A biophysical and socio-economic baseline assessment for landscape restoration and Integrated Water Resources Management in Sebeya Catchment

2019 Baseline assessment




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RWANDA RURAL REHABILITATION INITIATIVE
RWARRI

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Annexes

Acronyms and abbreviations

AMM	Adaptive Monitoring and Management system
CIDRA	Centre for Integrated Development Research and Action (CIDRA Ltd)
CMP	Catchment Management Plan
CROM DSS	Catchment Restoration Opportunity Mapping Decision Support System
DO	Dissolved Oxygen
DPSIR	Driving force – Pressure – State – Impact – Response
DRC	Democratic Republic of the Congo
EC	Electric Conductivity
EKN	the Embassy of the Kingdom of the Netherlands
EWMR	Embedding Integrated Water Resource Management in Rwanda
FDG	Focus Group Discussion
GIS	Geographic Information System
GoR	Government of Rwanda
HH	Household
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
KII	Key Informant Interview
KMS	Knowledge Management System
LAFREC	Landscape Approach to Forest Restoration and Conservation
LPG	Liquefied petroleum gas (LP gas)
M&E	Monitoring and evaluation
masl	meter above sea level
MCAP	Micro Catchment Action Plan
MINAGRI	Ministry of Agriculture
MoE	Ministry of Environment
MININFRA	Ministry of Infrastructure
MINIRENA	(former) Ministry of Environment and Natural Resources
NBS	Nature Based Solutions
NISR	National Institute of Statistics of Rwanda
NTU	Nephelometric Turbidity unit
PES	Payment for Ecosystem Services
QGIS	Quantum GIS
RAB	Rwanda Agriculture Board
RDB	Rwanda Development Board
REMA	Rwanda Environmental Management Authority
RMB	Rwanda Mines, Petroleum and Gas Board
RNRA	(former) Rwanda Natural Resources Authority
RWB	Rwanda Water Resources Board
RWFA	Rwanda Water and Forestry Authority
RWH	Rainwater Harvesting
SACCO	Saving and Credit Cooperative Organisation of the Rwandan Government
SLRPP	Sebeya Landscape Restoration Pilot Programme
SMART	Specific, Measurable, Achievable, Relevant and Time-bound
SNV	the Netherlands Development Organization
SWOT	Strengths, Weakness, Opportunities and Treats analysis
TSS	Total Suspended Solids
VLUAP	Village Land Use Action Plans
VUP	Vision 2020 Umurenge Program
W4GR	Water for Growth Rwanda
WASAC	Water and Sanitation Corporation
WASH	Water, Sanitation, and Hygiene
WEAP	Water Evaluation and Planning (modelling software)
WRI	Water Resources Institute

Executive Summary

This report presents the 2019 socio-economic and biophysical baseline assessment of Sebeya Catchment. This assessment was needed for the implementation of the "Embedding Landscape Restoration and Integrated Water Resources Management (IWRM)" in Rwanda Project (EWMR). The EWMR project covers several catchments in Rwanda and carried out by Rwanda Water Resources Board (RWB) in collaboration with International Union for Conservation of Nature (IUCN) and its consortium partners, the Netherlands Development Organization (SNV) and Rwanda Rural Rehabilitation Initiative (RWARRI) and financially supported by the Embassy of the Kingdom of the Netherlands (EKN). The overall goal of the EWMR project is "Improved water catchment management, contributing to increased resilience of communities & landscapes to the impacts of climate change and other drivers".

The baseline assessment entailed literature reviews, data mining, modelling, field studies, household questionnaires, monitoring and measurements, SWOT analyses, expert interviews and focussed group discussions. All the gathered information presented here was analysed and consolidated in order to determine and document on the required baseline indicators that are needed for monitoring socio-economic and biophysical developments throughout the implementation of the IWRM and landscape restoration measures in Sebeya Catchment by the EWMR project.
New data, information and recommendations are presented on:

- Land and soil degradation, river sedimentation, river water quality, droughts and flooding;
- Household incomes and resilience depending on the catchment resources;
- Water and landscape governance and management institutions; and
- Evidence-based guidelines for the landscape approach.

The key results of the socioeconomic and biophysical baseline analyses focussing foremost on the communities, the households and their livelihoods, status and trends in land and water resources, institutional capacity, knowledge management and transfer systems, catchment management and governance are summarised here below.

With regard to key biophysical catchment aspects, we have determined that currently the vegetative cover (buffer zone) along the main river network is 63%. Currently, 56% of Sebeya Catchment area we deem less vulnerable to erosion as the land is covered by either natural or plantation forest, riverbank trees or perennial agriculture, while 14% of the catchment is very sensitive to soil erosion. For the latter we mean a high risk of catchment degradation and severe runoff and soil erosion. Consequently, elevated erosion rates and sedimentation processes result in highly turbid river waters that along the found regional microbiological contamination, largely determines the overall river Sebeya water quality throughout the year.
With water demand increasing sharply over the next decade due to anticipated climate change, economic growth and demography we expect that demand cannot be met within years if not water saving technology and durable approaches are implemented. Regrettably, current water resources utilisation cannot be quantified due to unregulated water use and limited water users' information. With upcoming shortages, it is recommended to research the domestic water demand in more detail soonest.

We believe that the adverse impact of current anthropogenic and natural developments of the catchment can be mitigated to a large extend, and there is great potential to turn current

degradation around by the right interventions to the benefit of the catchment and the people therein.
E.g., there are ca. 20 mining cooperations' sites in the catchment and ca. 400 small mining areas, of which ca. 250 are still operational. Around the mining areas, many gullies are present, and landslides are favourable to occur. We observed that mineral ores including all sorts of wastewater and sediments from the mining site can still be easily washed into River Sebeya and its tributaries. This increases the undesirable influx from mining activities at the source of Sebeya. Cooperation with involved public and private stakeholders is recommended to design site rehabilitations plans to mitigate the inflow of Sebeya system degradation and monitor progress. We also show that this can be enhanced by further reducing sediment influx by riverbank revegetation.

For improving household status while preserving or enhancing catchment resources, we show that terraces combined with perennial agriculture are an interesting opportunity for sustainable agriculture both from an economic as biophysical perspective. Radical terracing is currently not widely practised in the catchment, it requires proper design and maintenance to decrease the occurrence of landslides. For building and operations, the farmers need multi-year financial and knowledge development support. But if carried out well, it increases crop productivity (e.g., Irish potatoes, maize, cassava and vegetables) and farm incomes, and lower erosion sensitivity, especially when it is further combined with reforestation.

The main income sources derive from agricultural activities. However, the current agricultural sector is neither economically nor environmentally sustainable. The small agriculture plots hardly support families towards business expansion and sustainable economic development, and the lack of skills and knowledge, causes intensive cultivation and continued loss of soil fertility and erosion. We conclude that the "technology push" for improving the agricultural sector by the implementation of innovative and sustainable technologies are therefore demanding because they are costly and require brainpower, creativity, entrepreneurship and time.
There are however alternative opportunities signalled for improving livelihood and incomes. For more revenue and investment, we recommend focusing more on the development of the following sectors agroforestry, coffee and tea production, composting and irrigation, off-farm job creation and value chain improvement, new sustainable cooking practices and resources and the approach of payment for Ecosystem Services (PES).

To briefly summarise, the younger generation show interest in 'off-farm jobs' activities, but still very few are involved. We assessed new agrobusiness, e.g. pig, chicken and avocado farming and also value chain development on milk and honey production and processing and there are, due to market demand, value chain development of potatoes, maize and vegetables. Agroforestry is being practised by many but could be upscaled as an important solution for soil restoration and protection, and provision of fuel wood, timber, fruits and livestock fodder with the advantage that it can be combined with more conservative agricultural practices currently in place.
Increasing perennial coffee and tea production is recommended as good solution for both increasing activities in the agricultural sector as to restore land degradation and soil erosion. With new knowledge and skills development, the coffee and tea farmers' business model could be revived, and the value chains improved. The integration of coffee or tea production with agroforestry should be further explored. Especially in various buffers zones of Sebeya river and areas with steep slopes this integration could increasing farmers' revenues and reduce erosion.

PES systems on the other hand are not yet adopted in the Sebeya catchment. But more noticeable damage caused by unsustainable landscaping can create a window or opportunity for ecosystem conservation and joint payment systems like PES. The viability of PES systems should be explored by engaging with key private companies that benefit from Sebeya's resources that are affected by upstream developments. When opportune, joint arrangements can be made for Private sector to invest in catchment ecosystem conservation.

With regard to the knowledge management systems and structures, we show that existing knowledge management structures and frameworks have several flaws that at this moment do not allow a comprehensive adaptive monitoring and management response that typically accompanies planned catchment investments and improvements.
A critical flaw concerns the lack of operational and consistent monitoring of a few key quality indicators that collect information on the catchment's status and trends following any interventions, developments as well as climate change impacts, and benchmark them against a set of predetermined and adopted objectives. Hence, systematic quality data and information consolidation for executing management is hampered, i.e., there is a clear risk that progress on anticipated or other change will not be perceived by decision makers in time.
Also, and despite a good enabling policy environment in Rwanda, there are gaps in harmonising relevant policies and agreed targets across the different districts, as well as lack of effective guidelines for an integrated landscape approach.

We strongly suggest to put in place an adaptive monitoring and management system (AMM) allowing the continued acquisition and consolidation of relevant data and information for decision makers. An AMM that ideally should be accompanied by a communication strategy that inspires, involves and empowers other problem owners and stakeholders. Concluding from several SWOT analyses we recommend that the AMM should entail the provision and -the teaching in- deployment of robust and easy accessible and free-of-charge tools, lasting approaches and cost-effective techniques that better involves and secures participation of citizens and their local leaders in their efforts of landscape restoration.

With regard to the governance, we conclude that inclusive governance of land and water resources is one of the critical aspect to be strengthened when implementing landscape restoration and Integrated Water resources Management. The project is operating following existing structures of administrative governance where the lowest administrative unit of a village is given high importance. Nonetheless, the governance structure with District, Sector, Cell and Village is the one that is currently operating due to success in the political mobilisation, flow of information, and organization of various programs. Approaches should be geared to combine both, i.e., from top to bottom and from bottom to the top. To increase ownership of the farmers and local leaders of their natural resources and get significant positive impact on downstream catchments, we recommend to gradually enable governance systems that are linked to hydrological rather than administrative boundaries.

The report presented here provide the basis for multiple options for the Sebeya catchment to combine sustainable ecological conservation and development while increasing income and livelihood levels. A sufficient awareness and availability of knowledge and financial resources are key issues to address. When combined in one process it requires guidance in a systematic way and as well as sustained financial and institutional support. We recommend a step-by-step and multilevel approach delivering durable proof first then stimulate required change at scale by more resilient communities that are enabled to effectively manage their water and landscape resources.

The comprehensive output of this project is in support of the ongoing initiatives by the government of Rwanda to implement Integrated Water Resources Management for improved management of land and water resources, landscape restoration, catchment management planning and implementation of innovative financing mechanisms to improve community household incomes.

During this study and challenging COVID 19 times, new pragmatic social, ecological and hydrological assessment methodologies have been developed specifically for Rwanda. These standardised approaches allow quick synthesis of complex catchment issues and the identification of multiple opportunities that help enabling the initiatives under the Sebeya development plan as well as to other Catchments plans (Lake Kivu, Rusizi River catchment, Mukungwa River, the Akanyaru, the upper Akagera) and are in full support of other Micro-Catchment Action Plans.

Baseline indicators

Table 1. Overview of the baseline indicators, their values found and units of measure for the state of Sebeya catchment as per November 2019. Indicators noted per EWMR project impacts and outcomes as described in the EWMR M&E plan, 2019. The baseline values do not consider the project deliverables from the W4GR programme, only if otherwise specified. Source information can be found at the specific page references.

Nr	Baseline indicators	Baseline value and unit of measure	Page reference/ source information
Impact: Increased livelihood and conservation benefits from restoration & improved local land management in Sebeya catchment			
Impact indicator: Improved livelihoods (e.g. food, water, health) due to project activities			
1	Household size	5 p. per household on average	p. 49
2	Male or Female head of household	Female-headed: 29.2% Male-headed: 70.8%	p. 49
3	Physical characteristics of the dwelling	• Roof (metal sheets: 38.1%; local tiles: 40%, plastic sheeting: 0.5%, other: 21.5%) • Wall (mud bricks: 72.9%; wood and mud: 5.8%; fired bricks: 1.2%; other: 20.1%) • Floor (beaten earth: 68.2%; concrete with cement: 10.7%; concrete with tiles: 0.2%; stones: 0.2%; timber: 0.2%, other: 20.3%)	p. 49
4	Safe water for domestic use	• 86.6% of the population in the Western province have access to clean water • 5.9% of the households have water piped into home	p. 64
5	Main source of energy used for Household cooking	Firewood: 85.5% Charcoal: 14.3% Other: 0.2%	p. 65
6	Wealth index	Wealth category 1 (very poor): 17.1% of the HHs Wealth category 2 (poor): 46% of the HHs Wealth category 3 (better-off): 36.9% of the HHs	p. 49
7	Household finance	• Average seasonal income from agriculture-related activities (Livestock sale: 176074 Frw; crop sale: 95585 Frw; livestock products sale: 29750 Frw) • Average monthly income from other sources (self-employment: 47388 Frw; Salaries/wages: 31197 Frw) • Percentage of households with a saving plan in place :45.3% (66% of the HHs save less than 5000 Frw) • Access to loan from formal financial institutions: 43.2% of the HHs own an account in a financial institution (16.2 % of these HHs have applied for a loan with a 100% success rate)	p. 52
8	Source of employment	Primary employment of the HH head: • Farming (own): 38.3% of the HH heads • Livestock rearing: 4.2% • Farming (as a worker): 14%	p.49

		• Self-employment: 4.4% • Mining: 4.2% • Petty trade: 2.8% • Civil servant: 1.4% • Other: 11% • Unemployed: 18%	
9	Household water use	• Average daily per capita water use for domestic activities: (10.5 litres: middle stream zone, 9.7 litres in the downstream and 8.1 litres in the upstream zone) • Average daily water use for livestock per household: 35 litres in the downstream zone, 65.9 litres middle stream; 53.8 litres in the upstream zone • Average daily water use for irrigation per household: 100 litres in the downstream zone, 64.4 litres in the middle stream and 64 litres in the upstream zone.	p. 64
10	Rainwater harvesting (RWH)	28% of the HHs have a RWH system in place (roof water harvesting system with a closed tank)	p. 65
11	Flooding	21% of the HHs indicates that they have experienced a flood	p. 67
12	Drought	17 % of the HHs indicate that they have experienced a drought	p. 69
13	Best agricultural practices	49% of the HHs have adopted/benefited from a type of best agricultural practices: 1) 48,8 % in Composting; 2) 34% with Chemical fertilizer; 3) 26.6% with use of improved seeds; 4) 26,6% with Crop rotation; 5) 23.1% with intercropping; 6) 16.8% with integration of livestock and crops; 7) 16.4% Terracing; 8) 2.6% with Mulching; 9) 18% Agroforestry	p. 59
14	Agricultural landholding	• Land ownership (60.5% of the Households in the upstream area; 68.5% in the middle stream and 31.1% in the downstream) • Area of land allocated to agriculture per household: (0.25 ha in downstream; 0.47 ha in the middle stream and 0.44ha in the upstream)	p.55
15	Yield, agricultural commercialization	• Most grown crops (Irish potatoes: 39.3% of the HHs; maize: 26.4%; beans: 24.1%) • Average yield irish: 11882 kgs/ha in Nyabihu and 11350 ha/kgs in Rubavu (Data from the seasonal agricultural survey) • Average yield maize: 1277 kgs/ha in Nogorero and 1501 kgs/ha in Rutsiro (Data from the seasonal agricultural survey) • Average yield beans: 12061ha/kg in Rubavu (Data from the seasonal agricultural survey) • 57% of the households have an extra production that can be sold to the market and 48% of these make less than 5000 Frw a season.	p.58
16	Livestock rearing	Among the 246 households that have access to land for agriculture and farming activities, 52% own at least one animal.	p. 60

Impact indicator: reduced turbidity of water			
17	Turbidity	Monthly Average Turbidity in rainy season from 853-1478 NTU and in dry season from 444 -1139 NTU (WASAC data)	p. 17
18	River Water quality status	Insitu values of key physicochemical variables: EC 17-1000 µS/cm, pH (5,5-7,9), DO (75-119 % sat.), Temperature (16.1-19.9 C), Turbidity (61-1118 NTU). Due to sediment loads and microbiological contamination values, the water body is outside acceptable range of FDEAS for natural potable water.	p. 17
19	River Water quantity status	Average outflow (mean daily discharge) into lake Kivu (Sebeya outlet) is in the range of 2.8 m^3/s - 5.3 m^3/s, and therefore in the range of 1,4 million m^3/year and 2,8 million m^3/year. Average 10% low flows Nyundo station: 0.5 m^3/s Average 10% peak flows Nyundo station: 8.3 m^3/s	p. 24
20	Structures (hard and NBS) build to manage peak flows in main river and tributaries	1 concrete channel, multiple gabion walls and multiple raised bridges are in place. More details can be found in the GIS database. Details on conveyance not part of the assignment.	p. 42
21	Mining areas	12 mining cooperation sites were identified with licenses (active in cassiterites, wolfram, tin mining). 15 sand and gravel mining companies are operational in Rubavu. According to RMB there are around 400 small mining areas of which ~250 are still operational.	p. 40
22	Land sensitivity to soil erosion	The area sensitive to soil erosion is 5009 ha	p. 33
23	Stable riverbanks	52% of all streams have vegetated riverbanks with a 5 m buffer and 63% of the main riverbanks are vegetated based on a 10 m buffer zone.	p. 28
24	Landslides	86 ha of bare land	p. 37
25	Forest cover	26% of catchment area covered by natural forest and 23% is plantation forest	p. 38
26	Perennial agricultural crops	17% of total cropland area or 1810 ha	p. 38
Outcome1: Degraded lands in Sebeya Restored			
Indicator: Area of degraded land under improved landscape governance & management			
27	Area of degraded land under improved landscape governance & management, and restoration	5227 ha of land under restoration	p. 73
28	Mines complying with environmental and mining standards	100% of the mines are requested to comply by the environmental and mining standards by their license. But no strict compulsory monitoring and management of the activities seems to be in place.	p. 40
29	Old mining area rehabilitated (post-closure rehabilitation)	0 old mining areas rehabilitated. An impact and mining assessment is needed to check mines that need post closure rehabilitation.	p. 41
30	Gully area	15 gully areas	p. 37
Output1.1: Village & Micro-catchment land use planning improved to enhance overall catchment management			
31	village & micro-catchment plans	6 MCAPs (from the W4GR programme) and 0 VLUAPs	p. 75
Output1.2: Priority landscape restoration & management actions implemented and monitored			
32	Number of villages implementing restoration actions as per the performance contracts	0 villages	p. 75
33	Community erosion control measures	18% of the households are involved in agroforestry and, 16.4% of the households have at least one plot with terraces.	p. 77

34	People to whom knowledge or skills have been effectively transferred	0 people by the EMMR project	p. 77
Outcome2: Innovative investments promoted for improved livelihoods and conservation benefits			
35	households engaged in sustainable livelihood activities	• 0.7% of the households involved in beekeeping • 18% of the households are involved in Agroforestry	p. 76
36	Status of Payments for Ecosystem Services schemes (PES)	0 PES schemes established	p. 77
37	Access to information on value chain improvement	• 10% of the households have information on value chain and are involved in value addition activities	p. 77
38	Commercial tree farming	4% of households are involved	p. 78
39	Alternative energy sources for charcoal and firewood	• 0.7% of the households use other energy source than charcoal and firewood.	p. 65
40	People coming from the city to Sebeya for business	Community members during focus group discussions mentioned rural – urban trades mainly involving people coming from neighbouring cities to by agricultural commodities (Irish potatoes and milk) to resale them in other cities.	p. 79
Output2.1: Sustainable livelihood options expanded			
41	Enterprises supported within targeted Value Chains	0 Enterprises	p. 78
42	Major Private Companies involvement in the catchment	32 Enterprises	p. 78
43	Income generated by new businesses/ entrepreneurial activities.	• 3% of the households are involved in new business activities. • Average monthly amount generated by new business activities is 80391 Frw.	p.78
Outcome 3: Scale up to entire Sebeya Catchment			
Output3.1: Catchment committees established or strengthened			
44	Catchment committees	0 Catchment committees in place	p. 76
Output3.2: Catchment Plans elaborated			
45	IWRM Packages prioritized	4 packages prioritized	p. 96
Outcome4: Knowledge management System implemented for improved & integrated landscape restoration			
46	Applied knowledge and skills	0 people trained by the EWMR project	p. 80
Output4.1: Knowledge-management system developed and operationalized			
47	Knowledge products	0 knowledge products by the EMMR project	p. 85
48	communication products	0 communication products by the EMMR project	p. 88

1 Introduction

This report presents the socio-economic and biophysical baseline assessment of Sebeya Catchment, for the implementation of the Embedding Landscape Restoration and Integrated Water Resources Management (IWRM) in Rwanda Project (EWMR). The EWMR project covers several catchments in Rwanda.

Sebeya Catchment is located in the North West of Rwanda, and is shared between four districts: Rubavu, Rutsiro, Ngororero and Nyabihu (Figure 1). The catchment area is 363.4 km², and its water flows into Lake Kivu just south of Gisenyi town.

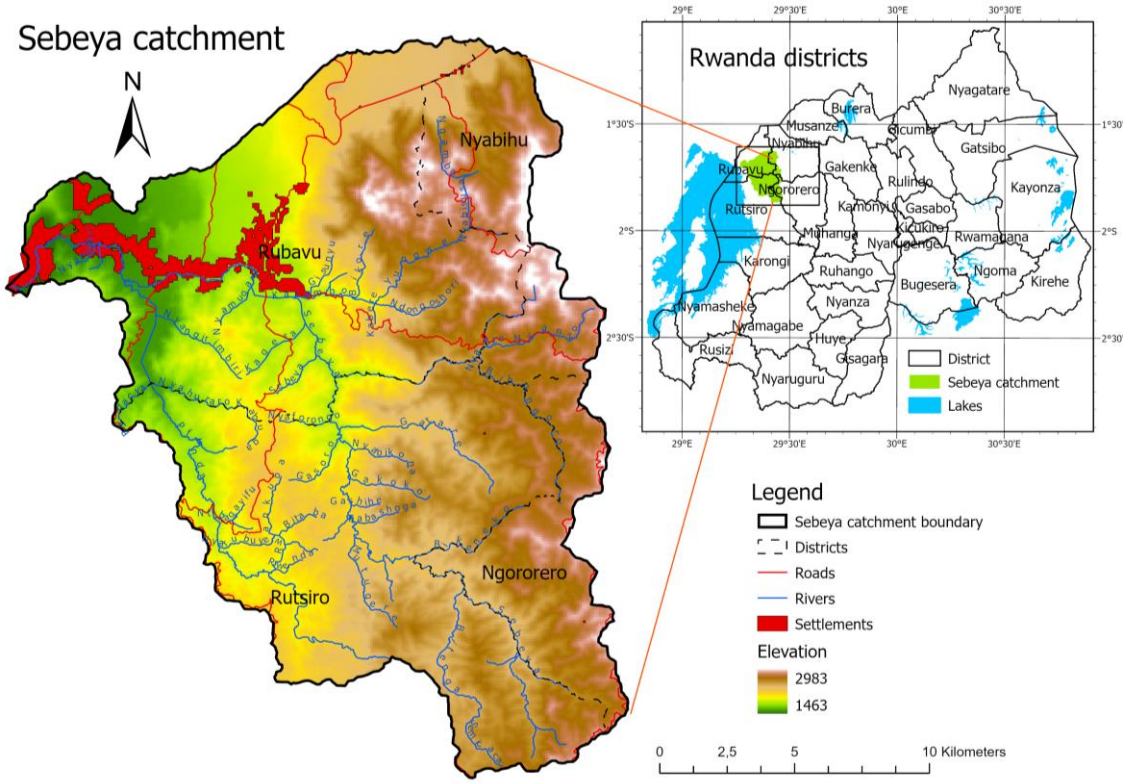

Figure 1. Location of Sebeya Catchment in North West Rwanda.

1.1 Summary of the project

The EWMR Project is carried out by Rwanda Water Resources Board (RWB) in collaboration with International Union for Conservation of Nature (IUCN) and its consortium partners, Netherlands Development Organization (SNV) and Rwanda Rural Rehabilitation Initiative (RWARRI). The project is supported with additional funding from the Embassy of the Kingdom of the Netherlands (EKN). The project is implementing IWRM and landscape restoration measures in Sebeya Catchment. The overall goal of the EWMR project is "Improved water catchment management, contributing to increased resilience of

communities & landscapes to the impacts of climate change and other drivers". The focus of the EWMR project is community engagement, Land and Water, Livelihoods, and Institutional capacity development. The EWMR approach strongly involves Catchment planning, Village Land Use Action Plans (VLUAPs) and Knowledge management.

1.2 Purpose of the baseline assessment

The purpose of this assessment is to determine and document baseline indicators for measuring socio-economic and biophysical parameters that will be monitored throughout the implementation of the EWMR project. As restoration begins to be implemented, it is necessary to establish a monitoring system that allows project management and decision makers to measure positive or negative changes, and to be able to link restoration activities and the impacts achieved in the catchment.

For the monitoring system to be effective, a baseline should be established that allows for comparisons on the biophysical landscape and socio-economic context from an initial scenario (WRI, 2020). Monitoring should facilitate the reporting of project impacts to allow the transfer of information on the state of the catchment to decision makers and those carrying out the restoration.

In the case of landscape restoration there are many desired impacts, including better water quality and soil and improved living conditions for rural populations, among others. Monitoring these impacts at a landscape scale is key to determining progress towards the accomplishment of established goals.

1.3 The baseline indicators

The baseline is founded by information on a set of developed indicators and consolidated expert judgements on for example drivers, context and trends. Indicators, having a prominent and legitimate role in assessing and understanding ecosystem status, impacts of human activities, and effectiveness of management measures in achieving objectives, are in particular of importance since they encompass a still growing role in rule-based decision-making (OECD, 2015; World Bank, 2002). It is a prerequisite that indicators should act as proxies, representing other aspects and dynamics of the catchment environment to diagnose its development and health.

The key objective of the EWMR program is to promote sustainable water and land resources use by communities in support of their development of social capital and sustained resilience. The indicators' development is based on the latest available data and experts' information, they need to be relevant, useful and of course used by the end users for a long time to come.
The M&E monitoring plan of the EWMR project is foremost a performance monitoring approach (EWMR M&E plan, 2019), which will promote accountability and continuous improvement of the implementation of project through tracking output, outcome and impact indicators.
For successful implementation, baseline indicators should be scientifically sound and specific and also designed to further unravel the catchment responses to variable human induced impacts.

A set of indicators was developed by the consultancy team and was evaluated on how Specific, Measurable, Achievable, Relevant and Time-bound (SMART) and powerful the baseline indicators were for monitoring changes in Sebeya Catchment. The indicators were checked to see if they were understandable, sensitive, specific, measurable, responsive

and applicable to the Sebeya Catchment situation. In the inception report of this study an example is given for the validation of the indicator turbidity (Langenberg et al., 2020). The indicators were validated if sufficient data allowed and set as final in agreement with IUCN and RWB (august 4th 2020). The full list of indicators for the baseline assessment is shown in Table 1.

