NYABARONGO UPPER CATCHMENT MANAGEMENT PLAN NNYU

NYIRAMUHONDI WATERSHED

REHABILITATION PLAN 2020-2024




By Centre of Excellence in Biodiversity and Natural Resource Management

University of Rwanda

This report was prepared for Rwanda Environment Management Authority by a team of University of Rwanda, College of Science and Technology academic staff led by the Centre of Excellence in Biodiversity and Natural Resource Management with collaboration from the School of ICT, School of Engineering, School of Sciences and Centre for GIS. The team included Prof Beth Kaplin (project lead), Dr. Christian Sekomo (water quality team leader), Mardoche Birori Mudakikwa and Emmanuel Nkurunziza (water quality field assistants), Prof Umaru Garba Wali (Catchment Management Plans team leader), Venerand Gwiza (Catchment Management Plans field assistant), Elisée Gashugi (wetlands management team leader), Chrisostome Ufitinema (wetlandsmanagement field assistant), Dr. Elias Nyandwi (GIS team leader), Maurice Mugabowindekwe (GIS co-team leader), Celestin Mbonabucya (IT team leader), Pelin Mutanguha (IT co-team leader), Dr. Richard Musabe and Dr. Alfred Uwitonze (IT strategic advisors). Suggested report citation: REMA, 2020. Environment and Natural Resources Management (ENRM): National Wetlands Management Framework for Rwanda. Kigali, Rwanda.

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EXECUTIVE SUMMARY

Nyiramuhondi watershed is one of the level four catchment of Nile Nyabarongo Upper Catchment (NNYU). It is about 694 ha and high populated watershed with a population density of about 595 people per square kilometre. It is home to about 4,165 people. The watershed is fully located within the Ngororero Sector of the Ngororero District in the Western Province of Rwanda. Four cells have part of their territory within the Nyiramuhondi watershed, they are Kazabe, Nyange, Rususa and Terero cells. The watershed is mountainous and has Nyamuhondo River as it main River. Nyamuhondo River has three tributaries (3) that drain into it, they are Mazimeru, Kabutura and Nyabibugu Rivers. Nyamuhondo River is a direct tributary of Nyabarongo River.

Nyiramuhondi watershed is an agricultural watershed with over 80% of the population defending on agriculture for their livelihood. It is highly degraded watershed with some of the key issue of the catchment include: soil erosion, floods, landslides, deforestation, poverty, insufficient domestic water supply, poor drainage systems, lack of buffer zones (catchment delimitation), water pollution and high level of sediment transport, lack of diverse income opportunities, scarce firewood and degraded forests, limited capacity to afford modern RWH tanks and lack of social infrastructures.

The main river of the Nyiramuhondi watershed, Nyabarongo River and its tributaries provides water to the population, sustain its stream ecosystem and also contribute water to Nyabarongo River. The health of Nyabarongo River is extremely important for the riparian community and also for the state of the Nyabarongo River. As it is very well known one of the key problems of Nyaborongo River is pollution inform of high sediment transport as a result of erosion in the contributing catchments. Nyabarongo River is a critically important River in Rwanda, it is therefore essential that it is appropriately managed. To achieve the management of Nyaborongo River, it is important to manage the sub-watersheds that make up the catchments contributing water to it, including Nyiramuhondi watershed.

The update CROM DSS, 2019 highlighted about 117 degraded sites with erosion potential from extremely high to high and proposed appropriate intervention for its restorations, this was also confirmed by the field observations and survey conducted during data collection for the current study. Some of the key innervations proposed in this this watershed restoration plan emanates from the proposal of the CROM DSS as this were interventions that were consider to be relevant by all the involved stakeholders.

Appropriate management of Nyiramuhondi watershed will contribute to improve welfare of its population and conserve biodiversity there by improving water quantity and quality in the watershed. In turn this will lead to improve water quantity and quality downstream.

It is worth noting that a lot of effort was put in place by REMA/UNDP in restoration/rehabilitation Nyiramuhondi watershed and other neighbouring watershed. Some of the interventions put in place include buffer zone protection, flood and landslide management, reforestation and afforestation, and socio-economic empowerment of the community of Nyiramuhondi watershed. It is essential that this effort is continued in order to ensure sustainable management of the watershed, secure livelihood for the population and contribute to the management of Rwandan catchments. The main aim of this study is to highlight the areas of intervention and propose it for implementation. The generalized vision for the Nyiramuhondi watershed which was taken in accordance to the approved catchment management plan of Nyabarongo Upper (NNYU) Catchment which is **"*A well-managed catchment that is home to prosperous communities living in harmony with their environment and drawing social and economic benefits from sustainable ecosystem services***". The main objective of this plan is to restore Nyiramuhondi watershed for sustainable socioeconomic development of its population and protect Nyabarongo River. The eventual goal is to restore the watershed, minimize soil losses and water pollution in order to improve the quality of water and protect downstream water body from heavy siltation, maintain agricultural soil and it fertility at farm level, mitigate climate change and improve the standard of living of the population. This is inline with the National Strategy for Transformation (NST1) and Vision 2050 of Rwanda and also to contribute toward achieving the Sustainable Development Goals (SDGs).

The specific objective of the project includes (1) Improve water quality and quantity in water bodies taking into account resilience to climate change in the catchment, (2) Reduce the pressure on natural resources by diversifying alternative livelihoods, (3) Ensure equitable allocation of available water resources for the users of current and future generations and (4) Strengthen the water governance framework to ensure effective implementation of integrated programmes in line with IWRM. The estimated budget for this intervention is about 323 million Rwandan Francs. It is recommended that the Rwandan Water Resources Board work with relevant stakeholders to secure funding for implementation of this restoration plan.

ABBREVIATIONS AND ACRONYMS

CBO	Community Based Organisation
CMC	Catchment Management Committee
CMP	Catchment Management Plan
DDP	District Development Plan
DEM	Digital Elevation Model
EIA	Environmental Impact Assessment
EDPRS 2	Economic Development Poverty Reduction Strategy - 2
GoR	Government of Rwanda
IMCE	Integrated Management of Critical Ecosystems Project
IP	Implementation Plan
IUCN	International Union for the Conservation of Nature
IWRM	Integrated Water Resources Management
IWRMP	Integrated Water Resources Management Planning
M&E	Monitoring and Evaluation
MEP	Monitoring and Evaluation Plan
MIDIMAR	Ministry of Disaster Management and Refugee Affairs
MINAGRI	Ministry of Agriculture and Animal Resources
MINECOFIN	Ministry of Finance and economic Planning
MININFRA	Ministry of Infrastructure
MoE	Ministry of Environment
NGO	Non-Governmental Organization
NISR	National Institute of Statistics of Rwanda
NST	National Strategy for Transformation (2017-2024)

ROAM	Restoration Opportunities Assessment Methodology
REMA	Rwanda Environmental Management Authority
RWB	Rwanda Water Resources Board
SDG	Sustainable Development Goals
SEA	Strategic Environmental Assessment
WASAC	Water and Sanitation Corporation

GLOSSARY OF TERMS

Adaptation	In human systems, the process of adjustment to actual or expected climate and its effects in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate.
Catchment	The area of land that contributes water to a particular river. Includes the natural resources, people and land use activities on the area of land.
Climate Change	A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. See also Climate variability and Detection and attribution.
Climate Variability	Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate at all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). See also Climate change.
Disaster	Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery.
Ecosystem function	Ecosystem functions are the physical, chemical, and biological processes or attributes that contribute to the self-maintenance of an ecosystem; in other words, what the ecosystem does. The products of ecosystem functions are the goods and services humans use on a daily basis e.g. clean air, food, timber, etc.
Erosion	The action of surface processes (water or wind) that remove earth materials from one location and transport it to another. Rainfall, and the resulting runoff

	from it, produces soil erosion. The different forms of soil erosion are: splash, sheet, rill and gully erosion. The impact of a falling raindrop creates splash erosion - once surface runoff occurs, loosened soil particles, termed sediment, will be transported. Sheet erosion is the transport of sediment by overland flow, with rill erosion occurring as concentrated flow paths. Gully erosion occurs as a certain threshold is reached and flow paths become deeper channels.
Gender roles	A gender role is a set of societal norms determining the types of behaviours which are generally considered acceptable, appropriate or desirable for people based on their actual or perceived gender or sexuality, i.e. Gender roles refer to society's expectations for how men and women should act.
Governance	The way government is understood has changed in response to social, economic, and technological changes over recent decades. There is a corresponding shift from government defined strictly by the nation-state to a more inclusive concept of governance, recognizing the contributions of various levels of government (global, international, regional, local) and the roles of the private sector, of nongovernmental actors, and of civil society.
Land use and land use change	Land use refers to the total of arrangements, activities, and inputs undertaken in a certain land cover type (a set of human actions). The term land use is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction, and conservation). Land use change refers to a change in the use or management of land by humans, which may lead to a change in land cover. Land cover and land use change may have an impact on the surface albedo, evapotranspiration, sources and sinks of greenhouse gases, or other properties of the climate system and may thus have radiative forcing and/or other impacts on climate, locally or globally.
Mitigation (of climate change)	A human intervention to reduce the sources or enhance the sinks of greenhouse gases.
Pollution	The Enviromental Law (Law 48/2018,) defines pollution as the the contamination caused by waste, harmful biochemical products derived

	from human activities that may alter a person's habitat and cause adverse effects on the environment including a person's social wellbeing, flora, fauna and the world he/ she lives in.
Runoff	That part of precipitation that does not evaporate and is not transpired, but flows through the ground or over the ground surface and returns to bodies of water. See Hydrological cycle.
Sedimentation	(Refer to Erosion above) Once loosened soil is picked up by either wind or water, it is termed "sediment". In terms of soil erosion, sediments collected by the flow of water may be transported by rolling or sliding along the floor of a river (bedload) or by suspension in the moving fluid (suspension) before being deposited. A catchment may be made up of a patchwork of sediment source zones (source of sediment) and sink zones (sediment deposition areas), with sediment spending most time in storage. Management of sedimentation therefore needs to be at the catchment scale to effectively manage the irregular pattern of sources and sinks throughout the catchment.
Watershed	A catchment boundary is called a watershed, which is usually on the highest point between 2 catchments e.g. on top of a ridge, hill or mountain. A watershed divides the pathways that water will follow/drain into the catchments on either side of it. A watershed is therefore referred to as the source area of catchments.

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND

Climate change is negatively affecting local communities in Rwanda due to it variability resulting in flooding events in the central and north-western highlands, and droughts in the eastern and southern lowlands. Consequently, major development sectors in Rwanda are affected by climate change, including agriculture and water. Such effects are leading to decreased agricultural production because of soil erosion, reduced soil moisture and water availability; decreased agricultural yields because of crop damage from flooding, landslides, droughts; and decreased quality and quantity of water as a result of erosion, flooding, landslide and droughts.

On the other hand, Rwanda's catchment ecosystems provide a wide range of services. These include provisioning and regulating services such as water provisioning and flood mitigation respectively etc. Thus, these ecosystems significantly contribute to the resilience of local communities to adverse effects of climate change. However, these ecosystems are at risk. The most prevalent threat is unsustainable use of catchment ecosystems by local communities, leading to their degradation and thereby reducing their capacity to provide their ecosystem services. Consequently, the vulnerability of local communities in Rwanda to the adverse effects of climate change is increased. This call for integrated catchment management begins with catchment planning.

Rwanda is implementing a pilot project of LDCF II titled "Building resilience of communities living in degraded forests, savannahs and wetlands of Rwanda through an Ecosystem-based Adaptation (EbA) approach. The project is funded by Global Environment Facility (GEF) through the United Nations Environment Programme (UNEP) under climate change adaptation GEF focal area for a 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 project is being implemented for restoration of Nyiramuhondi watershed in Ngororero District; Murago wetland and Lake Cyohoha North in Bugesera District; Kibare lakeshores in Kayonza District and Nyandungu wetland in Gasabo and Kicukiro Districts; and Lake Ruhondo in Musanze District.

It is in that context that LDCF II/REMA Project aspires to conduct a study on wetland and catchment management framework that will be used for upscaling of wetland ecosystems restoration activities under LDCF II Project. This study will collate current knowledge on status and health of wetland and catchment ecosystems in Rwanda with particular focus on Nile-Akagera Upper (NAKU), Nile-Nyabarongo Lower (NNYL) and Nile-Nyabarongo Upper catchments including Nyiramuhondi watershed. This restoration plan is specifically for the Nyiramuhondi watershed (See Figure 1.1).

