater discharge was also recorded at downstream Huye Prison where the drains from the prison discharged waste water and sludge from the prison into a pond that was constructed in the agricultural plots behind the

prison. That water looks black and contained some of the solid waste. There site has a strong fishy smell. The wastewater contained practically no oxygen. More images of urban pollution in Huye District are attached as annex V..

Figure 9 below presents key urban water pollution issues found in Muhanga Districts. These include the drainage channel draining water to Rugerammigozi wetland, carrying out all the stormwater from the hospital, market and bus station.

Figure 7: Stormwater channel discharging into Rugeramigozi

4.3.1.2. Municipal Solid waste pollution

Solid waste refers to litter (other terms used include trash / rubbish / garbage / refuse / floating matter) that entered urban stormwater drains and is deposited in urban streams and rivers. This includes solid waste that has deposited directly into the river of tributaries. One definition of litter is "all improperly discarded waste material, including, but not limited to, convenience food, beverage, and other product packages or containers constructed of steel, aluminium, glass, paper, plastic, and other natural and synthetic materials, thrown or deposited on the lands and waters".

Field visits and visual inspections carried out in Nile Nyabarongo Upper revealed that Municipal solid waste management is still at rudimentary levels, with collection coverage rates less than 10%, with limited infrastructure for waste treatment and disposal. The majority of urban residents still follow the traditional ways of handling waste, essentially open dumping. This traditional practice of handling waste has negative impacts on health and environment through methane and carbon emissions from burning and uncontrolled dumpsites. In most of districts urban areas in Nile Nyabarongo Upper catchment, municipal waste collection services are provided by

private companies that are facing challenges associated with limited physical and financial capacities due to limited local demand, and low willingness-to-pay for the service.

Table 6 presents the key composition of solid wastes litter in Nile Nyabarongo Upper

Table 7: Solid waste classification system

Main categories	Examples of items
Plastic	Shopping bags, wrapping, containers, bottles, crates. straws, straps, ropes, nets, music cassettes, syringes, eating utensils
Paper	Wrappers, serviettes, newspapers, advertising flyers, food and drink containers, bus tickets.
Metal	Foil, bottle tops, number plates.
Glass	bottles
Vegetation	Garden refuse, rotten fruit and vegetables.
Sediment	Building sand, building rubble
Miscellaneous	Shutters, planks, timber props, broken bricks, lumps of concrete. old clothing, rags, blankets, fibre-glass, shoes, sponges, balls, pens and pencils, balloons, oil filters, cigarette butts, tyres, etc

All of the solid waste management challenges mentioned above are attributed to:

- Low enforcement of solid wastes management guidelines and lack of systematic approaches on mobilizing community participation;
- Limited infrastructure and facilities to adequately dispose, discharge and treat waste, especially in Muhanga;
- Limited physical and financial capacity of service providers, which results in irregular service provision and low service contract rate;
- Low level of awareness and willingness to use and pay for the waste collection services;
- Small local markets and demand for recyclable materials and organic composts; among others

Figures 8 &9 below present the current status of solid waste litter in Nile Nyabarongo Upper catchment

Figure 8: People carrying out their activities nearby the dumping site in Muhanga

Figure 9 : Rwabayanga Ravine nearby the market (Informal dumping site)

4.3.1.3. Urban air pollution

Urban air pollution is in the form of diverse and widespread sources of emissions and natural phenomena. The primary man-made sources of urban air pollution arise from transportation, industry, combustion fuels, industrial processes, and use of pesticides in urban agriculture. More specifically, the pollutants include suspended

particulate matter, sulphur dioxide (SO_2), nitrogen dioxide (NO_2), hydrocarbons and ozone due to population growth, urbanisation, industrialisation, and increased use of motor vehicles (Rugigana et al, 2016). Emissions from motor vehicles specifically are identified as a major source of air pollution growing as a result of population growth and associated urbanisation.

Dust emissions from unpaved urban roads and maize and wheat milling operations can be major sources of particulate organic matter. Monitoring of air pollution in Nile Nyabarongo Upper catchment should be strengthened and management of sources that exceed EAC guidelines and standards should be instituted. Currently, air pollution is not a priority issue in Nile Nyabarongo catchment.

4.3.1.4. Peri-urban diffuse pollution

Peri-urban land use area has been extensively investigated during this task, however it is recognised as an important landscape component being the transition zone between rural and urban areas where the majority of development takes place and such is a principal source of intensive diffuse pollutant. Among key development activities in peri-urban areas of NNYU include small industrial zones, known as Agakiriro centres; quarries and unplanned settlement communities. Most of per-urban centres in NNYU are not serviced with solid wastes and wastewater treatment systems, becoming a principal source of diffuse pollutants with the range of rural pollutants and some specific urban pollutant concentrations e.g. septic sewage. Therefore, concentration of pit latrines creates a potential water quality issues, especially with regard to seepage to groundwater and possibly to the base flow of waterways.

4.3.2. Rural diffuse pollution

4.3.2.1. General overview

In Nile Nyabarongo Upper catchment, agriculture (perennial)' and open areas or grass jointly totalize 85% of land use. Rained agriculture is predominant, but also intensive puddy irrigation and non-irrigated crops (e.g. maize) is found in the catchment. The different management activities associated with these different land uses result in different types and/or quantities of water quality pollutants.

Typical diffuse source pollutants in rural areas include sediment, nutrients (nitrogen and phosphorus) and pesticides, which are eroded and/or collected from land surfaces, typically in rainfall runoff, and carried to receiving waters e.g. streams, lakes, reservoirs and wetlands. This overland flow, also known as sheet or hillslope erosion, combines with gully erosion and streambank erosion to provide the majority of the total end of catchment pollutant loads

Movement of sediment and nutrients in rainfall runoff is a normal component of natural weathering and erosion processes. Additional inputs of bioavailable/soluble nutrients combined with land disturbance and inappropriate management practices often results in accelerated run off and erosion rates and the subsequent transport of sediment and nutrients to receiving waters, well above normal background levels.

It is the delivery of sediment and nutrients to receiving waters at elevated levels (and for nutrients in forms that are bioavailable) that create threats to aquatic habitats and biodiversity and, in some cases, human health.

Sediment and nutrient pollutants, their sources and environmental threat rating are listed in Table 5.

Table 8: Main rural diffuse polluants

Pollutant	Source	Rating	notes
nutrients			
Nitrate (NO3)	Fertiliser	5	Low natural levels
Ammonia (NH4)	Fertiliser	2	Low natural levels
DON	Fertiliser	2	Moderate natural levels, slow turnover
PN	Fertiliser and erosion	4	Moderate natural levels, loss to sediments
Phosphate (PO4)	Fertiliser, salt licks	2	Low natural levels
DOP	Fertiliser	1	Moderate natural levels, slow turnover
PP	Fertiliser and erosion	3	Moderate natural levels, loss to sediments
Silicate (Si (OH)4)	Erosion	0	
Sewage	STP discharge, septics	5	Contains all N, P forms at high levels
Coarse (>63 µm)	Erosion	0	No likely impact, forms delta fans
Medium (2-63 µm)	Erosion	2	Carried only short distance
Fine (< 2µm)	Erosion	4	Carried widely over shelf, especially after dry year

Source: Mitchell et al 2007 (p.7)

Note: Rating is potential threat posed by the pollutant where 5 is greatest threat and 0 is no threat.

4.3.2.2. Sub-standard farming & mining practices aggravating soil erosion and pollution

- **Soil erosion (including riverbank erosion by agriculture, cattle and deforestation)**

The high population density in the catchment, combined with a high use of fuel wood for cooking and poor agricultural practices, leads to deforestation and over-exploitation of agricultural land. Due to a lack of adequate management, soils become depleted of nutrient and, especially in the western part of the catchment

which has steep slopes, rates of soil loss are very high. Once the eroded soils enter waterways, they contribute to high sediment loads thereby, amongst other adverse impacts, they increase flood risk as they deposit in the riverbed and floodplains reducing flow capacity. Farmers will need to be encouraged to adopt and utilise agro-forestry and other tree species e.g. fruit trees, on their farms. Combined with other tailor-made and already popular soil and water conservation technologies, based on lessons from ongoing and past projects, this can curb the rates of deforestation, soil erosion, stream sedimentation and flood risk.
On the other hand, in a survey carried out in 2015 with purpose to develop the Nyabarongo Upper rehabilitation plan, it was observed that some of the agricultural areas (mostly in Nyanza and Karongi District) are covered by radical and progressive terraces which are not valorized reducing their capacity to control erosion. Additionally, in some parts of the catchment, agricultural activities are being done within the 10m buffer zones reserved for river bank protection. This was observed on the riverbank of the Nyabarongo after the confluence of Mwogo and Mbirurume River on the side of Karongi as well as Ruhango Districts but also in many other parts of the catchment.

Analysis show that the mean annual soil loss in Nile Nyabarongo Upper catchment stands at 45.0 t/ha/year or catchment total annual Soil Loss of 158.7 million tons. This high soil loss potential explains high river siltation in the catchment. The Figure 10 below presents the status of soil loss in Nile Nyabarongo Upper catchment while Table 9 presents the estimated Annual Soil Loss per Area in NNYU Catchment.

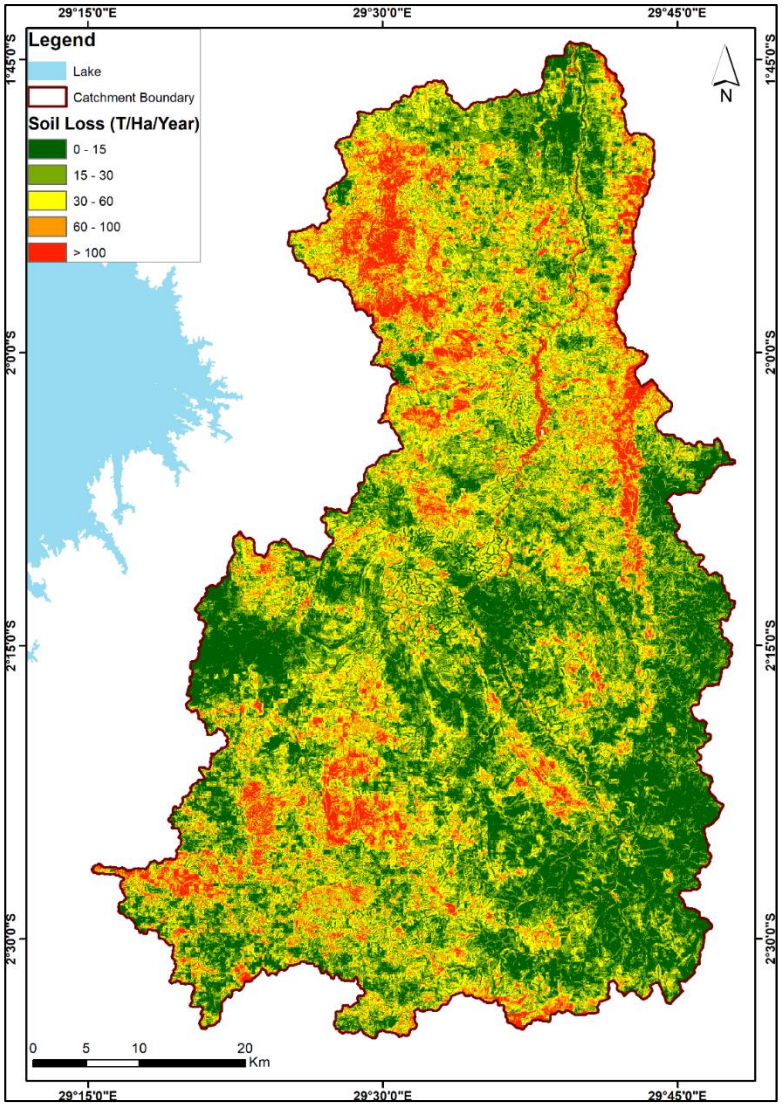

Figure 10: Estimated Annual Soil Loss in NNYU Catchment

Table 9: Estimated Annual Soil Loss per Area in NNYU Catchment

S/N	Soil Loss Interval	Area coverage		Mean	Total Annual Soil Loss	
		Ha	%		Million t	%
1	0 – 15	94,186.0	28.1	8.8	8.8	5.5
2	15 – 30	92,421.1	27.6	21.9	21.3	13.4
3	30 – 60	87,036.2	26.0	42.4	38.9	24.5
4	60 – 100	38,219.1	11.4	76.1	30.6	19.3
5	> 100	22,884.6	6.8	245.5	59.1	37.3
6	Overall Catchment Mean Annual Soil Loss				45.0 t/ha/year	
7	Catchment Total Annual Soil Loss				158.7 million tons	

At last, many cases of deforestation were observed in Nile Nyabarongo Upper catchment. This particular issue is related to biomass energy production since wood is used as primary source of energy (mostly for cooking purposes) for the local population. This pronounced deforestation in Nile Upper Nyabarongo has many negative effects on the streams in the Upstream Nyabarongo catchment that are caused by siltation due to soil erosion. It follows the reduction in water availability

in the catchment through reduced water supply potential for domestic use, degradation of the water quality (what can lead to eutrophication) making impossible fishery, reduced hydropower potential, etc. There are many streams with high sediments loads in Nile Upper Nyabarongo , but those directly affecting the NyabarongoI hydropower reservoir include the most critically affected streams like Secoko, Mwogo, Bakokwe, Gasayo, Rwobe and Kagogo streams , among others.The photos below taken within the purpose of development of Nyabarongo Upper rehabilitation plan show the extend of deforestation in Nile Nyabarongo Upper catchment

Figure 11: Deforested area in Nyamirama cell for biomass energy and wood production (Source: Nyabarongo Upper Rehabilitation Plan)

- **Mining exploitation increasing siltation to rivers**

Sediment loads in rivers are further aggravated by mining activities throughout the catchment. Both formal licensed and informal, unlicensed, usually artisanal, mines use poor, environmentally damaging practices that lead to ingress of large quantities of sediment into watercourses. The contribution of mining activities to sediment loading in rivers is considered at least to be equal to the contribution made by agricultural soil erosion, and in some individual sub-catchments mines are the predominant source of sediments.