2 Methodology

2.1 Introduction

This section of the report presents the applied methodology to gather and analyse required data in the Sebeya Catchment. First, the bio-physical components required a triangulation of methods to be able to collect all data including water and land cover characteristics. Quantitative and qualitative data was collected by different surveys, Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs). The methodology of these different data collection tools is described in the paragraphs below. The developed questionnaires and field data forms are presented in Annex 1.

First the literature review is shortly described. The literature study provided a thorough starting point to cover the biophysical and socio-economic assessments both. Section 2.2 and 2.3 describe the methodology for biophysical and socio-economic data collection. Section 2.4 describes the results of the field data collection campaign.

2.2 Literature study

To date extensive research has been conducted in Sebeya Catchment that produced valuable technical reports, notes and papers and this has served as a benchmark for this baseline study. This information has been collected during the project and stored in a literature database. Over 90 literature items have been added to the project database. Not all data was freely available, and efforts have been made to request relevant reports.

The baseline values in this report are based on validated field findings, databases, and results and information from the desk study. The literature in the database was reviewed for useful information related to context, indicators, and targets. The documents in the database have been used for analysis and cross-checks of field findings related to the baseline values.

Key literature of the database is:

- EWMR (2019) Inception report of the Embedded Integrated Water Resources Management in Rwanda, May to September 2019 (revised 21-02-2020) Project number P03151
- EWMR Programme Monitoring and Evaluation (M&E) Plan of IUCN, September 2019. Landscape and Integrated Water Resources Management and Restoration in Sebeya and other Catchments, Rwanda.
- Ministry of Environment (2018), Sebeya Catchment Management Plan (2018-2024),. IWRM programme Rwanda. Mott Macdonald / SNV / SHER. Kigali, October 2018
- Water for Growth (2017a), Volcanoes area flood management. Technical Report 26. IWRM Programme Rwanda, Mott Macdonald / SNV / SHER. January 2017
- BRL (2020) Flood mapping report for the Development of a National Early Warning Platform for Rwanda and a Flood Early Warning System for the Sebeya river basin 19/06/2020.

- Uwacu, R.A. and O. J. Akintande, 2019. Impacts of Land Use on Water Quality in the Sebeya Catchment Area, Rwanda. (2019) J Environ. Health Sci 5(2): 77-89.
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2.3 Biophysical data collection

The biophysical field team (CIDRA staff) collected data related to land cover, land use, riverbanks, landslide, and environmental issues such as (sand abstraction and erosion characteristics), while the team and Rwanda Water Resources Board (RWB) collected data on water quality.
The sampling sites for biophysical parameters are presented in the map Figure 3. While the sampling points for Water quality are presented in Figure 6.

The biophysical field data collection sites in villages were selected following the livelihood zones (see chapter 4) and the sub catchment delineations. Livelihood zones are areas within Sebeya catchment used for agricultural activities and whether they are upstream or downstream in the catchment. The selected sites represent the biophysical characteristics of the different livelihood zones. The purpose of biophysical data collection was to observe in situ the physical features, identify and discuss trends, observe key issues, and validate key features captured on various maps. The fieldwork also provided opportunity for a discussion with local people on linkages between biophysical characteristics and adaptation measures for improving their livelihood.

Biophysical data were collected using the questionnaires (Annex 2) which, were recorded in the Android application Kobo collect. Collection of data consisted of in situ observation of different features, measuring where possible, taking photos, recording geographic coordinates, interviewing, and discussing with Key Officers and farmers on the ground. Data were immediately transmitted by a digital survey in the projects online database.

Water Quality data consisted of measuring the physical-chemical parameters such as temperature, turbidity, EC, pH, TSS, DO in various locations. More data on water turbidity was collected at WASAC Treatment Plant of Gihira (kindly provided by WASAC) to assess the challenges that WASAC faces with treating turbid water in Sebeya Catchment.

Table 2. Physical-chemical parameters that were analysed were pH, DO, TSS, EC, and turbidity. They were measured using water quality multimeter probe MPS-D on the following sites

#	Sites
1	Sebeya outlet
2	Sebeya Pfunda
3	Pfunda
4	Karambo
5	Bihongora
6	Sebeya up stream sub catchment
7	Sebeya Karumbi

Collected field data were analysed and consolidated with published secondary sources, e.g. water quality data. The biophysical data were used in validating land cover /Land use maps, overlaid, and as well compared to satellite imagery or Google Earth Imageries to confirm the current physical features on the ground. The data and information were also used in the discussion with Officers of Environment in districts visited and RWB. Technical background on map development is provided in Annex 4.

The collected data allowed to obtain an overview on landscape characteristics, its dynamics, and developments as well as the related challenges the Sebeya Catchment residents face from day to day. Challenges with, for example dealing with polluted drinking water due to activities upstream, or undertaking efforts in riverbank protection, soil conservation, and terracing, while settling as well in high-risk areas prone to flooding or unstable hillsides. The catchment is challenged ultimately with the need of balancing better the conservation and restoration of their natural surroundings and resources while changing to low-impact activities and entrepreneurship improving their livelihoods.

Spatial data (from the project GIS database) was used to generate indicator values related to for example forest cover and land sensitivity to soil erosion (See Annex 1 for the survey tools). The indicator targets for the indicators were set by making use of the information from District officers, existing spatial data, Google Earth Imagery, and combination of knowledge of the project implementation on the ground.

2.4 Socio-economic data collection

2.4.1 Approach and Sampling frame

The Household Economic Approach with selected households has been the main approach in socio-economic data collection. The approach has been adapted to the local conditions and the study cut across sampled villages of Sebeya Catchment where restoration activities have or have not yet started.

At the initial stage, a standard sampling procedure was carried out including all households in sectors crossed by Sebeya River (see Figure 2). However, the catchment boundary showed that some of the cells of those sectors were out of the catchment delineation and were too far away to have an impact on the river's biophysical nor their daily livelihood to be directly related to the catchment.

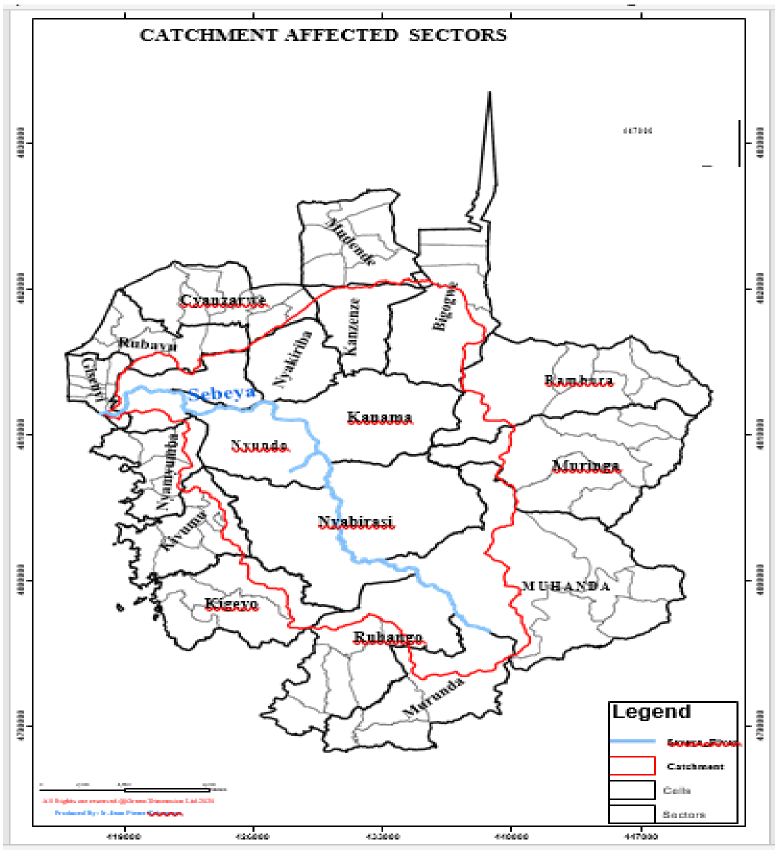

Figure 2. Administrative sectors located within Sebeya catchment. The catchment boundary is indicated in red.

A total of 428 Households were surveyed for the study. The sample size was calculated at 95% confidence level and 5% margin of error, using the Krejcie and Morgan's (1970) sample size formula for finite population size as:

$$n = \frac{N.z^2.p(1-p)}{(N-1)d^2 + z^2.p(1-p)} \quad \ldots\ldots\ldots\ldots (i)$$

Where;

n = estimated sample size

z = value on standardized normal distribution curve corresponding to a level of significance. Which is 1.96 for the 95% confidence level.

P = is the estimated proportion of an attribute that is present in the population (i.e. usually 0.5 that will offer the greatest sample size)

N = Population size/**33208 households** [1]

d = Selected accepted error (level of precision) (5% in our case)

Hence,

$$n = \frac{33208\ 1.96^2 * 0.5 * 0.5}{33207 * 0.05^2 + (0.5 * 0.5)} = 382$$

[1] According to the Rwanda's latest Population and Housing Census (NISR, 2012)

The sample size calculated using the formula was found to be 382, and by adding 12% for loss and the non-response we reached at a total sample size of 428 households. The sample distribution was made in such a way that could ensure the representation of the targeted population based on their agro-ecological and economic activities. To this end, the study has given more attention to get an appropriate representation of the sample from the upper, middle, and downstream sectors. Moreover, the consultant tried to take a minimum sample size of 66 so as to allow the agro-ecologically disaggregated statistical analysis at a 90% confidence level and a 10% margin of error.

Besides, the homogeneity of the study unit in the selected sectors has given us the insight to focus on the agro-ecological and livelihood characteristics of the targeted population rather than having a sample size proportional to the size of the sector population. Accordingly, the sample distribution was also made considering the environmental effect of the main economic activity of the people in the sectors identified as; the upper, middle, and lower stream sectors.

It is in light of this that the consultant has taken a sample size of 185 households from the upper stream sectors of Muhanda and Murunda; mainly dependent on mining as a main economic activity. Likewise, 177 households from agriculture intensive middle stream sectors of Bigogwe, Nyakiriba, and Nyamyumba were included in the study; while we have taken only 66 households from downstream sectors of Rugerero, and Kanama where the majority of the population depend on the small business activities that have less impact on the agro-ecology and land of the River Catchment. (See Table 3).

Given the extent of sectors' relation to the Sebeya River buffer/catchment and the population livelihood characteristics, the sampling frame for this survey was done in two steps. The first consisted of demarcating livelihood zones based on agro-ecological zones and the second of catchment characteristics (upstream vs middle stream vs downstream).

Table 3 Sampling distribution for the household survey by type of livelihoods. From the inception report of this baseline assessment (June 2020).

Sampling Summary					
Livelihood zone/ Village	**Sampled HHs**	**Percentage of sampled HHs within the zone**	**Percentage of sampled HHs within the total sample**	**Total number of HHs in the sampled villages**	**Percentage of sampled HHs within the total number of HHs per village**
Upstream zone					
Bambiro	27	15%	6.3%	207	13.0%
Rurambo	31	17%	7.2%	178	17.4%
Gatomvu	31	17%	7.2%	253	12.3%
Runayu	29	16%	6.8%	75	38.7%
Karumbi	32	17%	7.5%	165	19.4%
Satinsyi	35	19%	8.2%	136	25.7%
Subtotal (upstream)	**185**	**100%**	**43.2%**	**1014**	**18.2%**
Middle stream zone					
Busasamana	27	22%	6.3%	111	24.3%
Bukinanyana	39	31%	9.1%	118	33.1%
Rushubi	30	24%	7.0%	246	12.2%
Kingoma	28	23%	6.5%	228	12.3%
Subtotal (Middle stream)	**124**	**100%**	**29.0%**	**703**	**17.6%**
Downstream zone					
Byima	25	21%	5.8%	133	18.8%
Gatyazo	28	24%	6.5%	194	14.4%
Nyantomvu	32	27%	7.5%	221	14.5%
Nyamugari	34	29%	7.9%	364	9.3%
Subtotal (Downstream)	**119**	**100%**	**27.8%**	**912**	**13.0%**
Overall total	**428**		**100.0%**	**2629**	**16.3%**

In each category, there are different population clusters following the livelihoods and agro-ecological zones:

- Population upstream staying around the mining zones and mostly working in the mining activities with small scale subsistence agriculture (Murunda/Rutsiro and Muhanda/Ngororero sectors)
- Population living around farming areas and mostly practicing livestock activities
- Population living in the different agglomerations in the catchment as well as around the national park/Grazing area (Nyakiriba/Rubavu and Bigogwe/Nyabihu sectors of Ruvavu and Nyabihu districts respectively)
- Population in the downstream urban areas (Kanama, Rugerero and Nyamyumba Sectors), with houses and other social infrastructures, are in close vicinity of Sebeya river and are generally more exposed to flooding, landslides, etc. and also might benefit from river sand mining and practice numerous small-scale businesses.

2.4.2 Quantitative Data

Data Collection, Management and Analysis

The setup of the sampling framework was followed by the preparation of the data collection and data management tools. Data collection started on 13th August 2020 up to 20th August 2020, in 15 villages purposively sampled, targeting the three main agro-ecological zones. The data collection activity consisted of the following elements to secure high quality of the data.

Training of enumerators

The training of the enumerators was aimed at increasing their understanding of data collection tools to their performance and productivity in the field. Each enumerator had to comprehend the questioning structure and underlying calculations. For securing a coherent and attuned training, the enumerators were trained on both quantitative and qualitative data collection tools. This was done through implementation exercises (questionnaire tests).

Next to the project background, the enumerators were equipped with practical skills and familiarized with the questionnaire by the so-called "the fill in questionnaire" technique where, first, using papers, one enumerator interviewed his fellow enumerator who acted as the respondent.

The trainers ensured all aspects were covered in the data collection process ranging from completing electronic tablet forms, assessing perceptions, and identification of any observable changes. The training considered the theoretical understanding, the technical capability, and the classroom practice.

- *Theoretical training*: The training included the project background, a review of the questionnaire and data collection protocols to fully understand the objective of each question, using a paper version of the questionnaire.
- *Technical and classroom practice*: The technical training focussed on how to use tablets in completing electronic questionnaires including (interface and functioning). This included as well individual and group exercises to make the data collection team more familiar with the practice and situation on the ground.

Terrain Reconnaissance visit, Introduction of the project to the local leaders and data collection chronology

After the preparation of data collection tools and the training of enumerators, a team composed of three CIDRA Ltd staff and one RWRB staff visited all sites in Ngororero, Nyabihu, Rutsiro and Rubavu. From 28th to 31st of July 2020. The aim of this preliminary visit was a reconnaissance of the field where data collection was to be undertaken and the preparation of the data collection activities in consultation with IUCN and RWB representatives in the project areas. During this field visit, local leaders were also contacted and informed about the project and they promised to support the data collection activities that were to follow thereafter.

Data collection

Before starting the data collection process, a "pilot survey" was implemented. The importance of this exercise was to test adequacy of research instruments and assess the feasibility of a (full-scale) study/survey. The pilot survey was conducted in one village in the vicinity of the project in Ngororero.

Each enumerator visited at least two households and sent two filled questionnaires to the CIDRA Central data Server. After finalization of the pre-test and revision of the questionnaire, the later was imbedded in the tablets.

The field teams included a supervisor for coordination while all output of the quantitative household data collection was sent back to the server on a daily basis and consequently, for consistency and back and forth feedback, cross-checked by the data manager.

Data cleaning and analysis
To capture data, the enumerators used tablets equipped with Survey CTO software, which improves the functionality of the data collection tools, the collecting time need, and monitors for data quality.

Consequently, the data cleaning was carried out through appropriate statistical software consisting of the following steps:

- Process of detecting, diagnosing, and editing faulty data
- Editing will consist of changing the value of data shown to be incorrect.
- Detection of inlier which is data value falling within expected range
- Detection of outlier which is data value falling outside the expected range

After data screening we considered several data types: lack or excess of data; outliers, including inconsistencies; strange patterns in (joint) distributions; and unexpected analysis results and other types of inferences and abstractions. Using STATA software, we developed frequencies and crosstab tables.

2.4.3 Qualitative Data collection

Next to the quantitative data collection tools, also the qualitative data collection tools (by Focus Group Discussions and Key Informant Interviews were an integral part of the data collection.

Focus Group Discussion (FGD)
These were conducted with community members in 7 sectors located in the catchment, one FGD per sector was held with community members living in the catchment area. The participants in the FGD were community-level leaders and regular community members that represented others as well to provide valuable information. The group size was between 8 and 12 participants and a total of 67 participants participated in the FGDs. The gender aspect was considered to ensure each gender is represented and a participatory approach was used to encourage the active participation of each member.

Key Informants Interview (KII)
The KIIs were conducted with leaders from the Cell to the District level to capture useful qualitative data. The key informants were sampled purposively depending on the type of data needed and up to 25 respondents were interviewed in all the 7 Sectors in the catchment and at the District level.

The main thematic areas covered during the key informants' interviews are:

- Livelihood in Sebeya catchment
- Agriculture and livestock
- Basic Infrastructure availability
- Community engagement in the catchment restoration management activities
- Improved landscape governance & management
- Payments for Ecosystem Services and Value chains
- Entrepreneurial activities, markets, and innovation

2.5 Summary field data collection milestones

Overview of data collection activities:

- From 28th to 31st of July 2020 a team composed of three CIDRA Ltd staff and a staff member of RWB visited all sites in Ngororero, Nyabihu, Rutsiro and Rubavu for a reconnaissance mission.
- Household surveys and qualitative data collection were conducted from 13th August 2020 to 20th August 2020 by a team of CIDRA.
- Biophysical data collection was carried out from 24th to 28th August 2020 by a team of two enumerators from CIDRA, CIDRA staff member, together with a team of IUCN and Rwanda Water Resources Board.

In general field data collection was successful for both socio-economic and biophysical exercises. Interviews and focus groups discussions were carried out with support from local administration. Farmers were quite receptive, open for discussion and eager for providing their opinions and information for the overall improvement of their livelihood. Additional data on biophysical characteristics were also successfully. Despite the poor condition of some roads, the field data collection team could survey all required locations. The figure and table below also present the locations where household surveys and biophysical assessments in Sebeya Catchment were conducted. The locations of FGDs and KIIs are not shown on the map.

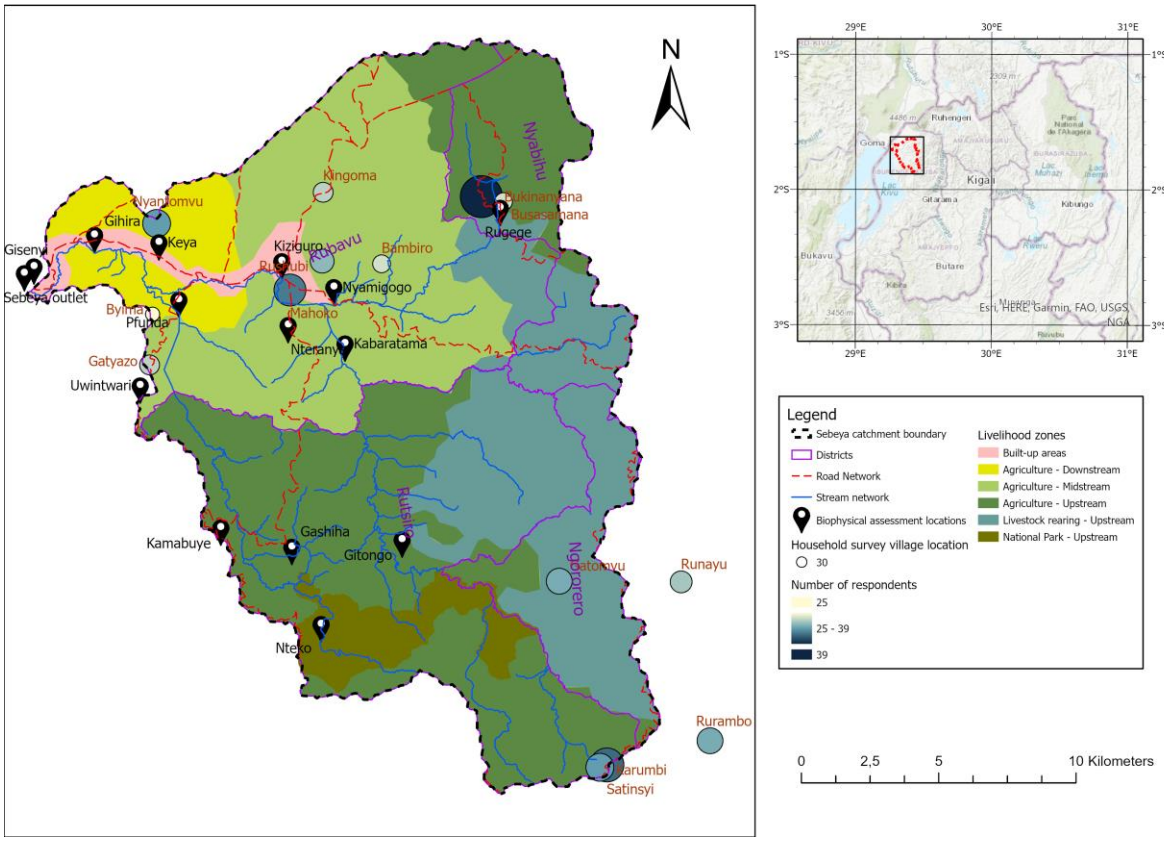

Figure 3. Locations of areas where household surveys (blue dots) and biophysical assessments (black pinpoints) in Sebeya Catchment conducted. The livelihoods zones are indicated on the base map. The livelihoods zones were developed based on the landuse map and hydrological subcatchment boundaries.

Two villages (Runayu and Rurambo), included in the household survey, are outside of the official catchment boundary of Sebeya, however, respondents indicated to be working in Sebeya catchment in the mining sector. Additionally, these two villages have been subject to government-supported interventions for landscape restoration in the past.

Assessment location	1.1 Site descrip-tion	1.2 Land cover	1.3 River-bank	2.1 Flooding areas characteris tics	2.2 Flooding areas water needs	2.3 Flooding problems	3 Water quality	4 Environ-mental issues	5 Agri-cultural practices	6 Land-slides
Gisenyi	X	X	x	X	X	X	X	X	X	X
Sebeya outlet	X	X	X	X	X	X	X	X	X	X
Nteranya	X	X						X	X	
Kiziguro	X	X	X	X	X	X		X		
Keya	X	X		X		X		X		
Nyamigogo	X	X	X	X		X		X	X	X
Sebeya Pfunda							X			
Pfunda	X	X	X	X	X	X	X	X	X	
Gihira	X	X	X	X		X		X	X	
Kamabuye	X	X						X	X	
Gashiha	X	X						X	X	
Kabaratama	X	X						X	X	
Uwintwari	X	X						X	X	
Gitongo	X	X	X					X	X	
Nteko	X	X	X					X		
Rugege	X		X							
Karambo							X			
Bihongora							X			
Sebeya upstream sub catchment							X			
Sebeya Karumbi							X			

Table 4. Bio-Physical assessment types per village/location

3 Biophysical baseline

3.1 Catchment description

Sebeya catchment is a level 2 sub-catchment, part of the larger Lake Kivu catchment (level 1) in North-West Rwanda (MINIRENA-RNRA, 2015). Sebeya Catchment is 363.4 km² in size and flows in a north-westerly direction from its origin in the mountains (2,660 meters above sea level (masl)), into Lake Kivu at an altitude of 1,470 masl, near Rubavu town. In the Sebeya catchment over 74% of the population live in rural areas, with the remaining 26% in urban areas. Sebeya combines valuable natural ecosystems, such as Gishwati National Park, with densely populated areas along the national road, to agricultural land and livestock grazing pastures. In general, the catchment has a dense network of watercourses, with steep slopes, draining predominantly mature, deeply weathered soils with high infiltration rates. The catchment is covered by four administrative Districts, namely Rubavu and Nyabihu in the north, and Rutsiro, and Ngororero in the south.

Sebeya catchment is drained by two main rivers, the Sebeya and the Pfunda. Sebeya upstream splits into Karambo and Bihongora tributaries. The river water is the source for marshland irrigation and water treatment plants: the Gihira Water Treatment Plant, Keya and Sebeya Hydropower Plants; and also, for the BRALIRWA brewery.

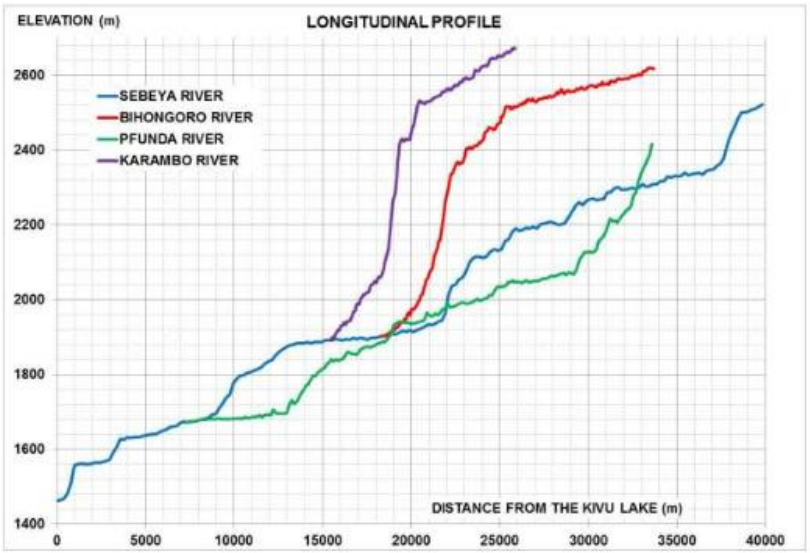

Figure 4. Longitudinal profile (height vs distance in m) for the rivers of the Sebeya catchment (W4GR, 2017)

The graph above shows the longitudinal profile for the Sebeya catchment indicating low slopes (1%) up to steep slopes (more than 35 %), resulting in high peaks in water flow towards the densely populated downstream sections of the Sebeya catchment during rainfall.

The catchment is dominated by a granite base aquifer with low storage capacity, and a highly permeable volcanic basalt layer in the north. On the contrary, the volcanic basalt layer in the northwest has excellent infiltration, storage, and transmission characteristics to the extent that permanent surface watercourses are almost absent. The soils in the Sebeya catchment are dominated by deeply weathered, well-drained, erodible, tropical soils and dark surface layer soils with a high infiltration capacity originating from volcanic materials (CMP Sebeya, 2018).

Gishwati Forest National Park is located in the south of Sebeya catchment and home to important biodiversity including world-wide recognized species such as the east chimpanzees, golden monkeys, mountain monkeys, and more than 130 species of birds including 14 that are endemic to the Albertine Rift. The Gishwati Natural Forest Reserve has faced many ecosystem threats over the last years. According to REMA (2015), since 1980s, forest clearing for large scale cattle ranching projects, pine plantation, cropland and settlement resulted in the loss of a big part of the forest (93% in 30 years). Efforts have been made to extent the area of the Gishwati Forest reserve and in 2015 a law was passed to have a National Park, the Gishwati-Mukura National Park, contributing to protection and the tourism industry of Rwanda. In 2020 The Gishwati-Mukura National Park became part of the World Network of Biosphere Reserves. The park has been named a "biosphere reserve" by UNESCO providing support to the ex-situ conservation of indigenous species.