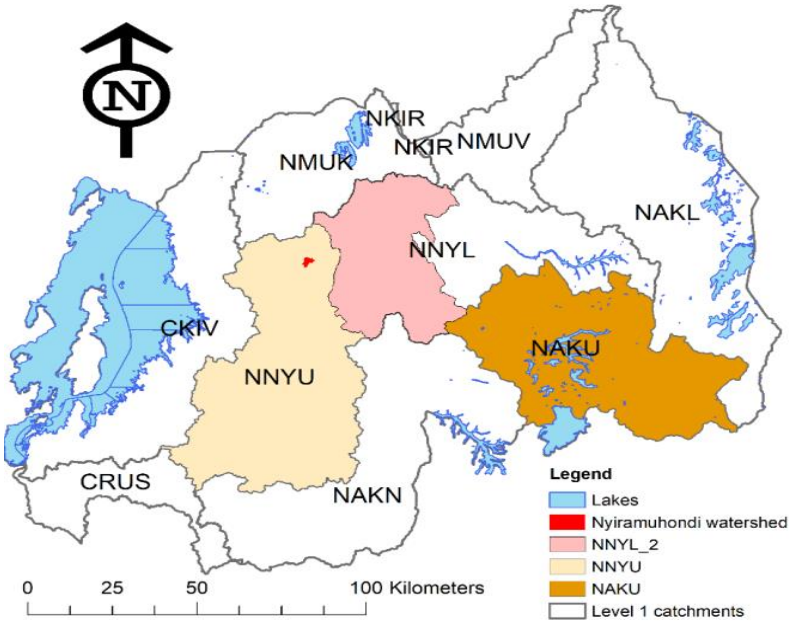

FIGURE 1-1: LOCATION OF THE STUDY AREAS

The main task of this study is to develop Nile-Nyabarongo Upper including Nyiramuhondi watershed. However, there is an approved catchment management plan for NNYU catchment. In consultation with Rwanda Water Resources Board (RWB) it was therefore agreed to develop implementation plan for rehabilitation Nyiramuhondi watershed. This document therefore presents an implementation plan for rehabilitation Nyiramuhondi watershed.

1.2 PROPOSED LOCATION FOR INTERVENTION

The proposed intervention sites are located within the Nyiramuhondi watershed which is one of the level 4 catchment of Upper Nyabarongo (NNYU) Catchment FIGURE 1-1 and FIGURE 1-2. This watershed is fully located within the Ngororero Sector of Ngororero District of Rwanda. The territory of the watershed cut across four cells TABLE 1-1. Nyamuhondo River is the main water body of the watershed and it is a tributary of Nyabarongo River. The

watershed has no upstream water dependency. Nyiramuhondi watershed has a total area of about 695 ha which is less than 1% of the total surface area of NNYU catchment. There are three streams that drain into Nyamuhondo River: Mazimeru, Kabutura and Nyabibugu FIGURE 1-2 and FIGURE 1-3.

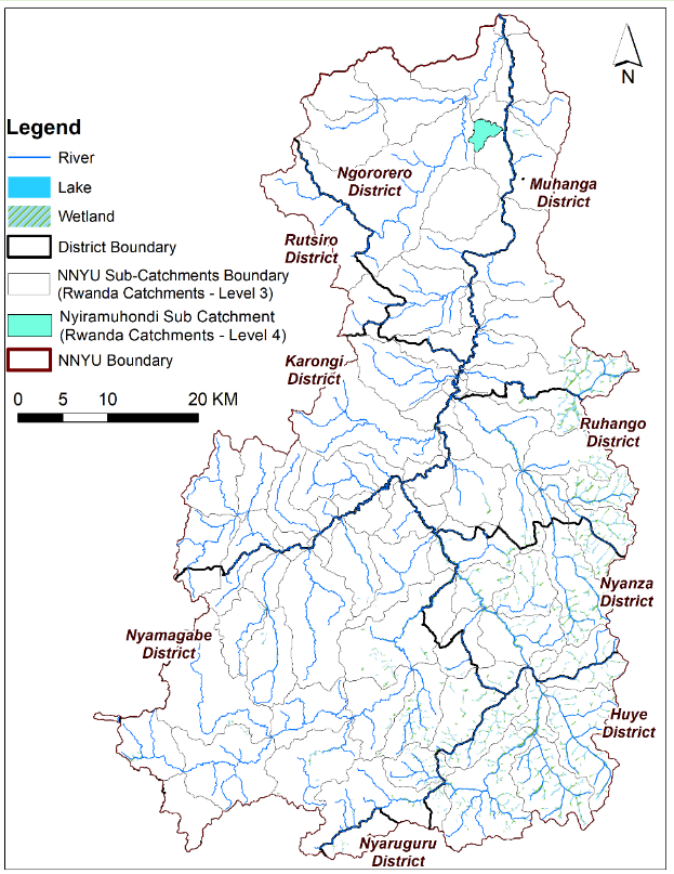

Figure 1-2 LOCATION OF NYIRAMUHONDI WATERSHED WITHIN NNYU CATCHMENT

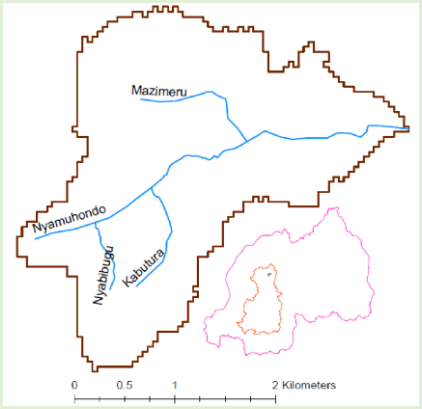

FIGURE 1-3: LOCATION OF NYIRAMUHONDI WATERSHED IN RWANDA

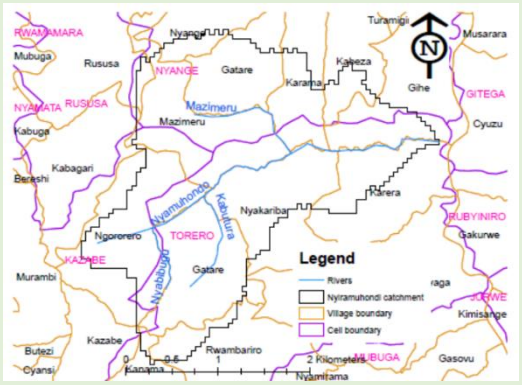

FIGURE 1-4 CELLS WITH THEIR TERRITORY IN NYIRAMUHONDI WATERSHED

TABLE 1-1.1: CELLS WITHIN NYIRAMUHONDI WATERSHED

S/N	Cell	Villages
1	Kazabe	Ngororero (1)
2	Nyange	Gatare, Kabeza, Karama, Mazimeru, Nyange (5)
3	Rususa	Kabagere, (1)
4	Torero	Gatare, Karera, Nyakamba, Rwambariro (4)

1.3 JUSTIFICATION OF THE PROPOSAL

Four Cells (nine villages) have their territory in Nyiramuhondi watershed. The total population of the watershed is estimated to be 4615 people with a population density 595 person per square km. The livelihood of majority of this people is based on the ecosystem services of the watershed. Nyiramuhondi watershed is mountainous with steep slope and highly prone to sheet and gully erosion during the rainy season. The mountainous nature of the watershed put together poor and unsustainable agricultural practices, destruction of river and streams banks, uncontrolled exploitation of forests leading to depletion of the forest cover, illegal mining, and minimal application of conservation measures by the users, have resulted excessive erosion leading to loss of top soil and its fertility, low agricultural productivity at the sites of erosion and high sediment transport by the streams and siltation of the Nyabarongo river thereby threatening it ecosystem. The effect of land degradation lead to severe rill, gully, excessive sheet and stream bank erosion. It is therefore extremely important to take conservative measures to ensure the protection and wise use of ecosystems of the watershed. A very important effort was put in place by LDCF II/ REMA in rehabilitation of this watershed. About 100 ha of radical terraces and 10 ha of River bank protection was put in place by LDCF II/ REMA. The activity was implemented through community based approach with all the relevant stakeholder in participation. Regardless of the effort made the level of degradation in the watershed is still very high. There is urgent need to restore the ecosystem functionality of the watershed to ensure sustainable development in the area. The socioeconomic survey and field visit conducted at the area confirmed that the Nyiramuhondi watershed is an agricultural watershed with about 88% of the population in the catchment area being farmers, 80 % of them are farming only for providing food for the family's consumption. About 65.1% leave below the extreme poverty line of 1.25 USD per day, and 66.6% consider themselves to be poor. Rehabilitating the watershed and training the population on diverse income opportunities will protect the watershed from further degradation and reduce the amount of sediment in Nyabarongo River. This is in line with targets of the National Strategy for Transformation (NST1) of Rwanda and Sustainable Development Goals of the United Nations.

1.4 PROJECT BENEFICIARIES

The local population of the Ngororero districts where the project area lies will be the principal beneficiaries since they will be directly involved in the implementation of the proposed rehabilitation measures. On a general perspective, the country also is a beneficiary because the project will be improving the national environment and protect among the major rivers constituting the national water tower i.e. the Nyabarongo Upstream Watershed (not to mention that this project will be a benchmark for other watershed rehabilitation in the country) but also increasing the awareness and practice of integrated watershed management approaches in the country.

CHAPTER 2 CATCHMENT CHARACTERIZATION

2.1 GENERAL DESCRIPTION OF NYIRAMUHONDI CATCHMENT

Nyiramuhondi catchment is one of the level 4 catchment of Nile Nyabarongo Upper (NNYU) catchment is fully located within the Ngororero District of Rwanda. It is located downstream of NNYU. It is a tributary of Nyabarongo River and has no upstream water dependence. Nyiramuhondi catchment has a total area of about 7 km^2. There are three streams that drain into Nyiramuhondi River they are Mazimeru, Kabutura and Nyabibugu. The livelihood of most of the people living in this catchment depends on the Nyamuhondo River and its tributaries. Four cells have part of their territories in the catchment they are Kazabe, Nyange, Rususa and Torero.

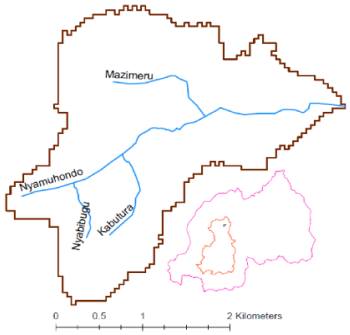

FIGURE 2-1 LOCATION OF NYIRAMUHONDDI WATERSHED IN RWANDA

2.2 PHYSICAL CHARACTERISTICS OF NYIRAMUHONDI WATERSHED

Nyiramuhondi watershed is a small fraction of Nile Nyabarongo Upper (NNYU) catchment located downstream of it and draining directly to Nyabarongo River. Physical characteristic of Nyiramuhondi watershed is the typical characteristic of NNYU-3 catchment.

2.2.1 RAINFALL AND EVAPOTRANSPIRATION

Nyiramuhondi watershed enjoy very high amount of rainfall compared to many places in Rwanda. The mean annual rainfall ranges from about 1280 mm to about 1365 mm (Figure 1-2), while the mean annual evapotranspotational ranges from about 627 mm to about 1146 mm (Figure 1-3). The is sufficient amount of rainfall for sustainable management.

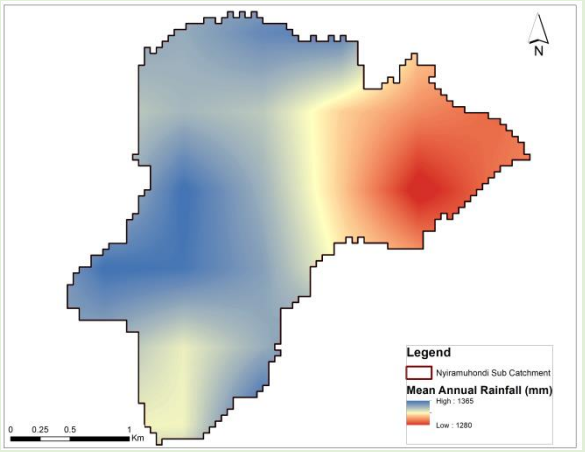

FIGURE 2-2 RAINFALL DISTRIBUTION

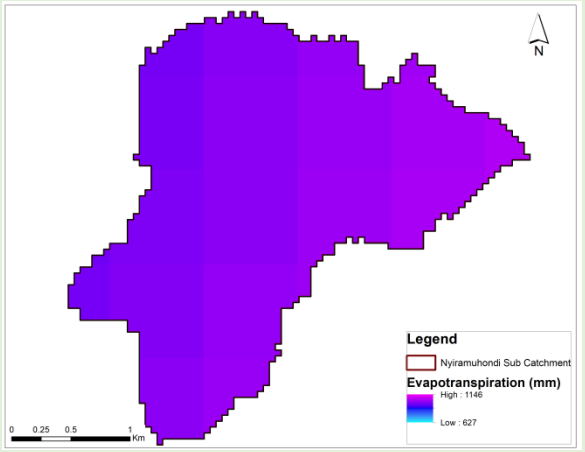

FIGURE 2-3 EVAPOTRANSPOTRATION

2.2.2 GEOLOGY AND SOIL

The geology of the watershed is dominated with shale and quartzite formation. Being a basement aquifer, groundwater exploration in the area should expect average yield wells. This kind of rock usually has moderated storage and transmission properties. As such the recharge rates, base-flow and recession behaviour of these formations is within the average expectation.