Illegal and unsustainable mining activities are widely spread Nile Nyabarongo Upper catchment. Heavy siltation due to mining activities was observed in Mwogo sub-catchment, Rurangazi Cell, Nyagisozi Sector, in Nyanza District. The Mwogo River wetland is also under heavy sedimentation as a result of mining activities as well. Figure 6 below shows the status of Secoko river on 25th July, 2020. High sediment loads were consistent even during the dry season as consequence of river pollution by upstream mining activities.

Figure 12: Siltation of Secoko River caused by mining activities upstream

This is the same case in the Mbirurume sub-catchment which covers parts of Karongi and Nyamagabe Districts, mining activities are contributing largely to the siltation of the river characterized by a high sedimentation load in the river even during the dry season. In the downstream of the NNYU catchment, Gatumba Mining Concession is affecting Secoko and Rubanda streams, affluent to Nyabarongo River with high sediment loads. A group of mining companies operate in this concession in an unsustainable manner which is heavily polluting the streams directly discharging in the Nyabarongo I hydropower reservoir.

In most operational and closed mine sites, there is an issue of persisting illegal mining activities despite all the efforts put in place by the current companies (like hiring security services). Complaints from license owners to the Rwanda Mining Board (RMB) are mostly that illegal miners caught red-handed are presented to the relevant organs but usually released without any punishment. Local authorities in the concerned districts have been flagged as less involved in the enforcement of existing regulations therefore giving room to illegal mining and other malpractices such as unregulated dredging of rivers. Cases of illegal mining polluting rivers are more pronounced in the many sectors of Ngororero (Gatumba, Muhororo, Ndaro, Bwira, Mukuru and Nyange sectors), Muhanga (Kabacuzi, Muhanga, Nyarusange and Kiyumba) Ruhango (Mpanda and Byimana sectors).

Box4.1: Impact of sedimentation on hydropower: Case of Nyabarongo I

The Nyabarongo I hydropower plant was completed in October 2014 at an estimated cost of US$110 million and installation capacity elevated at 28 MW. The dam reservoir for Nyabarongo I hydropower is located in Muhanga district (Mushishiro and Nyarusange sectors) and Ngororero district (Nyange and Ndaro sectors). The surrounding catchment is characterised by poorly mining activities or artisanal mining, which combined with soil degradation and poor agricultural practices are leading to the following issues that threaten the sustainability of the dam:

Loss of reservoir storage capacity resulting into reduction in power production forcing to run expensive fuel to generate electricity;

Excessive accumulation of the silt into reservoir produces structure damages for the dam;

Loss of investment from shortening the life span of plant equipment (turbine, penstock, gates, etc); and

Reducing plant (machines) efficiency, and increasing operation & maintenance costs due to unplanned plant shutdowns.

Measures to reduce/limit the sedimentation of dam reservoir will include:

Landscape protection to contain land sliding and erosion

Proper river bank and catchment protection

Regular Sediment management (dredging)

Monitoring on regular basis the silt accumulation into reservoir

Conduct analysis of the current status of silt accumulation into reservoirs, and forecast its evolution, impacts (over the life span of plants facilities

Box 4. 2: Towards Sustainable Mining: Model Ming

Mining in Rwanda is characterised by a wide distribution of small scale mining sites with inadequate mine extraction and processing practices, poor management of water and mineral wastes as well as lack of effective closure and abandoned site remediation activities.

The above practices in Nile Nyabarongo Upper have the following impacts on natural environment:

- Unmanaged disposal of mineral wastes
- Discharge of sediment loads from processing water
- Erosion of disturbed land
- Downstream water contamination potential and water quality deterioration within the catchment.

EDPRS introduced Model mining concept to promote material, water, and energy efficiency in mining to reduce the environmental footprint of mineral-based product life cycles. Model mining includes elements of Corporate Social Responsibility, environmental protection and the

achievement of improved work conditions of miners. Associated activities to manage water quality include:

- Construction of water/sediments retention ponds;
- Construction of a water recycling system;
- Rehabilitation of mined area and closed mine sites; and
- Involvement of the catchment community for water resources management and catchment restoration

There are currently two mines functioning as model mines and 25 more mine operations are engaged in trying to achieve this status. Supporting the artisanal mining sector can improve the water quality of the catchment. The Government of Rwanda and stakeholders are encouraged to continue to provide support in organisation of artisanal miners into cooperatives allowing them access to loans and better technology and skills. Forest of Hope initiative in Gishwati Forest and Rwanda Mining Board with the support of DFID have ongoing initiatives to support artisanal minors.

4.4. Identification and mapping of key activities and infrastructure, potential sources of pollution in Nile Nyabarongo Upper catchment.

During discussions with the district officials and field visits, key pollution sources and concerns were identified. The list is by no means complete for all pollution sources. However, it includes the most important source categories namely industrial sources, landfills, workshops and garages, informal settlements and slums, mining, etc. Key point sources of pollution are as presented on Figure 12 below while full lists of the sources of pollution, types and location is attached as annex VII.

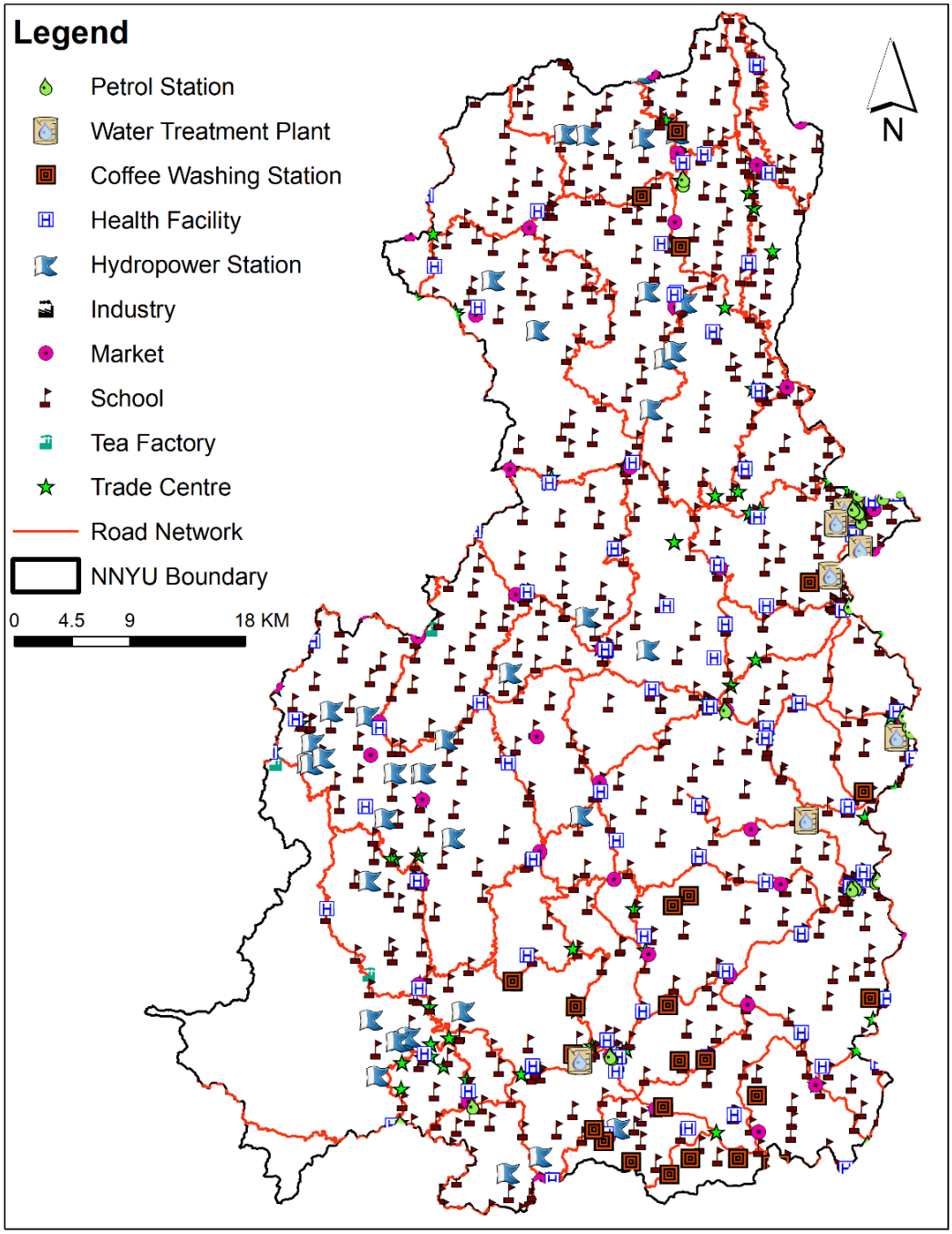

Figure 13: Key infrastructures potential point sources of pollution

Table 10: Potential point sources of pollution in NNYU Catchment

S/N	Key Infrastructures potential sources of pollution	Number
1	Health Centers	83
2	Trade Centers	72
3	Schools	557
4	Markets	43
5	Coffee Washing Stations	22
6	Industry	4
7	Tea Factories	3
8	Hydropower Station	37

4.5. Mapping of Pollution hotspots

For a more comprehensive understanding of impacts of pollution sources on natural environment and to allow prioritisation of resources and actions, a mapping of key pollution hotspots in Nile Nyabarongo Upper was carried out. Figure 13 below displays key hotspots in NNYU. The list of key pollution hotspots (Mining sites, petrol stations, hydropower station, coffee washing stations and water treatment plants) in Nile Nyabarongo Upper catchment are attached as annex VII

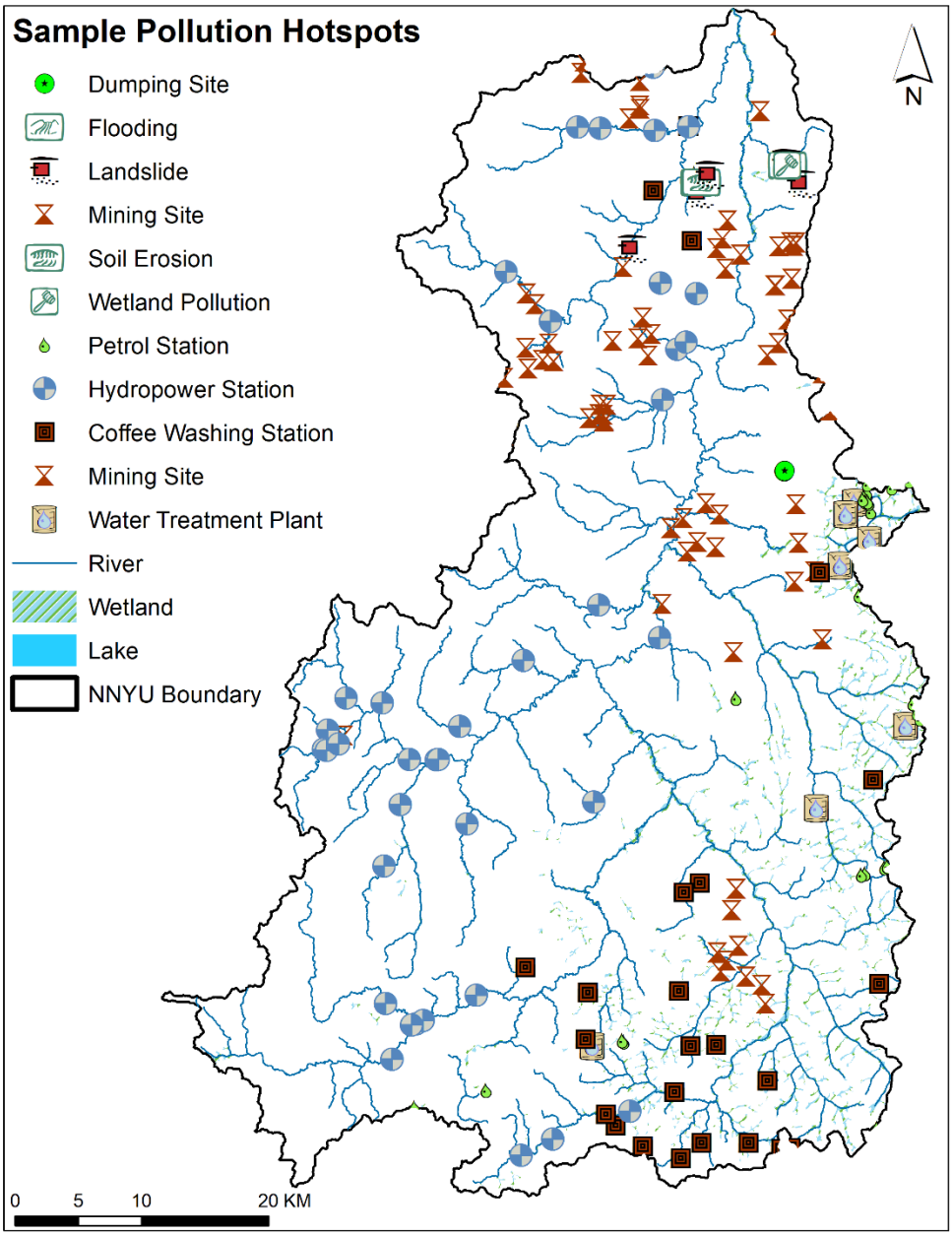

Figure 14: Key Pollution Hotspots in NNYU Catchments

4.6. Approaches to Integrated Pollution Management

Pollutants are produced through human activities and create long-term effects when released into ecosystems. Strategies for reducing these impacts can be directed at

three different levels in the process: altering the human activity, regulating and reducing quantities of pollutant released at the point of emission, and cleaning up the pollutant and restoring ecosystems after pollution has occurred