3.2 Land cover/land use in Sebeya catchment

Land cover in Sebeya catchment has been analysed in ArcGIS to create a map of the current land cover in the catchment. The land cover map of the W4GR project (MoE, 2018) was compared to satellite imagery and the land cover map was then updated with the newly acquired information representing the current land cover in the catchment better. Furthermore, two other classes: observed riverbank trees and landslides were added. Landslides were visible as bare land on the map. Note therefore, only relatively recent landslides are visible on the landcover map. The area and relative proportion of each land cover/ land use class are presented in Figure 5 and Table 5**Fout! Verwijzingsbron niet gevonden.**.

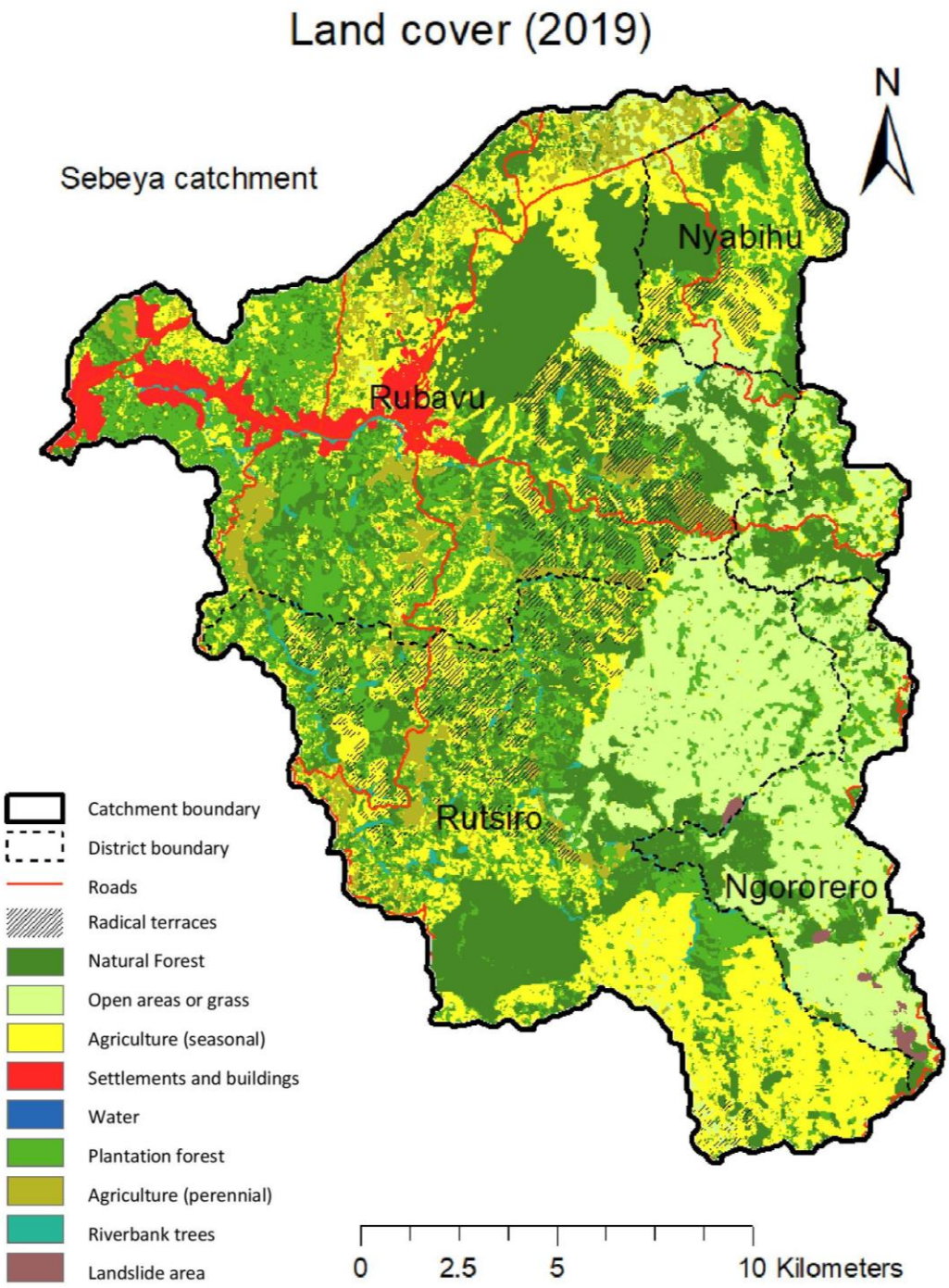

Figure 5 Land cover / land use in Sebeya catchment (2019). The map was developed by updating and refining the land cover map from the W4GR project (CMP Sebeya, 2018). The landcover class 'settlements and buidings' does not include the community homesteads, only the grouped/urban areas. The landcover class 'river bank trees' consist of small areas located in the riparian area of Sebeya river, they are only sparsely visible on the map.

Landslides are dominantly found in the south-eastern part of the catchment. In this area one of the main activities is mining (from the Household survey: villages Runayu and Rurambo). Unsustainable mining practices lead to a higher risk of soil erosion and likely explains the occurrence of landslides in the area. The land in Sebeya catchment is intensively used for agriculture (47.8% sum grasslands/agriculture), showing the pressure

of population growth. The previous land cover map consisted for 1% of settlement and buildings area (W4GR, 2018), in the current landcover map this is 2.9%. This increase is due to a slight increase in urban areas, but mostly due to a more detailed mapping of urban areas in the 2019 landcover map. The urban areas have been updated through visual analysis of satellite imagery.

Table 5 Land cover in ha and % per landcover class in Sebeya catchment in 2019

Land cover class	Area (ha)	Percentage
Natural Forest	9306	25.7%
Plantation forest	8141	22.5%
Open areas or grass	6512	18.0%
Agriculture (seasonal)	9009	24.8%
Agriculture (perennial)	1810	5.0%
Riverbank trees	350	1.0%
Landslide	86	0.2%
Towns and major urban areas	1037	2.9%
Surface water	1	0.0%
Total	**36252**	**100 %**

From the seasonal and perennial agricultural lands, a part was converted to terraced agricultural lands. The area (ha) with radical terraces have been mapped based on google earth imagery. Radical terraces (or bench terraces) are constructed on terrain with steeper slopes compared to progressive terraces. The terraced areas were mapped that consist of a terrace width of less than 10 m. The distance between the risers of the radical terraces was in general ~5 m wide. The analysis showed that there is 2607 ha of radical terraces in Sebeya catchment, equivalent to 7% of the Sebeya catchment.

3.3 Sebeya catchment water characteristics

3.3.1 Water quality

For decades it has become clear how progressing climate change, intense land use and land use practices may impact the East African rift valley systems (Kimbadi et al., 1999; Langenberg et al., 2008). Thorough water quality assessments are still scarce in the Sebeya catchment but deriving from the rural population density and current land use practices in comparison to other less populated and developed catchments in the rift region where water quality degradation is an issue, it is likely that also for the Sebeya catchment water quality degradation is as well an issue.
Here below we reflect on several key studies and findings that have become available recently as well as our field measurements carried out during this baseline study and also water quality data from the Gihira Water treatment plant that draw water from the Sebeya river.

Due to the poor availability of Water quality data (insufficient temporal and spatial coverage and often with uncertain quality), we limited our baseline assessment to those water quality parameters that have been reported earlier with more certainty by e.g. RWFA (2019), W4GR (2016) and Uwacu, R.A., and Akintande (2019).

In 2016, concerns were raised about Sebeya's river water quality status in terms of elevated levels of E. Coli, coliform bacteria and other pathogens from untreated sewage, high organic loads, high biological and chemical oxygen demand (respectively BOD and

COD), low dissolved oxygen (DO) concentrations, and very high sediment loads and turbidity (W4GR, 2016).

From a countrywide study commissioned by the RWFA (2019) a first comprehensive overview was generated covering 16 important water quality variables BOD, DO, Potential in Hydrogen (pH), Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Turbidity, Chloride (Cl-), Sulphate (SO42-), Nitrate (NO3-), Total nitrogen (TN), Total Phosphorus (TP), Total Dissolved Inorganic Nitrogen (DIN), Total Dissolved Inorganic Phosphorous (DIP), Faecal coliform (F.C) and Escherichia coli (E.coli). The study revealed that many water quality parameters (TDS, DIN, DIP, EC, pH, NO3, TN, CL-, $SO4^{2-}$) were generally within the acceptable range of the Rwandan and East African water standards (FDEAS, 2012, 2018; RS, 2017).

Furthermore, and more relevant for this baseline study, for monitoring locations up- and downstream the Sebeya (respectively Mushabike and Nyundo station) it showed that:

1) values for DO, pH, EC, TDS did not show large fluctuations across the dry and wet season, indicating relatively good water quality as compared to other catchments in Rwanda

2) BOD and concentrations of plant nutrients, especially the nitrogen compounds, tend to increase during the dry season by sewage discharge, animal waste and industrial effluents discharge (order of magnitude of ca. 2), still within FDEAS standards (2019) and that

3) values and concentrations for other parameters F.C., E. coli, TSS and Turbidity were considerably higher during the rainy season, generally higher downstream and often out of the acceptable range for Natural (untreated) potable water (according to FDEAS standards).

Key variables and drivers

For Sebeya the main concerns in terms of surface water quality variables F.C., E. coli, BOD, TSS and Turbidity seem strongly related to the sedimentation and siltation as well as microbiological contamination. In the available studies these variables seem often grouped meaning their dynamics seem to be interrelated.
Our findings corroborate with the work of Uwacu, R.A., and Akintande (2019) that indicated that Sebeya's water pollution is mostly associated to land use type, the area with human settlements and forestry and that:

- Settlements and land use areas have generally poor waste management that easily result in direct discharge (or through runoff and ground water) of sewage into the river system (by poor WASH systems and practices) and shown at times to lead to critical microbiological contamination;
- Mining and deforestation activities directly lead to high erosion rates and consequently high turbidity, TSS and sedimentation of the Sebeya River and its tributaries. And that
- Land use areas such as cropland and tea plantations may also contribute significantly to the above seemingly grouped water quality parameters, causing at times high water pollution from the drainage water of the plantations. Tea drainage is regularly practised in the Sebeya catchment (Kambwiri et al., 2014).

Turbidity, TSS and TDS

One of the key variables used as proxy for erosion, land use as well as surface runoff and therefore (especially in WASH-poor urbanised areas) also indicative for biological contamination is turbidity. This is somewhat supported by the strong links between turbidity with TSS rather than TDS. TSS was not captured during this study, however RWFA (2019) showed that for Sebeya even during dry season when TSS concentrations are lower due to less runoff, the locations Musabike and Nyundo mostly do not comply with Rwanda standard board of < 30 mg/l. During this study and with support of the RWB monitoring team a field visit was carried out from the 24th to 29th August 2020 to help collecting current basic water quality data. Here below a table with the results from the field visit and the monitored sites: Bihongora, Karambo, Pfunda, Karumbi Sebeya Gihira and Sebeya upstream. as were set as being representative for the catchment sub regions.

Table 7. **Physico-chemical parameters** (Dissolved oxygen-DO, Temperature, Conductivity-EC, and turbidity, Total dissolved Solids-TDS, Total Suspended Solid-TSS, Dissolved Inorganic Nitrogen-DIN, Nitrate, Total Nitrogen-TN, Dissolved Inorganic Phosphorus-DIP, Total Phosphorus-TP, Biological Oxygen demand-BOD and colonies E. coli). Compilation from different studies in comparison with this baseline field study and benchmarked against the FDEAS (FDEAS 12:2018) and the Rwanda Standard board RSB (2019): a] from Rwanda Water and Forestry Authority (2019) and b] from field measurements by RWB using SEBA hydrometry water quality multimeter probe MPS-D 8. The b Site locations shown on Figure 6. Orange shaded cells indicate respectively above standards.

	Variable	DO		Temperature		pH		Turbidity		EC		TDS		TSS	
	unit of Measure	**%**		**°C**				**NTU**		**uS/cm**		**mg/l**		**mg/l**	
	Season (short)	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**
Study	Location														
a	Musabike	97,2	100	na	na	7	7	1865	1390	65	67	35	35	854	605
a	Nyundo station	95,2	100	na	na	7,4	7,5	2015	1080	72	76	39	40	1017	480
a	Lake, Gisenyi beach	111,4	119,6	na	na	9,2	9,1	2,3	2,6	973	985	484	475	1	1
b	Sebeya outlet	na	91	na	19,9	na	7,5	na	1118	na	106	na	na	na	na
b	Sebeya +pfunda	na	75	na	17,8	na	7,2	na	1035	na	94	na	na	na	na
b	Pfunda	na	112	na	21,3	na	6,9	na	552	na	70	na	na	na	na
b	Karambo	na	93	na	17,3	na	7,9	na	64	na	231	na	na	na	na
b	Bihongora	na	96	na	16,1	na	7,3	na	61	na	1000	na	na	na	na
b	Upstream sub catchment	na	93	na	16,2	na	6,7	na	1018	na	25	na	na	na	na
b	Sebeya Karumbi	na	119	na	18,0	na	5,5	na	431	na	17	na	na	na	na
Standard	*FDEAS*	*na*	*na*	*na*	*na*	*5.5-9.5*	*5.5-9.5*	*25*	*25*	*2500*	*2500*	*1500*	*1500*	*na*	*na*
Standard	*RSB*	*53*	*53*	*25*	*25*	*6.5-8.5*	*6.5-8.5*	*5*	*5*	*<1000*	*<1000*	*na*	*na*	*<30*	*<30*
	Variable	**DIN**		**Nitrate**		**TN**		**DIP**		**TP**		**BOD**		**E.coli**	
	unit of Measure	**mg/l**		**mg/l**		**mg/l**		**mg/l**		**mg/l**		**mg/l**		**Cfu/100ml**	
	Season (short)	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**
Study	Location														
a	Musabike	3,4	5,5	1,9	2	5,5	8,9	0,4	0,5	1,1	1,2	8,9	8,9	50	8000
a	Nyundo station	4,7	5,7	2,5	2,6	4,8	8,7	0,4	0,4	1,3	1,2	7,5	11,3	200	600
a	Gisenyi beach	2,6	3	1,6	1,8	3,6	8	0,8	1	1,1	1,2	5,4	4,4	7	10000
Standard	*FDEAS*	*30*	*30*	*na*	*na*	*na*	*na*	*5*	*5*	*na*	*na*	*na*	*na*	*0*	*0*
Standard	*RSB*	*na*	*na*	*na*	*na*	*<3*	*<3*	*na*	*na*	*<5*	*<5*	*<30*	*<30*	*4*	*4*

These data confirm the high values of Turbidity especially at Sebeya Tam Tam, Sebeya Pfunda site, Sebeya upstream sub catchment. RWB noticed here that Pfunda subcatchment used to have water with less turbid elements in the past but current results indicate higher turbidity as well in this sub catchment. The River waters in the sub catchments of Karambo and Bihongora seem less turbid, especially during dry season.

Visual observation indicated that the high turbidity values (>500 NTU) upstream seemed linked to intense mining activities in Rutsiro, Tubindi. Wet season river water turbidity values are normally higher compared to dry seasons due to erosion, deforestation, poor road construction and landslides of fragile hills. However, as found earlier (Uwacu, R.A., and Akintande, 2019), and in line with our observations, regardless the weather season, very high turbidity value can be attributed to upstream mining activities, reduced river dilution and low discharge.

It was also noted that next to soil also waste water and other wastes from these areas may end up in the river.

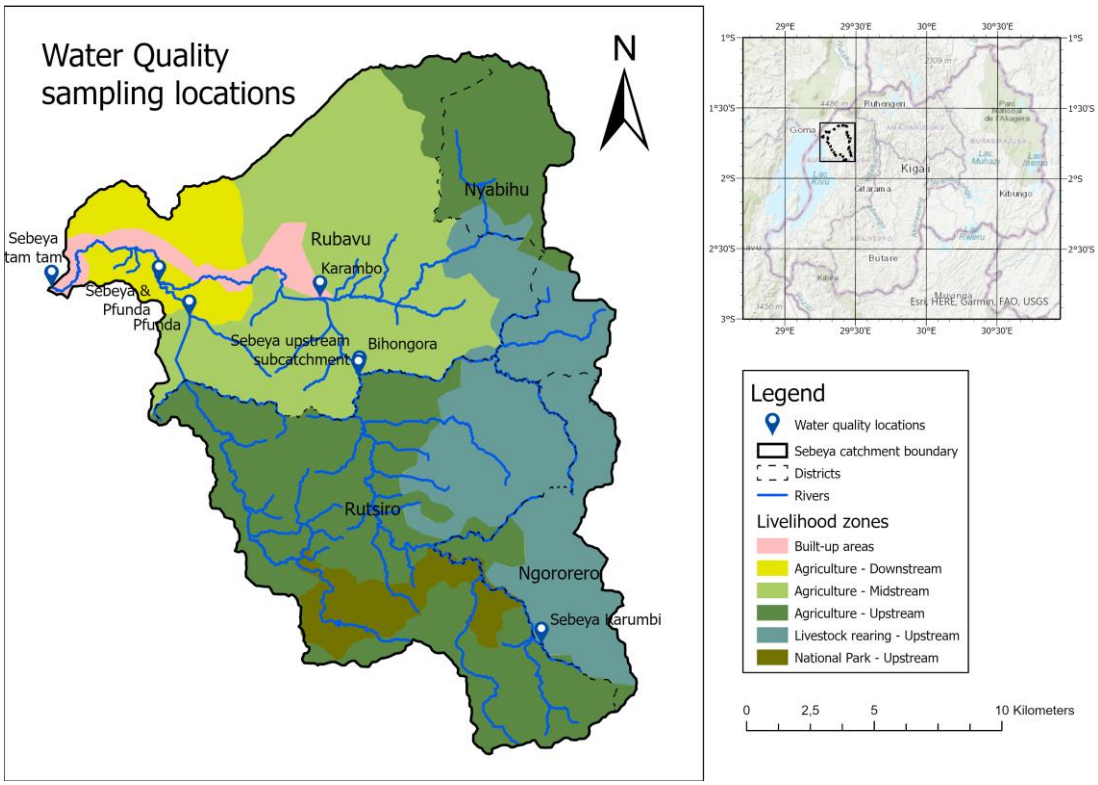

Figure 6. Map with the water quality sampling locations

Figure 7. Three photos of the Sebeya River: Left) Sebeya at its source. Middle) Sebeya in built up area, on volcanic riverbed. Right) Pfunda river.

Similarly, values and concentrations of turbidity related variables (BOD, and TSS and microbiological contamination) seem as well related to the run–off and siltation processes. Their values are often higher during the dry season. Nevertheless, the actual loads and sediment transport from in particular unmanaged and old mines sites, runoff from agriculture soil coupled with landslides are reportedly higher during the rainy season.
Noted during field survey in Pfunda catchment was that despite the improved land use, mostly with tea in the nearby valley and sugar canes on some slopes, the river water had not improved and was still very turbid indicating other pressures explained above higher in the catchment.
On overall, water quality in Sebeya Catchment is marked by turbidity differences; low values at the source of Sebeya River and high values downstream. The pictures above taken during the same period at source and downstream highlight those differences.

The Sebeya River system plays an important role in hydropower production, water provision to the catchment's inhabitants, plants and animals and provides the most suitable soil for agriculture as well as allows sand mining downstream for construction. It is important to understand the processes behind the river pollution and develop measures for its protection.
As noted, the high turbidity of the Sebeya river is of particular importance to be controlled since it is governing the river's natural functioning, controlling biodiversity in and around the river system, its productivity and its natural self-purification ability and also impacts downstream waters and adjacent biotopes up to the shore zones of the lake Kivu system.

Despite its importance, turbidity is not structurally and regularly monitored throughout the Sebeya sub catchments and districts. Reported and scattered data shows turbidity to be highly dynamic in time and place and can range from almost 10 to more than 3000 NTU in a short period of time (Birdlife 2018; RWFA, 2019).
With the courtesy of the experts of the Gihira water treatment plant we have plotted and analysed the daily water quality data on turbidity of the incoming raw water, presented here below in two graphs.

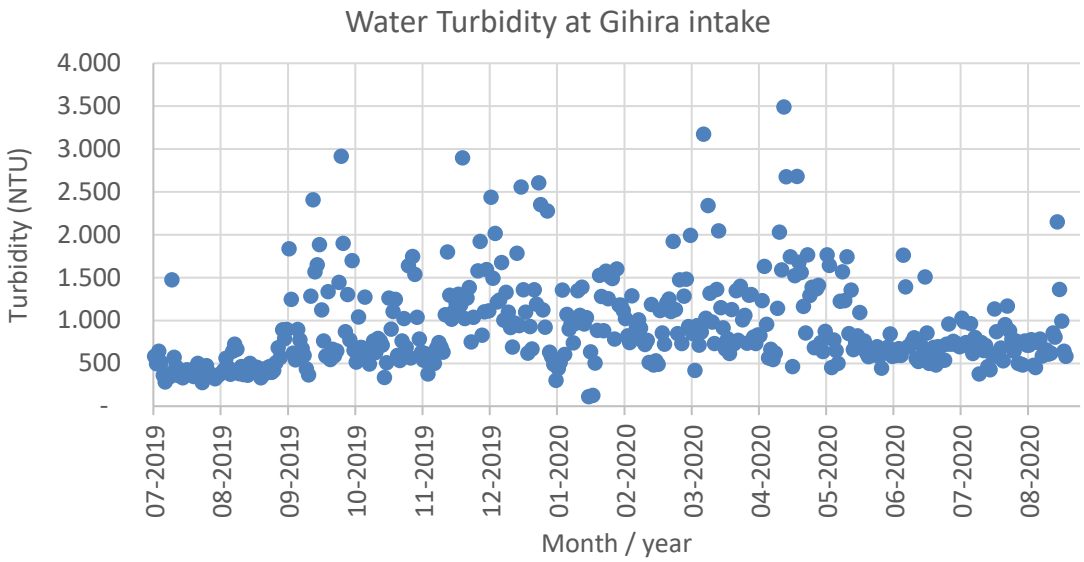

Figure 8. Turbidity (NTU) of the incoming raw Sebeya river water from July 2019 to August 2020.

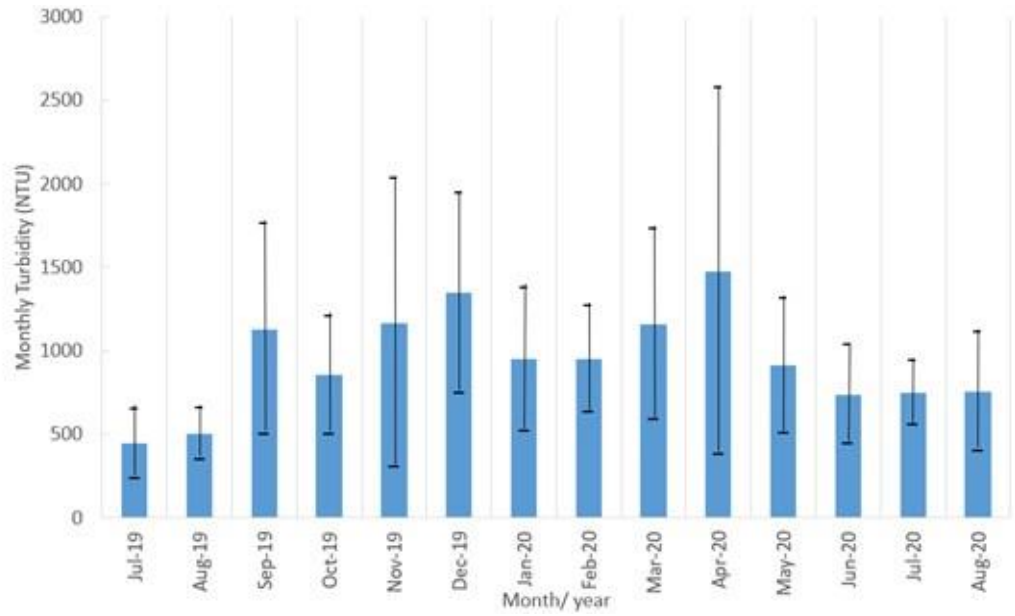

Figure 9. Monthly averaged Turbidity (NTU) of the incoming raw Sebeya river water at Gihira intake from July 2019 to August 2020. Indicated are averages (blue bars) and standard deviations.

These results show that turbidity values become more variable reaching higher values during both the rainy seasons per year (up to 2500 NTU monthly average with daily extremes up to 3500 NTU). High-turbidity water requires additional treatment, like us of flocculants to reach values for further treatment.

Turbidity values are lower during the dry seasons in particular during July and August but always higher than the limit 25NTU for acceptable standard used for potable water (FDEAS 12:2018).

3.3.2 Sebeya River water quantity

The Hydrologic data on the Sebeya River and tributaries is available through the Water Portal[2] and from literature. The Water Portal provides real-time and historical datasets. The historic datasets provide useful information on the general river characteristics, but lack accurate information on peak flows and floods, in which a daily time step is too large for accurate monitoring. A telemetric station at Nyundo is operating since 2017 providing discharge data with a 15-minute interval, its data is useful for flood characteristics analysis and calibrating hydrological models.

The Sebeya River enters Lake Kivu at Rubavu, east of Gisenyi town. Average outflow (mean daily discharge) at the outlet station is reported as 2.76 m3/s by BRL (2020) and 5.3 m3/s by PROTOS (2006) and therefore annual average discharge is in the range of 1,4 million m3/year and 2,8 million m3/year. Analysis of the manually collected data shows a minimum discharge of 0.83 m3/s (date: 11/08/1950) and a maximum of 3.5 m3/s (date: 05/05/1951). As this is manually collected data with only 23 registered measurements since 1950, it is likely that this dataset may not be sufficiently representative missing short-term peak flows due to sampling frequency.

The historical dataset of Nyundo station (located 12 km upstream of the Sebeya outlet, south of Mahoko town (dataset with over 7000 daily measurements since 1974) shows an average flow of 3.6 m3/s, a median flow of 1.7 m3/s and a max of 100 m3/s (date: 08/08/2012). The 10% low flow average is 0.5 m3/s. the 10% peak flow average is 8.3 m3/s. There is a large gap in the data in the years 1988 and 1995. After 1995, baseflow in the river is higher due to higher river levels measured during low flows, compared to the years before. This could be caused by a rise in the riverbed (for more information see p.65 of TR26 - W4GR 2017). Also, more peak flows have been registered after 1995 (Figure 10).