The geology FIGURE 2-4, soil FIGURE 2-5 and elevation FIGURE 2-4 of the catchment together with its hydro-meteorological characteristics are a very important factors as per as the hydrological behaviour is concerned. They play an important role in determining the runoff rate, erosion potential, aquifer recharge and discharge (base flow) as well as characterise groundwater potential of a catchment.

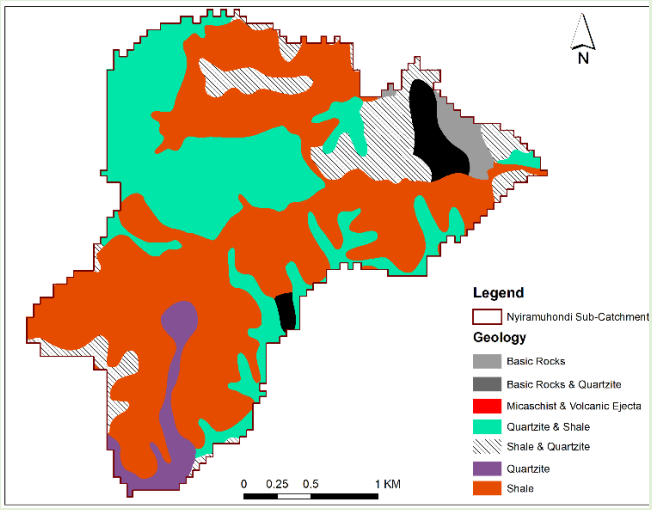

FIGURE 2-4: GEOLOGY OF THE NYIRAMUHONDI SUB-CATCHMENT

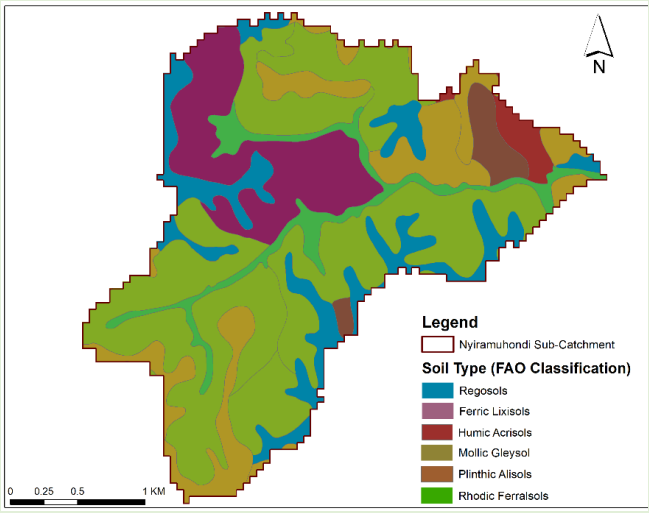

FIGURE 2-5: SOIL CHARACTERISTIC OF THE NYIRAMUHONDI SUB-CATCHMENT

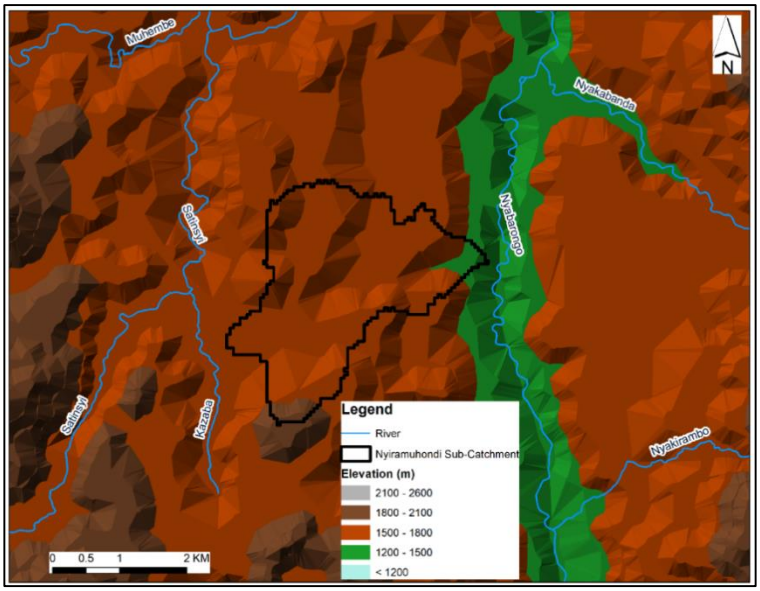

FIGURE 2-6: DRAINAGE NETWORK OF NYIRAMUHONDI SUB-CATCHMENT

2.2.3 LANDUSE/LANDCOVER, NDVI, SOIL LOSS AND CATCHMENT DEGRADATION

Seasonal agriculture is the main land use Nyiramuhondi watershed it covers about 66% and there is an open area and grass land that covers about 10.6% of the territory. These coupled with the type of geology, steep slopes, high intensity rainfall and poor land management explained why this catchment is yielding very high amount of sediment.

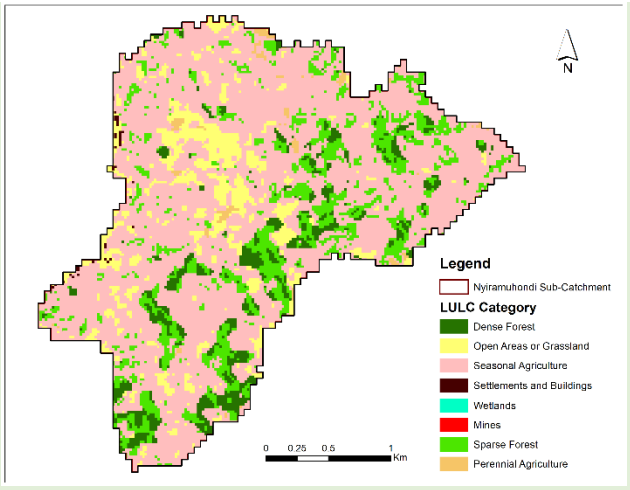

FIGURE 2-7: SPATIAL DISTRIBUTION OF LULC IN NYIRAMUHONDI SUB-CATCHMENT

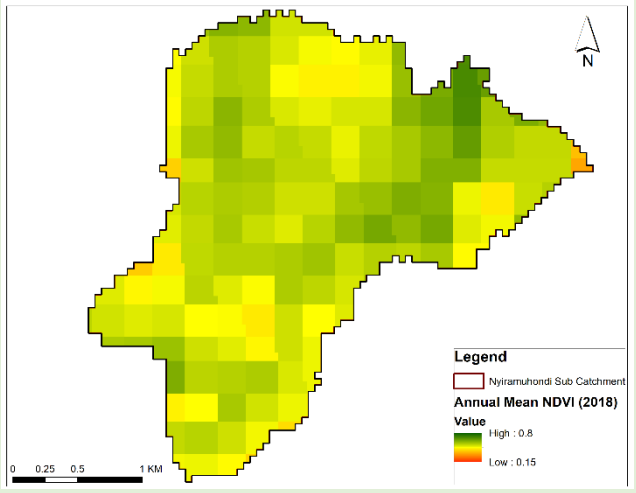

FIGURE 2-8: SPATIAL DISTRIBUTION OF ANNUAL MEAN NDVI IN NYIRAMUHONDI SUB-CATCHMENT

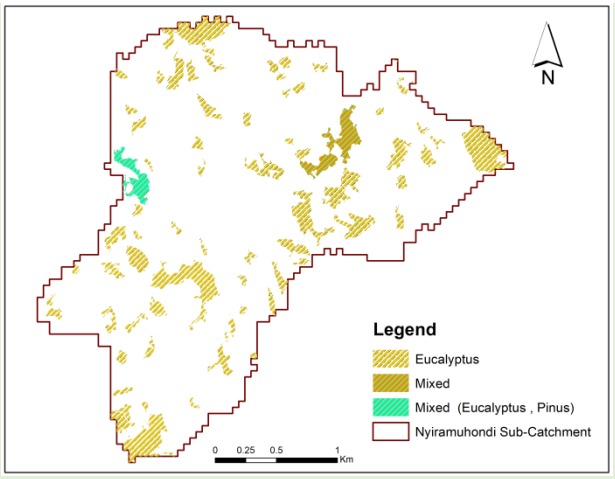

FIGURE 2-9: DIFFERENT TYPES OF FOREST IN THE WATERSHED

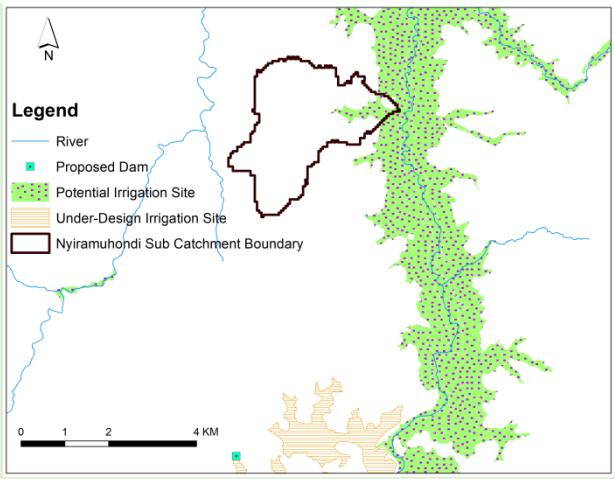

FIGURE 2-10: DPOTENTIAL IRRIGATION SITES

TABLE 2-1 : AREA COVERAGE OF EXISTING LULC IN NYIRAMUHONDI SUB-CATCHMENT

S/N	LULC Category	Area (Ha)	Area (%)
1	Seasonal Agriculture	458.3	66.0
2	Perennial Agriculture	7.0	1.0
3	Dense Forest	48.1	6.9
4	Sparse Forest	106.0	15.3
5	Open Areas or Grassland	73.4	10.6
6	Settlements and Buildings	1.6	0.2

Soil degradation (the long-term decline on soil productivity) is exacerbated through the physical decline in soil structure or through accelerated erosion via water and wind (Lal, 2001). Soil erosion and sedimentation may be considered to be one the biggest problems facing mankind globally due to the serious environmental, economic and social consequences, including loss of productive land, siltation of reservoirs, reduction of water quality for human use and impacts on aquatic ecosystems. Soil erosion involves the detachment, transport and eventual deposition of soil particles (Lal, 2001). Energy for these processes is provided for by physical (wind/water), gravity (landslides), chemical (weathering) or tillage sources.

Issues of soil erosion in the watershed were find to be significant and require immediate attention Figure 2-8 and 2.9.