Figure 15 shows the value and limitations of each of the three different levels of intervention.

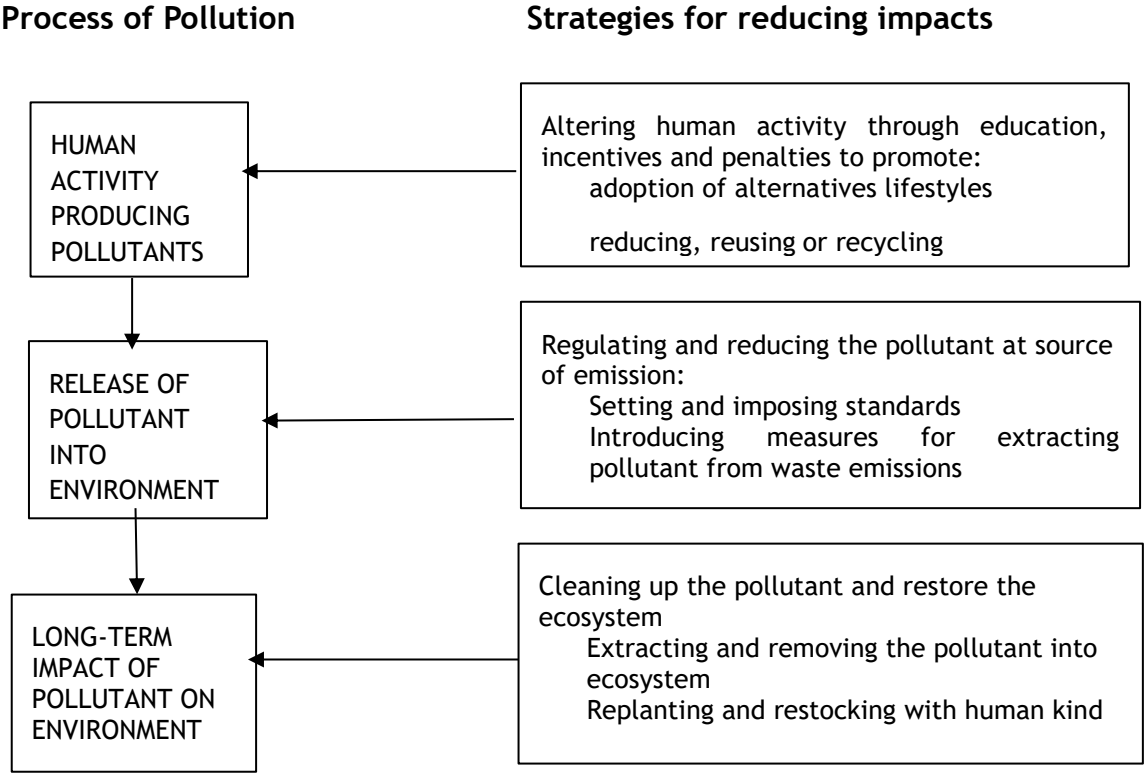

Figure 15: Approaches to integrated pollution management

4.6.1. Altering human activity

Changing human actions has the greatest benefit overall, but is often the hardest to achieve and takes long term planning. If no pollution was produced in the first place there is no need for any intervention. Though often intervention is needed originally to help change the behaviours that contribute to pollution. This strategy depends very much on behavioural change of people, industry / business and Governments and can come into conflict with short term economic tensions

4.6.2. Regulating and reducing pollutant at source of emission

Reducing the amount of pollutant released into the environment has the next greatest impact. This help to control the source of the pollution rather than the effect of the pollution. This form of pollution management is built into government policies around the world where pollution regulation can have direct results. In Rwanda, the Environment Organic Law (2005) was an early pollution legislation measure.

While business and industry are often the main focus of pollution legislation, domestic pollution may also be controlled by legislation. Many countries, especially

in Europe have legislation that forces households to separate domestic waste so less waste enters landfill and recyclable products like PET bottles can be separated out easily.

Imposition of appropriate standard is also important for source emission standards. Applicable standards and guidelines for pollution sources reduction in Rwanda were detailed above in paragraph 4.2.

4.6.3. Cleaning up the pollutant and restore the ecosystem

Cleaning up pollution problems is the least effective way of dealing with pollution. This is dealing with the problem after the problem has already caused damage. Much of the old industrialised world has inherited the problems created since the industrial revolution. Cleaning up an already damaged environment is often costly and can often take many years from inception to complete clean up. Though often where heavy industry has been in the past or with contaminants such as radiation the clean-up can only ever be limited

In case of urban stormwater discharges, the need for pollution reduction has led to an emphasis on a stormwater management approach that focuses on keeping pollutant out of receiving streams by upstream control; that is attenuation and treatment measures close to where the runoff is generated (Abbott Grobicki, 2001). Most urban stormwater management measures can be classified as structural or non-structural (Abbott Grobicki, 2001, Debo & Reese, 2003):

Non-structural BMPs are BMPs are almost exclusively focussed on pollution prevention and the objective is to minimise the pollutant load from urban areas. These include a variety of institutional and educational measures focussed on land development, public awareness to modify behaviour that contribute to urban pollution, detection of illicit wastewater discharges, and enforcement of ordinances designed to prevent the deposition of nutrient containing waste and products on urban landscapes. Non-structural BMPs are generally grouped into educational BMPs, planning and procedures BMPs, and site-based local control BMPs (Abbott Grobicki, 2001, Debo & Reese, 2003). Educational BMPs refer to measures that are devised to sensitise citizens about their role in water quality degradation, protection and enhancement. Planning & procedures refer to minimising urban stormwater pollution through effective planning procedures (e.g. master plans, comprehensive plans, and zoning ordinances) designed to promote improved water quality by restricting certain types of activities in sensitive areas. Site-based local controls refer to ordinances and by-laws that require the inclusion of buffer strips, preservation of riparian zones, minimising disturbance and impervious areas, and maximising open spaces.

Structural BMPs are generally measures that act as a backup for non-structural BMPs by providing attenuation or treatment facilities before transportation of polluted water to receiving streams and rivers. Structural BMPs can be grouped into storage practices, infiltration practices, and vegetative practices (Debo & Reese, 2003). Storage and detention BMPs refer to measures to collect urban runoff in wet ponds, dry basins or multi-chamber catch basins and slowly releasing to a receiving stream

or river or stormwater canal. Infiltration practices refer to BMPs that facilitate infiltration of urban runoff through the soil to groundwater. Vegetative practices refer to landscaping BMPs that enhance pollutant removal, maintain and promote natural site hydrology, promote healthy habitats and increase aesthetic appeal.

Currently, only structural management facilities were selective planting of bamboo within the riparian buffer zones to stabilise river banks, and enforcement of exclusion zone (buffer zones) around the main rivers.

4.7. Summary on Nile Nyabarongo Upper catchment pollution drivers, pressures, states and impacts

The DPSIR (Driving forces, Pressures, States, Impacts and Responses) approach was adapted from IWRM/W4GR Upper Nyabarongo Catchment Plan (2018-2024) developed by Rwanda Water and Forestry Authority in 2018. Table11 below provides drivers, pressures, states and impacts of pollution in Nile Upper Nyabarongo catchment

Table 11: Drivers, Pressures, States and Impacts of pollution in Nile Nyabarongo Upper Catchment

Drivers	Pressures
• High population density • Economic development • Low skills &awareness levels • Insufficient enforcement of environment laws and regulations on mining • Little knowledge, understanding &skills in agrochemicals/pesticides/herbicides application best practices • Low capacity and skills in solid waste and wastewater management	• Siltation from mining exploitations • Soil over exploitation, land degradation & soil erosion • Limited management of solid and liquid wastes • Encroachment of river banks & pollution of water bodies • Sub-standard farming & mining practices aggravating soil erosion and pollution
States	**Impacts**
• High river sedimentation • Low water quality, including high E.Coli counts in surface water • Proliferation of Municipal Solid wastes litters • Planning process is not aligned with catchment governance • Lack of prioritisation of pollution issues in Districts	• High cost for drinking water treatment & maintenance of distribution networks • High sediment loads which damage the hydropower plant operations • Water borne diseases

Plans.	• Loss of reservoir storage capacity resulting into reduction in power production

4.8. Opportunities

4.8.1. Past and ongoing soil conservation interventions

Lessons learnt from reforestation and other soil conservation interventions implemented by different projects (PAREF, LVEMPII, PAGREF, FONERWA, LWH/RSSP, etc) in Nile Nyabarongo Upper catchment will serve as an opportunity to upscale future plans to reduce soil erosion and increase productivity.

4.8.2. Laws, regulations and standard

During the two decades, the Government of Rwanda put in place different laws, regulations and standard on environment and natural resources protection, management and conservation that would be regarded as opportunities to improve pollution management in Nile Nyabarongo Upper. Limited enforcement capacity of the above legal instrument is still law in the catchment, for this opportunity to become effective, stakeholders need to join hands in improving enforcement of legislation, e.g. through water permitting and strengthening of field-level enforcement of environmental legislation.

4.8.3. Mineral resources

Mineral resources are listed among the opportunities for economic activity in the catchment. Importantly, mining activities are also mentioned among the main issues in the catchment. A sustainable approach to mining is required in order for there to be economic benefit from this sector without associated environmental damage. Experience needs to be developed in sustainable mining, e.g. through the concept of model mines. Best practices can be developed in pilot projects e.g. in one sub-catchment and replicated in other sub-catchments within and beyond catchment boundaries.

4.8.4. Decentralised governance framework

Existing District authorities and catchment committees in Nile Nyabarongo Upper Catchment are regarded opportunities since they have better knowledge of environmental and socio-economic problems of the catchment and are well placed to enhance environment protection measures if they are supported. In addition, they will facilitate local communities' participation and allow the building of local capacities for provision of services that are more consistent with the local requirements.

CHAPTER 5. NILE NYABARONGO UPPER INTEGRATED POLLUTION MANAGEMENT PLAN

5.1. Introduction

This chapter sets out the vision, goals and objectives to address these issues and to ensure the sustainable management of natural resources going forwards. The goals and objectives are generic for all catchment included in this project. However, the targets and activities are specific to the Nile Nyabarongo Upper catchment.

5.2. Vision, goals and objectives

The formulated vision statement is broad to allow for wider interpretation and buy-in from various stakeholders. A generality has also been incorporated to give it a long lifespan and allow its constituent medium term plans to remain relevant to the long-term goal and objectives of the plan.

Scoping workshops that brought together representatives of all the districts in the catchment and national institutions discussed and agreed on common key pollution issues and opportunities. Main pollution issues characteristic to Nile Nile Nyabarongo upper catchment include inadequate measures by District authorities to enforce pollution control guidelines and standards, uncoordinated planning processes at catchment level, inadequate management of solid and liquid wastes, sub-standard farming & mining practices aggravating soil erosion and pollution, encroachment of river banks & pollution of water bodies, low enforcement of laws and regulatory instruments on environment pollution, lack of data on pollution as well as low awareness in sustainable mining practices and little knowledge & understanding of environment laws and regulatory instruments. The opportunities include past and ongoing sustainable land management &soil conservation interventions, existence of laws, regulations and standards on pollution management, mineral resources in most of the districts within the catchment as well as decentralized governance framework that facilitate the participation of local communities during the implementation of the plan.