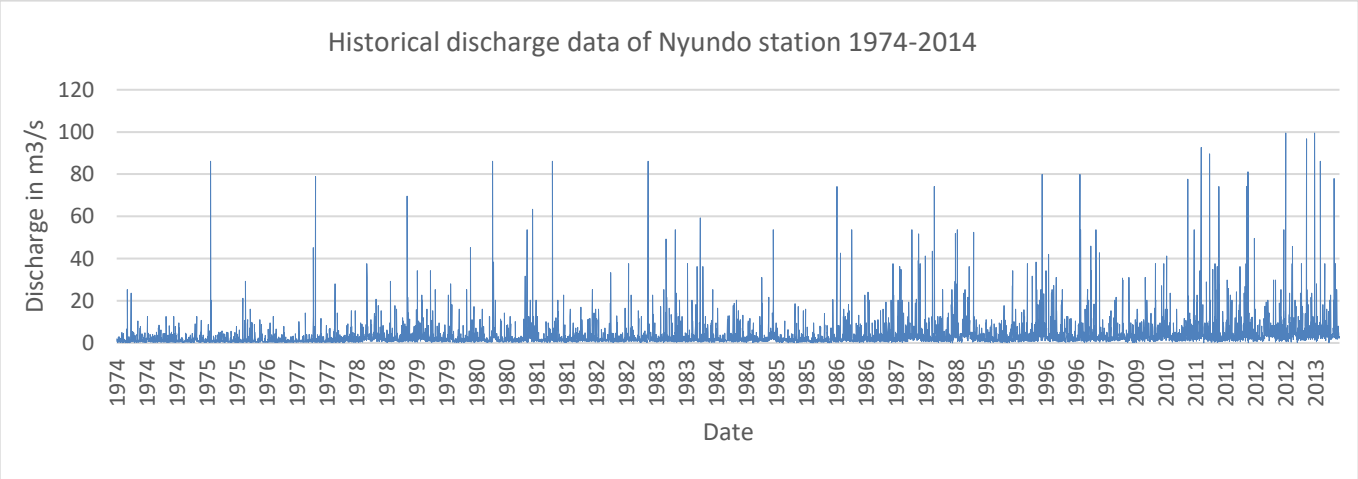

Figure 10. Historical discharge data of Nyundo station 1974-2014. Discharge was recorded daily. There is a large gap in the data in the years 1988 and 1995.

The telemetry dataset on river water level of Nyundo station (beginning 2017) provides a good insight in the hydrological flood characteristics of the river. The peak discharges at Nyundo station show a very short time to peak and a very short lag time (time before river level is back to normal). The figure below shows an example of a sharp rise in the river level. In this event, the river increased from 0,8 m height to 1,6 m in just 1,5 hours. These river characteristics indicate that supporting measures that promote dispersed water

[2] https://waterportal.rwb.rw/

storage e.g., rainwater harvesting can play significant roles to not only dampen or attenuate the peak discharges but also reduce chances of flooding.

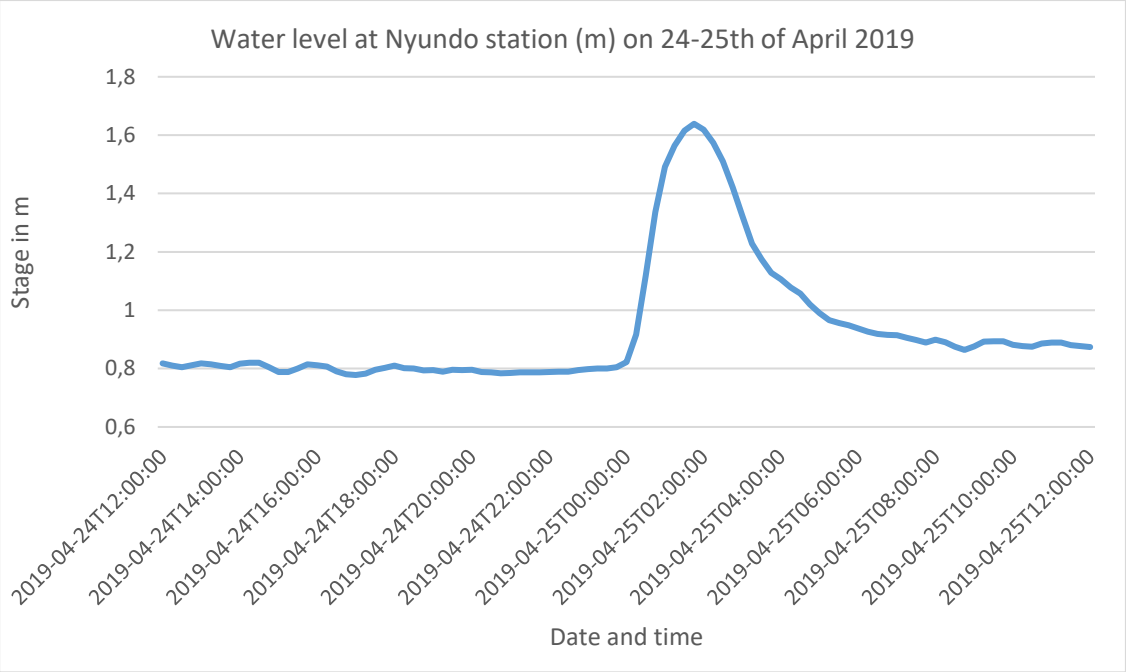

Figure 11. Example of a peak flow of April 24th 2019 measured by the Nyundo Telemetry hydrological station (m). Data shows a very short time to peak and a very short lag time.

Table 6 presents the results obtained from hydrological modelling by the W4GR project for Sebeya River at Nyundo station. The confidence interval resulting from the application of minimum and maximum hypothesis for runoff computation is indicated in square bracket, in order to illustrate possible variations of peak flood for a given return period. The table shows for example that it is likely that once in every 10 years, there is a peak flow in the order of 34 m^3/s (HEC-HMS) to 47 m^3/s (PLUTON). These simulated values are low compared to the historical dataset of Nyundo. In the historical dataset of Nyundo of 1974 – 2014, there were 84 discharge measurement above 33 m^3/s, this is almost twice a year when evenly distributed. The difference between simulations (with a model calibrated on recently measured data) and measured historical discharge data could be caused by various things. For example, the use of a different Q-h relation (resulting in different Q with same h values, formula from early years compared to recent years) to calculate discharge or a change in measurement equipment over the years. This could not be verified with the RWB.

Table 6. Main results from hydrological analysis carried out on Sebeya catchment – Peak discharges (m^3/s) at Nyundo station for various return period. From W4GR, 2020a. Note: the confidence interval resulting from the application of minimum and maximum hypothesis for runoff computation is indicated in square bracket, in order to illustrate possible variations of peak flood for a given return period.

Sebeya river at Nyundo station	T = 2 years	T = 10 years	T = 50 years	T = 100 years	T = 1000 years
PLUTON	31 [16.5 – 49]	47 [24 – 74]	65 [31 – 101]	75 [38 – 121]	105 [53 – 169]
HEC-HMS	16 [14 – 19]	34 [29 – 38]	71 [63 – 84]	83 [73 - 98]	141 [124 - 164]

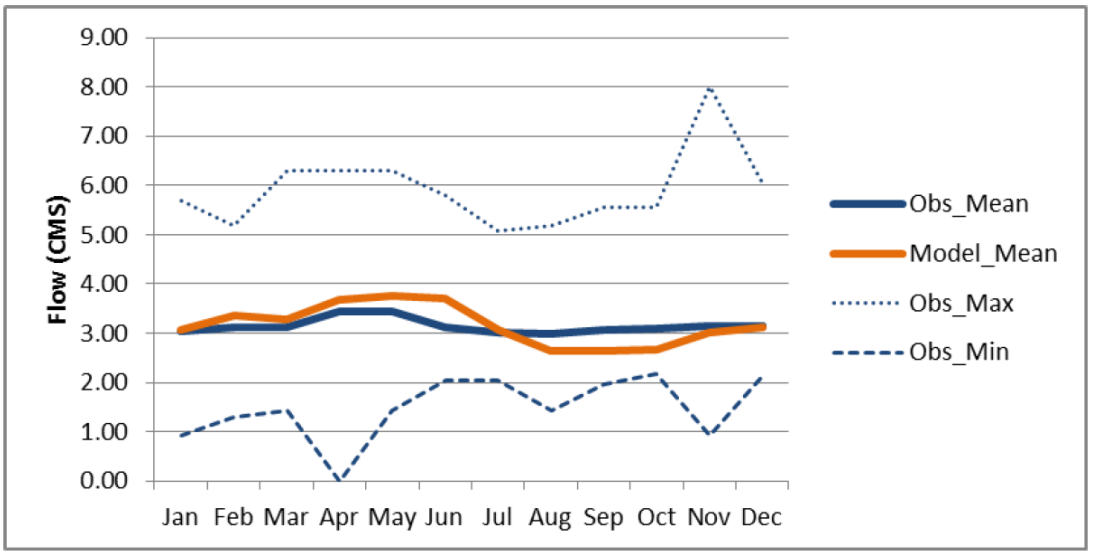

Figure 12 Observed and simulated mean, min and max flow for station Nyundo (Future Water, 2017). Observed values over the years 1974 - 2014. Simulated by WEAP model.

Adequate and quantified knowledge of current water resources utilisation by sector is limited due to unregulated water use and, limited information on individual water users. For the Water balance and allocation modelling report of Future Water (2017), water use rates were determined by combined different sources, expert knowledge and a water users survey (2016). The following water use was determined based on literature:

- Domestic use: 80 l/cap/d for rural areas and 100 l/cap/d for urban areas.
- Industrial use:
  - Mining: 100 l/cap/d
  - Coffee washing: 60 l/cap/d
  - Tea factories: 30 l/cap/d
  - Other: 30 l/cap/d
- Livestock: 125 l/animal/day (excluding chickens)

Section 4.5 in this report describes the estimated water use by households in Sebeya catchment, which, for rural areas is much lower as the figures above. The actual water use rates will make great differences in water gap calculations. Currently the higher water use is used in water demand calculations. It is recommended to research the domestic water demand in more detail.

Recorded water users from the survey in the catchment included: hydropower plants, water treatment plants for domestic and commercial use (including the Bralirwa brewery as large user), mineral extraction sites, fish farms, a tea factory, and other industries (CMP Sebeya, 2018). Water from Sebeya and Pfunda River is actually the only treated water that is supplied to Rubavu Residents and even beyond Rwanda (Goma town in DRC). It is also the water source for BRALIRWA/Heineken breweries in Rubavu.

A water balance was developed for Sebeya catchment based on WEAP model simulations (FutureWater, 2017). According to the simulation for 2017, there was no water shortage in 2017. In the WEAP analysis, the land cover map of Rwanda in 2015 was used to create a baseline value for the surface runoff component in the water balance. This is 0.72 MCM/y. From the WEAP analysis for Sebeya Catchment the most important conclusions for the future were that:

- Water demand is expected to increase substantially in the future: from currently 18 MCM/y to 249 MCM/y in 2050. WEAP simulations show that water demand by 2030 will be 4 to 10 times higher compared to 2017. Since the future has quite some uncertainty in climate, economic growth and population a low and a high-impact projection have been run as well. Results show that water demand by 2030 will be 4 to 10 times higher (FutureWater, 2017)
- Therefore, water shortage (unmet demand) is expected to increase substantially. Without proper actions taken, it is expected that 15% of the demand by 2030 cannot be delivered.

Following the WEAP modelling different intervention scenarios were evaluated. Annex 9 of the Sebeya Catchment Management Plan (2018) concludes the following on the water demand and allocation modelling:

- Growing water demand can be fully and easily met up to 2024;
- Only implementation 'Planning by Catchment Boundaries' alternative avoids unmet water demand by 2050 and is therefore the preferred planning scenario. Its implementation requires a strong focus on sustainable land management, combined with enhanced water use efficiency and restricted development of (new) irrigation schemes;
- The programme of measures, including IWRM packages, needs to implement the strategic directions of the preferred alternative, i.e.:
    - Limit development of new irrigation;
    - Enhance water use efficiency by irrigation (30%), domestic (20%), and industrial (20%) users by 2050, or sooner;
    - Enhance catchment rehabilitation and soil moisture management, e.g. by agroforestry, terracing, live hedges, etc.

Recommendations on water quality

The field team observed that mineral ores including all sorts of wastewater from the mining site are still being washed in Sebeya and its tributaries. This increases the influx of sediments from mining activities at the source of Sebeya in Muhanda Sector of Ngororero District and Nyabirasi Sector of Rutsiro District, but also downstream in Kanama and Nyundo Sector of Rubavu District. Also agricultural activities seem to contribute to the solid loads, although mining activities are the most likely major contributors. Therefore, in addition to landscape restoration measures, the enforcement of mining regulation and law by local authorities and mining companies is recommendable.

Key water quality variables should be monitored regularly and in a standardised manner and year-round to determine the status and trends in water quality to help in making informed adaptive management decisions and action plans.
In particular, the indicator Turbidity as proxy for erosion and sedimentation processes requires more attention. Values are too high. Currently, due to poor coverage of turbidity monitoring in time and space, the respective impact of the different pressures determining turbidity are not known.
Investigative research by expert teams with calibrated field kits regularly validated by laboratory analyses and international protocols will give more insight on the most important factors that cause high turbidity and are manageable. Sediment fingerprinting Work carried out by Birdlife (2018) furthermore may unravel specifics of sediment sources and sensitive regions. Only, when the underlying causal relations between drivers, pressures and turbidity impact are known the investigative research can move to

operational monitoring of standardised turbidity/ sediment methodology with proper coverage in time and space, on fixed locations for management purposes.
It is recommended that an effective waste management, of both liquid and solid waste, be implemented in the Sebeya catchment area to prevent water pollution. For urban areas an improved wastewater treatment technology and management seems feasible, whereas for rural areas the most appropriate approach could be through on-site sanitation systems coupled with education, sensitization and behaviour change campaigns on improved sanitation practices.

3.4 Riverbanks

3.4.1 Stable riverbanks and Buffer zones

Stability of riverbanks is dependent on the soil/bedrock type, vegetation cover and human alterations. For example, gabion structures can be used to protect the riverbanks from soil erosion and scour, keeping the river in place. A natural vegetation cover (trees, shrubs, etc) improves the stability of the bank. The vegetation slows down surface runoff, before it enters the river itself. The root system of the trees and shrubs increase the strength of the bank.

The vegetated riverbank can help in improving the stability of riverbanks by increasing the shear strength of the soil, mitigating floods and enhancing water flow during times of drought. The areas of non-vegetated riverbank are less resilient to erosion, which can result in significant land loss as well as unstable river and stream banks. It can contribute to higher peak flows following intense rain events. Some human activities like mining, wood and timber collections are the practices that cause riverbanks to be non-vegetated (Figure 13).

Figure 13. Riverbank of Sebeya (source: Birdlife International, 2018)

Length and area of vegetated riverbanks

Estimations of the length of the riverbanks that are vegetated were made to get insight in the current situation regarding the stability of the riverbanks. The approach was to take a river feature and put a thin buffer around it, and then calculate the area within this buffer that is vegetated according to the land cover map. The Ministerial order no 007.16.01 of 15/07/2010 prescribed the width of land on shores of lakes and rivers transferred to public property (article 3) and determining a buffer zone of 10m for main rivers and 5m for small rivers/tributaries. The current landcover map has a class "riverbank trees" that was manually updated by creating new polygon features in areas where these were observed on google earth imagery. These were not identified by the original W4GR land cover map. With these new "riverbank trees" areas around the river channels, the total area of riverbanks that are vegetated could be estimated. Two different river representations were analysed for comparison. First a 10m buffer was put around the main river, showing only the larger tributaries (Figure 14). Secondly, another 10m buffer was put around a detailed stream network, which also covers the smaller tributaries of the catchment (Figure 15). Then the area within the buffers was compared to the land cover map to determine the part of the buffer that is covered with vegetation. Table 7 shows the vegetated and non-vegetated area of both the buffers. Table 7 presents the percentages of each vegetative land cover class covering the different buffers.

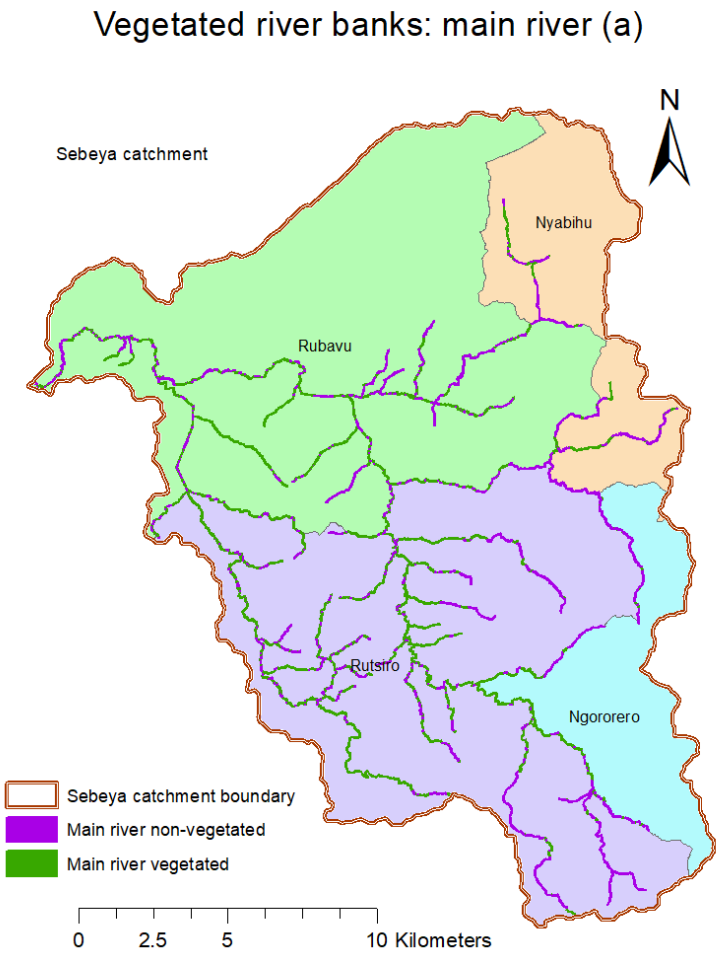

Figure 14. Vegetated riverbanks of the main river (a), based on a 10 meter buffer zone around the main river network.

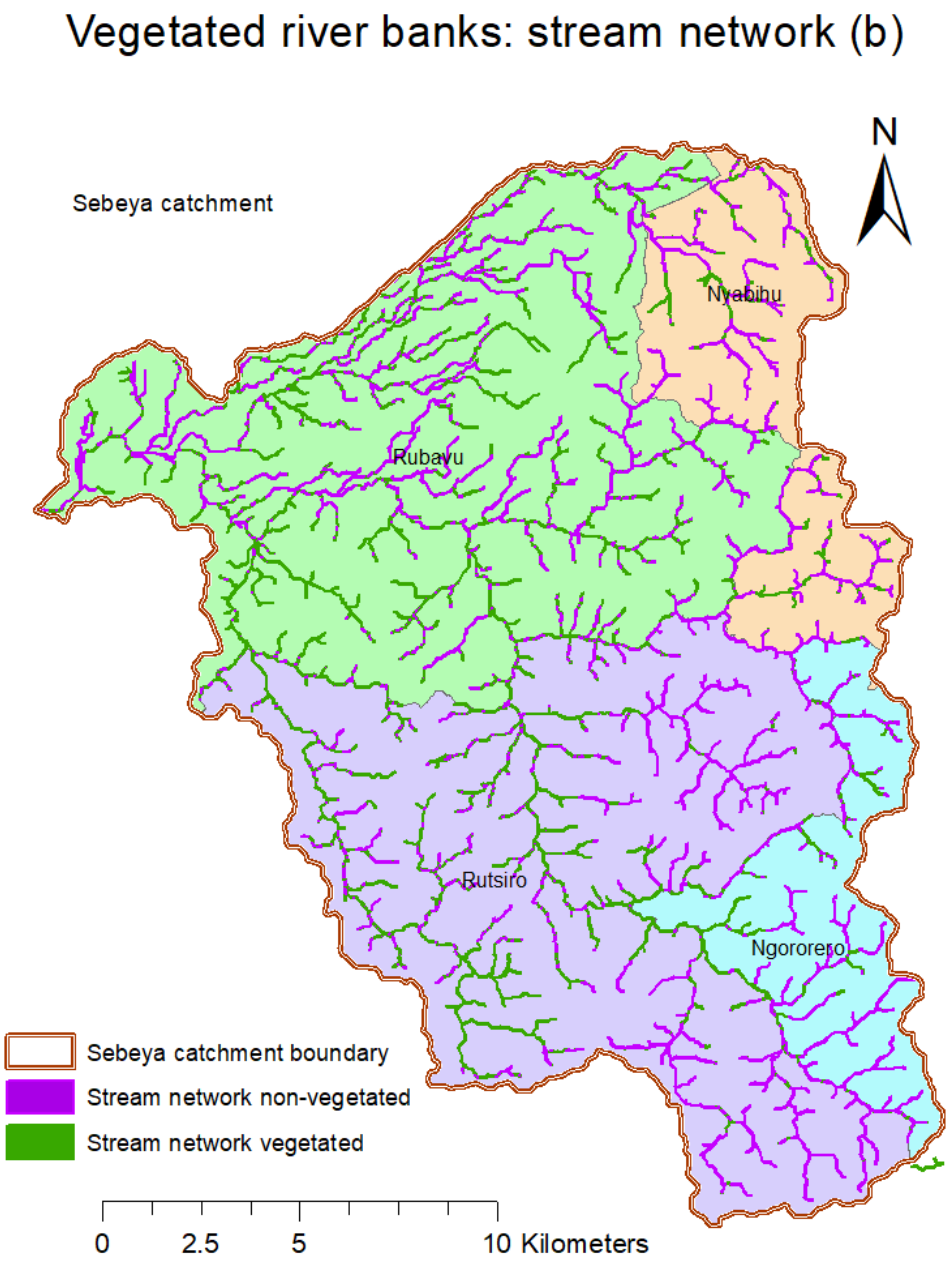

Figure 15. Vegetated riverbanks of the detailed stream network (b), taking into account the tributaries to the main river.

Table 7. Vegetated area of the different river network buffers, considering a 10 m buffer zone.

	Main river	Detailed stream network
Vegetated	275 ha (63%)	593 ha (52%)
Non-vegetated	162 ha (37%)	551 ha (48%)
Total area	437 ha	1144 ha

The main riverbanks have a vegetative cover of 63%, which is higher than the average vegetative cover of the whole catchment (54%). It shows that there are efforts to increase the vegetative cover of riverbanks. The detailed stream network, however, has a lower vegetative cover on its riverbanks (52%), which is very similar to the catchment average of 54%. Table 7 shows the areas covered per vegetative land cover class. The largest difference between the two buffers is in the class "riverbank trees", indicating that the main channels are covered for 17.3% with patches of trees next to the river, while this is only 5.1% for the detailed stream network. The total area of the detailed stream network buffer amounts to 1144 ha, almost three times the area of the buffer around the main Sebeya river (437 ha, Table 7). The relatively low vegetative coverage of the detailed stream network (52%) can be explained by the fact that it entails much smaller streams as well (but not smaller than 5m wide). The areas around these streams are used for grazing or seasonal agriculture (especially in the eastern part of the catchment) and they are often not protected by vegetation. They are very vulnerable to erosion, resulting in high sediment loads in the river channels downstream. Therefore, interventions should be focussed on the tributaries upstream (eastern part) in Sebeya catchment. Figure 14 & Figure 15 also show that especially tributaries in the upstream parts of the catchment are relatively poorly vegetated.

Table 8. Vegetative cover (ha and %) of riverbanks per (vegetative) land cover class with percentages of the total 10 meter buffer.

	Main river	Detailed stream network
Natural forest	91 ha (20.7%)	225 ha (19.6%)
Plantation forest	76 ha (17.4%)	210 ha (18.4%)
Perennial agriculture	33 ha (7.6%)	100 ha (8.8%)
Riverbank trees	76 ha (17.3%)	58 ha (5.1%)
Total vegetated	**275 ha (63.0%)**	**593 ha (51.8%)**

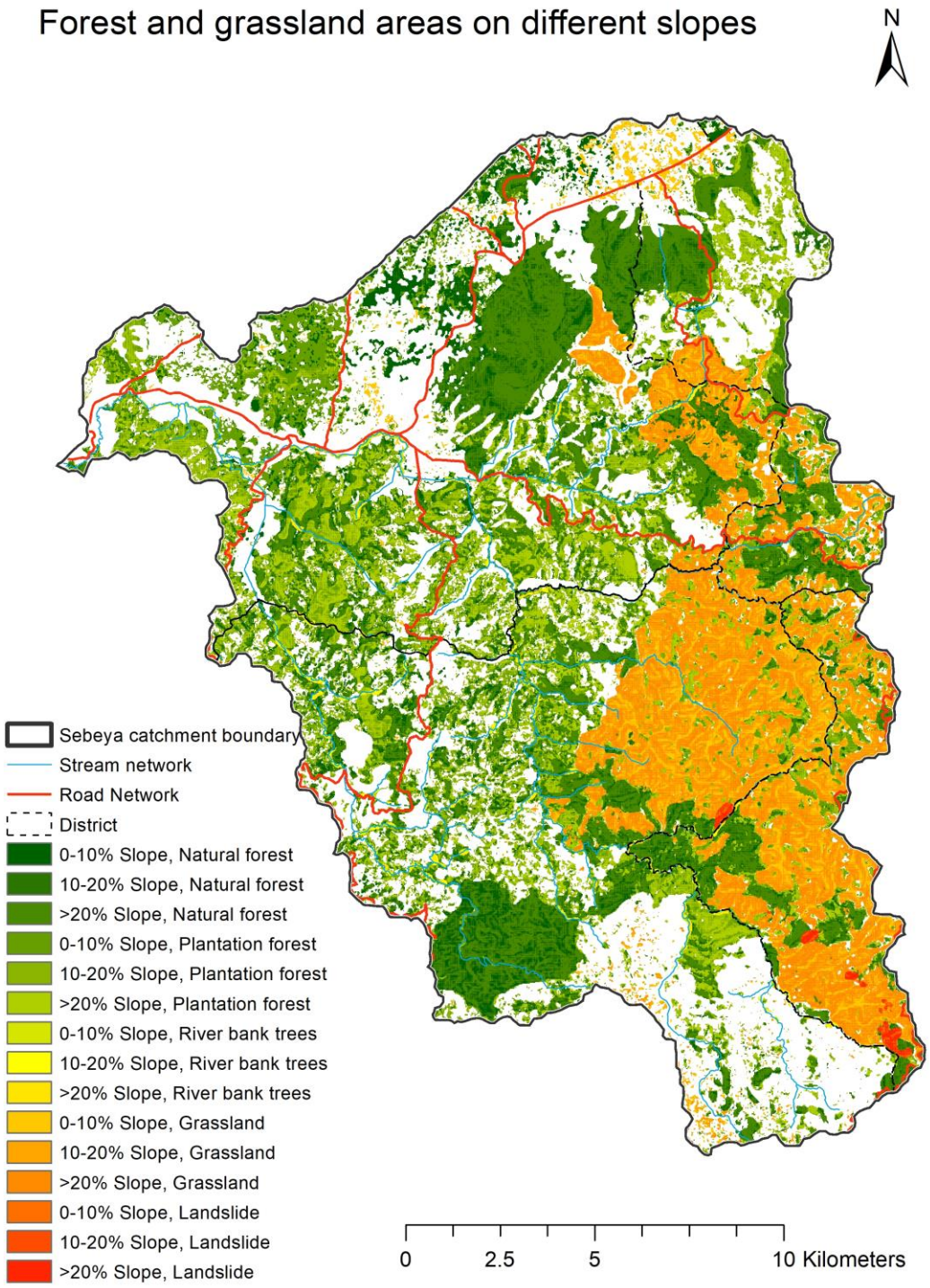

Figure 16 Forested areas on different slopes rates. Colours do not have a linear association with erosion risks, however the green areas have a lower erosion risk.