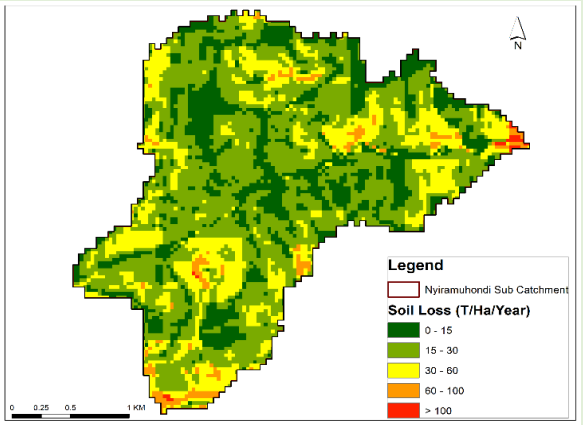

FIGURE 2-11: ESTIMATED ANNUAL SOIL LOSS IN NYIRAMUHONDI SUB-CATCHMENT

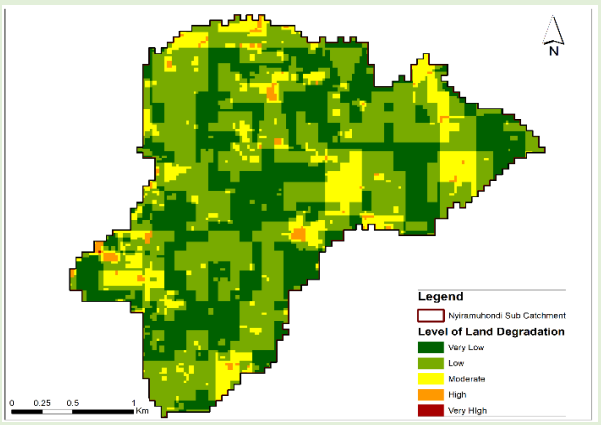

FIGURE 2-12: CATCHMENT LEVELS OF LAND DEGRADATION IN NAKU CATCHMENT

TABLE 2-2: ESTIMATED ANNUAL SOIL LOSS IN NYIRAMUHONDI SUB-CATCHMENT

S/N	Soil Loss Interval	Area coverage		Mean	Total Annual Soil Loss	
		Ha	%		Thousand T	%
1	0 – 15	165.7	23.8	10.5	18.4	10.0
2	15 – 30	352.8	50.7	21.8	80.9	44.1
3	30 – 60	154.0	22.1	39.6	64.2	35.0
4	60 – 100	20.7	3.0	72.5	15.8	8.6

S/N	Soil Loss Interval	Area coverage		Mean	Total Annual Soil Loss	
		Ha	%		Thousand T	%
5	> 100	2.2	0.3	184.7	4.3	2.3
6	Overall Catchment Mean Annual Soil Loss	25.1 t/ha/year				
7	Catchment Total Annual Soil Loss	183.6 thousand tones				

TABLE 2-3: AREA AND LEVEL OF SOIL DEGRADATION IN NYIRAMUHONDI CATCHMENT

S/N	LULC Category	Area (Ha)	Area (%)
1	Very Low	250.0	36.1
2	Low	336.9	48.6
3	Moderate	97.1	14.0
4	High	9.4	1.4
5	Very High	0.0	0.0

2.3 SOCIO-ECONOMIC SURVEY

Socio-economic survey of the community of Nyiramuhondi was conducted with a sample of 66 people. In some cases, the respondents prepare not to respond to certain questions. The results of the survey are presented in the Tables below, with questions and responses shown. The survey outcome was classified into three viz: (i) Occupation and income, (ii) Sources of energy and access to electricity and (iii) water supply and sanitation.

1.1.1 POPULATION DENSITY

The Nyiramuhondi sub catchment is highly populated with a population density of about 595 people per square kilometre, this cumulate to a population of 4,165 people in 2020. This high level of population density has high impact on resources needed – food, water, energy, etc.

1.1.2 POVERTY LEVEL & POVERTY HEADCOUNT INDEX

The poverty level in the sub catchment has poverty level = **4,** and poverty headcount Index = **45.27 this means** over 45% of the population below the poverty level. With about 87% of the population of the sub catchment depending on agriculture this factor means a lot on the sustainability of the catchment. This call for the conservative agriculture to ensure that the area is well protected from erosion.

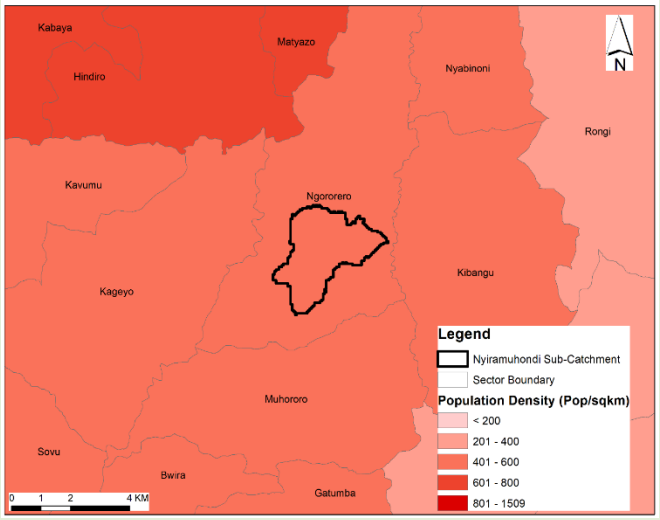

FIGURE 2-13: POPULATION DENSITY

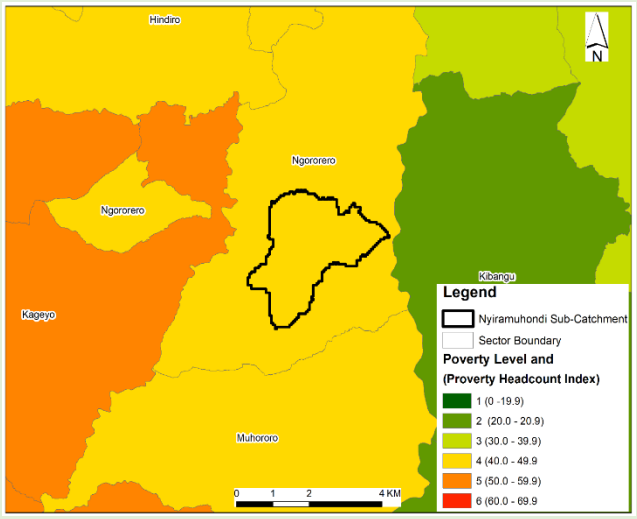

FIGURE 2-14: POVERTY LEVEL

1.1.3 *EXISTING SOCIO-ECONOMIC INFRASTRUCTURE*

Recent CROM DSS mapping shows that there are not some socio-economic infrastructures such Hospital, Market, School, Tea factory within the Nyiramuhondi watershed. Considering the population of the watershed which is over 4000 people it is important to bring development to the people living in the watershed.

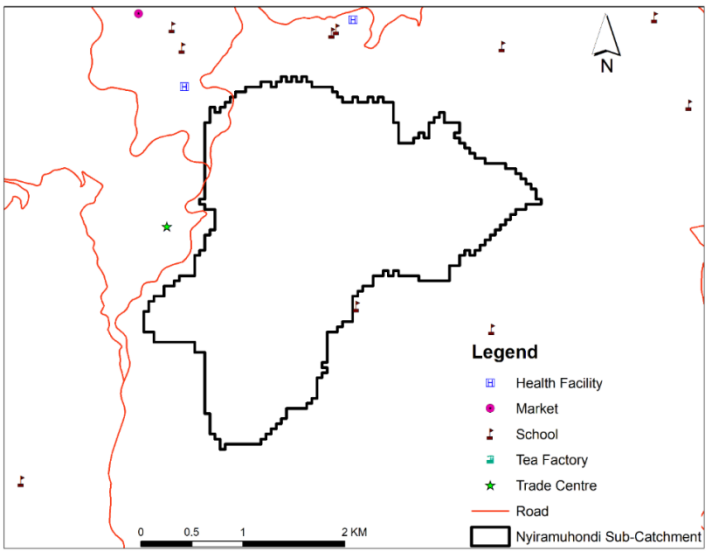

FIGURE 2-15: EXISTING SOCIO-ECONOMIC INFRASTRUCTURE IN NYIRAMUHONDI SUB-CATCHMENT

TABLE 2-4: NUMBER OF DIFFERENT SOCIO-ECONOMIC INFRASTRUCTURE IN NYIRAMUHONDI SUB-CATCHMENT

S/N	Socio-economic Infrastructure	Number
1	Health Centers	-
2	Trade Centers	-
3	Schools	-
4	Markets	-

1.1.4 OCCUPATION AND INCOME

Based o the opinion and perception of the respondent about 88% of the population in the catchment area are farmers, 80 % farm only for the family consumption, 65.1% leave below the extreme poverty line of 1.25 USD per day, and 66.6% consider themselves poor. Majority of the respondent agree that there is decline in agricultural productivity and attributed it to erosion, landslide and heavy rainfall. It was also disclosed that people with disability, orphans and the elderly are considered the most vulnerable persons in that community.

TABLE 2-5: TYPE OF PROFESSIONAL ACTIVITY (EMPLOYMENT)

Respondents' professional activity (employment)	Responses	% response
Agriculture	58	87.9

Respondents' professional activity (employment)	Responses	% response
Government salaried	2	3.0
Private sector salaried	3	4.5
Transport	0	0.0
Labour / casual pay	0	0.0
Skilled handcraft (Carpentry, Masonry, Weaver, Electrician, Repair work etc.),	0	0.0
Unemployed	3	4.5
Other	0	0.0
Total	66	100.0

TABLE 2-6: THE PRIMARY PURPOSE OF FARMING ACTIVITIES IS FOR HOUSEHOLD CONSUMPTION

Purpose of farming?		Responses	% response
Only for the household		52	80.0
Selling at local market		5	7.7
Selling at external markets		0	0.0
Home consumption and sell the rest		0	0.0
Other (please specify) markets		0	0.0
Total		57	87.7
System		9	.12.3
	Total	66	100.0

TABLE 2-7: THE PRIMARY REASON FOR DECLINE IN AGRICULTURAL PRODUCTIVITY

Reasons why agricultural production decreased?	Responses	% of response
Erosion	20	30.8
Flooding	3	4.6

Reasons why agricultural production decreased?	Responses	% of response
Poor soil fertility	1	1.5
Not using enough fertilizer/pesticide	3	4.6
Lack of labour	0	0.0
Low product prices	0	.0
Lack of extension support	0	0.0
Lack of Government sponsored inputs	0	.0
family labour was sick	0	0.0
Other, (15-Heavy rain, 4 Landslide & 1 CChange	20	30.8

TABLE 2-8: MONTHLY INCOME

Monthly income	Responses	% response
Under 5,000	8	12.1
5,000 to 20,000	35	53.0
21,000 to 50,000	17	25.8
51,000 to 100,000	4	6.1
101,000 to 300,000	1	1.5
301,000 to 500,000	1	1.5
501,000 to 1,000,000	0	0.0
1,001,000 and above	0	0.0

TABLE 2-9: PERSONAL CONSIDERATIONS IN TERMS OF INCOME

How do you consider yourself? (economically)	Responses	% response
Very poor	20	30.3
Poor	20	30.3
Lower middle-income level	25	37.9

Middle income level	1	1.5
Higher middle-income level	0	0,0

TABLE 2-10: CAUSE OF POVERTY

	Lack of land	Soil infertility	Climate change	High population pressure	Others
Frequency	22	21	15	3	5
Percent	33.3	31.8	22.7	4.5	7.8

TABLE 2-11: CATEGORIES OF VULNERABLE GROUPS

Categories of vulnerable groups	Responses	% response
Refugees	0.0	0.0
Orphans	18	27.3
Child-headed households	2	3.0
Widows	4	6.1
Woman-headed households	3	3.0
Genocide survivors and widows	4	6.1
People with disability	24	36.4
Albinos	0	0.0
People with illness e.g. HIV/AIDS, TB	0	0.0
Elderly people (over 65 years)	12	18.2

1.1.5 SOURCES OF ENERGY AND ACCESS TO ELECTRICITY

About 45.5% of the respondent has access to electricity, wood and charcoal are sources of cooking fuel. About 47% of the fuel wood is source from forest, while 31 % is source from agricultural farmland.

TABLE 2-12: ENERGY TYPE USED FOR LIGHTING

Energy type used for lighting	Responses	% response

Electricity	30	45.5
Candle	0	0.0
Kerosene Lamps	5	7.6
Battery	0	0.0
Solar energy	2	3.0
Torch	26	39.4
other (specify)	3	4.5
Total	66	100.0

TABLE 2-13: IN TERMS OF ENERGY FOR COOKING, FUELWOOD REMAINS THE DOMINANT ENERGY SOURCE

	Electricity	Gas	Wood	Charcoal	Biogas	Biomass	Other
Frequency	**0**	**0**	**59**	**7**	**0**	**0**	**0**
Percent	**0.0**	**0.0**	**89.4**	**10.6**	**0.0**	**0.0**	**0.0**

The households were also asked where they collect the wood and biomass from; the predominant source being unprotected forests then agricultural farmland.