Following the scoping workshops held with stakeholders, consultancy team synthesized the workshop messages and outcomes and then formulated an agreed vision for the Nile Nyabarongo catchment as follows:

"Nile Nyabarongo upper is a well-managed catchment supporting the community to meet its socio-economic needs in a sustainable manner without compromising natural ecosystem to provide its services"

Achievement of the vision will be through the following strategic goals:

Goal 1: Strengthening pollution management planning at catchment level

In order to manage pollution at catchment level, there is a need to align the plans at catchment and District Development Strategies to ensure that pollution and protection of environment are considered in all activities undertaken by the district. This goal will be achieved through the following objectives and targets:

Objective 1.1. Alignment of catchment planning with District Development Strategies

This objective will be achieved through accomplishing the following key activities

i. Support District Authorities to enforce the Rwandan pollution control standards (industrial effluent standards. & EAC industrial and incinerator air emission standards)
ii. Support joint inspections of environment polluting activities in Nile Nyabarongo catchment.
iii. Facilitate integration of catchment pollution management interventions into the districts' annual performance contracts

Objective 1.2. Establish coordination mechanisms for pollution management at catchment level

This objective will be achieved through accomlishing the following key activities

i. Operationalise the Nile Nyabarongo Upper catchment committee;
ii. Establish and operationalise Nile Nyabarongo Upper catchment Technical Committee;
iii. Support integrated planning at catchment level; and
iv. Support regular coordination meetings of water committee, environment

Goal 2: Efficient and effective pollution management in Nile Nyabarongo Upper catchment

There is a need for districts to be more adaptive in their management of pollution. This will require increasingly identification and implementation of efficient and effective management practices to minimise the impacts of rural and urban pollution. It would also require the strengthening of compliance and enforcement activities within urban areas. This goal will be achieved through the following objective and goals:

Objective 2.1. Support effective pollution management in Urban and per-urban areas of NYU

This objective will be achieved through accomplishing the following key activities:

i. Develop sewerage systems and wastewater treatment plants
ii. Develop sludge management and treatment facilities
iii. Support resettlement of population in high risk zones
iv. Support small industries &SMEs to implement cleaner production measures
v. Support rainwater harvesting on rooftops of settlement areas
vi. Construction of water drainage to capture road drainage & settlements
vii. Support construct of a designed landfill that makes provision for waste separation and recycling

Objective 2.2. Effective management of rural pollution

This objective will be achieved through accomplishing the following key activities:

i. Invest in river bank protection along all rivers and wetlands in NNYL
ii. Support the implementation of sustainable mining practices /Model mining
iii. Enhance payment of ecosystem services in NNYL

iv. Multiply inspections for environmental compliance in mining sector
v. Support the implementation of sustainable mining practices/Model mining
vi. Enhance payment of ecosystem services in NNYU for catchment protection
vii. Increase awareness and education on environment protection

Goal 3: Effective information and knowledge management

This goal requires a renewed and strengthened drive to improve monitoring networks in urban, per-urban and rural areas and to strengthen and consolidate information management systems. Adaptive management is based upon the support of monitoring networks and systems. This goal also includes building capacity in pollution management through education, training, and knowledge transfer.

Strategic goals are supported by specific objectives and targets.

Objective 3.1. Ensure continuous Monitoring of urban and rural pollution

This objective will be achieved through accomplishing the following key activities:

i. Inventory of small industries and SMEs with/without wastewater treatment facilities in NNYU;
ii. Enforce continuous monitoring of vehicle emissions through regular standardised tests.
iii. Integrate key urban pollution hotspots monitoring points into national sampling network program

Objective 3.2. Building capacity in urban pollution management

This objective will be achieved through accomplishing the following key activities:

i. Develop training package on urban and rural pollution and BMPs;
ii. Conduct trainings, awareness raising and capacity building among farmers on smart agriculture;
iii. Conduct capacity building in sustainable mining approach/Model mining among mining operators; and
iv. Disseminate policies, laws and regulatory instruments on environment protection, sustainable mining and smart agriculture

5.3. Implementation arrangements

5.3.1. Stakeholders analysis

Effective implementation of this Pollution Management Plan will depend on how best planned activities in the Districts within the catchment are coordinated and harmonized. The stakeholder analysis showed that the following key stakeholders will take part in implementation of the plan:

- Institutions at national level, in the form of line ministries and their authorities / agencies, including the significant projects and programmes carried out under their auspices;
- Parastatal utilities for water supply, sanitation or electricity;

- Decentralised entities such as district authorities, as the main catchment level plan owners, represented by their members of the Catchment Committee;
- NGOs and INGOs, active in the districts;
- Communities;
- Private sector stakeholders.

The above stakeholders can be classified into three categories three broad categories according to the role they are expected to play, the level of influence they are expected to exert within the framework for design and implementation of the catchment plan, and their role in the stakeholder engagement strategy:

Primary stakeholders: Include business holders, farmers, herders, fishermen etc., all of whom derive their livelihoods from land or water resources, or whose activities directly rely or impact on land and water resources. They are sometimes grouped into water user organisations within and downstream of the catchment and business entities directly affect or affected by catchment management.

Secondary stakeholders: These are individuals, institutions or organisations that are intermediaries in catchment plan development and implementation. Secondary stakeholders are "indirectly affected" by outcomes in the catchment and include District authorities, NGOs, WASAC, RURA, REG and key projects such as IUCN and LAFREC II. The catchment committee are the focal points for this group. Although only indirectly affected by the outcomes, secondary stakeholders are powerful and often highly involved in the catchment pollution planning process, and should remain so during the plan implementation;

Tertiary stakeholders: These are referred to external stakeholders and usually only play an advisory, approval or advocacy role. They include the institutions at national level, the development partners, and technical ministries which formulate policies, plans and programs relevant to the catchment plan (e.g. MoE, MINAGRI, MINALOC, MININFRA, etc). The apex bodies for water management, such as the Water Inter Ministerial Committee and National Water Consultative Committee, are also included in this category and play a critical role in approval of the catchment plan.

5.3.2. Roles and Responsibilities of key stakeholders

The Ministry of Environment and Rwanda Water Board are the primary coordinating government organs that will ensure a well coordination and synchronization of planned activities to avoid unnecessary duplication and conflicts that may arise. Table 12 below clarifies the roles and responsibilities of key stakeholders in implementing the Nile Nyabarongo Upper catchment whereas Table 14 provides a summary on the lead, co-lead, support and analysis of roles and responsibilities for all identified institutions/organisations. A lead or co-lead designation means that the institutions/organisations noted would be responsible for leading the implementation of the activity but the actual work can be done by the lead group and/or others in a cooperative effort. The co-lead and other designations can also provide management support and/or technical assistance for actions led by the lead institution

Table 12: Institutions with important roles in Pollution Management

No	Institution	Function
Policy institutions		
1	Ministry of Environment	Ensure that environment and pollution control policies and strategies are passed by Cabinet and communicated to stakeholders. The Ministry of Environment will provide policy oversight to the plan implementation including enforcement of accountability and continued alignment to high level political interests
2	Ministry of Local Government	Facilitate the management of efficient and effective decentralized government systems capable of law enforcement and delivery of required services to the local communities
3	Ministry of Agriculture	In its mandate of increasing agricultural and animal production, modernising farming, ensuring food security and promoting surplus for the market, and given the close link between agriculture and the catchment management, especially for land husbandry, irrigation feeder roads improvement and fertilisers application in farms, this Ministry will be involved in promoting policies and strategies for soil conservation and agrochemicals/pesticides application best practices.
4	MININFRA:	By supporting rehabilitation of buffer zones around water sources and hydropower infrastructure, MININFRA will facilitate implementation of the IPMP at catchment level and at national level through policy and standards formulation and participation in the programme steering committee, and at local level in the catchment;
5	Ministry of Commerce and Industry	Policy formulation and promotion of investments in cleaner production by the private sector for industries and manufacturing.
Financing institutions		
6	Ministry of Finance and Economic Planning	Mobilization and allocation of financial resources including co-ordination of donor inputs
7	Rwanda Green Fund (FONERWA)	Funds Mobilization and investment in the best public and private projects that have the potential for transformative change and that align with Rwanda's commitment to building a strong green economy.
8	Development partners	LDCF, World Bank, German Embassy, Embassy of the Kingdom of Netherlands and other regional or international environment management partners on the ground and those not on the ground but with interest in pollution management in Nile Nyabarongo Upper catchment will be critical to the success of the plan implementation. Their experience in pollution management and control links to potential financiers or

		financing capability will be very important for the implementation of the plan.
Regulatory Institutions		
9	Rwanda Environment Management Authority (REMA)	Key areas of intervention relate to prevention of soil erosion, deforestation, pollution and water contamination. REMA should support LODA in ensuring that the focus on LED does not negatively impact on the environment, including through destruction or depletion of natural resources, and should work towards promoting innovation and green enterprises
10	Rwanda Utilities Regulatory Agency (RURA)	Enforcement of compliance by public utilities with the laws governing their activities, mainly liquid and solid wastes collection, transportation & disposal
11	Rwanda Bureau of Standards (RBS)	Provision of standards based solutions for a safe and stable environment.
Implementation & Services institution		
12	Rwanda Water Board	The Rwanda Water Board leads management and promotion of water Resources. RWB establishes strategies related to the protection of catchments and coordinate the implementation of erosion control and water quality monitoring actions.
13	LODA	The Local Government Development Agency plays a unique and essential role in supporting and promoting local economic development across Rwanda. As a central agency but with staff at district level and providing funding to improve development at the local level, LODA has a key role in supporting LED. In close collaboration with MININFRA &MoE LODA will ensure that projects needed in the catchment are designed and executed in a sustainable manner(i.e without or low adverse environment impacts)
14	WASAC	WASAC: is responsible for ensuring access to clean water and adequate sanitation infrastructure. WASAC is therefore a key player in catchment plan implementation especially with regard to achieving safely managed water and wastewater
15	RDB	RDB is responsible for supporting private investment and business development in Rwanda, including through addressing the needs of companies and investors. In catchment pollution management plan implementation, RDB will lead attraction of investors in waste management infrastructure development and be consulted for approving Environmental Impact Assessments and mitigation plans for all pollution management projects at catchment level.
16	RAB	Given its responsibility to implement the national policy of agriculture and animal husbandry, RAB will ensure the promotion of agriculture and husbandry practices

		that minimise the impacts of diffuse agricultural pollution of water, land and air
17	NIRDA	Promote the use of environmentally friendly and resource efficient technologies and services in pollution management at catchment level
18	Districts	Implementation of the government policies and laws
19	PSF	Design, construction, operation and maintenance of pollution management infrastructure and equipment. Provision of other commercial services, e.g. mobilization of financial resources for waste management infrastructures.
20	Non-Governmental Organizations (NGOs)	NGOs operating in Nile Nyabarongo Upper catchment will supplement the public sector efforts in pollution management through conduct training and capacity building for communities

5.4. Financing of the Plan

Acquisition of adequate resources is a prerequisite for the successful implementation of this plan. Rwanda Water Board (RWB), Rwanda Environment Management Authority (REMA) and the Ministry of Environment who are the primary coordinating institution responsible for the implementation of the Pollution Management Plan should be the vehicle for the mobilization of the necessary resources. These resources shall be mobilized from national sectoral budgets, bilateral and multilateral donors and the private sector. Support from organizations such as GCF, World Bank, GEF, SIDA and others with a long history of support in the conservation and sustainable development projects in Rwanda will be critical in providing the funding to implement the plan.

5.5. Actions cost estimates and budgeting

The budget estimate for the implementation of this plan based on the strategic activities is also presented in Table as annex IV. Funds for the implementation of the plan is expected to come from the government budget, grants and donor agencies.

5.6. Prioritization of Actions and Schedule

Effective implementation of the Nile Nyabarongo Upper Pollution Management Plan is enhanced by the prioritization and scheduling of all recommended actions. In order to accomplish this, a priority rating system and implementation schedule parameters were considered for each action.

Factors included as part of the prioritization rating system include importance, coverage under existing programs, timing and sequencing, and ease/difficulty of implementation of the recommended actions. For each factor, professional judgment and experience were used to consider the following types of priority information:

i. *Importance* - Recognizing that all recommended actions are essential for sound pollution management, which actions are most critical or critical versus others that are important?
ii. *Coverage Under Existing Programs* - What are the significant pollution management needs that either have little or no, limited, or incomplete coverage under existing programs?
iii. *Timing and Sequencing* - Are there any considerations, such as developmental time for programs and regulations that require actions to be phased in over time? Do any of the plan's recommendations rely upon another action(s) to be done first?
iv. *Ease/Difficulty of Implementation* - Given the many parameters to be considered for implementation, which actions are relatively easy versus difficult? Some of the parameters to consider include technology available, staffing, in terms of manpower and subject matter expertise, competing program priorities and workload, legal or policy constraints, and public support.