3.5 Soil erosion sensitivity

3.5.1 Land sensitivity to soil erosion

A low or lack of proper vegetation/forest cover in the steep sloping areas of the catchment likely results in a high risk of degradation and severe runoff/soil erosion. These non-vegetated steep sloping lands were found in areas of high altitude of the catchment and these areas are very prone to erosion or the development of gullies. These areas should be vegetated/forested or terraced (radical terraces) to boost erosion control. The steeper land, the more severe erosion. Erosion increases when there are no terraces or vegetation/trees to stabilize that land.
Soil erosion leads to a high sediment load in rivers and an increased landslide risk. Soil erosion is limited in vegetated areas. Especially on steep slopes dense forests are a significant countermeasure to soil erosion. The Ministry of Environment published a report on erosion control mapping in February 2020. The erosion risk map of the report shows only the potential risk of erosion in different areas, however this map does not neither show areas already protected against erosion nor indicate the location of erosion features as proof of risk. Ngororero district is ranked the second highest erosion risk district with 41,450 hectares under risk (61% of the district land) while the third is Rutsiro district with 35,110 hectares prone to erosion estimated to 53% of the district land.

To estimate the current area of Sebeya catchment that is under high risk of soil erosion, the land cover map of Sebeya catchment was compared to a slope map and a map of radical terraces.

The total catchment area of the landcover raster is 36252 ha of which 55% (19780 ha) is covered by either Natural forest (27%), Plantation forest (23%), Riverbank trees (1%) or Perennial agriculture (5%). These land cover types represent areas that are vegetated throughout the year and are therefore less vulnerable to erosion. If we look at the areas with their corresponding slope classes, we find the following results:

Table 9. All slope classes with their corresponding area (landcover class 'Urban areas' not included in total area).

	Slope class (percent rise)		
	1 (0-10%)	2 (10-20%)	3 (>20%)
Area (ha)	9721	13203	12505
% of total	27.4	37.3	35.3

35% of the catchment has slopes over 20%, the areas with steep slopes are located in the higher elevated, mountainous eastern part of the catchment.

The steep slopes are most vulnerable to soil erosion, but also the medium slopes should be vegetated to limit soil erosion. Table 10 shows the area of each land cover type for slope class 2 and 3. In this table, the 'settlements' and 'water' land cover types are not considered.

Table 10. Area of each landcover type for steep slopes (slope class 2 and 3).

		Slope class 2: 10-20% (ha)	Slope class 3: >20% (ha)
Forest, grass and landslide cover on slopes	Natural Forest	3307	4469
	Plantation forest	3119	2843
	Riverbank trees	115	93
	Open areas or grass	2905	2304
	Landslide	34	43
Intensive agriculture on slopes	Perennial	368	253
	Seasonal	3355	2500
Total (all)		**13203**	**12505**

There is high seasonal agricultural activity on medium slopes (2905 ha grassland and 3355 ha seasonal agriculture) and on steep slopes (2304 ha grassland and 25004 ha seasonal agriculture).
The following table shows all the area that is vegetated (LC types: Natural forest, Plantation forest, Riverbank trees, Perennial) and the area that is (temporarily) not vegetated (LC types: open areas, landslides, seasonal agriculture) on medium slopes and on steep slopes.

Table 11. Ha land Medium and steep slopes covered by vegetation.

		Forested	Non-forested	Total
Medium slope 10-20%	Area (ha)	6909	6294	13203
	% of catchment*	19.5	17.8	37.3
Steep slope >20%	Area (ha)	7658	4847	12505
	% of catchment*	21.6	13.7	35.3

*catchment area does not include the landcover classes 'settlements' and 'water' in these calculations.

17.8% (6294 ha) of the medium slopes in the catchment are currently not vegetated with Natural forest, Plantation forest, Riverbank trees or Perennial agriculture. For steep slopes this is 13.7% (4847 ha). For these non-vegetated slopes on medium slopes, 551 ha is located on radical terraces. For the steep slopes 369 ha of non-vegetated slopes is located on radical terraces, and therefore less sensitive to soil erosion. The land sensitivity to soil erosion is steep sloping land (>10%) that is in use for seasonal agriculture and not part of a radical terrace. Also, the landslide areas on sloping land are very sensitive to soil erosion. The area sensitive to soil erosion based on this analysis is therefore 5009 ha, or 14% of Sebeya catchment.
This value was cross checked with the Erosion Control Mapping Report 2020 (source: Ministry of Environment, see map in Appendix 6). In this study, the land was classified based in three different erosion risk categories: high, very high and extreme high erosion risk. The erosion risk maps show similarities and differences. Both show a scattered erosion risk pattern in the centre of the catchment. The erosion risk for grasslands is more homogeneous in this baseline study compared to the erosion in the Erosion Control Mapping study. In the analysis of MoE, there is 3934 ha under high/very high/extremely high erosion risk. This is lower than the 5009 ha in this baseline assessment.

The areas that are prone to soil erosion can be characterized by the steeper slopes in combination with unsustainable land management. A representation of these areas is presented in Figure 17 below. This map was created by assigning weight to the different land cover classes corresponding to different slope classes. In addition, a hashed layer was added showing the areas where radical terraces are already constructed to support

sustainable agriculture. In the W4GR Sebeya catchment plan (W4GR, 2018) an erosion risk map was also developed by implementing the RUSLE model. However, the RUSLE model does not account for the impact of grazing, missing out on some key risk areas. The map below shows the erosion risk for Sebeya catchment. Mostly upstream parts of the catchment are vulnerable to erosion. Radical terraces are always located on most of the steep slopes in the central part of the catchment (progressive terraces can be found on less sloping terrain), lowering erosion in these areas. Especially the eastern and upstream part of the catchment is sensitive to erosion due to unsustainable seasonal agriculture and grazing in combination with steep slopes. When there is a well-developed grassland with well -developed grass root system and a low grazing pressure, grazing activities do not lead to a high erosion risk. Only when grazing pressure is too high or livestock has preferred walking paths (like an entrance to a meadow or at preferred watering places) erosion can take place.

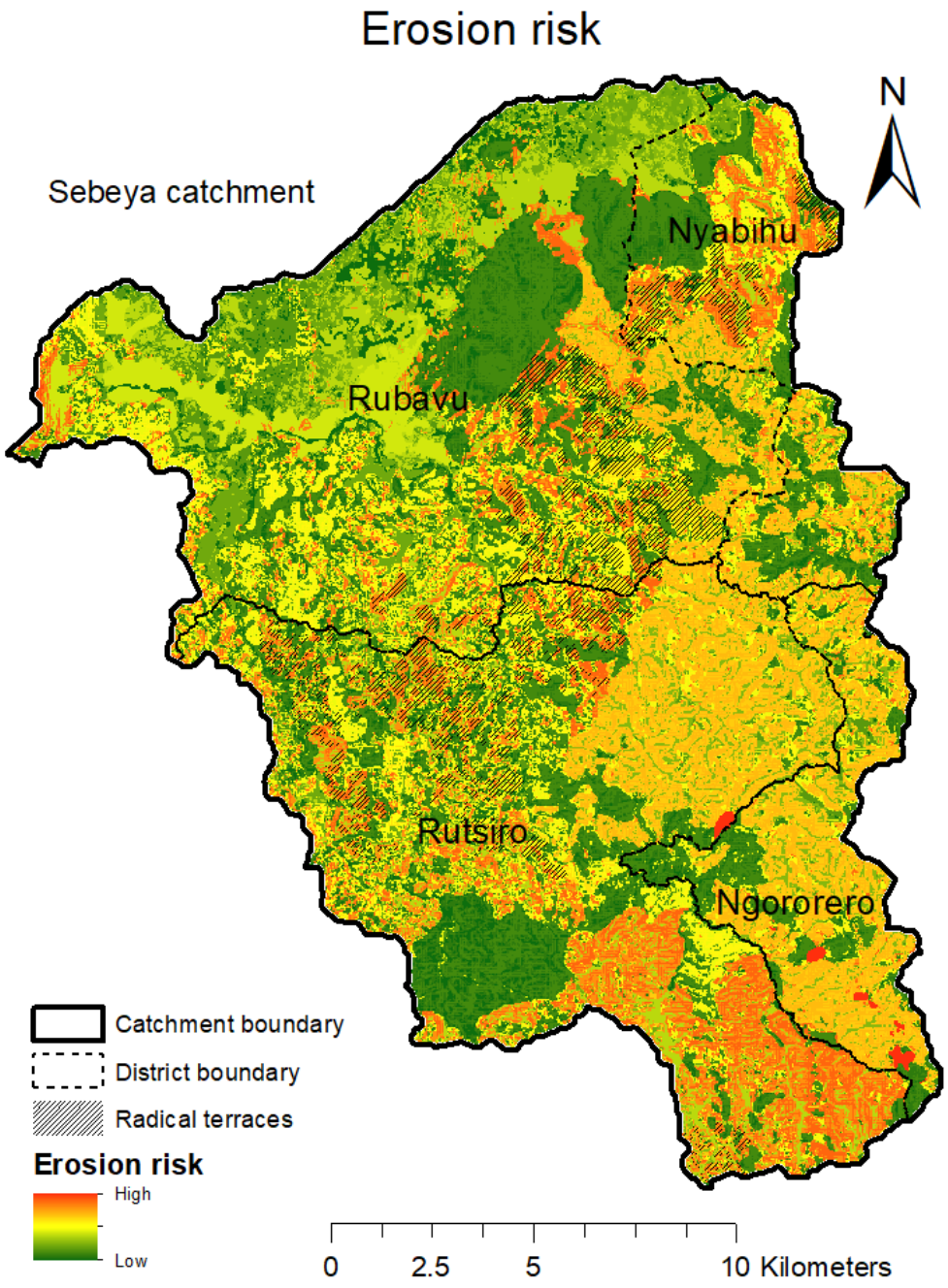

Figure 17 Erosion risk areas in Sebeya catchment in 2019. (based on reclassification in Annex 4). Note that this table was developed through expert judgement by ranking slope and land cover ordinally and that different interpretations of erosion sensitivity will lead to different results. The erosion risk map is overlaid by the locations of radical terraces. Where radical terraces are present in the field, a hashed overlay was added to the map in black.

Annex 4 shows the reclassification table that was used to create the erosion risk map. The erosion risk of every land cover type was assessed for every slope class and was given a value for the erosion risk. Landslides that are identified on the land cover map are a clear representation of erosion and therefore score the highest on erosion risk (landslide areas are shown in red on Figure 17). The steepest slopes with settlements, seasonal agriculture and grasslands come next, followed by perennial agriculture and plantation forest. The lowest risk is assigned to the gentle slopes with dense forests.

3.5.2 Gullies and landslides

Figure 18 presents the 15 gullies and several landslides locations that were observed during the field work (main landslide type: Mud soil landslide), supplemented by sightings through Google Earth imagery. The eastern and south-eastern parts of the catchment are severely damaged. These areas are also marked as vulnerable to erosion on the erosion risk map (Figure 17) and turn out to have significant mining activities (see also Figure 20). The steep slopes, unstable soils in combination with heavy rainfall leads to greater risks of gully formation.

The landslides indicated on the map below are only the more recent landslides, as they were derived from bare land visible on satellite imagery. Older landslides have currently a new vegetation cover and are therefore not indicated on this map.

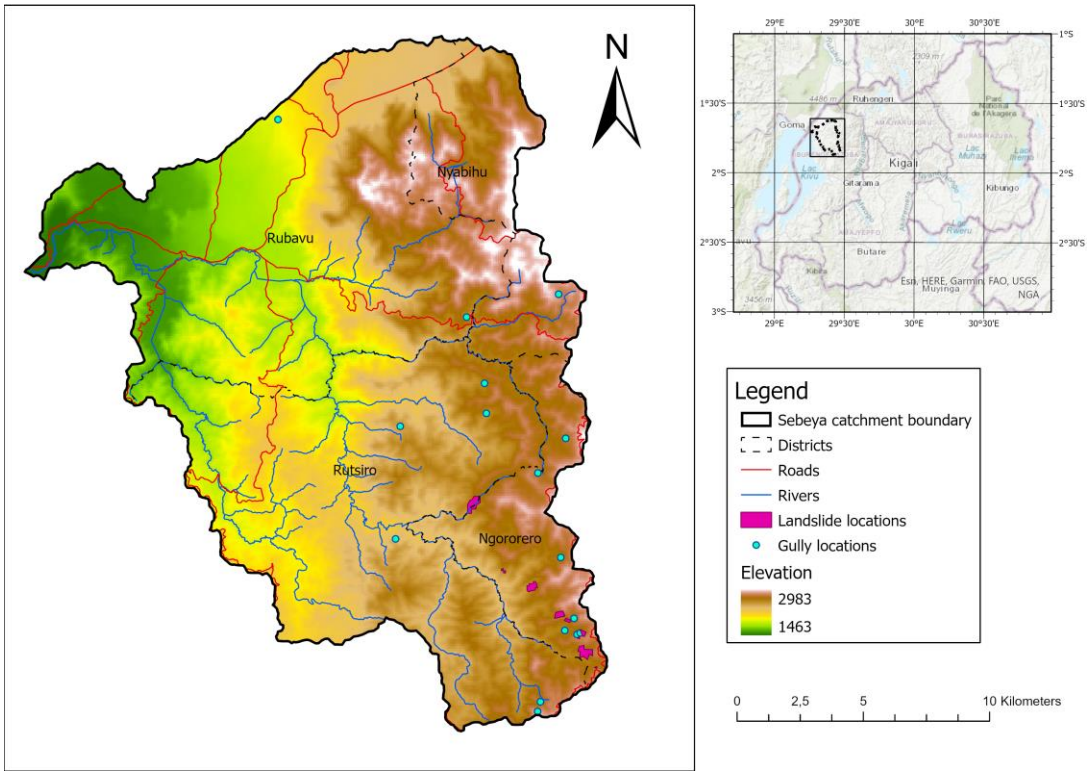

Figure 18 Locations of gullies (blue dots) and landslides observed in the field or on satellite imagery.

Additional information is provided by the Erosion Control Mapping report 2020 by the Ministry of Environment. The report provides the following information on the types and extent of erosion features present in several sectors of Sebeya catchment (Table 12).

Table 12. The land affected by gullies, landslides and erosion described per sector that is positioned within Sebeya catchment. The information in ha is for the entire sector in total [1].

District	Sector	Gullies (ha)	Landslide (ha)	Rill erosion (ha)	Severe Gullies (ha)	Total land affected in ha
Ngororero	Muhanda	148		2	130	279
Rutsiro	Murunda	592	35	1172	4	1803
Nyabihu	Bigogwe	5			7	12

[1] Note that the area most affected in Muhanda sector (Ngororero District) is in the south-west, therefore mostly outside of Sebeya Catchment boundary. The entire District of Rubavu is reported as not having any erosion feature types which is in contradiction with the findings of CROM model by which 19% of the District land is at high erosion risk and with the 6 gullies sited by this baseline assessment on Google Earth Imagery. The Report on soil erosion mapping (2019, RWFA) states 1 ha of gullies in Rubavu District.

3.5.3 Forest cover and perennial agriculture crops

Forest is essential in reducing erosion risk as trees stabilize the soil and slow down runoff both on land and in the soil. Perennial crops have a similar impact on the soil as the plants are not removed from the land during harvest. Figure 19 shows the areas in Sebeya catchment that are forested and the areas that are covered by perennial crops. Forest cover is 17797 ha (49% of the whole catchment), consisting of (dense) Natural forest (26%), Plantation forest (23%) or Riverbank trees (1%). There is no information on commercial tree farming yet available.

Large deforestation of Gishwati forest for agriculture, charcoal and firewood production in the past 3 decades has led to the decrease of natural forest in Sebeya. Currently, 1810 ha (5%) of the catchment is used for perennial agriculture (Table 13), mainly in the flatter areas. Additionally, nowadays terracing is more widely applied in the catchment, leading to lower gradients and less erosion. Terracing combined with perennial agriculture is a very suitable counter-erosion measure on steeper slopes. Further implementation of terraced (perennial) agriculture in combination with reforestation in erosion prone areas will enhance the catchment's resilience.

Table 13 Area (Ha) of seasonal and perennial cropland in Sebeya catchment

	Hectares	% of total cropland
Seasonal crops	9009	83
Perennial crops	1810	17
Total cropland	10819	100

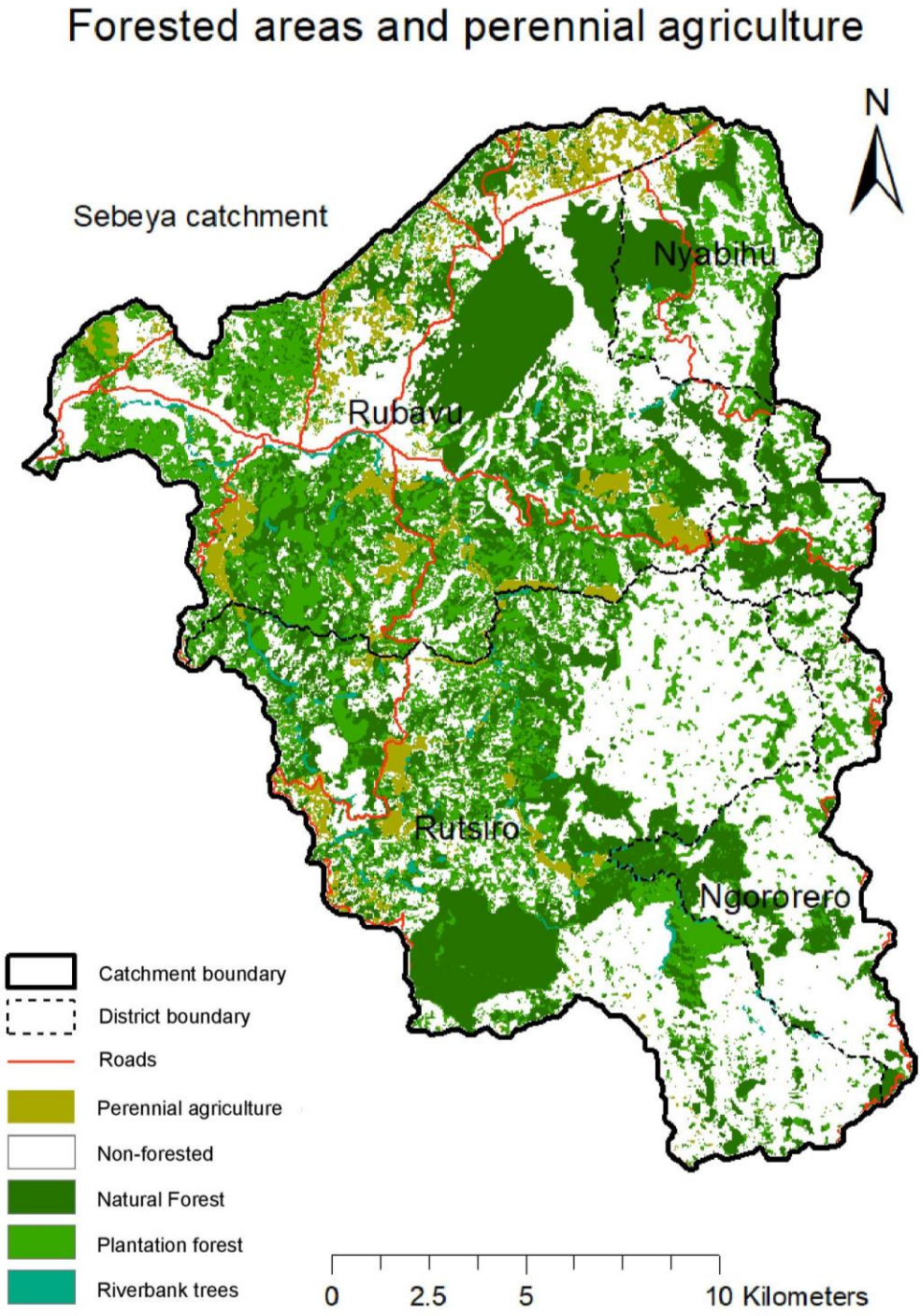

Figure 19 Map of forest and perennial cropland in Sebeya catchment in 2019.

3.6 Mining

3.6.1 Mining areas and activities

According to data from Rwanda mines, Petroleum and Gas Board (RMB), there are around 20 mining cooperation sites in the catchment and around 400 small mining areas of which ~250 are still operational. The minerals being exploited are wolfram, coltan and cassiterite. Some of the sites are open cast while others are underground. There are in Rubavu 4 mining sites for coltan and cassiterite and 15 sites for sand and gravel, 5 in Rutsiro and 3 in Ngororero. In total there are 12 mining cooperation's operational with licences in the Sebeya catchment. Artisanal mining is also very active in the catchment especially on old sites despite frequent inspections.

All mines are requested to comply by the environmental and mining standards by their license from RMB. The RMB goes in the field for inspection. If they find that mining practitioners are not following the standards, they get sanctions including a possible license to be revoked or suspended. In practice there seems not to be a very strict compulsory management in place.

All the mining sites use water from Sebeya River or connected streams. Around areas where mining sites are concentrated, many gullies are present, and landslides are favourable to occur. The map below shows the locations of the mining activities.

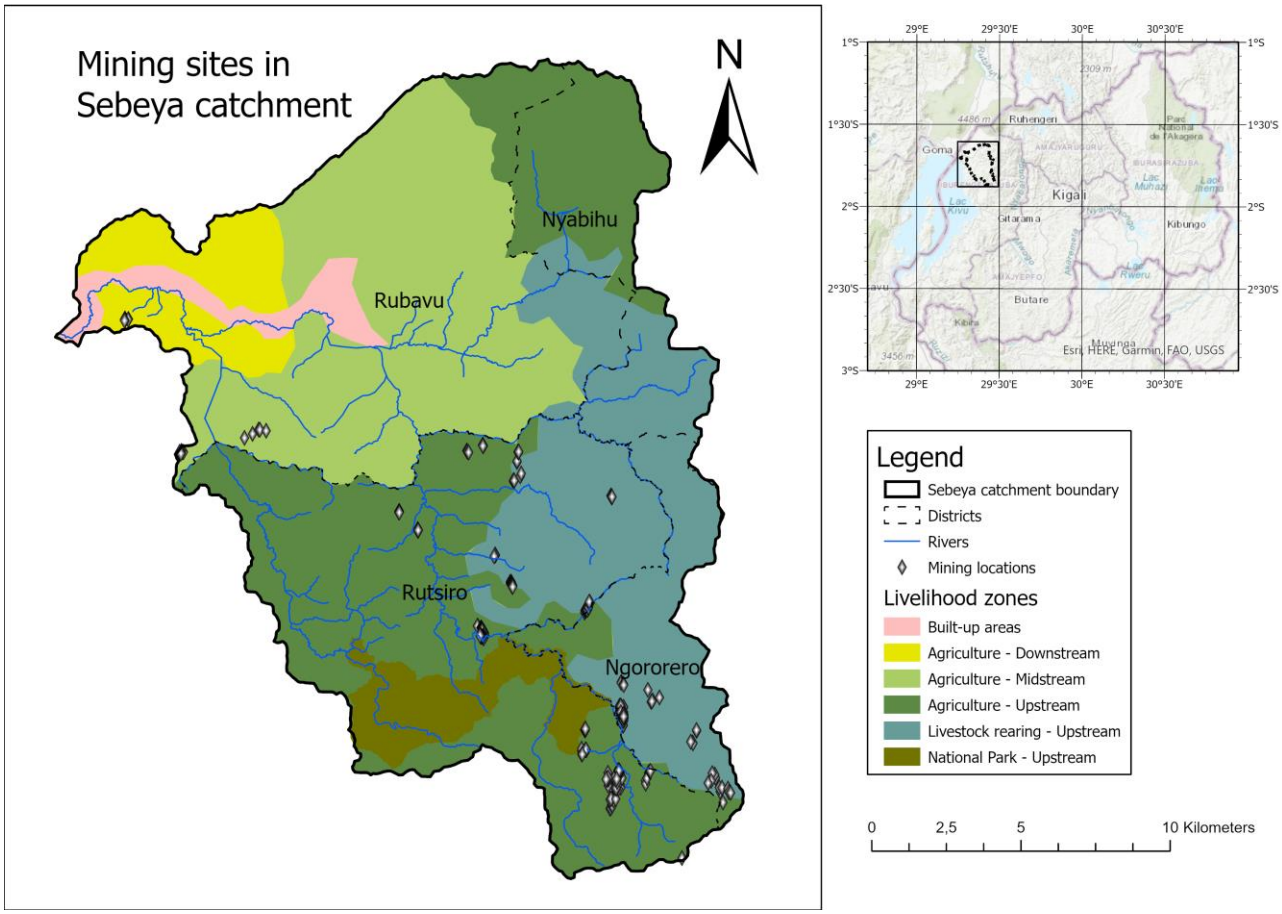

Figure 20 Locations of mining sites in Sebeya catchment (Source: RMB)

3.6.2 Old mining areas rehabilitated (post-closure rehabilitation)

During the field visit of the biophysical team, several Mining Companies were observed which were deploying efforts to reduce used wastewater from their activities to flow directly into Pfunda River. Ponds have been dug; water is pumped downstream and taken upstream to wash cassiterites. Wastewater was then reused before it flowed downstream to an area where sugar canes was planted.

The cleaning (a.k.a. washing) used water becomes more difficult during the rainy season due to increased sediments washed downstream on high slopes. When soil becomes saturated by water and contain pegmatites rocks and schists, it flows easily on steep slopes.

The Companies visited were CEMIYAKi and Masengati, although the Masengati sites seems dormant with less activities. Ponds to recycle water were very small (~4x2m) and not containing wastewater.

Figure 21. Active mining area in Sebeya Catchment

The biggest problem of pollution in Sebeya catchment comes from sites located at Tubindi as can been seen on the google earth imagery in Figure 22. Those mining sites are mostly old mines from colonial period. Because there is no special policy and enforcement on closing old mines, they were left completely opened and local companies that took over could not bear the cost of closing them. Artisanal miners now exploit some of those sites.

Figure 22. Google Earth imagery of the Turbindi mining complex in Sebeya catchment. Imagery date of February 2019.

The undulating hills with grazing areas are interrupted with large patches of bare land. Although some of those mining patches are rehabilitated through afforestation, they contribute large quantities of sediments which are washed downstream by Sebeya River. Water from Cassiterites mines is also washed directly into Sebeya River. This practice has a negative impact on the water quality status of Sebeya River. Artisanal miners need to be encouraged to undertake sustainable mining system with proper waste water management mechanisms e.g. natural treatment. Strong policy and enforcement of closing some of those sites accompanied with rehabilitation actions by artisanal miners need to be in place. A discussion of alternative livelihood options for the artisanal miners should take place.