TABLE 2-14: WHERE BIOMASS IS COLLECTED

Where biomass is collected?	Responses	% of responses
Protected forest	3	4.5
Unprotected forest	28	42.4
Agriculture farmland	21	31.8
Own woodlot	6	9.1
Community/village woodlot	0	0.0
Buffer areas	0	0.0
Other (specify)	1	1.5
Total	59	89.4
System	7	10.6

Where biomass is collected?		Responses	% of responses
	Total	66	100.0

1.1.6 WATER AND SANITATION AND SICKNESS

The main source of domestic water supply in the area are protected well, public tap/stand pipe and protected springs. The problem with access to water supply in the area is attributed to difficulty in access and poor reliability (erratic) of the supply. About 89.9% of the population uses pit latrine, 1.5 uses flush toilets while about 7.6 per cent have no access to any kind of toilet. Solid waste disposal in the area is generally by open pit. About 70% of the respondents confirmed the members of their family got sick within the last six month and water borne diseases are most prevalent in the area.

TABLE 2-15: MAIN SOURCES OF WATER

Main sources of water	Responses	% response
Piped into dwelling	0	0.0
Piped to yard/plot	3	4.5
Public tap/standpipe	21	31.8
tube well /borehole	0	0.0
covered well	0	0.0
protected well	24	36.4
unprotected well	2	3.0
protected spring	15	22.7
unprotected spring	1	1.5
rainwater	0	0.0
rain water harvesting	0	0.0
surface water (river /lake /pond /stream / irrigation channel)	0	0.0
other (specify)	0	0.0
Total	66	100.0

TABLE 2-16: EXISTING PROBLEMS WITH WATER SUPPLY

Existing problems with water supply	Responses	% response
Expensive	1	1.5
Water cuts	17	25.8
Runs dry	0	0.0
Difficult to access	35	53.0
It is a long way from the house	0	10.0
Not clean (water is muddy or unusual colour or not transparent)	2	3.0
Water smells bad/unnatural (for example, swampy smell, chemical smell, rotten egg smell)	0	0.0
Water tastes bad/unnatural (for example, too salty, soapy taste, unnatural taste)	0	0.0
other (specify)	11	16.7

TABLE 2-17: TYPES OF TOILETS USED

Types of toilets used	Responses	% response
Flush toilet	1	1.5
Pit latrine with constructed floor slab	6	9.1
Pit latrine without constructed floor slab	54	81.8
No toilet, open defecation	5	7.6
composting toilet/econoloo	0	0.0
Other	0	0.0
Total	66	100.0

TABLE 2-18: DISPOSAL OF SOLID WASTES

Disposal of solid wastes	Responses	% response
They are collected regularly and disposed in a predefined landfill	0	0.0
Disposed to a wild disposal area	5	7.6

Disposed in my own open pit (nearby household)	55	83.3
Disposed irregularly	5	7.6
Burning,	1	1.5
Disposed to the river/lake	0	0.0
compost it	0	0.0
other(specify)	0	0.0
Total	66	100

TABLE 2-19: IF MEMBER OF THE HOUSEHOLD EXPERIENCE ILLNESS WITHIN THE LAST SIX MONTH

Household member illnesses in the past six months?	Responses	% response
Yes	46	69.7
No	20	30.3

TABLE 2-20: TYPES OF ILLNESSES

Types of illnesses	Responses	% response
Malaria	20	30.3
Diarrhoea	2	3.0
Chest infection/cough/breathing difficulty	13	19.7
Bilharzia	25	37.9
Migraines or headaches	0	.0
Visual disturbances (blind spot, halos, etc.	0	.0
Burning extremities	0	0.0
Other	11	16.7

1.1.7 DISASTERS AND CAUSES

Landslide was reported to be the most prevalent disaster in the area and about 89.4 % attributed it climate change.

TABLE 2-21: KIND OF DISASTER FACED IN THE PAST 2 YEARS

Kind of disaster faced in 2 past years	Responses	% response
Erosion	5	7.6
Flooding	2	3.0
Landsliding	59	89.4
Drought	0	0.0
Earthquake	0	0.0
Snow	0	0.0
None	0	0.0
Other (specify)	0	0.0

TABLE 2-22: THE CAUSES OF THE DISASTERS WERE IDENTIFIED AS

Causes of the disasters	Responses	% response
Unsuitable agriculture activities	0	0.0
Deforestation	0	0.0
Mining activities	0	0.0
Climate change	42	63.6
Irrigation infrastructures	0	0.0
Topography of the area	6	9.1
Spell/curse/magic	0	0.0
Other (specify)	18	27.3
Total	66	100.0

2.4 ISSUES AND OPPORTUNITIES IN THE CATCHMENT

Some of the key issues and opportunities identified within the Nyiramuhondi watershed include:

- Landslide,
- Soil Erosion,
- Floods,
- Deforestation,

- Poverty
- Lack of water treatment,
- Shortage domestic water,
- Lack of drainage,
- Lack of buffer zones (catchment delimitation),
- Ignorance, Sediments
- Power agricultural soil management
- Lack of diverse income opportunities
- Scarce firewood and degraded forests;
- Limited capacity to afford modern RWHtankspresentsa challenge domestic water needs;

Opportunities in Nyiramuhondi Watershed

- Community based approach in implementation of project
- Irrigation,
- Possibility to sustainably exploit the streams and river
- Gihe forest
- Political will (VUP),
- Horticulture,
- High water availability,
- Job creation for women and men for catchment rehabilitation, terracing, river bank protection Sustainable food production,
- Promote small livestock to incentivise catchment restoration efforts among women;
- Support farmers to afford the cost of RWH tanks
- Initiate family tree nurseries (agroforestry and fruit trees).
- Afforestation and reforestation of degraded forests. increase tree nurseries per cell;
- Training of men in improved farm practices, hillside irrigation, alternative livestock and drought resistant breeds;
- Increase the limited knowledge of irrigation investment for new crops (cash generating) by mixed cooperatives

2.5 DPSIR ANALYSIS FOR NYIRAMUHONDI CATCHMENT

DPSIR stands for Driving forces, Pressures, State, Responses, and Impacts (see schematic relationships in Figure 2:11 and Figure 2:12). This causal framework describes the interactions between society and the environment (in or beyond the catchment) through driving forces, pressures, states, impacts, and responses. The DPSIR analysis supports the selection of responses to mitigate negative IWRM related impacts identified in the watershed. These responses may target causes, as well as effects, i.e. The Driving forces, Pressures, and/or Impacts, as originally found in the catchment. For each situation the optimal (mix of) response is defined, to achieve sustainable solutions.

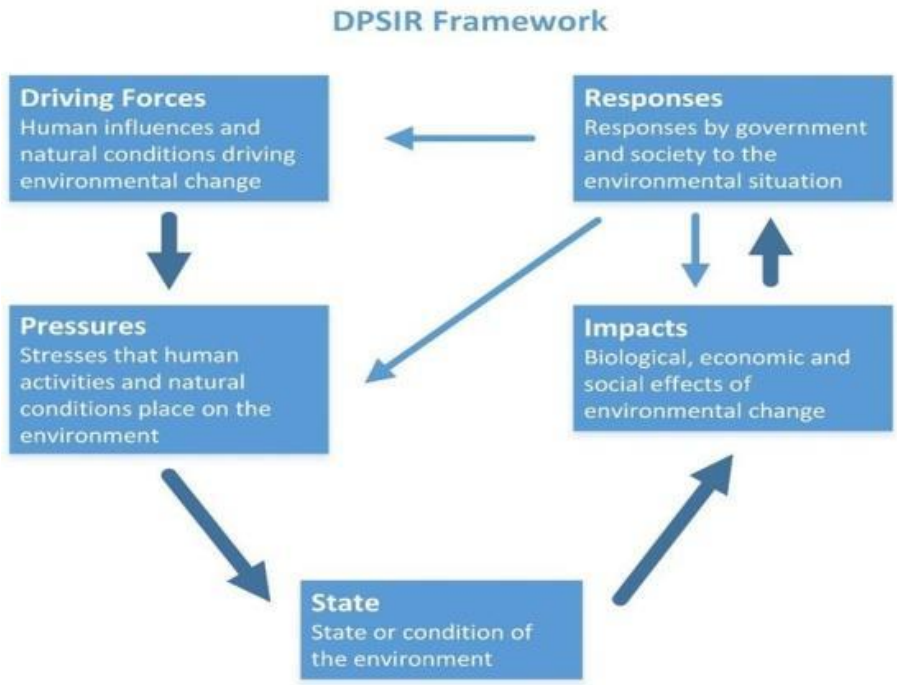

FIGURE 2-16: VISUALISED DPSIR FRAMEWORK

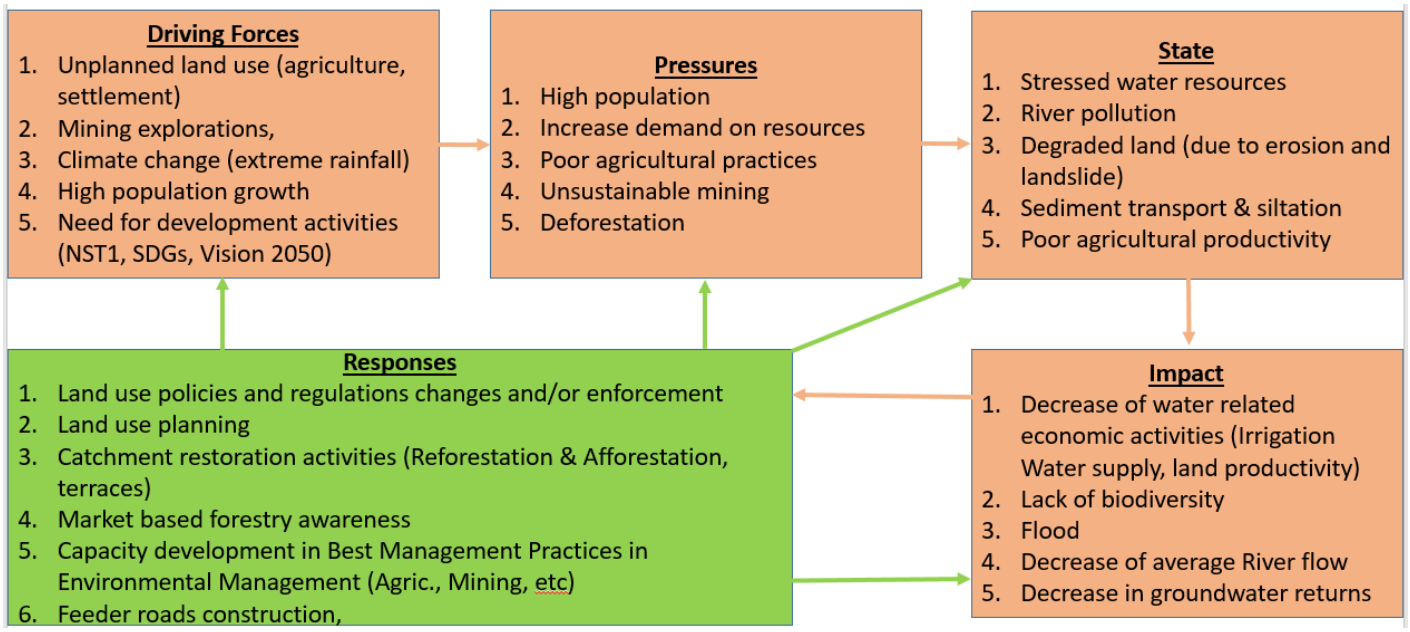

FIGURE 2-17: DPSIRFRAMEWORK NYIRAMUHONDI WATERSHED

2.6 CONCLUSION AND RECOMMENDATIONS

2.6.1 CONCLUSION

Nyiramuhondi watershed is facing land degradation issue with about 134 hactares at different level of degradation from high to very. Urgent attention is required in restoring and rehabilitating the watershed to avoid further degradation. Earlier Substantial effort was put by REMA in protecting this watershed, this effort need to continue to ensure sustainable development. Some of the pressure in the catchment include: high population density and associated demand for resources, poor agricultural practices, high level of poverty, deforestation, unsustainable mining, river bank cultivation etc. The updated catchment restoration CROM DSS revealed that some socio-economic infrastructure such as Health Centre, School, Market etc are missing in the watershed.

- Nyiramundi watershed is mountainous with sufficient amount of rainfall that can be manage for sustainable management of the population. There is need to control run-off to prevent flooding and landslide as well improved access to water supply for the population
- Majority of the land use about 76% is agriculture and open areas and grasses, with amount of rainfall the watershed is receiving the risk to flood, landslide and erosion is high. There is need to train the farmers on sustainable agriculture.