Each recommended action was evaluated, using the factors listed above, to determine ratings of top priority, high priority, and priority. The importance factor was given added weight by requiring an action to be rated as a top or high priority in importance before it can have an overall rating of top or high priority, respectively.

Table 13: Ratings System for Essential Pollution Management Actions in NNYU

Rating Factor	High Priority (H)	Medium Priority (M)	Low Priority (L)
Importance	Most critical	Critical	Important
Coverage Under Existing Programs	Little or no coverage	Limited coverage	Incomplete coverage
Timing and Sequencing	No other action required	Other short-term action(s) required	Other long-term action(s) required
Ease/Difficulty of Implementation	Expect fairly easy implementation	Expect fairly easy implementation, but some difficulties possible	Expect some difficulty in implementation

The specific implementation schedule for each element of the management plan is dependent on the priority and resources given to the elements. For the purpose of this management plan, implementation scheduling was addressed by grouping actions under the following three time frames. Again, professional judgment and experience were used to assign schedule time frames.

i. *Short-Term Actions* - Those actions of any priority level that should be initiated and/or effectively implemented within one or years.

ii. *Medium-Term Actions* - Those actions of any priority level that should be initiated and/or implemented within two years and above but full implementation of these actions may not take more than 4 years.
iii. *Long-Term Actions* - Those actions of any priority level that should take from three years and above to initiate and effectively implement.

An example of a medium-term action is ongoing program changes such as those that require new information or a complementary study is to be undertaken before implementation. Short-and long-term actions, will require positive program and budget decisions in the future. Rwanda Water Board and REMA will take a proactive approach to implementing the plan's recommendations in a timely manner. It is anticipated that the other lead stakeholders also will be proactive in plan implementation. Table 11 below presents the Integrated Pollution Management Plan actions prioritization, scheduling and roles and responsibilities of different stakeholders

Table 14: IPMP actions prioritization, scheduling and roles and responsibilities of different stakeholders

	Status	Challenge/Issue	Recommended action	Prioritisation	Sequencing	Responsible
Goal 1: Strengthening pollution management planning at catchment level						
1	Planning process is not aligned with catchment governance	Inadequate measures by District authorities to enforce pollution control guidelines and standards	Support District Authorities to enforce the Rwandan standards on pollution (industrial effluent standards &. EAC industrial and incinerator air emission standards)	Medium	Short-term	**REMA** (Lead),RURA (Co-lead), RSB, Districts, RNP, RIB (Others)
			Support joint inspections of environment polluting activities in Nile Nyabarongo catchment.	High	Short-term	**REMA (Lead),** Districts (Co-lead), RNP, RIB (others)
			Facilitate integration of catchment pollution management interventions into the districts' annual performance contracts	High	Continuous	**RWB (Lead),** LODA (Co-lead), MoE, Districts, Catchment Committee
		Uncoordinated planning processes at catchment level	Operationalise the Nile Nyabarongo Upper catchment committee;	High	Short-term	**RWB (Lead), Districts** (Co-lead), MoE, REMA, RHA, RTDA (Others)
			Establish and operationalise Nile Nyabarongo Upper catchment Technical Committee	High	Continuous	**RWB (Lead**), Districts (Co-lead), Catchment Committee (others)

			Support integrated planning at catchment level	High	Medium-term	**RWB (Lead)**, Districts (Co-lead), Catchment Committee (others)
			Support regular coordination meetings of water committee, environment committee and water users organisations	Medium	Medium-term	**LODA (Lead)**, RWB (Co-lead), Districts, MINALOC, MINECOFIN (Others)
Goal 2: Efficient and effective pollution management in Nile Nyabarongo Upper catchment						
2	Water bodies and wetland are polluted following the discharge of polluted runoff and inadequately treated wastewater	Inadequate management of solid and liquid wastes	Develop sewerage systems and wastewater treatment plants	High	Long-term	**WASAC (Lead),** CoK &Districts (Co-lead), MINICOM ,MoE, MININFRA, REMA, RWB, (others)
			Develop sludge management and treatment facilities	High	Long-term	**WASAC (Lead),**RURA (Co-lead), REMA, CoK,Districts (Others)
			Support resettlement of population in high risk zones	High	Long-term	**MINALOC (Lead**),LODA (Co-lead), MINEMA, Districts (others)
			Support small industries &SMEs to implement cleaner production measures	Medium	Long-term	**NIRDA (Lead),**REMA (Co-lead) MINICOM, MoE, Districts (others
			Implement air pollution control guidelines	Low	Continuing	
			Support rainwater harvesting on rooftops of settlement areas	Medium	Continuing	**RWB (Lead),** LODA (Co-lead), MINSLOC, districts (others)
			Construction of water drainage to capture road drainage & settlements	High	Continuing	**RTDA (Lead),**RWB (Co-lead),MININFRA,

						MINALOC, Districts (others)
			Support construct of a designed landfill that makes provision for waste separation and recycling	Medium	Long-term	**WASAC (Lead),** CoK (Co-lead), MINICOM, MoE, REMA, RWB, District (others)
			Enforce oil separation at all garages and vehicle workshops	High	Continuing	**RURA (Lead),** REMA (Co-lead), PSF, Districts (others)
			Multiply inspections for environmental compliance in mining sector	High	Continuing	**REMA (Lead),** RIB (Co-lead), RMB, RNP, Districts
3	High River sedimentation	Sub-standard farming & mining practices aggravating soil erosion and pollution	Support the implementation of sustainable mining practices/Model mining	High	Long-term	**NIRDA(Lead),** WASAC(Co-lead),MoE, MINICOM, RURA, REMA, Districts (Others)
			Enhance payment of ecosystem services in NNYU for catchment protection	Medium	Continuing	**RMB (Lead),** Districts (Co-lead), MoE, REMA, RMA (others)
			Multiply inspections for environmental compliance in mining sector	High	Short-term	**RWB (Lead),** FONERWA (Co-lead), REMA, , Districts (others)
		Encroachment of river banks & pollution of water bodies	River bank protection along all rivers and wetlands in NNYU	High	Continuing	**RMB(Lead)**, Districts (Co-lead), REMA RNP,RIB, RMA (others)
			Increase awareness and education on environment protection	Medium	Continuing	**REMA (Lead),** COK & Districts(Co-lead), NGOs, Partners (others)
Goal 3: Effective information and knowledge management						

4	Low skills & awareness levels among water users	Lack of data on pollution	Inventory of small industries and SMEs with/without wastewater treatment facilities in NNYU	High	Short-term	**NIRDA (Lead),** REMA (Co-lead), MoE, districts
			Enforce continuous monitoring of vehicle emissions through regular standardised tests.	Medium	Short-term	**REMA** (Lead), RNP (Co-lead), RMB, RIB, Districts
			Integrate key urban hotspots monitoring points into national sampling network program	Medium	Short-term	**RWB (Lead)**, REMA (co-lead), MINAGRI, UR, Districts, NGOs (others)
		Little knowledge, understanding &skills in agrochemicals/ pesticides/herbicides application best practices	Develop training package on urban and rural pollution and BMPs.	Low	Short-term	**RWB (Lead),UR (Co-lead),** REMA, WASAC (Others)
			Conduct trainings , awareness raising and capacity building among farmers on smart agriculture	Medium	Continuing	**RAB(Lead),MINAGRI** (Co-lead), REMA, MoE, RWB, Districts (others)
		Low awareness in sustainable mining practices	Conduct capacity building in sustainable mining approach/Model mining among mining operators	Medium	Continuing	**RMB(Lead),RWB**(Co-lead), REMA, MoE, Districts (others)
		Little knowledge & understanding of environment laws and regulatory instruments	Disseminate policies, laws and regulatory instruments on environment protection, sustainable mining and smart agriculture	Medium	Short-term	**MoE (Lead),** REMA (Co-lead), districts

CHAPTER 6. MONITORING AND EVALUATION

6.1. Framework for Pollution Management Plan Monitoring and Evaluation

The monitoring and evaluation system will be based on the indicators defined in the log frame (Table12). The monitoring system will function as a management tool to report progress, constraints, and deviation from annual activities against Annual Plan targets, as well as to review and adapt, where necessary, the program strategies. Furthermore, it will function as a mechanism to proceed with timely and punctual data collection.

The overall responsibility for monitoring and evaluation will rest with the Authority in charge of Environment Pollution Control, the Rwanda Environment Management Authority but sources data during monitoring and reporting under this Plan entail the following mechanisms:

6.1.1. Sector level targets and indicators: Information for the indicators set by the plan will come primarily from the districts with RWB and REMA to ensure quality assurance. Information will also be drawn from national institute of statistics in Rwanda (NISR) for surveys, censuses and abstracts as well as from databases of key line sectors, such as health, agriculture, disaster management, land, environment, etc.

6.1.2. Reports of Major Water Users

RSB, WASAC, EDCL, RAB and processing industries may have good pollution management data for various water uses included in their annual reports.

6.1.3. Decentralized entities *M&E systems*

District annual performance contracts (*imihigo)* provide another important source of information and will be reviewed on a quarterly basis. Districts have targets relating to soil erosion control, protection and rehabilitation of buffer zones, effluent discharge and environment inspection, in their *imihigo* and District Development Strategies (DDS).

6.1.4. Private sector, civil society and NGOs reporting systems: The current legal framework requires these stakeholders to report regularly on their activities, and the districts in which they work must certify their good cooperation and conduct. This compels them to work within existing development priorities and share information about their work.

6.2. Indicators, data collection and reporting

Data collected will be organized into quarterly and annual reports. Additionally, data collected will be used to expand the Water Information System of Rwanda Water Board as well as the RBME of the Ministry of Environment.

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ANNEXI: NILE NYABUGOGO UPPER CATCHMENT INTERVENTIONS LOG FRAME

Goal 1: Alignment of urban planning, policies and strategies to mitigate the impacts of urban pollution								
Objective	**Activities**	**Indicators**	**Target**	**Timing**			**Responsible Authority**	**Indicative costs (US$)**
				2021/ 2022	2022/ 2024	2025-2030		
Objective1.1: Alignment of catchment planning, policies and strategies	Support District Authorities to enforce the Rwandan standards on pollution (industrial effluent standards &. EAC industrial and incinerator air emission standards)	% of industries complying with Rwandan industrial effluent standards	80% of SMEs are complying	X	X	X	REMA, RURA	22,400
	Support joint inspections of environment polluting activities in Nile Nyabarongo catchment	Number of joint inspections per year	2 inspections per year	X	X	X	REMA, Districts	8,000
	Facilitate integration of catchment pollution management interventions into the districts' annual performance contracts	%of Districts integrating IPMP into their annual plans	100% of Districts within the catchment		X	X	RWB	4,800
Objective 1.2. Establish coordination mechanisms for pollution management at catchment level	Operationalise the Nile Nyabarongo Upper catchment committee;	Operational catchment committee	Mukungwa catchment commitee	X			**RWB (Lead), Districts** (Co-lead), MoE, REMA, RHA, RTDA (Others)	5,200
	Establish and operationalise Nile Nyabarongo Upper catchment Technical Committee	Number of Catchment Technical Committee meetings per year	3 coordination meetings per year	x	x	x	**RWB (Lead)**, Districts (Co-lead), Catchment Committee (others)	5,200

	Support integrated planning at catchment level	Number planning meetings	2 meetings/year (2 technical committee meeting+1 general assembly)	X	X	X	**LODA (Lead)**, RWB (Co-lead), Districts, MINALOC, MINECOFIN (Others)	12,800
	Support regular coordination and environment committee meetings with water users organisations	% of water users organisations operational	100% of water users organisations are operational	X	X	X	**RWB (Lead)**, REMA (Co-lead), Districts (others)	22,400
Goal 2: Efficient and effective pollution management in Nile Nyabarongo Upper catchment								
Objective2.1: Support effective pollution management in Urban and per-urban areas of NYU	Develop sewerage systems and wastewater treatment plants	(i)% of districts in NYU catchment with semi-centralised wastewater treatment plants (ii)% of IDPs and trading centres with wastewater treatment facilities	(i) 40% of districts Muhanga &Huye) (ii) 100% of IDP villages and 80% of trading centres with WWTPs	X	X	X	**MINICOM (Lead),** WASAC (Co-lead), REMA, RWB, District (others)	110,000,000
	Develop sludge management and treatment facilities	% of districts in NYU with FSTP	FSTP feasibility studies for Huye & Muhanga districts completed	X	X		**WASAC (Lead),**RURA (Co-lead), REMA, Districts (Others)	3,000,000
	Support resettlement of population in high risk zones	% of population in high risk zones relocated	80% of population in high risk zones relocated	X	X	X	**MINALOC (Lead**),LODA (Co-lead), MINEMA, Districts (others)	1,500,000