The mining areas exploited by artisanal miners require special attention of rehabilitation. There is a need to work together with artisanal miners to highlighting consequences of ecosystem degradation and designing together rehabilitations plans that combine alternative livelihoods, afforestation, constructed wetlands, and ponds for recycling wastewater can certainly reduce the pollution in Sebeya River.

3.7 Structures

Hard and NBS structures to manage peak flows in the main river and tributaries

Since increased flooding in Sebeya Catchment especially in 2012, The Government through Rwanda Natural Resources Authority together with District authorities have put a series of urgent infrastructures to adapt to the increased volumes of waterflow. These can be hard structure or Nature Based Structures (NBS) such as artificial wetlands.

Hence various bridges have been raised up especially between from 2015 to 2017 compared to the old bridges such as the bridge located near Nyundo Petit Seminaire. Most of the old bridges were built without any consideration of the hydrological parameters and with increased flow in the catchment, they were frequently submerged and could not cope with large amount of river flow.

Figure 23. Gabion wall near Mahoko Tax Park, Google Earth Imagery.

Gisunyu Bridge (at junction of Karambo river and Sebeya at a place called *mu cyondo)* was raised up in 2015 as it used to be submerged and inundating residential area and a local market were flooded. Gabion walls have been built also at some places where Sebeya easily overflows its riverbanks, such as near the main road after Mahoko Taxi Park in Kanama and near Nyamugali Bridge.

A structure in the form of a concrete channel has been built to channel excess water towards the main road preventing water passing a densely populated area Figure 24.

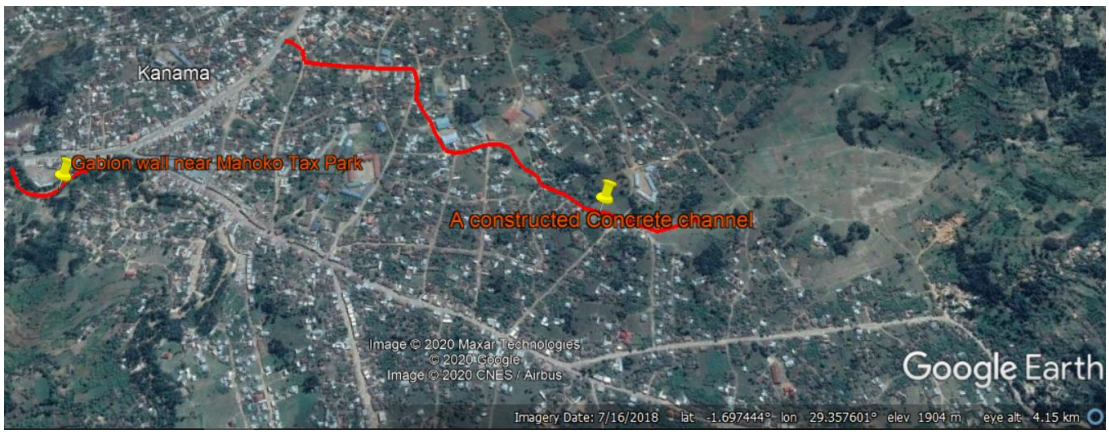

Figure 24. A concrete channel was constructed in Kanama to divert the surface water flowing towards Sebeya river. Google Earth Imagery.

Most of those infrastructures, bridges, gabion walls, concrete channels have been built as quick emergency infrastructures to cope with increased peak flow in Sebeya River. In fact the Sebeya River had been channelled between levees, in order to develop tea farmland in the wetland in the alluvial valley just south of Nyundo gauging station. During one of the historical flood events, Sebeya River breached a sandy levee near Musabike and inundated a large cultivated area. Looking at the historical river flow and natural flood plains, these cultivated areas where part of the natural flood plain of the Sebeya river and therefore a high-risk area for cultivation.

Two sites (Sebeya lateral retention dikes and flood retention pond) have been identified by W4GR for infrastructure implementation that will really contribute in reducing the peak flow before it reaches areas where human presence and economic activities are established. The sites are 1) a flood retention pond (just upstream of Nyundo gauging station) and 2) a large retention dike (at Musabike village). RWB will start with implementation of the flood retention dike in 2020.

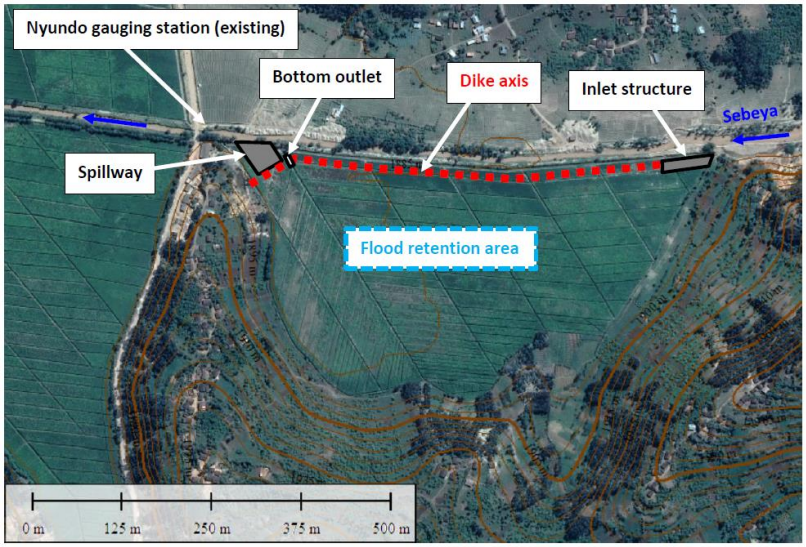

Figure 25. Planned intervention 'Sebeya lateral retention dike' in former tea plantation area. (W4GR, 2020a)

The site that has been identified a flat area between two hillsides, occupied now by tea. Like a retention dam, the objective of these construction works is to store part of the flood volume and have it released later, at a lower flowrate. The retention structure generates a dampening effect on the flood, by reducing and delaying the peak flood downstream. This structure would have an effect on floods generated on Sebeya upstream catchment, and floods generated on Karambo catchment. Karambo torrential river can produce rapid and intense floods that cannot be mitigated along its own course as its slope is very steep and its valley narrow (W4GR, 2020a).

Figure 26. Sebeya retention dam – selected site for dam implementation (W4GR, 2020b) at Musabike village.

In order to reduce the flood risk across Mahoko town and further downstream, a site for flood retention has been identified 2 km upstream the Karambo-Sebeya confluence. This structure is planned to be a part of the flood protection program to be implemented on Sebeya catchment; it consists in building a flood retention dam in order to reduce peak floods. The upstream area of the dam will flood in order to spare the downstream inhabited areas with economic activities (W4GR, 2020b).

4 Baseline Socioeconomic data

4.1 Introduction

This section portrays the socioeconomic characteristics of the respondents living in the Sebeya River catchment. These respondents' households were visited from the different Sebeya sub-catchments and livelihood/agroecological zones. These zones, though sharing similar features mostly related to their location in the vicinity of the Sebeya river, have differences mostly related to types of livelihood activities which in most cases depart from existing economic opportunities or else from the adaptation of residents to the existing landscape. In addition to this, since the river crosses different districts (Ngororero, Rutsiro, Nyabihu, and Rubavu) and the later have different development strategies depending on the soil characteristics and the district plan, the livelihood of inhabitants and the type of livelihood activities subsequently differs. In all sampled zones, agro-ecological and livelihood characteristics of residents are presented in reference to the general characteristics of concerned districts in which the selected sites are located.

Table 14: Livelihood/agro-ecological zones description

District and Livelihood zones	Visited Cells /village	Socio-economic characteristics	Particularity of the selected sector/village
Ngororero **Upstream zone**	Muhanda Sector/*Rutagara Cell*/Bambiro&Rurambo Villages, *Bugarura Cell*/Gatomvu&Runayu Villages	With reference to the 2018-2024 District Development Strategy (DDS), Ngororero district aims to become a vibrant agro-processing and Mining hub.	Muhanda sector is one of the upstream zones in which households were selected to respond to socioeconomic questions. These were selected in Rutagara cell and precisely in Bambiro and Rurambo villages. This place is known to be the source of Sebeya river and the first stream of Sebeya river waters are found in Rurambo village. Three hills (kwitara, Kayanza and Bambiro) are all located both in Rurambo and Bambiro villages. Main livelihood activities have been illegal mining mixed with subsistence agriculture and a few households who are cows keepers (but on behalf of other people from Kigali). These illegal mining activities are not only practiced by local residents, but also by others for example also others from Karumbi in Rutsiro sector used to come for mineral mining activities on these hills. Negative effects of illegal mining on these hills environmental degradation with gullies/erosion, sedimentation and water turbidity on one hand and death of miners on the other hand. Efforts to curb illegal mining on these hills include the deployment of Inkeragutabara to patrol the area and arrest illegal miners. In addition, Ngororero district and especially Muhanda sector has potential in Mineral deposits with Colombo-tantalite (coltan), cassiterite and wolfram ressources. With the aim of supporting the district's long term district development strategy (DDS), the Muhanda/Rurambo village mining sites were rented to NL Mining company for the last five years. This company in turn is currently partnering with ALGO Mining company, a Russian company to carry out mining activities with modern equipment. Local residents will as well be employed in the mining activities and will earn a living out of them, instead of involving themselves in high-risk illegal mining.
Rutsiro **Upstream zone**	Murunda Sector/Kirwa Cell/Karumbi&Satinsyi Villages	Population in farming areas (mostly livestock).	Murunda Sector is located in upstream areas where these 2 Villages namely Karumbi and Satinsyi have been selected according to the fact that they are occupied by the farming/livestock activities. Though the 2 villages have presently minor mining activities but most of them are under control by the private company, Rutsiro district and these sectors are known to be a hub for illegal mining activities, and the government has adopted strategic mechanisms to fight this risky activity and most of the men get employed there in. Main activities of the population are cattle rearing but mixed with agricultural for mainly potatoes. The majority of the agricultural land has been protected from erosion through radical terraces and agroforestry. The bottom sides of the 2 villages are located in Sebeya river bunch where in the rainy seasons there may be overflow and flood may damage crops down there.

Nyabihu **Middle stream zone**	Bigogwe Sector/Arusha Cell/Busasamana&Bukinanyana Villages	Population in agricultural lands (Irish potatoes) and livestock rearing	Bigogwe Sector is mainly located in the Middle stream area of Sebeya catchment and the 2 villages have been selected considering the fact that they are all located in the agricultural lands with mainly Irish potatoes. In addition to the agricultural activities, the 2 villages population are practicing cattle rearing where some farms are out of the 2 villages. The soil is much protected against erosion as the radical terraces and agroforestry practices are well maintained. People there are much mobilized about soil protection as recently, terraces activities are still in process. In these 2 villages, there are some households who benefited from rain water harvesting system and rain water plastics tanks have been given to them by RWFA as this was requested and proposed by the local population in the community sessions as held in 2019.
Rubavu **Middle stream zone (Nyakiriba Sector)**	Nyakiriba Sector/*Gikombe Cell*/Rushubi Village *Yungwe Cell*/Rugogwe Village *Bisizi Cell*/Kingoma Village	Population in perennial and annual agricultural lands	Nyakiriba Sector is in The Middle stream of the catchment where 3 villages have been selected reference to their agricultural crops and habitat. Mainly, the villages are occupied by perennial and annual agricultural crops mainly with beans, maize and vegetables. The soil is well protected from erosion as the slop is low and the soil textures are mainly volcanic and resistant to the erosion The soil is also protected by agroforestry trees and Pennisetum
Downstream Zone (Nyamyumba, Kanama, Rugerero sectors)	Nyamyumba Sector/*Kinigi Cell*/Byima and Gatyazo Villages	Population practicing agriculture and small-scale business	Nyamyumba Sector is in Downstream area of the catchment where 2 villages have been selected according to 2 reasons: (1) agricultural area and (2) small-scale businesses. The majority of the population in the 2 villages are busy with agricultural, mainly women, while men are in the side busy with small scale businesses. Agriculture is of cereals, sugarcane and tea (either in the bottom side of the village and up there). The erosion down there may occur as the soil topography is with steep slope somehow and as the soil is intensively exploited. To control erosion, trenches, terraces and agroforestry practices are introduced in the area. While moving on the villages, women are the ones you meet in the villages while men use to move far for different businesses.
	Kanama Sector/*Mahoko Cell*/Nyamugari Village Nyundo Sector/*Terimbere Cell*/Terimbere Village Rugerero Sector/*Rugerero Cell*/Nyantomvu Village	Population in urban areas (Mahoko, Nyundo, Pfunda and Rugerero) is exposed to downstream water flow with high velocity (flooding, landslides)	Nyundo, Rugerero and Mahoko Sector are located in the Downstream area of Sebeya catchment. The Villages selected there according to the livelihood of most of the population are living in urban areas, land exposed to water flow where flooding is with serious damage along the side of Sebeya from Mahoko till down to the river inlet to the lake. The population is busy with commercial businesses, small scale agriculture while others are making business of sand and stones mining. It's a serious case in some of the villages where due to sand and stones mining in and around Sebeya river, the erosion becomes serious and may overflow and flooding reaches the main road and destroy houses, crops etc. It's recommended to ensure that sand and stones are secured with much control to avoid serious erosions in the downstream area.

The table above summarizes key areas and population livelihood characteristics. The diversity of both landscape and population activities along the whole Sebeya River catchment has been captured to draw representative information on the socio-economic activities of residents along the river's riverbank.

4.2 Household socioeconomic status and trends

4.2.1 Household profile

Households in the catchment differ in various ways, however, there are common characteristics in households belonging to the same wealth or socio-economic category. Households sampling was carried out randomly, Data on the socio-economic aspects of the population in the catchment area was collected, and the ubudehe categories (wealth categories) were considered to identify the similarities and dissimilarities in the households' wealth and socio-economic status. Ubudehe categorization is the Rwandan government initiative that classifies people in socio-economic categories for effective planning and targeting of beneficiaries in pro-poor programs. The categories considered during this baseline socio-economic assessment were approved by the government in 2016, and classified households into the four categories (Ezeanya-Esiobu & Chika, 2017):

- **Category 1**: Very poor and vulnerable families, who are unable to cover basic needs without assistance.
- **Category 2**: Citizens who can afford some form of rented or low class owned accommodation, but who are not gainfully employed and can only afford to eat once or twice a day.
- **Category 3**: Citizens who are gainfully employed or are even employers of labor. Within this category are small farmers who have moved beyond subsistence farming, or owners of small and medium scale enterprises.
- **Category 4**: Citizens classified under this category are chief executive officers of big businesses, employees who have full-time employment with organizations, industries, or companies, government employees, owners of lockdown shops or markets, and owners of commercial transport or trucks

Households in the catchment belong to the first three wealth categories, with 17.1% in category 1 (very poor), 46% in category 2 (poor), and 36.9% in category 3 (better off). Ownership of assets is one of the determinants of wealth, and in the rural areas land and livestock are considered as part of the main assets. In Sebeya catchment, better-off families mainly own larger land and more livestock than the poor and very poor families and mainly make income from livestock and crop sale. The poor households' main source of income is labor either on their small farms or working in the farms of the better-off families. The very poor gain support from the government to cover the basic needs such as education and health care and mainly gain income working at the farms of the better-off families. The very poor and poor households are more likely to experience food shortages and shocks, and hence face unusual situations that affect their ability to provide for the household members; as they have limited or no saving and little to no assets to exchange, as a coping mechanism.

Table 15 below provides an overview of households' characteristics within the catchment per wealth category.

Table 15: Households characteristics overview

Household characteristics		Wealth category		
		Category 1	Category 2	Category 3
Percentage within the sampled households		17.10%	46%	36.90%
Household size	1 to 3 persons (**26.9% of the total sample**)	35.6%	31.5%	17.1%
	4 to 6 persons (**50.2% of the total sample**)	49.3%	48.20%	53.2%
	7 to 9 persons (**20.3% of the total sample**)	12.3%	18.3%	26.6%
	10 to 12 persons (**2.3 % of the total sample**)	2.7%	1.5%	3.2%
	13 to 15 persons (**0.2% of the total sample**)	0%	0.5%	0%
Physical characteristics of the dwellings	Roof	• Local tiles (56.2%) • Iron sheets (20.5%)	• Local tiles (36.5%) • Iron sheets (36%)	• Iron sheets (48.7%) • Local tiles (36.7%)
	Wall	• Mud bricks (74%) • Wood and mud (6.8%)	• Mud bricks (70.1%) • Wood and mud (3.6%)	• Mud bricks (75.9%) • Wood and mud (8.2%)
	Floor	• Beaten earth (79.5%) • Concrete with cement (1.4%)	• Beaten earth (64.5%) • Concrete with cement (9.1%)	• Beaten earth (67.7%) • Concrete with cement (17.1%)
Gender of the household head	Female	26.40%	41.60%	32%
	Male	13.20%	47.90%	38.90%
Percentage of the households that own land		15.80%	36.30%	47.90%
The average size of land used for agriculture		0.25 Ha	0.32 ha	0.55 ha
Livestock ownership		10.20%	39.80%	50%
number of livestock owned	cows	1 to 2 (2 on average)	1 to 3 (2 on average)	1 to 25 (3 on average)
	goats	1 to 4 (2 on average)	1 to 5 (3 on average)	1 to 15 (3 on average)
	Pigs	1 to 4 (3 on average)	1 to 3 (1 on average)	2 to 10 (5 on average)
	Chickens	1 to 2 (2 on average)	1 to 4 (3 on average)	1 to 10 (3 on average)
	Sheep	1 to 3 (2 on average)	1 to 5 (3 on average)	1 to 8 (3 on average)
Average monthly/seasonal (for livestock, crop, and animal products sale) income (in Frw)	Livestock sale	**37000**	**150962**	**198417**
	Crop sale	**13900**	**61898**	**133683**
	Animal products sale	**32500**	**20843**	**35252**
	Self-employment (petty trade, craft etc)	**29286**	**50180**	**50735**
	Salaries and wages	**21682**	**35492**	**29872**
	Remittances, pension allowances, and social welfare grants	**23955**	**17400**	**10143**

4.2.2 Gender of the household head and wealth

Approximately 70.8% of the surveyed households are headed by a male parent or guardian, while 29.2% are headed by a female parent or guardian. Female-headed households are more likely to belong to the vulnerable group, as approximately 26.4% of the female-headed households are in the very poor category as compared to 13.2% of the male-headed households. The wealth status is slightly different between female-headed

and male-headed households in the poor and better-off categories though as revealed in Table 15.

4.2.3 Physical characteristics of the dwellings

Considering the national statistical data (NISR,2018), 72% of non-poor households have at least a corrugated iron roof, compared to 58% of poor households; and 41% have a modern floor, compared to 9% for poor families.

Houses in the catchment area are mainly made of mud bricks, with earthen floors and local tiles or metal sheets for the roofs. However, wealth category 3 has the highest percentage of households with metal sheets roofing (approximately 48.7%, as opposed to 36% and 20.5% for wealth category 2 and 1 respectively); and concrete with cement for the floor (approximately 17.1%, as opposed to 9.1% and 1.4% for wealth category 2 and 1 respectively) compared to the poor and very poor groups.

4.2.4 Household size and wealth status

The household size in the catchment ranges from 1 to 15 persons per household; with 50.2% of the households having the size of 4 to 6 persons; 26.9% with the size of 1 to 3 persons; 20.3% with 7 to 9 persons, 2.3% with 10 to 12 persons, and 0.2% with a household size of 13 to 15 persons. The average household size in the catchment is 5 persons per household which is above the national average of 4 persons per household (NISR, 2018). The pattern observed here is that larger families tend to be wealthier than smaller families as 82.9% of the better-off households (in wealth category 3) have 4 and above persons, and the average household size in this category is 5.4 persons per household which is higher compared to 4.8 and 4.5 persons per household in wealth category 2 and wealth category 1 respectively. The detailed data in Table 15 show that wealth category 3 has a higher proportion of households with a large size, compared to other wealth categories, and this contrasts with the national context[3] where poor families tend to be larger than non-poor families. There is a correlation between household size and having access to agricultural land which may explain the pattern that larger families tend to be wealthier. While the percentage of households in the sample with no land is substantial across the board, it is lower for larger households; and leaving out the category without land, it is clear that there are more relatively large farms among large households. As agriculture and livestock are the main sources of income in the catchment, families with larger farms and productive members tend to earn more income from agricultural activities.

[3] The Fifth Household Living Conditions Survey (NISR, 2018) revealed that the average household size is 5.2 and 4 persons per households for the poor and non-poor groups respectively.

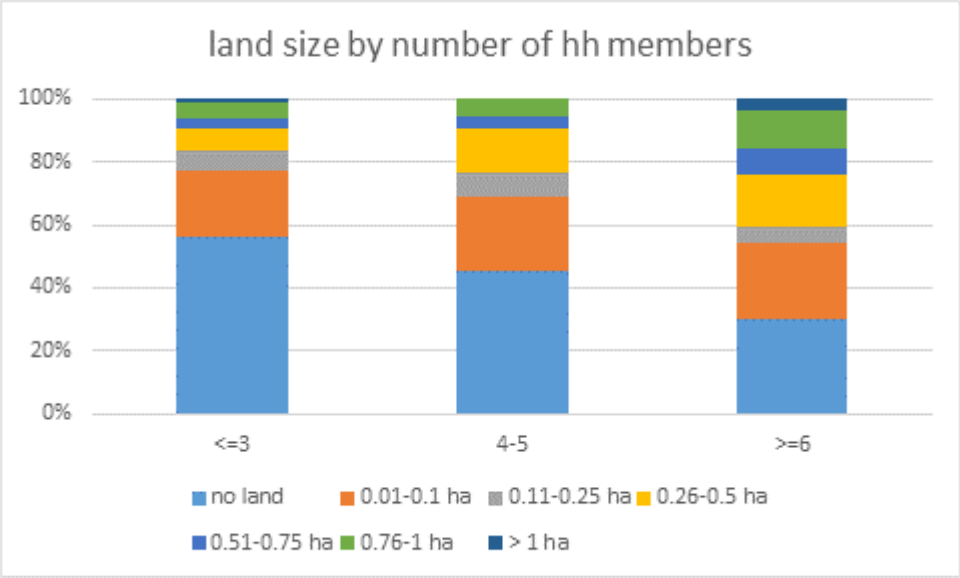

Figure 27: Farm size in ha by household size (number of household members)

4.2.5 Assets ownership

Land ownership is one of the main determinants of wealth in the Sebeya catchment. The primary data collected during this assessment show that 55% of the surveyed households own land. However, 81% of the households confirm to have access to land they can use for their economic activities since the landowners avail part of their land to the non-holders either as rent or through a sharecropping mechanism. Land ownership is concentrated in the better-off households (wealth category 3) as 47.9% of households that own land belong to this category, as opposed to 36.3% belonging to category 2 (poor) and 15.8% to wealth category 1 (very poor). The land is mainly used for small-scale farming activities, and the average area of land used for agriculture is 0.25 ha, 0.32 ha, and 0.55 ha for households in wealth category 1, category 2, and category 3 respectively. This provides the better-off households with an advantage over the households in other wealth categories regarding food security and a likelihood to gain more income from agriculture activities.

Livestock is considered as an asset that can be exchanged for cash to satisfy other household needs, or save the household in cases of financial shock or other emergencies. Livestock ownership is more noticed in wealthier households than in poor families. Regardless of the wealth categories, 29.9% of the surveyed households in the catchment own at least one domestic animal; and 50% of these households belong to the better-off category (category3), 39.8% belong to the poor category (category 2) and 10.2 % belong to the very poor category (category 1). Households from all the categories can own each type of livestock commonly reared in the catchment area (cow, goats, sheep, pigs, and chicken), however wealthier families tend to own more livestock than poor families (see: Table 15, for details on the number of livestock owned per wealth category). Sometimes, the better off families have more livestock than they can look after and hence give responsibility to poor families to look after a certain portion of the livestock for a given period, in exchange for a certain percentage of the offspring that are born during the agreement period.

4.2.6 Household income

Agriculture and livestock rearing are the most common sources of income in the catchment as they are practiced by 56.5% of the household heads as their main

employment. The pattern observed as presented in the figure below (Figure 28) is that there is a considerable difference between the average monthly income generated by households across the wealth categories. Households from all the categories make an income from all the identified income sources; however, primary data collected during household surveys revealed that the better-off households (Category 3) earn 31% and 436% more income from livestock sales compared to the poor (in category 2) and the very poor (category 1) households respectively. Better-off households also earn 116% and 840% more from crop sales compared to the poor and very poor households (Category 2 and 1) respectively. This pattern is justified by the fact that the better-off households practice agriculture on larger land and own more livestock; which provides them with an opportunity to practice market-oriented agriculture compared to their counterparts in wealth category 2 and 1 whose agricultural activities are in most cases for subsistence. Households in wealth category 2 are mainly employed in farms of better-off families, and other casual employment opportunities like through VUP programs, and earn 64% and 19% more income from wages and salaries than the households in category 1 and 3 respectively. The households in category 1 are very poor and classified as vulnerable groups. They earn an income from other sources but require external support to satisfy the basic needs. Households in this category earn 136% and 31% more from remittances, pension allowances, and social welfare grants than the better-off households (category 3) and the poor households (category 2) respectively.

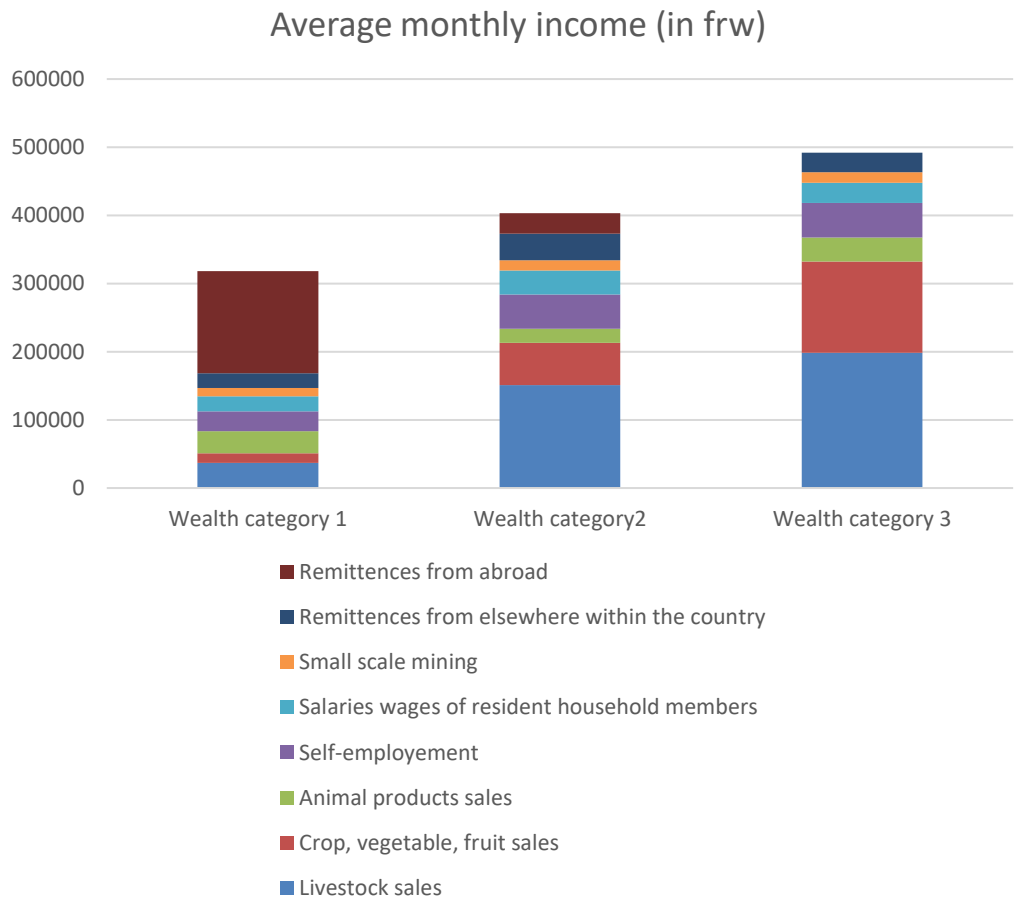

Figure 28 Average household monthly income per wealth category

The primary data collected during the survey revealed a clear pattern between landholding size and household income. Approximately 45% of the households with the smallest land (less than 0.25 ha) have non-farm income as compared to less than 30% of the households with larger farms (0.26 ha to 0.75 ha). The households with the smallest farms do not produce enough to generate income and hence have no option but to look for non-farm income to cover their needs; while households with larger farms (0.25 ha and above) can sell at least a certain portion of their produce to cover household expenses and have a side income from non-farm activities as well.