- The level of poverty in the watershed is high, taking into consideration that over 90% of the population uses wood for energy the risk of deforestation is very high. To mitigate this the is need to train people on diverse income generation activities as well as support the with alternative like improve cooking stoves and/or bio gas system construction.
- of the population uses Existing intervention need to be There is suffice

2.6.2 RECOMMENDATIONS:

To ensure sustainable development and achievement of the National Strategy for Transformation (NST1) and Vision 2050 of the government of Rwanda it the followings are recommended:

i. To stop degradation of natural resources through the understanding of sustainable agricultural management practices by
   a. dealing with upstream and downstream resources management challenges,
   b. identifying and implementing sustainable land use practices,
   c. increasing sustainable agriculture production,
   d. decrease deforestation through and wise use of natural resources

ii. To lift standard of living of the local people through
   a. Economic diversification trainings such as other income generating agricultural activities
   b. Businesses and entrepreneurship training such as hair dressing, tailoring, welding and others
   c. Provision of alternative energy sources – including distribution of improved cooking stuff, biogas production at household level etc.
   d. Engaging in to cooperatives

iii. Increase access to water and sanitation
   a. Rooftop rain water harvesting
   b. Provision of community onsite sanitation facilities
   c. Etc.

CHAPTER 3 VISION AND OBJECTIVE

3.1 VISION

The generalized watershed vision was taken in accordance to the approved NNYU catchment management plan, the vision is:

A well-managed catchment that is home to prosperous communities living in harmony with their environment and drawing social and economic benefits from sustainable ecosystem services.

3.2 MAIN OBJECTIVES

The Ngororero District, where the Nyiramuhondi is located, is based on its main potentialities in trying to overcome the key challenges in the district. The District is focusing on the following priority interventions for its 2018-2024 DDS:

A. **Priority interventions under the economic transformation:**

- Increase employment by creating off-farm jobs
- Increase agriculture production and optimize agriculture value chain
- Modernize the mining sector in an environmental friendly way
- Increase basic infrastructure delivery such as electricity, water, road network and ICT
- Promote mechanisms for resilience to climate change and environment protection
- Promote urbanization and planned rural settlement

B. **Priority interventions under the social transformation pillar:**

- Eradicate extreme poverty and reduce the poverty through appropriate implementation of social protection programs
- Improve access to quality health and eradicate malnutrition
- Improve access to quality education

C. **Priority interventions under the transformational governance pillar:**

- Increase capacity of local government institutions for better service delivery
- Increase citizen participation and stakeholder engagement for integrated local

Based on the above priorities, NNYU catchment management plan, conducted field survey and discussion with the administration of the district it was agreed that:

The main objective of this implementation plan is to restore/rehabilitate Nyiramuhondi watershed and improve the living standard of its community for sustainable socioeconomic development and protect Nyabarongo River. The eventual goal is to minimize soil losses and water pollution in order to improve the quality of water and protect downstream water bodies from heavy siltation.

3.3 SPECIFIC OBJECTIVES

TABLE 3-1: THE SPECIFIC OBJECTIVE OF THE PROJECT INCLUDES

Specific Objectives	Target activities
1. Protect the Nyiramuhondi watershed and improve the quantity and quality of its water resources as well as for Nyabarongo river taking into account resilience to climate change in the watershed:	● Contour bank terraces, plantation of perennial crops, agroforestry, afforestation, reforestation, hedgerows, no-till agriculture according to CROM DSS
	● River bank protection
	● Support in development of kitchen garden for vegetables, tomatoes, etc. ● Cultivation of other cash crop such as beans, soya beans, mushroom etc.
2. Reduce the pressure on natural resources by diversifying alternative livelihoods	Training of the local people on off farm income generation activities such as: ● Agricultural extension training for intensification of production; ● Livestock keeping extension training, and ● Business skills training: facilitation of access to alternative income generating activities.

Specific Objectives	Target activities
	● Skill development such as training inhair dressing, tailoring, restaurant and bakery, stock and sale of agricultural commodities etc..
3. Improve access to quality health through access to improve water supply and sanitation	● Support population in rooftop rainwater harvesting through distribution of supporting facilities such as, pipes, plastic tanks, cement etc. ● Provition of public latrine with onsite treatment facilities.

CHAPTER 4 MEASURES FOR IMPLEMENTATION

4.1 PROGRAMME OF MEASURES

1.1.1 PROPOSE WATERSHED REHABILITATION ACTIVITIES

Following details characterization of the watershed and the analysis of the CROM DSS documentation proposals for intervention was generated as in the Figure 4-1 and Table 4-1. The main activity of the intervention will be contour bank terraces.

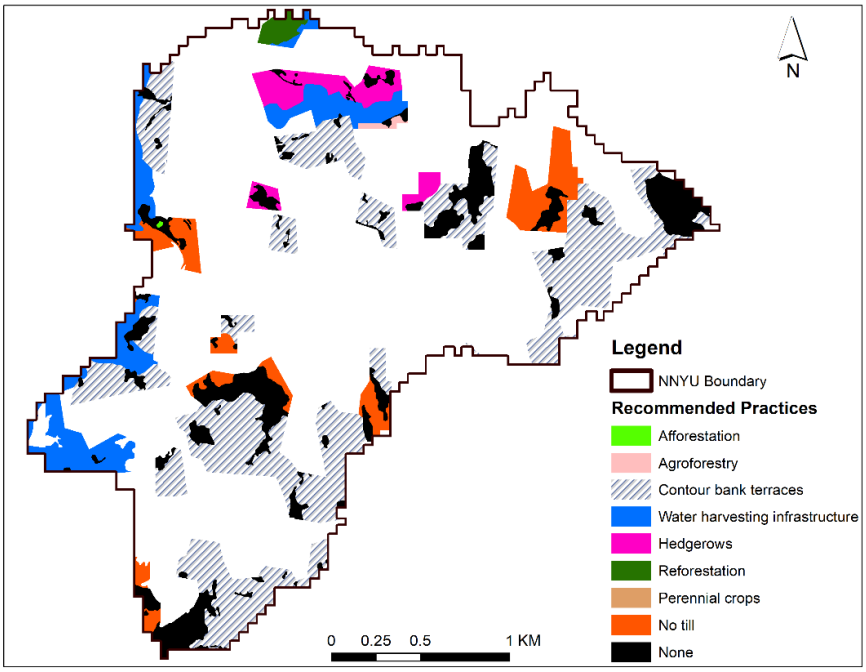

FIGURE 4-1: RECOMMENDED ENVIRONMENTAL-FRIENDLY PRACTICES AND RESTORATION OPPORTUNITIES IN NYIRAMUHONDI SUB-CATCHMENT

TABLE 4-1: AREA COVERAGE OF PROPOSED RESTORATION MECHANISMS IN NYIRAMUHONDI SUB-CATCHMENT

S/N	Proposed Intervention Measures	Area (Ha)	Area (%)
1	Contour Bank Terraces	132.16	49.76
2	Perennial Crops	-	-
3	Agroforestry	0.82	0.31
4	Water Harvesting Infrastructure	-	-

S/N	Proposed Intervention Measures	Area (Ha)	Area (%)
5	Afforestation	0.09	0.03
6	Reforestation	3.23	1.22
7	Waterways Infrastructure	34.55	13.01
8	Hedgerows	14.03	5.28
9	No-Till	26.05	9.81
10	None	54.68	20.59

1.1.2 RAINWATER HARVESTING

One of the key intervention activities proposed is raining water harvesting. The intention is to provide support to the population to enable the implementation of rainwater rooftop rainwater harvesting to supplement domestic water supply. This will also assist in controlling runoff there by reducing floods. The Rwanda Water Resources Board (RWB) has experience in implementing this kind of intervention. For the implementation of this there is need for sizing the tank that will be used for rainwater harvesting. Below is an example of model design of rainwater harvesting tanks that could be adopted.

1.1.2.1 SIZING OF RAINWATER HARVESTING STORAGE FOR HOUSEHOLD

For the sizing of the required storage for a particular rainwater harvesting (RWH) system, the Code of Practice for rainwater harvesting systems, issued by the Rwanda Bureau of Standards as Rwanda Standard RS187:2013, specifies three different approaches: a simplified approach, an intermediate approach and a detailed approach. These approaches can be outlined as follows:

(i) The simplified approach is viewed as suitable for residential properties with consistent daily water demand. No calculations are carried out, because the required storage size for a particular runoff surface area is read off from graphs provided in RS187:2013.

(ii) The intermediate approach comprises the calculation of storage capacity as the lesser of 5 % of the average annual rainwater yield or 5 % of the annual non-potable water demand.

(iii) The detailed approach should be used to calculate the storage size more accurately for any situation by developing a flexible and continuous model of rainwater yield, demand and storage changes, which is based on a continuous daily rainfall time series for a minimum of 3 years and, preferably, 5 years.

This Study needs a flexible calculation method in view of the variation in housing types, household demand and site-specific characteristics and annual rainfall across the Study catchment; hence, we have followed the above "detailed approach" but with some simplifications to accommodate the fact that the Level 2 catchment are relatively large and therefore only a generalised sizing of RWH storages can be provided.

A GENERALISED RWH CALCULATION TOOL

The generalised RWH calculation tool developed for this Study uses long-term mean monthly rainfall to perform a continuous mean monthly water balance of rainwater runoff, water usage and resulting storage fluctuations. For a particular storage-volume the tool outputs mean monthly overflows (if any) and mean monthly supplement volumes required from other water sources. The mean monthly rainfall values were reduced by 14% to account for losses due to absorption by roofing materials, evaporation, leaking or blocked gutters and pipework, etc. The tool is developed in spreadsheet format and the calculations are controlled by the following user-specified parameters:

- Runoff Surface Area (m^2) – This should be the horizontal footprint of the runoff surface.
- Runoff coefficient (%) – This is dependent on the roofing/runoff material and the following typical values apply: galvanised iron sheets – 90%; clay tiles – 75%; thatch/plant material – 30%; concrete – 80%; bricks – 60%; soil – 20%; natural stone – 50%.
- Number of persons using the water.
- Water consumption (l/p/d).
- Storage volume selected (m^3).

And present tabular versions of the spreadsheet-based tool and all its inputs and outputs for two different runoff surface areas and materials, but with identical rainfall, number of water users and storage volume. By changing the "Calculation Parameters" in the spreadsheet

sequentially, any number of alternatives may be examined for a particular location and runoff surface, leading to a first-order estimate of an acceptable storage volume.

For the refined optimisation and design of a particular RWH system, the above analysis should be conducted using a continuous daily rainfall time series for the area being investigated. The above tool can be comfortably modified to operate on a daily time-step, using the same calculations as described above.

TABLE 4-2: RWH STORAGE CALCULATION FOR A 60M2 RUNOFF SURFACE AREA AND GALVANISED IRON ROOF SHEETS

Calculation Parameters	
Area of runoff surface (m^2)	60
Runoff coefficient (%)	90
No. persons using the water	6
Consumption (l/p/d)	25
Storage volume selected (m^3)	5

Calculation Inputs and Outputs	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
No. days in month	31	30	31	31	30	31	30	31	31	28	31	30
Mean monthly rainfall (mm)	105	24	13	42	92	107	144	99	78	94	127	179
Reduced mean monthly rainfall (mm)	90	21	11	36	79	92	124	85	67	81	109	154

Calculation Inputs and Outputs	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Monthly storage inflow (m^3)	4.9	1.1	0.6	2.0	4.3	5.0	6.7	4.6	3.6	4.4	5.9	8.3
Monthly water usage (m^3)	4.7	4.5	4.7	4.7	4.5	4.7	4.5	4.7	4.7	4.2	4.7	4.5
Monthly balance (m^3)	0.2	-3.4	-4.0	-2.7	-0.2	0.3	2.2	-0.1	-1.0	0.2	1.2	3.8
Actual storage (m^3)	5.0	1.6	0.0	0.0	0.0	0.3	2.5	2.5	1.4	1.6	2.8	5.0
Monthly overflow (m^3)	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
Monthly supplement required (m^3)	0.0	0.0	2.4	2.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 4-3: RWH STORAGE CALCULATION FOR A 40M2 RUNOFF SURFACE AREA AND A THATCH ROOF

Calculation Parameters

Area of runoff surface (m^2)	40
Runoff coefficient (%)	30
No. persons using the water	6
Consumption (l/p/d)	25
Storage volume selected (m^3)	5

Calculation Inputs and Outputs	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
No. days in month	31	30	31	31	30	31	30	31	31	28	31	30
Mean monthly rainfall (mm)	105	24	13	42	92	107	144	99	78	94	127	179
Reduced mean monthly rainfall (mm)	90	21	11	36	79	92	124	85	67	81	109	154
Monthly storage inflow (m^3)	1.1	0.2	0.1	0.4	0.9	1.1	1.5	1.0	0.8	1.0	1.3	1.8
Monthly water usage (m^3)	4.7	4.5	4.7	4.7	4.5	4.7	4.5	4.7	4.7	4.2	4.7	4.5
Monthly balance (m^3)	-3.6	-4.3	-4.5	-4.2	-3.6	-3.5	-3.0	-3.6	-3.8	-3.2	-3.3	-2.7
Actual storage (m^3)	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monthly overflow (m^3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Calculation Inputs and Outputs	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Monthly supplement required (m^3)	0.0	2.8	4.5	4.2	3.6	3.5	3.0	3.6	3.8	3.2	3.3	2.7

4.2 FINANCIAL ESTIMATES OF THE REHABILITATION PLAN

In order to implement the restoration and rehabilitation of the Nyiramuhondi watershedTable 4-1 present the cost estimate of the rehabilitation plan. Unit price of activities was obtained from Rwanda Water Resources Board and the expected cost of the project was estimated. For immediate implementation under the NST1 up to year 2024 only degraded area with level of degradation high and very high were proposed for consideration.