	Support small industries &SMEs to implement cleaner production measures	% of small industries& SMEs implementing cleaner production measures	60% of small industries & SMEs	X	X	X	**NIRDA (Lead),**REMA (Co-lead) MINICOM, MoE, Districts (others	10,500
	Implement air pollution control guidelines	% of emitters of air pollutants in NYU implementing air pollution control guidelines	100% of air pollutants emitters	X	X	X	**REMA (Lead**), RSB (co-lead) ,RNP, MoE	11,200
	Support rainwater harvesting on rooftops of settlement areas	% of settlements with RWH infrastructure	100% of public buildings &schools, 60% of trading centres & 90% individual houses newly developed	X	X	X	**RWB (Lead),** LODA (Co-lead), MINSLOC, districts (others)	25,200
	Construction of water drainage to capture road drainage & settlements	% of district with urban drainage	Feasibility studies completed for all districts	X	X	X	**RTDA (Lead),**RWB (Co-lead),MININFRA , MINALOC, Districts (others)	32,000
	Enforce oil separation at all garages and vehicle workshops	% of garages enforcing oil separation	100%	X	X	X	**RURA (Lead),** REMA (Co-lead), Districts	50,000
	Support construct of a designed landfill that makes provision for waste separation and recycling	% of districts with engineered landfills	40% of districts (Huye and Muhanga)	X	X	X	WASAC (Lead), Districts (Co-lead) , PPP, others	26,400
Objective 2.2: Effective management of rural pollution	River bank protection along all rivers and wetlands in NYU	Number of Ha newly protected	Additional 400 Ha of river banks and wetlands protected	X	X	X	**NIRDA(Lead),** WASAC(Co-lead),MoE, MINICOM, RURA, REMA, Districts (Others)	21,000

	Support the implementation of sustainable mining practices/Model mining	% of mining companies supported	10% of companies supported	X	X	X	**RMB (Lead),** Districts (Co-lead), MoE, REMA, RMA (others)	52,000
	Enhance payment of ecosystem services in NYU	(i)Number livestock distributed (ii) Amount of money spent	(i)100 cows, 2000 goats and (ii) US$ 200,000 spent to support alternative jobs to subsistence agriculture	X	X	X	**RWB (Lead),** FONERWA (Co-lead), REMA, , Districts (others)	26,400
	Multiply inspections for environmental compliance in mining sector	% of mining operators complying with standards	TBD	80% of mining operators	X	X	XX	28,000
Goal 3: Effective information and knowledge management								
Objective	Inventory of small industries and SMEs with/without wastewater treatment facilities in NYU	% of industries complying with Rwandan industrial effluent standards	Inventory report	X			**NIRDA (Lead),** REMA (Co-lead), MoE, districts	60,000
	Enforce continuous monitoring of vehicle emissions through regular standardised tests.	% of road vehicles undergoing emission monitoring	80% of vehicles	X	X	X	**REMA** (Lead), RNP (Co-lead), RMB, RIB, Districts	40,000
	Integrated key urban hotspot monitoring points to national sampling program	Number of urban hotspots integrated into national water quality monitoring programme	16 sites (2 per District)	X	X	X	**RWB (Lead)**, REMA (co-lead), MINAGRI, UR, Districts, NGOs (others)	83,200
3.2: Building capacity in urban and	Develop training package on urban and rural pollution and BMPs.	Training document	Training Manuel	X			**RWB (Lead),UR (Co-lead),**	40,000

rural pollution management							REMA, WASAC (Others)	
	Conduct trainings , awareness raising and capacity building among farmers on smart agriculture	Number of farmers trained	500		X	X	**RAB(Lead),MINAGRI** (Co-lead), REMA, MoE, RWB, Districts (others)	20,400
	Conduct capacity building in sustainable mining approach/Model mining among mining operators	Number of miners trained	200		X	X	**RMB(Lead),RWB**(Co-lead), REMA, MoE, Districts (others)	20,500
	Disseminate policies, laws and regulatory instruments on environment protection, sustainable mining and smart agriculture	Number of material disseminated	1000	X	X	X	**MoE (Lead),** REMA (Co-lead), districts	30,000
Total								**115,157,600**

ANNEX II: POLLUTANTS COMMONLY FOUND IN URBAN STORMWATER AND THEIR SOURCES

The pollutants commonly found in urban stormwater and the forms in which they occur are summarised in Table 3 below (Shaver et al., 2007):

Table 15: Pollutants commonly found in urban stormwater and their sources

No	Type of pollutant	Common source
1	Solids (Settleable solids, Total suspended solids (TSS), Turbidity (NTU)):	Unpaved urban roads, Urban agriculture and grazing, Pavement wear, Construction sites, Quarries
2	Oxygen-demanding material (Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Organic matter (OM), Total organic carbon (TOC)):	Agriculture and grazing, Human sewage, Grey water disposal, Aquaculture in urban areas, Agro-processing industries within urban areas
2	Phosphorus (P) - (Total phosphorus (TP), Soluble reactive phosphorus (SRP), Biologically available phosphorus (BAP)):	Agriculture and grazing, Parks, lawn and landscape fertilizer
4	Nitrogen (N) (Total nitrogen (TN), Total kjeldahl nitrogen (TKN), Nitrate + nitrite-nitrogen (NO_3+NO_2-N), Ammonia-nitrogen (NH_3-N)):	Agriculture and grazing, Parks, lawn and landscape fertilizer
5	Metals (Copper (Cu), lead (Pb), zinc (Zn), cadmium (Cd), arsenic (As), nickel (Ni), chromium (Cr), mercury (Hg), selenium (Se), silver (Ag)- Galvanized metals, Paints and wood preservatives, Roofing and gutters, Tires (for Zn);	Gasoline, Paint, Batteries (for Pb); Building materials, Paints and wood preservatives, Algicides, Brake pads (for Cu); Electro-plating activities, Paints and preservatives (for Cd and Cr)
6	Herbicides and pesticides	Urban agriculture and grazing, Residential and commercial use, Roadside vegetation maintenance
7	Pathogens (Faecal coliform bacteria (FC), Enterococcus bacteria (EC), Total coliform bacteria (TC), Viruses):	Human sewage, Livestock manure, Domestic animal faecal material
8	Petroleum hydrocarbons (Oil and grease (OG), Total petroleum hydrocarbons (TPH)-	Internal combustion engines, Automobiles, Industrial machinery, Workshops and garages
9	Synthetic organics (Polynuclear aromatic hydrocarbons (PAH), Pesticides and herbicides, Polychlorobiphenols (PCB):	Industrial processes, Power generation

ANNEX III: OTHER RURAL DIFFUSE POLLUTANTS

Pollutant group	Specific pollutant and comments
Herbicides	Diuron, Atrazine, Ametryn, Hexazinone and 2,4-D are principally used in the sugar industry. Simazine used in forestry. Tebuthiuron used in grazing industry. Glyphosate and Paraquat used broadly in sugar cane and horticulture.
Insecticides	Organochlorines e.g. Endosulfan, and a variety of others are used principally in horticulture and, to a lesser extent, sugar cane. Chlorpyrifos used in sugar cane for cane grubs.
Non insecticide organochlorines	PCB's from industry (reduced use but residues may persist) and Dioxins from agriculture and industry. PAH's (polycyclic aromatic hydrocarbons) from cane firing, forest fires and oil spills.
DO reducing materials (organic material)	Manure principally from cattle grazing. Sewage from urban areas. Plant litter occurs naturally and is increased as byproducts of intensive agriculture.
Heavy metals	Cadmium and potassium from fertiliser and mercury from fungicide. Other trace elements.
Oil or hydrocarbons	Primarily from liquid fossil fuels and oil spills.
Salinity	Both dryland and irrigation salinity resulting from land clearing (dryland) and irrigation activities.
Antifoulants	Used primarily in the fishing industry at mooring sites (TBT is now banned).
Acid	Principally associated with disturbance of acid sulphate soils.

ANNEX IV: NOTE ON IPMP BUDGET/COSTING ESTIMATION

Item/	Unit	Quantity	Unit Price (US$)	Total Indicative costs (US$)	Source of data
Inspections to enforce EAC industrial and incinerator air emission standards.	Number	80	280	22,400	Ministerial Instructions (N°001/15/10/TC DU 20/07/2015)
Define legal framework and institutionalise NNYU catchment office	Number	50	160	8,000	Estimated based on Hotel Contracts
Support integrated at catchment level (planning meetings)	Number	30	160	4,800	Estimated based on Hotel contracts
Support regular coordination and environment committee meetings with water users organisations	Number	80	160	12,800	Estimated based on Hotel contracts
Develop sewerage systems and wastewater treatment plants	Number	2	55,000,000	110,000,000	WASAC Estimates
Develop sludge management and treatment facilities	Number	1	3,000,000	3,000,000	WASAC Estimates
Support resettlement of population in high risk zones	Number of HH	200	7,500	1,500,000	Adaptation Fund Project
Support small industries &SMEs to implement cleaner production measures	Persons trained	100	105	10,500	Based on W4GR estimates
Implement air pollution control guidelines	Number of inspections	40	280	11,200	Ministerial Instructions (N°001/15/10/TC DU 20/07/2015)
Support rainwater harvesting on rooftops of settlement areas	Number ($5m^3$)	60	420	25,200	RWH project/RWFA
Construction of water drainage to capture road drainage & settlements	m	1000	32	32,000	Expert judgement

Enforce oil separation at all garages and vehicle workshops	Number	20	2500	50,000	Expert judgement
Support construct of a designed landfill that makes provision for waste separation and recycling	Number	2	2,000,000	4,000,000	Estimates from WASAC
River bank protection along all rivers and wetlands in NYU	Ha	120	220	26,400	REMA SAP
Support the implementation of sustainable mining practices/Model mining	Persons trained	200	105	21,000	W4GR project
Enhance payment of ecosystem services in NYU	Number of Cows	100	520	52,000	Reference price on local market
	Number of goats	2000	60	120,000	Reference price on local market
	Projects supported	10	20,000	200,000	Reference to LVEMPII project
Multiply inspections for environmental compliance in mining sector	Number	100	280	28,000	Ministerial Instructions (N°001/15/10/TC DU 20/07/2015)
Inventory of small industries and SMEs with/without wastewater treatment facilities in NYU	Reports	1	60,0000	60,000	Comparison with similar projects
Enforce continuous monitoring of vehicle emissions through regular standardised tests.	Project	1	40,000	40,000	Expert judgement
Integrated key urban hotspot monitoring points to national sampling program	Number	160	5200	83,200	UR contracts with RWFA
Develop training package on urban and rural pollution and BMPs.	Consultancy	1	40,000	40,000	Similar Consultancy

Conduct trainings , awareness raising and capacity building among farmers on smart agriculture	Number	200	105	20,400	W4GR Project
Conduct capacity building in sustainable mining approach/Model mining among mining operators	Number	200	105	20,500	W4GR Project
Disseminate policies, laws and regulatory instruments on environment protection, sustainable mining and smart agriculture	Number	1000	30	30,000	Expert judgment

ANNEX V: STATUS OF POLLUTION IN NILE NYABUGOGO UPPER IN PHOTOS

Picture 1: Muhanga prison_ the prison upstream the wetland and bricks making site

Picture 2: Stagnating water where the bricks are made_ Muhanga District_Shyogwe Sector