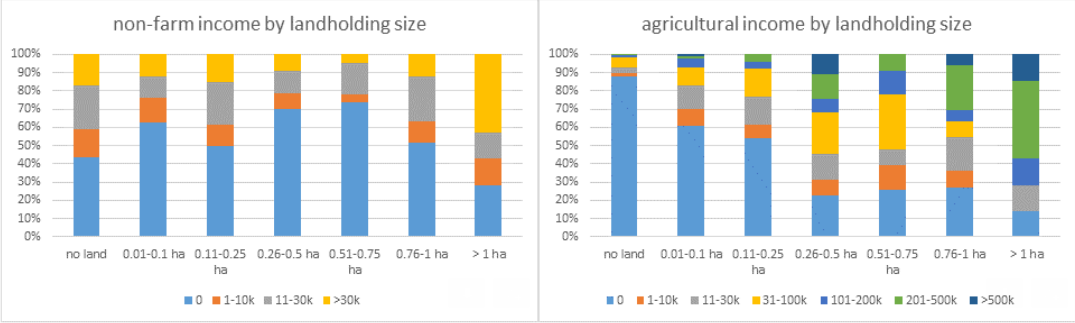

Figure 29: Non-farm and agricultural income by landholding size

4.2.7 Household Expenditure

The absolute amount of money spent on all the items tends to increase with the wealth due to differences in total income, and the most common pattern is that food items cover the largest portion of total expenditure for the poor and very poor households. As presented in Table 16, food items account for 38%, 25%, and 18% respectively of the total monthly spending of the very poor, poor, and better-off households. Because of higher agricultural production, food purchases account for a smaller portion of spending for the better-off households. For better-off households, education accounts for approximately 41% of the total monthly expenditure; and households in this category spend 1706% and 170% more on education compared to the very poor (category 1) and poor (category 2) respectively. The poor and very poor groups gain government support for education and health care. Their children mainly attend free education schools, and the very poor are even likely to gain support on school materials and school feeding hence a considerable difference in expenditure for education. Considering the absolute amount spent on labour; better-off households spend 506% and 40% more compared to the very poor and poor households respectively.

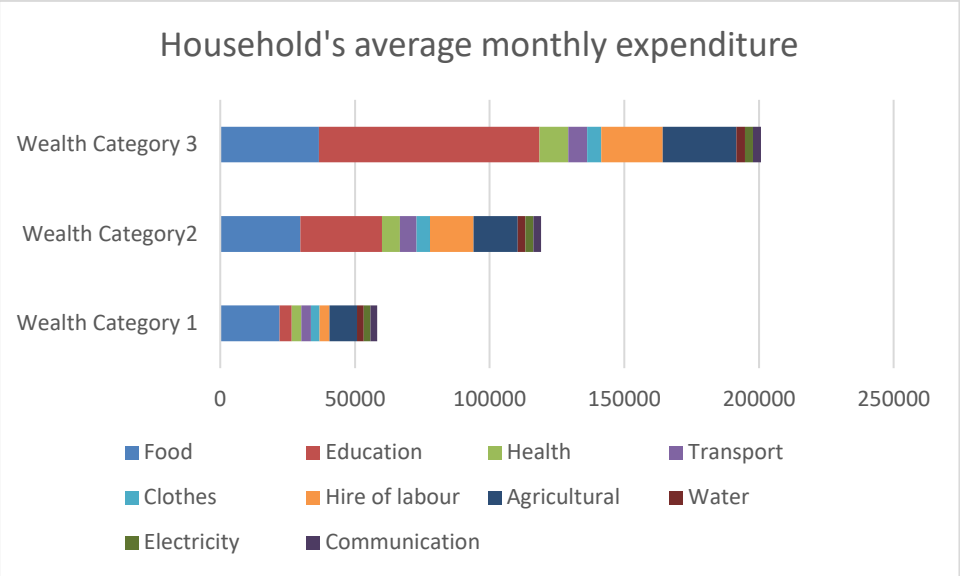

Figure 30: Household monthly expenditure across wealth categories

Table 16: Expenditure patterns by wealth category

Expenditure	Wealth Category 1 (Very poor)		Wealth Category2 (poor)		Wealth Category 3 (better-off)	
	Average monthly expenditure	% Total	Average monthly expenditure	% Total	Average monthly expenditure	% Total
Food	22055	38%	29746	25%	36661	18%
Education	4531	8%	30260	25%	81837	41%
Health	3493	6%	6637	6%	10696	5%
Transport	3594	6%	6289	5%	7042	4%
Clothes	3151	5%	4898	4%	5237	3%
Hire of labour	3750	6%	16184	14%	22734	11%
Agriculture	10167	17%	16394	14%	27391	14%
Water	2500	4%	2917	2%	3214	2%
Electricity	2500	4%	2985	3%	2974	1%
Communication	2500	4%	2750	2%	2959	1%
Total	58240	100%	119061	100%	200747	100%

4.3 Livelihoods in the catchment

Agriculture and livestock are the most common income-generating activities across the three agro-ecological zones of the Sebeya Catchment, though the level of engagement in each activity differs depending on the zone. Community members are also involved in other income-generating activities different from traditional farming, and the level of engagement depends on the availability of the market and the financial means to invest in such activities.

4.3.1 Agriculture landholding and use

The largest part of the Sebeya catchment is a rural area; agriculture and livestock are the main economic activities in this area, and hence landholding plays an important role in the livelihoods and wealth of community members. Land ownership is relatively low in

the catchment as 45.3% of the surveyed households do not own any plot of land. However, through mechanisms such as sharecropping, households with no land share the land available with landowners which allows approximately 61.3% of the households that do not own land to have access to a plot of land they can use for their agricultural activities.

Land ownership is higher in the middle stream area, with 68.5% of the households in this zone owning land, as compared to 60.5% and 31.1% in the upstream and downstream zones respectively; and the better-off households are most likely to own land in all the zones as presented in Table 17. The average size of land allocated to agriculture per household is below the national average of 0.59 ha per household (NISR, 2012) in all the three agro-ecological zones. Table 17 shows that the average size of land allocated to agriculture per household is 0.47 ha in the middle stream zone, 0.44 hectares in the upstream zone, and 0.25ha in the downstream zone.

The average size of agricultural land per household in the middle stream zone is closer to the Western region's average of 0.48ha, and the Downstream zone is far below this average. The middle stream zone is considered to be an agricultural hub, while the downstream zone is mainly characterized by agglomerations within commercial centres like in Mahoko village, hence a difference in agricultural land size. In the Middle stream and upstream areas, where agriculture and livestock rearing are the most common income-generating activities; the better-off households on average have a larger agricultural land compared to the poor and very poor households as revealed in Table 17, below.

In the areas with small farms, the adoption of best agricultural practices is important for improvement in natural resources management, and an increase in agricultural production and productivity. Best agricultural practices such as composting, use of chemical fertilizers, and improved seeds are practiced by more than half of the surveyed households in the middle stream zone, but there is still a need for improvement in other zones especially in the downstream zone. Much more details on best agricultural practices are provided below in section 4.3.5 (Best agricultural practices and sustainable livelihood activities).

The primary data collected during the household survey revealed that 11% of the surveyed households in the catchment have at least one plot under land use consolidation, as opposed to the proportion of 32.2% of the households in the Western province as reported by NISR (2018). Among the households with any plot under land use consolidation in the catchment 6.8% in are the middle stream area, 2.1% in the downstream, and 2.1% in the upstream zone.

Table 17: Agricultural landholding and use

Description		Agro-ecological zones		
		Downstream	Middlestream	Upstream
Percentage of households that own land	Within the agro-ecological zone	31.1%	68.5%	60.5%
	In wealth category 1	29.7%	12.9%	13.4%
	In wealth category 2	24.3%	37.6%	39.3%
	In wealth category 3	45.9%	49.4%	47.3%
The average area of land allocated to agriculture per household	Within the agro-ecological zone	0.25 ha	0.47 ha	0.44 ha
	In wealth category 1	0.32	0.30	0.25
	In wealth category 2	0.14	0.29	0.32
	In wealth category 3	0.29	0.67	0.55
Percentage of households that practice agriculture on consolidated land		2.1%	8.6%	2.1%
The average size of cultivated land per household in the western province		0.48 ha		
The national average size of agricultural land per household		0.59 ha		

4.3.2 Landholding and household livelihoods

As presented in section 4.2.6 (Household income), agricultural income increases with the farm size; and the households with no or small farm look for off-farm income as an alternative. They are mainly employed in informal sectors such as mining, construction, and charcoal making that provide low pay. As a result, households with less than 0.25 ha of land spend more than they earn monthly and hence are more likely to live with endless debt which increases the likelihood of vulnerability. Households with larger farms on the other hand earn more than they spend (Figure 31) which provides them with an opportunity to have a positive residual income that is saved or reinvested.

The availability of off-farm employment opportunities is low in the rural upstream zones, and the households with small to no land mainly work on the farms of the large-land owners. The downstream area on the other hand is characterized by agglomerations in the peri-urban areas with relatively high availability of infrastructures that provide an opportunity for off-farm employment creation. Hence, the vulnerability of households with less than 0.25 ha of land is higher upcountry than in the peri-urban areas of the downstream zone.

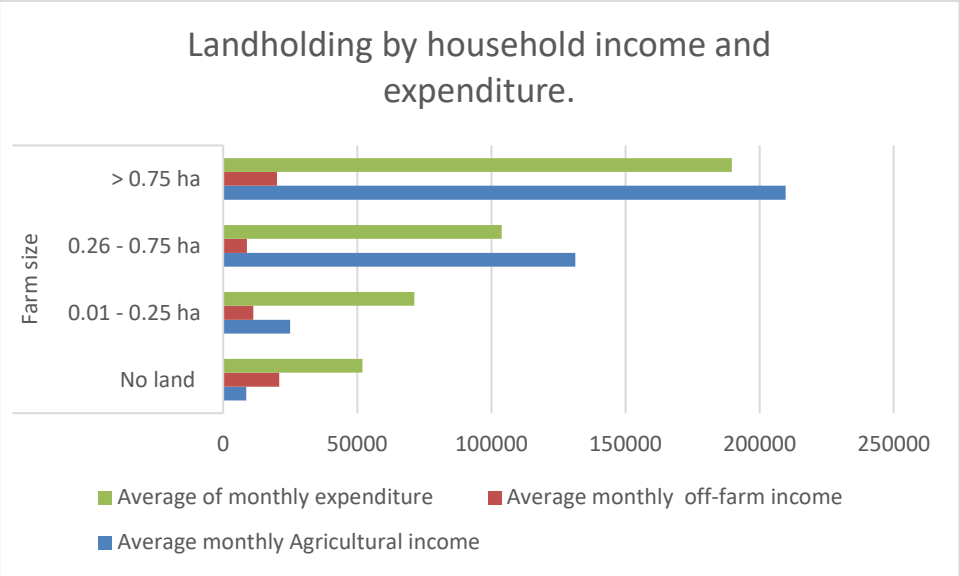

Figure 31: Landholding and household livelihood

4.3.3 Agriculture yield and commercialization

Approximately,57.5% of the surveyed households reported having an extra product to sell to the market; of which 27.8% (almost a half) make less than 5000 Frw per month. Agriculture is more practiced in the middle stream zone and is more likely to be market-oriented compared to the rest of the areas in the catchment; as 42.7% of the households in this area can make from 20000 Frw to 500000 Frw, and above from crop sale per season as opposed to 17% in the upstream zone and 8.4% in the downstream zone.

Irish potatoes are grown by 39.3% of the total sampled households in the entire catchment area and are grown by approximately 62.9 % of the households in the middle stream zone and 48.6% of the households in the upstream zone.

The latest seasonal agriculture survey (NISR, 2020), revealed that the average yield of Irish potatoes in Nyabihu and Rubavu (The Districts containing the middle stream area) is 11882 kg/ha and 11350 kgs/ha respectively.
Participants to a focus group discussion in the Bigogwe sector confirmed that Irish potatoes are mostly grown for sale and provide high profit.
"Irish potatoes growing is a profitable business in this area. Traders from the neighboring urban areas bring trucks and buy from farmers; in this area and a farmer can make around 3 million Rwanda francs on a good season". Said one of the participants in the focus group discussion.

The second most grown crop (considering the entire catchment) is maize that is grown by 26.4% of the households in the entire catchment followed by beans, sweet potatoes, vegetables, banana, and fruits grown by 24.1%, 13,8%, 13.3%, 6.1%, and 3.3% of the total surveyed households respectively.

Maize is grown by 44.9% of the households in the upstream zone and is mostly grown in this zone comparing to other agro-ecological zones. Data from the seasonal agriculture survey (2020) shows that maize yield in Ngororero and Rutsiro (Containing the upstream

zone) is 1277 kgs/ha and 1501 kgs/ ha respectively. Maize is mainly grown for sale in this area as reported by participants to the focus group discussions.

Beans are grown by 27.7% of the households in the downstream area and are the most grown crop in this zone, and followed by banana that is grown by 16% of the household. Banana plantations are mostly found in Rugereo and Kanama sectors and have a potential for increased production and commercialization as the average yield is approximately 12061 kgs/ha.

Table 18 Percentage of households per crops they grow

Types of crops growing	% of HHs within each agro-ecological zone			% with the total number of surveyed households
	Downstream	Middle stream	Upstream	Total
Irish potatoes	0.0	62.9	48.6	39.3
Maize	7.6	16.9	44.9	26.4
Beans	27.7	29.8	17.8	24.1
Sweet potatoes	5	21	14.6	13.8
Vegetables	4.2	17.7	16.2	13.3
Banana	16	4	1.1	6.1
Fruits	0.8	3.2	4.9	3.3

4.3.4 Commercial tree farming

Normally in the upstream and middle stream zones, people plant forests mainly to be able to get firewood, and trees used in construction and hence earn an income through selling trees, however, engagement in this sector as a business is still at a low rate. The data from the household surveys show that 4% of the surveyed households are involved in commercial tree farming. *"You can find like one person in the entire Cell/Sector who considers tree farming as a commercial or entrepreneurial activity and in most cases, they own tree nurseries that sell seedlings to people who want to grow trees."* Said one of the participants during a focus group discussion in Bigogwe Sector.

4.3.5 Best agricultural practices and sustainable livelihood activities

The level of community engagement in best agricultural practices is generally lowest in the downstream zone compared to other agro-ecological zones; and because the average size of agricultural land per household is small in this particular zone, there is a need for intervention in best agricultural practices improvement to ensure adequate productivity. During focus group discussions, community members expressed a need for technical knowledge dissemination in various best and sustainable practices such as composting, intercropping, crop rotation, agroforestry, and terracing.

Composting is being promoted by government extension service providers and is adopted by 48.8% of the agricultural households in the catchment. As presented in Table 19Table 27, composting is adopted by 65.3% of the households in the middle stream zone, 51.9% in the upstream, and 26,9% in the downstream zone.

The use of chemical fertilizers is adopted by 34.3% of the surveyed households in the entire catchment area; with the highest level of adoption by households in the middle stream zone as it is practiced by 59.7% of the households in this zone, as opposed to 36.2 % of the households in the upstream zone, and 5% of the households in the downstream area. Chemical fertilizers and improved seeds are provided at a subsidized price and

distributed by agro-dealers through public-private partnerships, to ensure availability and accessibility to farmers in all the communities.

Approximately 35.5% of the households in the middle stream zone have terraced plots, compared to 13.5% in the upstream zone. Farmers in these areas expressed a high need for terracing and reported technical knowledge and limited financial means as the main limiting factors for adoption; and that most of the households with terraces in their plots are beneficiaries of the projects that operated in the catchment area, through public-private partnerships.

Agroforestry can play a big role in erosion control and improvement in agriculture productivity and hence needs to be promoted. The level of adoption is at 18% of the households in the entire catchment area and mostly adopted in the middle stream zone (adopted by 42.7%) compared to the rest of the catchment's agro-ecological zones. Participants in the assessment reported a need for sensitization and technical knowledge dissemination to ensure the adoption of agroforestry and emphasized the engagement of community members in the planning and implementation of agroforestry programs to ensure a high level of adoption and success.

Table 19: Percentage of households that adopted the best agricultural practices

Type of best agricultural practice	% of HH that adopted the best agricultural practices within each agro-ecological zone			% with the total number of surveyed households
	Downstream	Middle stream	Upstream	
Composting	26.9	65.3	51.9	48.8
Use of chemical fertilizers	5	59.7	36.2	34.3
Use of improved seeds	6.7	51.6	22.7	26.6
Crop rotation	12.6	35.5	29.7	26.6
Intercropping	11.8	23.4	30.3	23.1
Integration of livestock and crops	4.2	28.2	17.3	16.8
Terracing	0.8%	35.5	13.5	16.4
Mulching	3.4	0.8	3.2	2.6
Agroforestry	6.7	42.7	8.6	18.0

4.3.6 Livestock rearing

Livestock rearing is practiced by 29.9% of the surveyed households in the entire catchment regardless of the type of livestock. The middle stream zone has potentialities in livestock rearing, with grazing pastures common in Nyabihu District, especially in Bigogwe Sector. However, there is a need to control the stocking rate, as the Gishwati area located in this zone has been identified as one of the areas where the stocking rates are often higher than the recommended rate of two adult animals per hectare (MINAGRI, 2009).
This zone has the highest number of households that practice livestock rearing compared to the rest of the zones in the catchment, with 54.8% of the households in this zone owning at least one animal; compared to 25.4% and 10.9% in the upstream and downstream zones respectively.
The better-off households are more likely to own livestock; since livestock is considered an asset especially in the middle stream and upstream areas where agriculture and

livestock rearing are the main income-generating activities. This is justified by the fact that in the middle zone, 73.5% of the households in the wealth category 3 own at least one domestic animal as compared to 46.6% in wealth category 2 and 29.4% in wealth category 1. The correlation between livestock ownership and wealth are not quite important in the downstream area, as 17% of the better-off households own at least one domestic animal as compared to 5.4% of the poor households and 13.4% of the very poor households.

Table 20: Proportion of households involved in livestock rearing, per agro-ecological zones and wealth categories

Description	Agroecological zones		
	Downstream	Middle stream	Upstream
% of HHs within each agro-ecological zone, that are involved in livestock rearing	10.9%	54.8%	25.4%
% of HHs within wealth category 1, that are involved in livestock rearing	13.8%	29.4%	14.80%
% of HHs within wealth category 2, that are involved in livestock rearing	5.4%	46.6%	25.30%
% of HHs within wealth category 3, that are involved in livestock rearing	17.6%	73.5%	29.30%

Cows, goats, and chicken rearing are most common in the middle stream zone compared to other zones, since the survey data revealed that 58.2%, 62.9%, and 52.2% of all the households owning cows, goats, and chicken (respectively) are located in this zone. Pigs and sheep rearing are most common in the upstream zone, as 61.5% and 55.6% (respectively) of the households owning pigs and sheep are located in this zone.
The limited size of agricultural land in the downstream area (0.25 ha per household), encourages people in this zone to practice intensive livestock and focus on farm animals that require a smaller space such as chicken and pigs. As detailed in Table 21 below, households in the downstream zone are more likely to own a smaller number of cows, goats, and sheep, compared to the households in the middle stream and upstream zones.

Table 21: Livestock rearing: number and proportion per livestock type

Livestock type	Minimum number of livestock owned	Maximum number of livestock owned	The average number of livestock owned	% of HHs within the total number of HHs that own that livestock
Downstream				
Cow	1	6	2	8.2
Goat	2	3	2.4	14.3
Chicken	1	9	3.8	21.7
Sheep	1	2	1.3	22.2
Pig	2	4	3	23.1
Middlestream				
Cow	1	25	2.8	58.2
Goat	1	13	2.8	62.9
Chicken	1	10	3.3	52.2
Sheep	1	5	3	22.2
Pig	1	4	2.5	15.4
Upstream				
Cow	1	20	2.3	33.7
Goat	1	15	3.5	22.9
Chicken	2	5	3	26.1
Sheep	1	8	2.9	55.6
Pig	1	10	2.5	61.5

4.4 Access and use of financial services

4.4.1 Saving

Households across all the wealth categories can save money monthly; however, better-off households are more likely to have monthly savings and save 301% and 60% more money compared to very poor and poor households respectively. Table 22 below shows that 50.6% of the Households in Wealth category 3 save money monthly, compared to 44.2% and 37% for wealth category 2 and wealth category 1 respectively.
Saving is done using various mechanisms (VSLA, bank, and mobile phone financial services); and VSLA (Village Savings and Loan Association) is the most preferred mechanism, used by 56% of the households across all wealth categories.

Table 22: Proportion of households with a monthly saving and average monthly saving per wealth category

	Wealth category		
Description	Category 1	Category 2	Category 3
% of households with a monthly saving	37.0%	44.2%	50.6%
Average monthly saving (in Frw)	2870	7040	11500

The field data revealed that the maximum range of monthly saving for the very poor household (in wealth category 1) is between 5000 Frw and 10000 Frw, while the maximum for poor families (wealth category 2) ranges between 20000 Frw and 50000 Frw, though only 3% can save up to this amount. Some better-off households (in category 3) can have a monthly saving between 100 000 and 500 000 Frw; however, only 0.6 % of the households in this category can save up this amount.

Table 23: Household monthly saving

Monthly saving per household in Frw	Wealth category		
	Category 1	Category 2	Category 3
Less than 5000	34.2%	28.4%	30.4%
5000- 10000	2.7%	7.6%	8.9%
10000- 20000	0.0%	5.1%	7.6%
20000-50,000	0.0%	3.0%	2.5%
50,000-100,000	0.0%	0.0%	0.6%
100,000-500,000	0.0%	0.0%	0.6%

Better-off households are more likely to participate in community-based groups/associations that focus on members' socio-economic development than poor households. Such associations play a big role in households' socio-economic development and welfare through saving and providing support to households in case of financial shock or any other emergency; however, poor households tend to lack the means to contribute as a requirement to be part of such groups. Table 24 shows that 56.3% of the households in wealth category 3 belong to a VSLA, compared to 45.2% and 37% of the households in category 2 and category 1 respectively.

Table 24: Households participation in VSLA

Do you belong to a VSLA?	Wealth category		
	Category 1	Category 2	Category 3
No	63.0%	54.8%	43.7%
Yes	37.0%	45.2%	56.3%
Total	100%	100%	100%

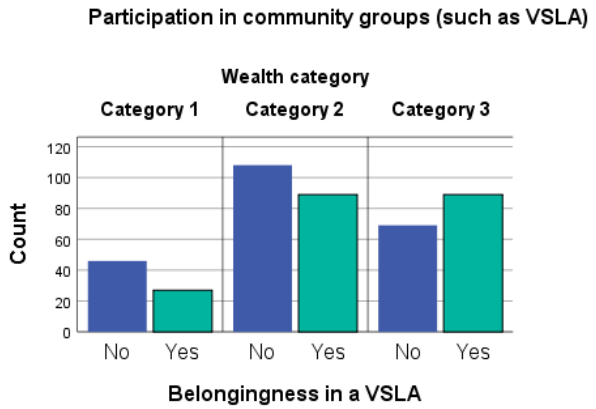

Figure 32. Households participation in VSLA per wealth category

4.4.2 Formal financial services

Ownership of an account in a financial institution (including commercial bank, Micro-financial institution, and SACCO) is at 43.2% of the households across all the wealth categories, with 36.4 % having an account in a SACCO, 4.9% in a micro-financial institution, and 1.9% having an account in a commercial bank. The approximate percentage of households with accounts in financial institutions that have applied for a loan is 16.2%, approximately 7% of the total surveyed households; with a success rate of 100%.

The observed pattern is that loan application is generally low across the households in all wealth categories, but specifically lower in the very poor households comparing to the poor and better-off households.

Table 25 shows that in wealth category 3, 19.4% of the households that own an account in a financial institution (8.2% of the total surveyed households) have applied for a loan, as opposed to 18.5% (7.6% of the total surveyed households) and 5.4% (2.7% of the total surveyed households) in wealth category 2 and wealth category 1 respectively. Rural poor households mainly receive loan packages to engage in businesses such as farming, livestock production, and trade; through a public-private partnership under the VUP Umurenge program (Ezeanya-Esiobu Chika, 2017), this factor explains the fact that the level of loan application in wealth category 2 is closer to that of category 3.

Table 25: Loan application

The proportion of households that applied for a loan	Wealth category		
	Category 1	Category 2	Category 3
% within households that have an account in a financial institution	5.4%	18.5%	19.4%
% within the total surveyed households in each category	2.7%	7.6%	8.2%

4.5 Water and energy

4.5.1 Access to safe water for domestic use

According to the report of the Fifth Integrated Household Living Conditions Survey (NISR, 2018); 86.6% of the population in the Western provision live in a household with access to clean water, and 5.9% of the households have water piped into the home. However, households in the upstream zone of the catchment reported the challenge of the availability of clean water facilities and infrastructures in the community. Water infrastructures are available in an insufficient amount in the middle stream area, but availability is higher compared to the upstream zone, *"One water tap is shared by people in the entire Cell and water is supplied once a month".* Said one of the participants to the focus group discussion in the Nyamyumba Sector. The middle stream zone has safe water infrastructures compared to the rest of the catchment area; however, water shortage and inconsistency in supply are still the most pressing issues.

4.5.2 Household water use

As per the report of the Ministry of Infrastructure (MININFRA, 2010), the daily per capita consumption of water in rural areas was between 6 and 8 liters, and the international standard is 20 liters. Field data revealed that the average daily per capita water use for domestic activities is above the national average in all the agro-ecological zones agro-ecological zones, but still far below the international standard. The daily per capita consumption of water in the middle stream zone is 10.5 liters; and in the downstream and upstream zones, the average is 9.7 liters and 8.1 liters respectively.