TABLE 4-4: COST ESTIMATE OF THE RESTORATION

S/N	Proposed Intervention Measures	RISK	Unit	Quantity	Area (%)	Unit Price in RWF	Cost in RWF
1	Contour Bank Terraces	Very high	ha	21.757	7.91	2,392,000	52,042,744
		High	ha	110.408	40.14	2,392,000	264,095,936
		Total	ha	132.165	48.05	2,392,000	316,138,680
2	Agroforestry	High	ha	0.8251	0.30	120,500	99,425
		Total	ha	0.8251	0.30	120,500	99,425
3	Water Harvesting Infrastructure	Very high	Nr	10	3.64	100,000	1,000,000
		High	Nr	25	9.09	100,000	2,500,000
		Total	Nr	35	12.72	100,000	3,500,000
4	Reforestation	Very high	ha	3.32	1.21	369,000	1,225,080

5	Hedgerows	High	ha	14.03	5.10		0
GRAND TOTAL				**276.07**	100.37		**321,963,185**

TABLE 4-5: IMPLEMENTATION PLAN

Specific Objective1:	**Activities**	**Indicators/ Outputs**	**Indicative phasing**	**Responsible Authority**	**Applicable District / Sectors**	**Indicative costing (RWF)**
1.1 Improve water quality and quantity in water bodies taking into account resilience to climate change in the catchment	Restore 132.165 ha of degrade areas with Contour Bank Terraces	Constructed Countour Bank Terraces based on the points indicated in CROM	Short term upto 2024 for very high erosion potential (21.757 ha) Medium term upto 2030 for high erosion (potential110.408 ha) River bank protection	RWB, RFA, REMA, RAB, Ngororero District and Ngorerero Sector.	Ngororero District and Ngorererero Sector.	52,042,744 264,095,936
					SUBTOTAL	318,463,185
2.1 Reduce the pressure on natural resources by diversifying alternative livelihoods	Develop and implement training local people on to diversify on income generation	120 people trained 5 from each village in the watershed and 5 staff from the Sector and the District.	Short term upto 2024	RWB, REMA, RDB, Ngororero District and Ngorerero Sector	Ngororero District and Ngorererero Sector	4,600,000
	Distributio n	100 improved	Short term upto 2024	RWB, REMA,	Ngororero District	50,000,000

Specific Objective1:	Activities	Indicators/ Outputs	Indicative phasing	Responsible Authority	Applicable District / Sectors	Indicative costing (RWF)
	improved cooking stop	cooking stoves share to the local population		RDB, Ngororero District and Ngorerero Sector Ngo rorero District and Ngorerero Sector	and Ngorerero Sector	
	Develop and implement community-based training and awareness programme in Natural Resources Management	100 trained include 90 from the local population and 5 each from the Sector and District.	Short term upto 2024	RWB, REMA, RAB, Ngororero District and Ngorerero Sector Ngo rorero District and Ngorerero Sector	Ngororero District and Ngorerero Sector	50,000,000
					SUB TOTAL	104,600,000
3.1 Ensure access to improve water supply	Identify potential implementers of domestic Rain water Hervesting and support them with plastic tanks.	100 rainwater harvesting tanks distributed	Short term upto 2024	RWB, Ngororero District and Ngorerero Sector Ngo rorero District and Ngorerero Sector	Ngororero District and Ngorerero Sector	25,000,000
					SUB TOTAL	25,000,000
					TOTAL	448,063,185

CHAPTER 5 COORDINATION OF CATCHMENT RESTORATION ACTIVITIES

5.1 STRATEGY FOR IMPLEMENTATION

Rwanda water resources board (its Catchment Restoration and Erosion Control Division) is to take the lead in sourcing funds and implementation of the plan. The restoration is proposed to be implemented in the form of a community based approach and should include the training of the local people on watershed management in accordance with integrated water resource management (IWRM) best management practices during the implementation.

- Involve Catchment Committee at Ngororero District level both the management and technical members of its.
- Mobilize and sensitize the local population for participation in the activities.
- Work with the local authorities at sector, village and cell levels to identify the beneficiaries.
- Train the local communities within the watershed on rehabilitation and conservation techniques in accordance to IWRM;
- Conduct the highlighted rehabilitations
- Put in place a monitor and evaluation team to monitor and evaluate the progress and report on a weekly, monthly and quarterly basis.
- Ensure provision of a common benefit driven approach, where communities witness the benefits of protecting and conserving their watershed.
- Make sure that local authorities and communities are involved at all levels of implementation in order to create ownership of the development.

The structure and role of the Catchment Committee are highlighted below in sections 5.2 – 5.5.

5.2 CATCHMENT COMMITTEE AND ITS ROLE

Catchment restoration need to be implemented in a coordinated manner Article 10: of the Law N°49/2018 of 13/08/2018 determining the use and management of water resources Rwanda established that there should be water resources management committee at catchment level composition, responsibilities, organization and functioning of the water resources management committee at catchment level are determined by a Ministerial Order.

The Ministerial Order has been drafted and is waiting for Cabinet Approval. The drafted Ministerial Order highlighted the responsibility of the Catchment Committee as follows:

1. Provide the general orientation for the catchment management plan and advise on the measures to be provided for in the plan;
2. Support the Authority in the development of the catchment management plan;
3. Provide information on water users and stakeholders within the catchment;
4. Identify the issues and priorities to be addressed by the catchment management plan;
5. Provide information on water bodies at risk of depletion, flooding or water quality degradation;
6. Support the Districts to align District development strategies with the Catchment Management Plan;
7. Support Districts and other partners in the development of Catchment Management Plan, annual implementation plans and joint performance contracts on topics pertaining to water resources management and water use;
8. Monitor and evaluate the implementation of the catchment management plan;
9. Monitor the compliance of water use permits on ground and advise the Authority accordingly;
10. Contribute to disputes settlement among water users;
11. Advise on any issue as requested by the Authority.

5.3 COMPOSITION OF CATCHMENT COMMITTEE

The Catchment Committee is composed of the following members from each District within the catchment:

1. The District Vice Mayor in charge of economic development
2. A representative of water user permit holders within catchment from each of the following categories:
   a. Domestic water supply
   b. Irrigation
   c. Livestock
   d. Mining
   e. Coffee washing

f. Power plant
g. Aquaculture

3. Representative of non-governmental organization operating in water
4. Representative of private sector

At least 30% of the catchment committee members must be women

5.4 TECHNICAL SUPPORT COMMITTEE AND ITS ROLE

In its functioning, the Catchment Committee shall be supported by the Technical Support Committee, the role of the Technical Support Committee is as follows:

1) To support effective execution of responsibilities of the Catchment Committee;
2) To prepare the annual action plan of the Catchment Committee and submit it to the Chairperson of the Catchment Committee;
3) To prepare the annual report of activities of the Catchment Committee and submit it to the Chairperson of the Catchment Committee;

5.5 COMPOSITION OF THE TECHNICAL SUPPORT COMMITTEE

The Technical Support Committee composed of a staff in charge of catchment management from the Authority and a staff from each District, within the Catchment, in charge of one of the following fields:

1) agriculture;
2) forestry and natural resources;
3) livestock;
4) water supply and sanitation;
5) environment;
6) land use and management;
7) urbanisation and rural settlement;
8) Planning

Organization of technical support committee

1) The Technical Committee shall elect a Coordinator, a Deputy Coordinator and a Secretary.

2) The Coordinator, Deputy Coordinator and the Secretary shall be elected for a term of two (2) years, renewable once.

3) The Technical Support Committee meets on a quarterly basis and whenever it is deemed necessary.

4) Meeting of the Technical Support Committee shall be held legally if at least two thirds (2/3) of its members are present.

5) Decisions shall be taken through consensus, if not possible, they shall be taken on the basis of a simple majority vote of the members present.

Logistical support

The Authority shall provide to the Catchment Committee and to the Technical Support Committee all the necessary logistical requirements and any other support.

Key responsibilities of Rwanda Water Board are the followings (see Figure 5.1):

(1) to implement national policies, laws and strategies related to water resources;
(2) to advise the Government on matters related to water resources;
(3) to establish strategies aimed at knowledge based on research on water resources knowledge, forecasting on water availability, quality and demand;
(4) to establish strategies related to the protection of catchments and coordinate the implementation of erosion control plans;
(5) to establish floods management strategies;
(6) to establish water storage infrastructure;
(7) to establish water resources allocation plans;
(8) to establish water resources quality and quantity preservation strategies;
(9) to control and enforce water resources use efficiency;
(10) to examine the preparation of roads, bridges, dams and settlements designs in order to ensure flood mitigation and water storage standards;
(11) to monitor the implementation of flood mitigation measures and water storage during the implementation of roads, bridges and settlements' plans;
(12) to cooperate and collaborate with other regional and international institutions with a similar mission.

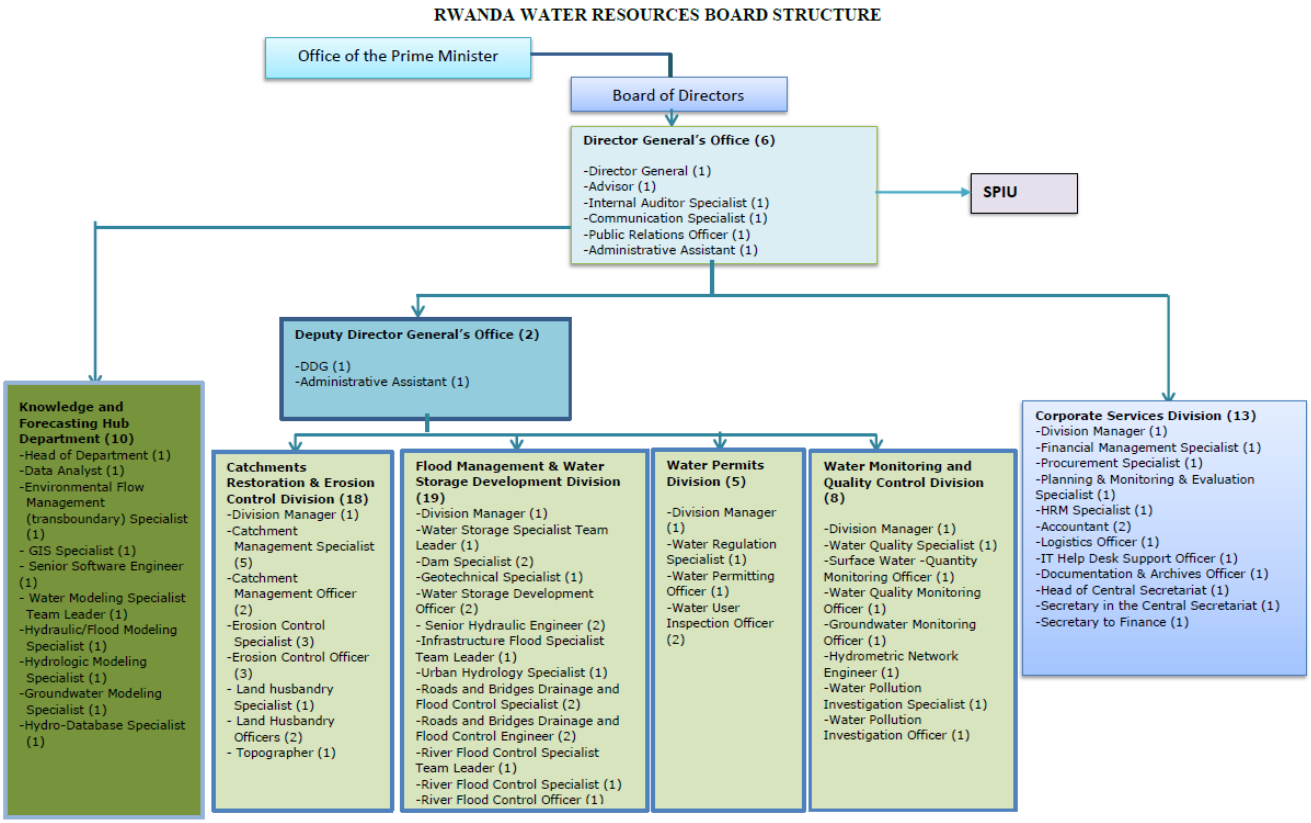

FIGURE 5-1: ORGANOGRAM OF RWB STRUCTURE

REFERENCES

Concept notes for selected IWRM packages in UNY DC. IWRM Package: Landscape restoration and water resources protection for the viability of ecosystem services in Mbirurume watershed (LWAPES)

International Water Management Institute. 2012. “Building Climate Resilience of Watersheds in Mountain Eco-Regions –Climate Change and Vulnerability Mapping in Watersheds in Middle and High Mountains of Nepal”. Project Preparatory Technical Assistance 7883-NEP. ADB: Manila.