Picture 3: Natural springs used for bricks making

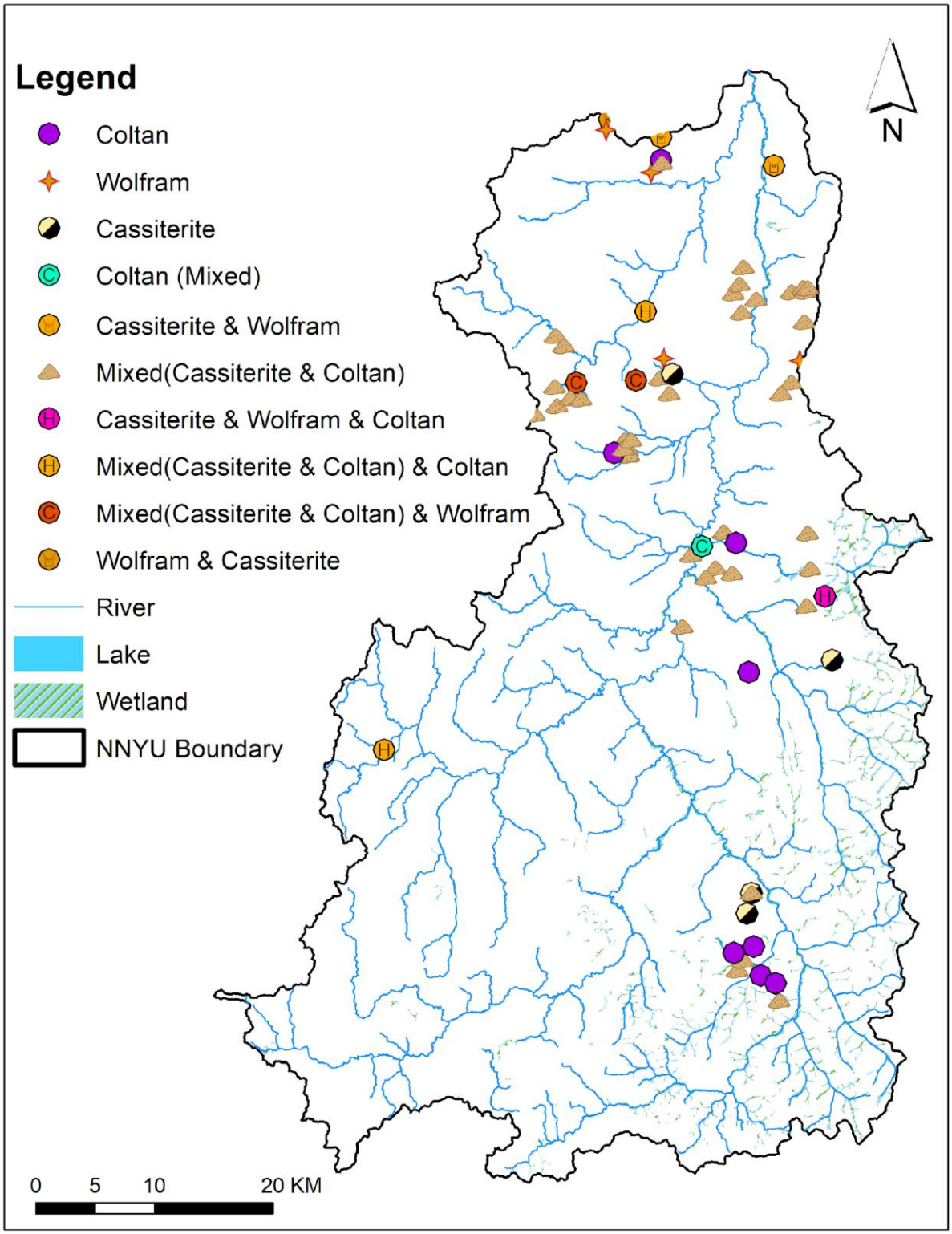
Picture 4: Marshland downstream the Muhanga prison used for bricks making

Picture 5: Dumping site behind Muhanga market

Picture 6: Grey water in the storm water drain from Huye Market

Picture 7: Informal dumping site in the cemetery at the back of the University of Rwanda/Huye Campus

ANNEX VI: EXISTING MINING IN NILE NYABARONGO UPPER



ANNEX VII: KEY POLLUTION HOTSPOTS

VII.1. List of coffee washing stations in Nile Nyabarongo Upper catchment

FID	Name	DISTRICT	SECTOR	CELL	OWNER_NAM	WATER_SOU	ENVIRO_PR	Village	X	Y
0	MIG Murera	HUYE	Kigoma	Kabuga	MIG	Natural Spring	Natural seepage	Nyarunazi	29.62879	-2.47595
1	Koakaka CWS	HUYE	Kigoma	Karambi	Koakaka	Natural Spring	Natural seepage	Nyarunyinya	29.61715	-2.50862
2	Rwanda Mountain Coffee	HUYE	Kigoma	Musebeya	Rubayiza Aloys	Natural Spring	Filtering System	Nyarurembo	29.64694	-2.47506
3	MIG Buremera	HUYE	Maraba	Buremera	MIG LTD	Lake/River	Filtering system	Kinazi	29.59477	-2.54724
4	Maraba II Kabuye Cws	HUYE	Maraba	Kabuye	Abahuzamugambi coop	Natural Spring	Natural seepage	Rukeri	29.62174	-2.55594
5	Maraba I Cyarumbo Cws	HUYE	Maraba	Shyembe	Abahuzamugambi coop	Natural Spring	Natural seepage + filt	Gisagara	29.66994	-2.54489
6	Gift Coffee Company Ltd	HUYE	Maraba	Shanga	Manirakiza Damien	Natural Spring	Filtering System	Gasororo	29.63639	-2.54482
7	COGIMUAKA	HUYE	Rusatira	Buhimba	COGIMUAKA	well	Natural seepage	Gasaka	29.76264	-2.43166
8	Simbi CWS	HUYE	Simbi	Gisakura	Rudahunga Abdul	Natural Spring	Filtering System	Kigarama	29.68317	-2.50059
9	MIG Ngoma	NYAMAGABE	Cyanika	Ngoma	MIG LTD	Natural spring+wat	Natural seepage	Kavumu	29.62062	-2.43678
10	Buf Coffee Remera	NYAMAGABE	Gasaka	Remera	MUKASHYAKA Epiphanie	Natural spring+wat	Natural seepage	Nyamifumba	29.55413	-2.47113
11	Buf Coffee Kamegeri	NYAMAGABE	Kamegeri	Nyarusiza	MUKASHYAKA Epiphanie	Natural spring+wat	Natural seepage	Nyarusiza	29.57565	-2.53258
12	Mother land CWS	NYAMAGABE	Kamegeri	Kamageri	Mother land co.	Natural spring	Filtering System	Rweru	29.5687	-2.52444
13	KOAKAKA Muganza	NYAMAGABE	Kibirizi	Bugarura	KOAKAKA	Natural spring	Natural seepage	Kasebutur any	29.55584	-2.4376
14	MIG Kibumbwe	NYAMAGABE	Kibumbwe	Gakanka	MIG LTD	Natural spring+wat	Direct in river	Nkurubuye	29.51167	-2.41978

15	Mizero coffee	NYANZA	Mukingo	Ngwa	Mizero Coffee Cooperative	Natural Spring	Natural Seepage	Biroro	29.75831	-2.28606
16	IWACU CWS	NYANZA	Nyagisozi	Kabirizi	Bizimana Evariste	Natural Spring	Filtering System	Muhaga	29.63534	-2.35943
17	Ikirezi coffee	NYANZA	Nyagizozi	Kabirizi	Kirezi coffee	Natural Spring	Natural Seepage	Muhaga	29.62411	-2.36635
18	Kagogo CWS	NGORORERO	Hindiro	Gatare	Rwacof Ltd (Rwacof/Ngororero CWS)	Natural Spring	Natural seepage	Kigarama	29.62735	-1.8197
19	Koduka Cooperative	NGORORERO	Kageyo	Nyamata	Koduka Coperative	Natural Spring	Natural Seepage	Bereshi	29.6024	-1.86577
20	Kopiguka CWS	NGORORERO	Muhororo	Myiha	Kopiguka cooperative	Natural Spring	Filtering System	Kabyiniro	29.62982	-1.90152
21	Mpanda CWS	Ruhango	Byimana	Mpanda	NDAGIJIMANA Eric & NIZEYIMANA	water pump	Filtering system	Nyagahinga	29.72041	-2.1382

VII.2. List of Hydropowers in Nile Nyabarongo Upper catchment

FID	Site_name	F3	Atlas_Code	District	Sector	X	Y	Est_Max_Ca
0	Cyintiti	Cyintiti	ONG-03	Muhanga-Ngororero	Mushishiro-Gatumba-Ndaro	457564	9781499	100
1	Gasharu	Mbirurume	0	Karongi	Mutuntu	438585.4	9749127	395.2772
2	Gisuma	Gisuma	ONG-06	Ngororero	Gatumba	459114	9785895	250
3	Kabavu	Kabavu	SNB-20	Nyamagabe	Gatare-Nkomane	434471	9740762	250
4	Karumbi	Karumbi	OKA-22	Karongi	Mutuntu-Twumba	430004	9751478	100
5	Kavumu	Muhembe	0	Ngororero	Kavumu	451507.3	9798934	499.1422
6	Kibilira	Kibilira	ONG-05	Ngororero	Bwira-Gatumba	456258	9786722	100
7	Kirasa	Kirasa	OKA-26	Karongi	Ruganda	440446	9751768	100
8	Masango	Masango	0	Ruhango	Kabagali	456200.7	9758752	105.4734
9	Mashyiga	Mashyiga	OKA-08	Karongi	Murambi	451408	9761335	140
10	Mbirurume A	Mbirurume A	OKA-19	Karongi	Mutuntu-Twumba	429676	9749957	100
11	Mbirurume B	Mbirurume B	OKA-18	Karongi	Mutuntu-Twumba	429934	9749874	100
12	Mbirurume D	Mbirurume D	OKA-20	Karongi	Mutuntu-Twumba	430856	9750367	100
13	Muhara III	Muhara III	SNB-27	Nyamagabe	Kaduha	451020	9745813	100
14	Muhembe	Muhembe	ONG-09	Ngororero	Hindiro-Kageyo-Kavumu	455814	9798749	250
15	Musasa II	Musasa	0	Karongi	Gishari	445451.8	9756982	255.129
16	Mwogo A	Mwogo A	SNB-03	Nyaruguru	Ruramba-Tare	445268	9717928	100

17	Mwogo C	Mwogo	0	Huye	Maraba	453871.1	9721416	194.3739
18	Nduruma	Nduruma	OKA-23	Karongi-Rutsiro	Rubengera-Rugabano-Mukura	434322	9753607	0
19	Ntaruko	Ntaruko		Ngororero	Kabaya	449736.8	9799023	139.2726
20	Nyabarongo	Nyabarongo	ONG-04	Muhanga-Ngororero	Mushishiro-Gatumba	458290	9782081	28000
21	Nyirabugoyi	Rukarara	0	Nyamagabe	Buruhukiro	434583.7	9729913	325.9096
22	Range	Range	0	Nyamagabe	Nkomane	436455.7	9749145	539.0634
23	Rorongora	Rorongora	0	Nyamagabe	Mushubi	440996.9	9744092	286.6953
24	Rubyiro II	Rubyiro II	SNB-15	Nyamagabe	Buruhukiro-Uwinkingi	435097	9725526	100
25	Rucanzogera	Rucanzogera	0	Ngororero	Bwira	447581.1	9783706	260.1235
26	Rukarara I	Rukarara I	SNB-17	Nyamagabe	-	441742	9730565	9500
27	Rukarara II	Rukarara II	SNB-34	Nyamagabe	-	436997	9728313	2000
28	Rukarara III	Rukarara III	SNB-33	Nyamagabe	Buruhukiro-Uwinkingi	437548	9728576	250
29	Rukarara IV/Mushishiro	Rukarara IV/Mushishiro	SNB-35	Nyamagabe	-	436642	9728211	5000
30	Ruramba	Ruramba	SNB-04	Nyaruguru	Ruramba-Tare	447781	9719221	500
31	Rwondo	Rwondo	SNB-24	Nyamagabe	-	435727	9745606	1000
32	Rwondo 2	Rwondo	0	Nyamagabe	Mushubi	438731.7	9749170	536.9021
33	Sanzare	Sanzare	ONG-12	Rutsiro-Ngororero	Rusebeya-Sovu	444101	9787624	250
34	Satinsyi	Satinsyi	ONG-10	Ngororero	Hindiro-Kageyo-Ngororero	458497	9799056	250
35	Secoko	Secoko	ONG-13	Ngororero	Ndaro-Nyange	456442	9777530	250

36	Uwintobo	Uwintobo	0	Karongi	Twumbwa	431470.7	9753990	1661.943

VII. 3. List of mining sites in Nile Nyabarongo Upper

S/N	Latitude	Longitude	Company_Co	Company__1	District	Sector__s_	Cell	Mine_Site	Mine_type
1	29.5917	-1.97111	Ets Munsad Minerals	R003	Ngororero	Ndaro	Kabageshi	Ruhanga	Mixed(Cassiterite & Coltan)
2	29.5989	-1.98306	Ets Munsad Minerals	R003	Ngororero	Ndaro	Kabageshi	Masoro 2	Mixed(Cassiterite & Coltan)
3	29.6475	-1.90667	Gatumba Mines Concession (GMC)	R008	Ngororero			Nyarigamba	Mixed(Cassiterite & Coltan)
4	29.6519	-1.89972	Gatumba Mines Concession (GMC)	R008	Ngororero			Mubuga	Mixed(Cassiterite & Coltan)
5	29.6539	-1.92111	Gatumba Mines Concession (GMC)	R008	Ngororero			Buranga	Mixed(Cassiterite & Coltan)
6	29.6553	-1.88667	Gatumba Mines Concession (GMC)	R008	Ngororero			Nyamisa	Mixed(Cassiterite & Coltan)
7	29.6647	-1.91111	Gatumba Mines Concession (GMC)	R008	Ngororero			Rusororo 1	Mixed(Cassiterite & Coltan)
8	29.6917	-1.90528	Gatumba Mines Concession (GMC)	R008	Ngororero			Nyarusange 1	Mixed(Cassiterite & Coltan)
9	29.7003	-1.90222	Gatumba Mines Concession (GMC)	R008	Ngororero			Karambi	Mixed(Cassiterite & Coltan)
10	29.7022	-1.905	Gatumba Mines Concession (GMC)	R008	Ngororero			Kabuba	Mixed(Cassiterite & Coltan)
11	29.4967	-1.99889	Rwanda Allied Partners (RAP)	R012	Rutsiro			Kibara 1	Mixed(Cassiterite & Coltan)
12	29.5122	-1.97778	Rwanda Allied Partners (RAP)	R012	Rutsiro			Darfour	Mixed(Cassiterite & Coltan)
13	29.5139	-1.9925	Rwanda Allied Partners (RAP)	R012	Rutsiro	Rusebeya	Kageyo	Rwamasizi	Mixed(Cassiterite & Coltan)
14	29.5286	-1.97444	TUHAGERE	R019	Rutsiro	Gihango	Gashubi	Gakomeye	Mixed(Cassiterite & Coltan) & Wolfram
15	29.6914	-1.97444	Mugabonake Jeanne	R021	Gakenke	Busengo	Birambo	Busengo	Mixed(Cassiterite & Coltan)