IUCN and WRI (2014). A guide to the Restoration Opportunities Assessment Methodology (ROAM): Assessing forest landscape restoration opportunities at the national or sub-national level. Working Paper (Road-test edition). Gland, Switzerland: IUCN.

Karamage, F., Zhang, C., Ndayisaba, F., Shao, H., Kayiranga, A., Fang, X., Nahayo, L., Nyesheja, E.M and Tian, G. (2016) ‘Extent of Cropland and Related Soil Erosion Risk in Rwanda’. Sustainability, 8 (609).

Lal, R. (2001) Soil degradation by erosion. Land Degradation and Development. 12, 519-539.

Ministry of Disaster Management and Refugee Affairs (MIDIMAR), (2015) The National Risk Atlas of Rwanda. Government of Rwanda.

Ministry of Natural Resources (MINIRENA), (2014). *Forest Landscape Restoration Opportunity Assessment for Rwanda*. MINIRENA (Rwanda), IUCN, WRI.

National Institute of Statistics of Rwanda (NISR). (2017) ‘Integrated Household Living Conditions Survey (EICV5) District Profile’. East-Bugesera.

REMA. (2015) ‘Rwanda: State of Environment and Outlook Report 2015’. Government of Rwanda.

Republic of Rwanda (2014). ‘Consultancy Services for the Development of Rwanda National Water Resources Master Plan’.

Republic of Rwanda. (2011) Green growth and climate resilience: national strategy for climate change and low carbon development. Available from: https://cdkn.org/wp-content/uploads/.../Rwanda-Green-Growth-Strategy-FINAL1.pdf [Accessed 22nd May 2017].

Richards, E., Masuoka, P., Brett-Major, D., Smoth, M., Kleijn, T.A., Kim, H.C., Anyamba, A., and Grieco, J. (2010). The relationship between mosquito abundance and rice field density in the Republic of Korea. *International Journal of Health Geographics* 2010, **9**:32

RNRA, (2014a) Consultancy services for development of Rwanda National Water Resources Master Plan. Exploratory Phase Report.

RNRA, (2014b). Consultancy services for development of Rwanda National Water Resources Master Plan. National Water Resource Master Plan Report: Main Volume.

RoR, 2018, Law n°48/2018 of 13/08/2018 Environmental Law

RoR, 2018 Law n°49/2018 of 13/08/2018 determining the use and management of water resources in Rwanda

RoR, 2018. Ngororero District Development Strategy 2018-2024. A Vibrant Agro-processing and Mining Hub

RoR, 2019. Draft Ministerial Order governing water resources management committee at catchment level.

UNDP (2013). *Building National and Local Capacities for Disaster Risk Management in Rwanda.* For Ministry of Disaster Management and Refugee Affairs.

UNESCO (2005). Water Resources Systems Planning and Management. An Introduction to Methods, Models and Applications.

Water for Growth. 2017. Upper Nyabarongo Catchment Rehabilitation Plan. Integrated Water Resources Management Department. Kigali.

TABLE 5-1: DEGRADED SITE WITHIN THE NYIRAMUHONDI WATERSHED PROPOSED FOR REHABILITATIONY

S/N	Province	District	Landcover Type	Erosion Feature Type	Erosion Control Mechanism	Recommended Practice	Old Risk Category	Risk Category	Area in Ha
1	West	Ngorerero	None	None	None	Afforestation	High	High	0.089
2	West	Ngorerero	Seasonnal crops	None	Forest	Agroforestry	High	High	0.825
3	West	Ngorerero	Seasonnal crops	None	None	Agroforestry	Very high	Very high	0.000
4	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	9.164
5	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	2.131
6	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	Very high	Very high	0.576
7	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	1.121
8	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	2.597
9	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	1.109

S/N	Province	District	Landcover Type	Erosion Feature Type	Erosion Control Mechanism	Recommended Practice	Old Risk Category	Risk Category	Area in Ha
10	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	Very high	Very high	2.246
11	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	3.561
12	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	Very high	Very high	7.593
13	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	2.678
14	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	Extremely high	Extremely high	0.393
15	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	1.745
16	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	1.874
17	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	0.278
18	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	20.479

S/N	Province	District	Landcover Type	Erosion Feature Type	Erosion Control Mechanism	Recommended Practice	Old Risk Category	Risk Category	Area in Ha
19	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	Very high	Very high	2.864
20	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	0.017
21	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	3.421
22	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	5.854
23	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	6.599
24	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	30.842
25	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	Very high	Very high	8.086
26	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	5.667
27	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	2.411

S/N	Province	District	Landcover Type	Erosion Feature Type	Erosion Control Mechanism	Recommended Practice	Old Risk Category	Risk Category	Area in Ha
28	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	0.017
29	West	Ngorerero	Seasonnal crops	Rill erosion	None	Contour bank terraces	High	High	1.560
30	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	1.742
31	West	Ngorerero	Seasonnal crops	None	None	Contour bank terraces	High	High	5.542
32	West	Ngorerero	Seasonnal crops	None	Bench terraces	Hedgerows	High	High	1.218
33	West	Ngorerero	Seasonnal crops	None	Bench terraces	Hedgerows	High	High	2.201
34	West	Ngorerero	Seasonnal crops	None	Bench terraces	Hedgerows	High	High	3.638
35	West	Ngorerero	Seasonnal crops	None	Bench terraces	Hedgerows	High	High	6.970
36	West	Ngorerero	Banana	None	None	No till	High	High	11.598

S/N	Province	District	Landcover Type	Erosion Feature Type	Erosion Control Mechanism	Recommended Practice	Old Risk Category	Risk Category	Area in Ha
37	West	Ngorerero	Banana	None	None	No till	Very high	Very high	2.761
38	West	Ngorerero	Banana	None	None	No till	High	High	5.398
39	West	Ngorerero	Banana	None	None	No till	High	High	1.168
40	West	Ngorerero	Banana	None	None	No till	High	High	1.367
41	West	Ngorerero	Banana	None	None	No till	High	High	1.464
42	West	Ngorerero	Banana	None	None	No till	Very high	Very high	1.088
43	West	Ngorerero	Banana	None	None	No till	High	High	1.201
44	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.693
45	West	Ngorerero	Dense forest	None	Forest	None	High	High	2.058

S/N	Province	District	Landcover Type	Erosion Feature Type	Erosion Control Mechanism	Recommended Practice	Old Risk Category	Risk Category	Area in Ha
46	West	Ngororero	Dense forest	None	Forest	None	High	High	0.507
47	West	Ngororero	Dense forest	None	Forest	None	High	High	8.046
48	West	Ngororero	Dense forest	None	Forest	None	High	High	0.836
49	West	Ngororero	Dense forest	None	Forest	None	High	High	0.659
50	West	Ngororero	Dense forest	None	Forest	None	High	High	0.175
51	West	Ngororero	Dense forest	None	Forest	None	High	High	0.126
52	West	Ngororero	Dense forest	None	Forest	None	High	High	1.172
53	West	Ngororero	Dense forest	None	Forest	None	Very high	Very high	1.724
54	West	Ngororero	Dense forest	None	Forest	None	High	High	0.242

S/N	Province	District	Landcover Type	Erosion Feature Type	Erosion Control Mechanism	Recommended Practice	Old Risk Category	Risk Category	Area in Ha
55	West	Ngorerero	Dense forest	None	Forest	None	High	High	1.378
56	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.125
57	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.343
58	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.107
59	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.266
60	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.140
61	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.284
62	West	Ngorerero	Dense forest	None	Forest	None	Very high	Very high	0.620
63	West	Ngorerero	Dense forest	None	Forest	None	Very high	Very high	0.382

S/N	Province	District	Landcover Type	Erosion Feature Type	Erosion Control Mechanism	Recommended Practice	Old Risk Category	Risk Category	Area in Ha
64	West	Ngorerero	Dense forest	None	Forest	None	Very high	Very high	7.234
65	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.187
66	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.441
67	West	Ngorerero	Dense forest	None	Forest	None	Very high	Very high	0.006
68	West	Ngorerero	Dense forest	None	Forest	None	Very high	Very high	0.811
69	West	Ngorerero	Dense forest	None	Forest	None	High	High	1.256
70	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.699
71	West	Ngorerero	Dense forest	None	Forest	None	Very high	Very high	1.388
72	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.147

S/N	Province	District	Landcover Type	Erosion Feature Type	Erosion Control Mechanism	Recommended Practice	Old Risk Category	Risk Category	Area in Ha
73	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.148
74	West	Ngorerero	Dense forest	None	Forest	None	Very high	Very high	8.753
75	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.053
76	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.221
77	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.019
78	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.144
79	West	Ngorerero	Dense forest	None	Forest	None	Extremely high	Extremely high	1.237
80	West	Ngorerero	Dense forest	None	Forest	None	Very high	Very high	0.558
81	West	Ngorerero	Dense forest	None	Forest	None	Very high	Very high	0.947

S/N	Province	District	Landcover Type	Erosion Feature Type	Erosion Control Mechanism	Recommended Practice	Old Risk Category	Risk Category	Area in Ha
82	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.224
83	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.001
84	West	Ngorerero	Dense forest	None	Forest	None	Extremely high	Extremely high	0.145
85	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.590
86	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.281
87	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.031
88	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.072
89	West	Ngorerero	Dense forest	None	Forest	None	Very high	Very high	0.116
90	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.073

S/N	Province	District	Landcover Type	Erosion Feature Type	Erosion Control Mechanism	Recommended Practice	Old Risk Category	Risk Category	Area in Ha
91	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.161
92	West	Ngorerero	Dense forest	None	Forest	None	High	High	6.657
93	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.121
94	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.045
95	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.150
96	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.085
97	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.231
98	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.029
99	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.030

S/N	Province	District	Landcover Type	Erosion Feature Type	Erosion Control Mechanism	Recommended Practice	Old Risk Category	Risk Category	Area in Ha
100	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.089
101	West	Ngorerero	Dense forest	None	Forest	None	Very high	Very high	0.097
102	West	Ngorerero	Dense forest	None	Forest	None	Very high	Very high	0.028
103	West	Ngorerero	Dense forest	None	Forest	None	Very high	Very high	0.187
104	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.138
105	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.144
106	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.168
107	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.288
108	West	Ngorerero	Dense forest	None	Forest	None	High	High	0.066

S/N	Province	District	Landcover Type	Erosion Feature Type	Erosion Control Mechanism	Recommended Practice	Old Risk Category	Risk Category	Area in Ha
109	West	Ngororero	Dense forest	None	Forest	None	High	High	0.045
110	West	Ngororero	Dense forest	None	Forest	None	High	High	0.169
111	West	Ngororero	Dense forest	None	Forest	None	High	High	0.091
112	West	Ngororero	Degraded forest	None	None	Reforestation	Very high	Very high	3.230
113	West	Ngororero	Build-up area	None	None	Water harvesting infrastructure	High	High	1.408
114	West	Ngororero	Build-up area	None	None	Water harvesting infrastructure	Very high	Very high	9.440
115	West	Ngororero	Build-up area	None	None	Water harvesting infrastructure	High	High	11.050
116	West	Ngororero	Build-up area	None	None	Water harvesting infrastructure	High	High	5.558
117	West	Ngororero	Build-up area	None	None	Water harvesting infrastructure	High	High	7.098