16	29.5739	-1.97278	Burera Minerals Deposit Company (BMDC)	R024	Ngororero	Gatumba	Karambo	Rusebeya	Mixed(Cassiterite & Coltan) & Wolfram	
17	29.5953	-1.95611	Burera Minerals Deposit Company (BMDC)	R024	Ngororero	Ndaro	Kinyove	Kinyove	Wolfram	
18	29.6014	-1.96778	Burera Minerals Deposit Company (BMDC)	R024	Ngororero	Ndaro	Kinyove	Ngurugunzu	Cassiterite	
19	29.5128	-1.93889	New Line Development	R025	Rutsiro	Rusebeya	Ruronde	Satinsyi	Mixed(Cassiterite & Coltan)	
20	29.6836	-1.98306	Ets Karinda	R029	Muhanga	Rugendabari	Gasave	Gasharu	Cassiterite & Coltan	
21	29.6981	-1.95778	Ets Karinda	R029	Muhanga	Kabacuzi	Burambа	Bahozi	Wolfram	
22	29.6614	-2.36361	HAVILA Mines	R035	Nyanza	Nyagisozi	Gashyenzi	Gashyenzi	Cassiterite	
23	29.6614	-2.36361	HAVILA Mines	R035	Nyanza	Nyagisozi	Nyamagana	Nyamagana	Mixed(Cassiterite & Coltan)	
24	29.5672	-2.02556	Niyigena Innocent	R038	Ngororero	Nyange	Vuganyana	Mbobo 2	Mixed(Cassiterite & Coltan)	
25	29.5678	-2.03028	Niyigena Innocent	R038	Ngororero	Nyange	Vuganyana	Nyagatama	Mixed(Cassiterite & Coltan)	
26	29.5681	-2.02944	Niyigena Innocent	R038	Ngororero	Nyange	Vuganyana	Mbobo 1	Mixed(Cassiterite & Coltan)	
27	29.6786	-1.80889	Ets Sindambiwe	R041	Muhanga	Nyabinoni	Masangano	Nyabinoni	Cassiterite & Wolfram	
28	29.6089	-2.16056	COMIKIGI	R046	Ruhango	Kinihira	Kabagari	Kamuramira	Mixed(Cassiterite & Coltan)	
29	29.6594	-2.195	COMIKIGI	R046	Ruhango	Kinihira	Kabagari	Rukina	Coltan	
30	29.6581	-2.37889	Rugamba Robert	R058	Nyanza	Nyagisozi	Rurangazi	Nyagisozi	Cassiterite	

31	29.6822	-2.44556	SUGIRA	R060	Huye	Rwaniro	Kamwambi	Rwimpiri	Mixed(Cassiterite & Coltan)	
32	29.5242	-1.98639	COEMIKI	R061	Ngororero	Ndaro	Kibanda	Kavure 2	Mixed(Cassiterite & Coltan)	
33	29.5319	-1.98722	COEMIKI	R061	Ngororero	Ndaro	Kibanda	Kavure 1	Mixed(Cassiterite & Coltan)	
34	29.5319	-1.98722	COEMIKI	R061	Ngororero	Ndaro	Kibanda	Mwogambere	Mixed(Cassiterite & Coltan)	
35	29.565	-2.01833	COEMIKI	R061	Ngororero	Ndaro	Kibanda	Nyamuremure	Mixed(Cassiterite & Coltan)	
36	29.5189	-1.94667	Rutsiro Miners Cooperative (RMC)	R065	Rutsiro	Rusebeya	Ruronde	Rutonde 2	Mixed(Cassiterite & Coltan)	
37	29.5536	-1.77361	CEMIR	R070	Ngororero	Kabaya	Kanyeneri	Muturirwa	Wolfram & Cassiterite	
38	29.5514	-1.78167	CEMIR	R070	Ngororero	Kabaya	Gaseke	Kirongo	Wolfram	
39	29.6506	-2.4225	TUGOBOKANE	R082	Nyamagabe	Cyanika	Nyanzoga	Nyanzoga	Mixed(Cassiterite & Coltan)	
40	29.6547	-2.415	TUGOBOKANE	R082	Nyamagabe	Cyanika	Nyanzoga	Mbeho	Mixed(Cassiterite & Coltan)	
41	29.6153	-2.10611	Rwanda Rudniki	R087	Karongi	Murundi	Kabaya	Cyanyanza	Mixed(Cassiterite & Coltan)	
42	29.6339	-2.11611	Rwanda Rudniki	R087	Muhanga	Nyarusange	Ngaru	Nyamyase	Mixed(Cassiterite & Coltan)	
43	29.64	-2.08861	Rwanda Rudniki	R087	Muhanga	Nyarusange	Musongati	Nyamirama	Mixed(Cassiterite & Coltan)	
44	29.6497	-2.09667	Rwanda Rudniki	R087	Muhanga	Nyarusange	Musongati	Remera	Coltan	
45	29.6239	-2.09917	SOREMI Intego	R093	Muhanga	Nyarusange	Ngaru	Kanyoni	Coltan (Mixed)	
46	29.6481	-2.40889	Kanamugire	R094	Nyanza	Nyagisozi	Kirambi	Murende	Coltan	
47	29.6631	-2.40417	Kanamugire	R094	Nyanza	Nyagisozi	Kirambi	Rwankuba	Coltan	

48	29.6683	-2.42611	Kanamugire	R094	Huye	Rwaniro	Kamwambi	Kashyaka	Coltan	
49	29.6794	-2.43222	Kanamugire	R094	Huye	Rwaniro	Kamwambi	Kibugazi	Coltan	
50	29.5856	-1.81417	CEMIEX	R096	Ngororero	Hindiro	Marantima	Kiringa	Wolfram	
51	29.5931	-1.78722	CEMIEX	R096	Ngororero	Hindiro	Runyinya	Nyarukore	Cassiterite & Wolfram	
52	29.5931	-1.80472	CEMIEX	R096	Ngororero	Hindiro	Marantima	Mbuye	Coltan	
53	29.5933	-1.80722	CEMIEX	R096	Ngororero	Hindiro	Marantima	Gataba	Mixed(Cassiterite & Coltan)	
54	29.6267	-2.12306	Mining Penina & Dieudonne (MPED)	R107	Ruhango	Mwendo	Nyabigugu	Gatoki 2	Mixed(Cassiterite & Coltan)	
55	29.6467	-2.12	Mining Penina & Dieudonne (MPED)	R107	Ruhango	Mwendo	Nyabigugu	Gasange	Mixed(Cassiterite & Coltan)	
56	29.7028	-2.14472	Mining Penina & Dieudonne (MPED)	R107	Ruhango	Mwendo	Nyabigugu	Karumbya	Mixed(Cassiterite & Coltan)	
57	29.5572	-2.02778	COMIVUNYA	R113	Ngororero	Nyange	Vuganyana	Mbobo	Coltan	
58	29.5642	-2.025	COMIVUNYA	R113	Rutsiro	Mukura	Mwendo	Mwendo	Mixed(Cassiterite & Coltan)	
59	29.7039	-1.9025	Special Mining Company (SPMC)	R115	Muhanga	Rugendabari	Mpinga	Kinogi	Mixed(Cassiterite & Coltan)	
60	29.7039	-2.08944	KAMU Mining	R125	Muhanga	Nyarusange	Rusovu	Rusovu	Mixed(Cassiterite & Coltan)	
61	29.7225	-2.18583	Akaramata Vital Import Export (AVIE)	R133	Ruhango	Bweramana	Rwinyana	Mukingi	Cassiterite	
62	29.5697	-2.01833	SESECO	R135	Ngororero	Ndaro	Kibanda	Rwambogo	Mixed(Cassiterite & Coltan)	
63	29.5811	-1.92	Harvest Mining Company	R136	Ngororero	Bwira	Cyahafi	Rushubi 2	Mixed(Cassiterite & Coltan) & Coltan	

64	29.7058	-2.11667	Cyusa Enterprise	R151	Ruhango	Byimana	Mpanda	Nyaburondwe	Cassiterite & Coltan	
65	29.3828	-2.25417	KOKAMK Cooperative	R156	Karongi	Mutuntu	Kinyonzwe	Mutuntu	Mixed(Cassiterite & Coltan) & Coltan	
66	29.7011	-1.92833	Cooperate Miniere de Nyabikenke (COMINYA)	R163	Muhanga	Kabacuzi	Kibyimba	Kinogi I	Mixed(Cassiterite & Coltan)	
67	29.7172	-2.13722	Akagera Mining Company	R169	Ruhango	Byimana	Mpanda	Rugunda	Cassiterite, Wolfram & Coltan	

VII.4. List of Water Treatment Plants

Water Treatment Plants in Nile Nyabugogo Upper				
FID	Shape *	OBJECTID	District	Sector
0	Point	20	Ruhango	Ruhango
1	Point	22	Muhanga	Shyogwe
2	Point	23	Muhanga	Nyamabuye
3	Point	24	Muhanga	Nyamabuye
4	Point	25	Ruhango	Byimana
5	Point	26	Nyanza	Mukingo
6	Point	27	Nyamagabe	Gasaka

VII.5. Petrol Stations

FID	Name	Latitude	Longitude	District	Sector	Cell
0	Nyanza	-2.35288	29.75265	Nyanza	Busasamana	Nyanza
1	Kavumu	-2.08287	29.75418	Muhanga	Nyamabuye	Gitarama
2	Kavumu	-2.08128	29.75375	Muhanga	Nyamabuye	Gitarama
3	Kamazuru	-2.09467	29.75669	Muhanga	Nyamabuye	Gahogo
4	Ngororero	-1.85652	29.63169	Ngororero	NGORORERO	Kazabe
5	Kavumu	-2.08389	29.75186	Muhanga	Nyamabuye	Gitarama
6	Nyarucyamu Iii	-2.08858	29.75546	Muhanga	Nyamabuye	Gahogo
7	Kabacuzi	-2.47261	29.58151	Nyamagabe	Gasaka	Nyamugari
8	Mukoni	-2.34746	29.76843	Nyanza	Busasamana	Kavumu
9	Nyanza	-2.35374	29.75002	Nyanza	Busasamana	Nyanza
10	Rutenga	-2.08735	29.75315	Muhanga	Nyamabuye	Gahogo
11	Gataka	-2.23152	29.78668	Ruhango	Ruhango	Munini
12	Nyarucyamu I	-2.08756	29.75475	Muhanga	Nyamabuye	Gahogo
13	Kabagari	-1.85309	29.63178	Ngororero	NGORORERO	Rususa
14	Kabacuzi	-2.47186	29.58034	Nyamagabe	Gasaka	Nyamugari
15	Rutenga	-2.08571	29.75117	Muhanga	Nyamabuye	Gahogo
16	Bususuruke	-2.5196	29.43309	Nyamagabe	Kitabi	Kagano
17	Murangara	-2.50714	29.48363	Nyamagabe	Tare	Gasarenda

VII.6. other hotspots: Floods, landslides, soil erosion &dumping sites

S/N	Pollution	District	Sector	Latitude	Longitude	Altitude
1	Dumping Site	Muhanga	Muhanga	-2.06599	29.69533	1801.2
2	Dumping Site	Muhanga		-2.06532	29.69564	1796.2
3	Flooding	Ngororero	Ngororero	-1.85995	29.6358	1663.4
4	Landslide	Ngororero	Ngororero	-1.8544	29.64292	1584.7
5	Landslide	Ngororero	Muhororo	-1.90718	29.5877	1943.9
6	Landslide	Ngororero	Ngororero	-1.8683	29.63524	1718.7
7	Landslide	Ngororero	Ngororero	-1.8544	29.64292	1584.7
8	Landslide	Muhanga	Kibangu	-1.84617	29.69712	1549.2
9	Landslide	Muhanga	Kibangu	-1.84593	29.69702	1551.3
10	Landslide	Muhanga	Kibangu	-1.861	29.70771	1926.4
11	Mining	Muhanga	Rugendabari	-1.93311	29.68952	1797.1
12	Mining	Muhanga	Rugendabari	-1.9331	29.68888	1786.9
13	Soil Erosion	Ngororero	Ngororero	-1.85982	29.63655	1670.5
14	Soil Erosion	Muhanga	Kibangu	-1.8477	29.69771	1553.9
15	Wetland Pollution	Muhanga	Kibangu	-1.8477	29.69763	1545.3