Table 26: Average daily water use per household in l/day/capita

Description	Agro-ecological zones		
	Downstream	Middlestream	Upstream
Average daily water consumption for domestic use per capita (in liters)	9.7	10.5	8.1
Average daily water use for livestock per household (in liters)	35	65.9	53.8
Average daily water use for irrigation per household (in liters)	100	64.4	64

The middle stream zone has the highest average daily water use for livestock compared to the rest of the areas in the catchment, with a daily water use per household of 65.9 liters. Livestock rearing is most predominant in this area than the rest of the catchment and has the highest number of livestock per household. Daily per household water use for livestock in the upstream and downstream zones are 53.8 liters and 35 liters, respectively.

Households in the downstream zone have the highest average of daily water use for irrigation, 100 liters compared to 64.4 liters and 64 liters in the middle stream and upstream respectively. Surplus water is discharged to the downstream zone giving the users in this zone more water available for use in various activities including irrigation.

4.5.3 Rainwater Harvesting systems

Among the 428 surveyed households, 28% confirmed to have a rainwater harvesting (RWH) system in place. An RWH system in place on a household property could be a roof water harvesting system with a closed tank connected to it or even a system where rainwater is harvested from the household plot into a small pond.

Approximately, 42.7% of the households in the middle stream zone have a rainwater harvesting system in place, and hence has the highest level of adoption compared to 24.3% and 19.3% in the upstream and downstream zones respectively. There is a need to promote rainwater harvesting, especially in the upstream zone to reduce the risk of landslides and erosion while contributing to water availability as well.

"The water from most of the households' rooftops is not harvested and the runoff plays a big role in landslide and erosion. If there could be a way of harvesting rainwater, it can be used in daily activities at home and even reduce those disasters." said the Environment Management Officer in Rutsiro District during an interview.

Table 27: Rainwater harvesting and use

Description	Agro-ecological zones		
	Downstream	Middlestream	Upstream
Percentage of households with a rainwater harvesting system	19.3	42.7	24.3
Percentage of households using harvested rainwater in domestic activities	19.3	41.1	21.1
Percentage of households using harvested rainwater for livestock	3.4	21.8	2.2
Percentage of households using harvested rainwater for irrigation	0.8	7.3	0.5

Harvested rainwater is mainly used in domestic activities and livestock watering.

4.5.4 Energy sources used for cooking

Firewood and charcoal are used by 99.8% of the households as the main energy source for cooking in the entire catchment; and the remaining 0.2% use other energy sources such as kerosene. Firewood and charcoal are also used as an alternative source for households that use one of these sources as the main energy source, and 0.7% of the households use another source such as kerosene (in kerosene stove) as the alternative energy source.

Firewood is mostly used as the main source of energy in the middle stream zone by 93.5% of the households, followed by 85.4% in the upstream zone, and 77.3% in the downstream zone. Charcoal is mostly used as the main energy source in the downstream zone by approximately 22.7 % of the households, followed by 14.1% in the upstream, and 6.5% in the middle stream. Community members during focus group discussions expressed concern of excessive exploitation of forests for firewood and charcoal, and health concern for the use of firewood on a traditional three-stone stove mainly used in their communities. The use of traditional three-stones stoves is inefficient and results in higher consumption of wood, which increases the environmental footprint due to excessive exploitation of forests.

The commercial charcoal production is common in the upstream zone (Murunda and Muhanda Sectors mostly), and charcoal is transported to the large cities, while a certain portion is sold in the peri-urban areas situated in the downstream area. Charcoal production in this area is still traditional with the use of traditional kilns (mostly earth pit) which is less efficient and requires higher consumption of wood. There is hence a need to explore the possibilities of introducing the use of improved kilns or industrial technologies to limit the environmental footprints of charcoal production in the catchment.

Table 28: Main and alternative energy sources for cooking

The energy source for cooking	Percentage within respective Agro-ecological zones			Percentage within the total surveyed HHs
	Downstream	Middlestream	Upstream	
Main energy source				
Firewood	77.3	93.5	85.4	85.5
Charcoal	22.7	6.5	14.1	14.3
Other	0.0	0.0	0.5	0.2
Alternative energy source				
Firewood	11.8	11.3	12.4	11.9
Charcoal	27.7	14.5	18.4	19.9
Other	2.5	0.0	0.0	0.7
None	58	74.2	69.2	67.9

The approximate proportion of 71.3% of the surveyed households expressed an interest in shifting to a more efficient energy source, of which 49.5% are willing to pay for the alternative more efficient energy source. The average amount a household is willing to invest is 12774 Frw. The interest in shifting to a more efficient energy source is highest in the upstream zone where 74.6% of the households expressed their interest; followed by the middle stream zone with 73.4% and 63.9% in the downstream zone.

Table 29: Interest in shifting to a more efficient energy source

Description	Agro-ecological zones			Percentage/ average within the total surveyed HHs
	Downstream	Middlestream	Upstream	
% of HHs interested in shifting to a more efficient energy source	63.9	73.4	74.6	71.3
% of HHs willing to invest a certain amount of money for a more efficient energy source	48.2	48.4	55.7	49.5
The average amount of money a household is willing to invest for a more efficient energy source (in Frw)	10600	17835	10859	12774

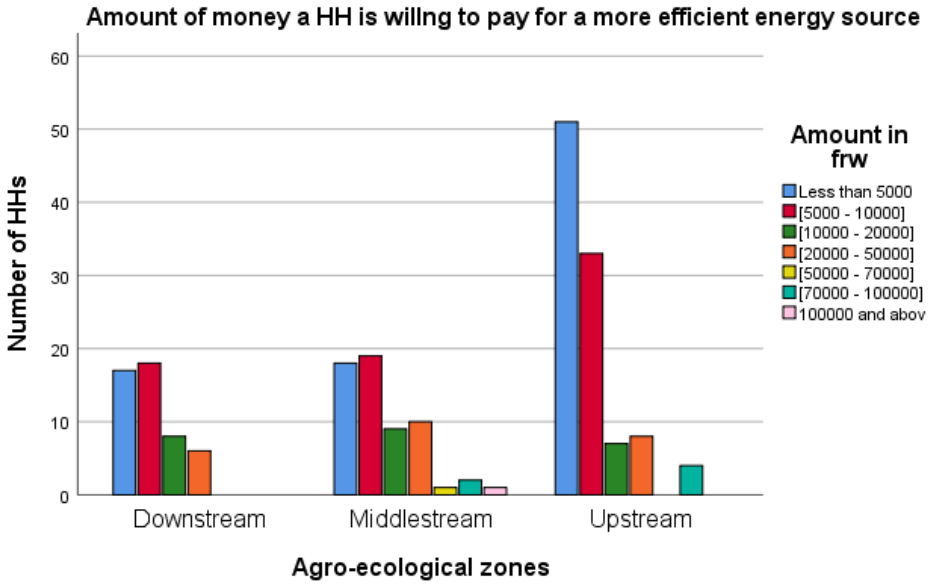

Figure 33 Amount of money a household is willing to pay for a more efficient energy source.

Dependence on biomass (firewood and charcoal) for the source of energy poses a burden to the forests that are excessively exploited to satisfy the need for cooking energy. Energy-efficient products should be promoted to reduce the pressure on forestry for biomass, which can slow or ultimately prevent further deforestation, and an alternative to wood (biogas for example) for energy sources would help where possible.

4.6 Floods & Droughts – Shocks to livelihoods

4.6.1 Floods

The focus group discussions state that "flooding is very common in the areas near Sebeya river", resulting in lives lost, food insecurity, and material damage. Examples of historical information on flooding events were collected by the W4GR program (2017). When the Sebeya river overflows its banks, the results in inhabited areas are catastrophic as they result in high casualties and damage to economic activities. Table 30 shows an example of historical flood events collected by the W4GR project. Flooding of 1 m of the floodplains and 2 m above bridge levels have been reported.

Table 30. Examples historical flooding event in Sebeya Catchment. Information collected on by the W4GR project (2017).

Nr.	Location	Upstream area (km2)	Information	Return period (years)	Estimated discharge (m3/s)	
					min	max
1	Bridge upstream of Mahoko	203	April 2015: Water up to the bel, on the floodplain. Biggest flood since 50 years	25 to 100	60	100
3	Petit seminaire's bridge	215	1 m height on the floodplain	20 to 80	60	80
4	Bridge downstream of Petit seminaire	216	1.7 m under the bridge, each year	0.5 to 2	15	20
5	Bridge upstream Gihira intake	358	Event in 2005 and 2006	0.3 to 20	22	28
6	Weir Gihira intake	359	1 m height on the floodplain	0.3 to 3	40	60
7	Bridge downstream Gihira intake	361	Each year: 2.2 m height above the bridge	0.5 to 3	30	40

Analyses of previous existing reports and rainfall data have shown that rainfall in the Sebeya catchment can be characterized as of a stormy type, with precipitation phenomena concerning a relatively concentrated area (30-100 km^2). The relatively steep sloping upper part of the catchment results in heavy downstream flooding (W4GR, 2017).

Heavy rainfall in the northern part of the catchment (volcanoes area) often results in floods. Whereas the observed floods may appear similar in nature, the dynamics of floods in the volcanoes area are quite different according to their locations: classic torrential rivers in the Sebeya river and flooded endorheic areas (catchments without external outlet, outlet is for example a lake) in Byangabo sector (W4GR, 2017)

Heavy rainfall in the upper, eastern part of catchment leads to high volumes of water flooding downstream floodplains. A problematic region is the area often flooded just south of Mahoko town. Here, Karambo river joins Sebeya river and during local rainfall a gully named Gisunyu also contributes to the flood. A diversion channel was dug in 2016 to change the flow path of excess flow from Karambo and Gisunyu (W4GR, 2017).

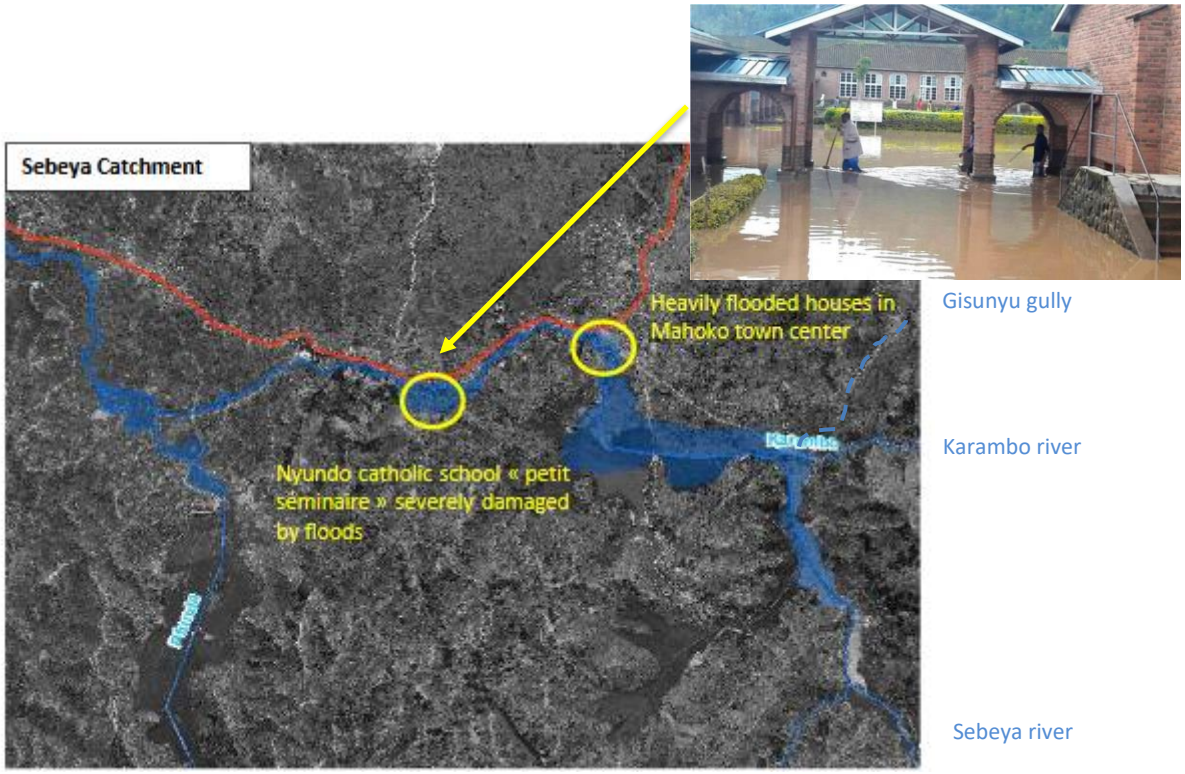

Figure 34. Sebeya flood risk map from the Volcanoes area flood management report, adapted from W4GR 2017, for the Mahoko town area. This site is located about 12 km upstream from the Sebeya river outlet into Lake Kivu, and regularly flooded. Mahoko is located along a section where the Sebeya river is "constrained" on its right bank by former lava flows. This result in a rather flat floodplain (while the watercourse is rather steep) (BRL, 2020). The photo shows the Nyundo Catholic School during the 2018 flood (photo credit: BRL, 2020)

The household survey shows that in total, 21 % of the households indicates that they have experienced a flood (among other disasters). In total, 18 % of the households lists a flood as the main type of disaster the household experiences.

The future flooding vulnerability of the downstream areas will be influenced by sediment transported in the catchment, implemented upstream structures to mitigate peak flow, land use change and climate change.

4.6.2 Droughts

A drought is simply put an exceptional lack of water compared to normal conditions. A drought can manifest itself in different ways: in below-normal rainfall (meteorological drought), in below-normal soil moisture levels (soil moisture drought) or below-normal river discharge, groundwater, lake or reservoir levels (hydrological drought). Human activities (e.g. landuse change, irrigation, groundwater abstraction, etc) influences drought impact, duration etc.

The household survey shows that in total, 17 % of the households indicates that they have experienced a drought (among other disasters). In total, 14 % of the households lists a drought as the main type of disaster the household experiences. The households indicating drought as main type of disaster, are from all 4 districts (villages: Karumbi, Satinsyi, Mahoko, Nyantomvu, Bambiro and Rurambo).

As drought impact, the respondents indicate 1) crop damage and 2) a reduction in yield from their agricultural fields as rains were late in relation to planting. With agricultural activities as main type of income, a drought could even lead to a famine as few respondents (<5) indicated. The respondents indicate that the last drought was less than 1 year ago and that they experience a drought about 'once a year' to 'more than once a year'.

A late onset of rains (meteorological drought) cannot be influenced by the EWMR project activities. The impact of a meteorological drought (soil moisture shortage in the root zone) and resulting crop damage can be reduced by project activities. Improved soil moisture conditions by practicing mulching, adding compost and change from annual crops to permanent vegetation Also rainwater harvesting systems could reduce the impact of droughts.

4.7 Land and Water governance

4.7.1 Land Governance

Regarding the land governance aspects on land tenure, accompanying regularization processes, gender, etc), the Land in Sebeya Catchment like throughout the whole of Rwanda is governed by Land Law of 2013.
Land tenure regularization (LTR) is an integral element of Rwanda's policies for inclusive economic transformation and growth as set out in Vision 2020 and its implementation strategies (Ngoga Hoza, 2018). Also in Rwanda's Vision 2050, which is specifically aiming at adaptation to climate change and achieving a low carbon growth path, it is a prerequisite that improvement of further land tenure (ownership) security must be achieved by the instigating of a robust integrated framework for development planning and sustainable land management.

The government through the Rwanda Land Management and Land use Authority has the mandate of managing all land situated in all catchments in the general interest of all with a view to ensuring rational economic and social development. The land management specifically relates to Rwanda's agricultural policy which aims to transform the sector from subsistence to modern commercial farming, with polices to increase non-farm employment and also gender equality and the empowerment of women. LTR needs to provide farmers with security of tenure (thereby encouraging them to invest in increasing productivity), provide landowners with legal titles of ownership (so they can use to get loans from formal financial institutions to invest in farm and non-farm enterprises), to ensure that women as well as men are able to claim their rights to own land (as provided for in the inheritance and land laws). To that end great progress has been made in the LTR in terms of land right procedures, securing loans for investing in farm and non-farm enterprises, men/ women equity, and reduction in land disputes (see Abbot and Mugisha, 2015; ADB, 2016).

The relevant governmental bodies realize that with land tenure also comes the responsibility to manage the land in accordance to planning codes and the economic incentive to improve the asset. With projected demography, increased competition for land resources will likely continue to grow with increased pressures from intensive agriculture and livestock, exacerbated by climate change impacts. Encroachment on sensitive areas will persist until land reforms are completed. Poor or limited access to land and productive arable lands contributes to urbanization. Industrialization further competes for the limited land resource. It is believed that as the labour force shifts from subsistence agriculture to processing and manufacturing roles, the land demand for

housing changes. higher density urban development will become then increasingly necessary.
In this context, the government has carried out a series of catchment restoration activities in the Sebeya catchment mainly with the construction of radical terraces, reforestation, and agroforestry. In Bigogwe Sector, their interventions have been implemented in the Water for Growth in terracing, and rainwater harvesting facilities provision. An Enterprise called OPEDESA (from 2010 to 2013) implemented some activities such as reforestation, terracing, and planting grasses on the hills for erosion control purposes.

Our study also shows that as an initiative of Districts, activities like reforestation and planting grasses for land cover were implemented in all the Sectors in the catchment but mostly through relatively small interventions and not across a large area.

Furthermore, some terracing activities were implemented in collaboration between the Ministry of Agriculture and Animal Resources (MINAGRI, 2017), the District, and the Rwanda Reserve Force in some areas (Like in Kanama Sector).

It is also noted that measures to protect against soil erosion, including terracing and tree planting, are occasionally undertaken as part of community work (Umuganda) or organized by districts.
It has been reported by Abbot and Mugisha (2015) that in general Individual farmers do not invest in these improvements in the same way they do in improved inputs (seed quality and fertilizers).

Participants of this study that did invest in interventions reported that the catchment restoration activities implemented have contributed significantly to the decrease in cases of disasters such as erosion and landslide and hence an increase in agriculture productivity. “Looking at how people are getting a good production of Irish potatoes from the terraced plots, some people have even started to request the District official to be helped to get terraces on their land.” Said, one of the respondents during the focus group discussion in Arusha Cell (Bigogwe Sector).

4.7.2 Policies for sustainable landscape and water governance

The aspect of sustainable landscape and water catchment governance is promoted by the Agriculture policy, environment and Climate Change policy, Housing policy, Forestry policy, Water policy. There are still some gaps in the mining policy which need to be addressed as highlighted by various researchers. Here below in short are summarized other relevant policies

- **Agriculture policy focus**

The agriculture Policy focus is on development of irrigation in context of integrated water resources management (IWRM) and landscape approaches. Landscape planning and IWRM promotes to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. Landscape approach needs to be followed in order to restore the productivity of degraded landscapes. This will be done by rehabilitating degraded land, by using a combination of natural and protective forests, by improving the management of existing woodlots, and by stimulating the adoption of agroforestry.

- **Forestry Policy**

The forest policy (MINIRENA, 2014) suggests the use of financial incentives to promote agroforestry and the sustainable management and expansion of forests. Finally, the plan sets a target of increasing the nationwide forest cover to 30% by 2016, from a 20% baseline in 2006, which would help reduce risks of climate change impacts over time, The policy recognizes the need to manage forest resources to support the country's development goals for sustainable, low-carbon and climate resilient growth to improve livelihoods of present and future generations.

- **Water Resources Policy of 2011**

The Water Resources Policy (MINIRENA, 2011) calls for adoption of Integrated Water Resources Management approach and catchment development plans in planning and implementation of landscape restoration activities. Also the Energy Policy supports the landscape approach by promoting the need to shift consumption from biomass-based energies to clean energies like electricity and Liquefied Petroleum Gas (LPG) to reduce pressure on forest resources. Water Supply and Sanitation Policy aims for sustainable, equitable, reliable and affordable access to safe drinking water and sanitation for all Rwandans, as a contribution to improving public health and socio-economic development. This implies development of Water Safety Plans.

- **Revised Land Policy of 2019**

The revised Land Policy adopted in 2019 (MOU, 2019) calls for efficient land management for sustainable development. The overall principle is that land must be used for productive and development purposes without compromising its use by future generations. Among measures related to efficient land management, there is enforcement of existing policies and strategies on land reclamation, rehabilitation (vertical and horizontal) and soil conservation measures including transboundary catchment protection initiatives.

- **Climate Change Policy of 2019**

As observed by several research institutions on land governance such as Chemonics (2015) Rwanda has included climate change adaptation elements into some land use policies, regulations, programs and national growth strategies, although these elements are often weak and lack substantive direction or mandate for land use planners and managers (Heermans, 2015). Climate change impacts in Rwanda are amplified by a fast-growing population under an increasing density distribution, with a large portion (45%) of the population living below the poverty line and increasing competition for dwindling natural resources

- **Housing Policy (2015)**

The National Housing Policy (2015) promotes green construction methods that minimize energy use and environmental impacts while also creating healthy living environments for occupants. Many of the green building treatments can be designed as climate adaptation measures, including: onsite storm water retention to reduce flooding down slope.

- **Mining Policy**

as assessed by IGF Mining Policy Framework Assessment (IGF,2017; see also work of Smith School of Enterprise and the Environment, 2011) calls for a regulatory framework for EIA, Environmental monitoring. However, mining policy is still lacking many important aspects such as:

- Water quality guidelines and monitoring specific to metal contamination of water catchment
- Limited capacity to carry out an Environmental Impact Assessment at central and local level
- Lack of formalizing waste management
- Limited experience with mine closure
- Lack of formal process to address ownership for abandoned and orphaned mines

· **Human settlement policy in Rwanda (2009)**

According to the Human settlement policy, MININFRA (2009) the government is encouraging rural population to regroup in villages or Imidugudu, sites equipped with the basic infrastructure. This will contribute to the rational use of land, avail more land for agriculture production and develop more off farm activities and markets.

· **Feeder Roads Policy and Strategy (2017)**

In order to support transport of the value chain for all agriculture produce, The GoR remains determined to improve the transport services through improvement of the feeder roads, since 2011 the Ministry of Agriculture together with the Ministry of infrastructures deployed efforts to support farmers to access market for their agriculture produces with improvement of feeder roads.

4.7.3 Area of degraded land under improved landscape governance and management

The area of degraded land under improved landscape governance and management cannot be readily put in abstract numbers since Landscape governance entails a broad array of efforts and approaches that as well allows for numerous interpretations and perspectives.

For example, Tropenbos & EcoAgriculture (2017) defines landscape governance as "the set of rules (policies and cultural norms) and the decision-making processes of public, private and civic sector actors with stakes in the landscape that affect actions in the landscape". Institutional arrangements in landscape governance vary widely, and a wide variety of configurations can work effectively to support sustainable development. In other words, there is no single formula for "good" landscape governance (Tropenbos & EcoAgriculture, 2017).

In this project we assume that good landscape governance is a precondition for achieving a sustainable landscape. This can be described as a landscape that "helps to meet the principles of sustainable development as defined in the UN Sustainable Development Goals [..and..] aims to ensure synergies and minimise trade-offs between economic, social and environmental (including climate) goals where these objectives compete" (Denier et al. 2015). The map below shows the areas in Sebeya catchment where it is known that the rules and decision-making processes are done in such a way that the actors and interests in the landscape are coordinated so that the landscape can be managed well.

The Giswati-Mukura National Park recently designated as one of UNESCO biosphere reserve is managed by the Rwanda Development Board (RDB). The Landscape Approach to Forest Restoration and Conservation (LAFREC) project is restoring degraded Gishwati-Mukura landscape by rehabilitating forests and biodiversity within its forest reserves, enhancing sustainable land management in the agricultural lands between them. Landowners in the Gishwati forest buffer zone are required to abandon growing food

crops such as potatoes, beans, maize, and they are supported to transfer to others and only grow tea, plant trees, and establish pasture in the buffer zone. These crops avoid conflict with wildlife along the boundaries of the NP.

Some other areas in Sebeya catchment were restored by different interventions from REMA and for example the LAFREC project. Silvo-pastoralism (a type of agroforestry) was introduced in rangelands and trees were planted in the Silvopastorale zones.

The Ha of land under improved landscape governance is (source: REMA):

- Silovpastoral: 86 ha
- Afforested zones: 260 ha
- Restored areas: 442 ha
- Gishwati forest National Park: 1832 ha
- Total: 2620 ha

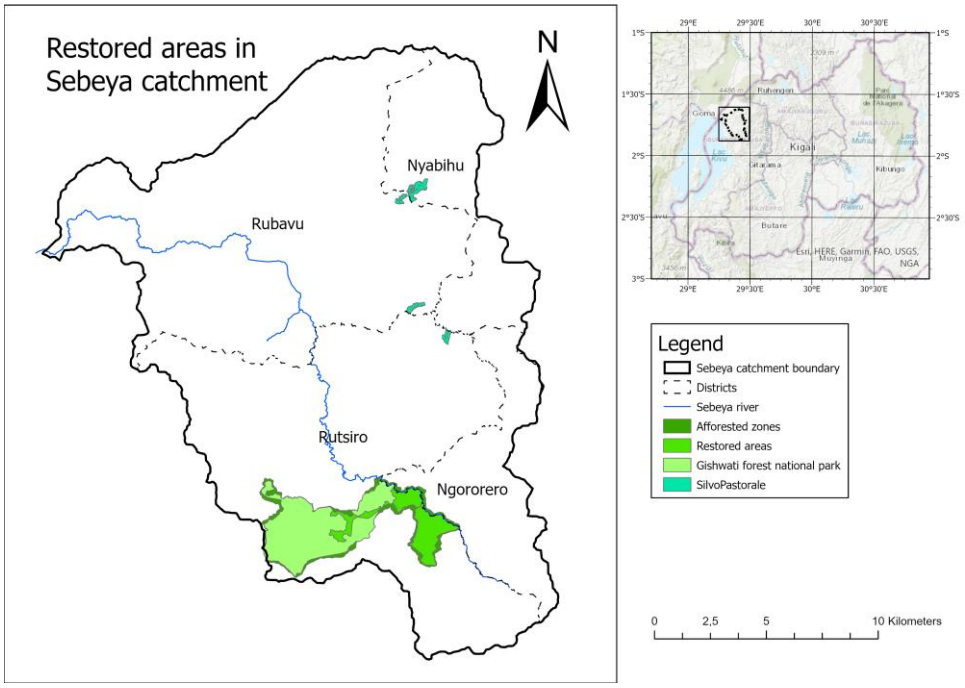

Figure 35. Known area of land under improved landscape governance. The area indicated as 'afforested zones' are part of the Gishwathi Mukura buffer zone around the National Park. (source: REMA)

The area under restoration is higher than the number of ha under improved governance as there are many small initiatives ongoing throughout Sebeya Catchment. There is restoration and reforestation along riverbanks, although exact numbers are difficult to determine (due to several reasons; for example the storage of restoration activity progress data is done per administrative boundary, instead of subcatchment boundary). Local initiative to reduce gully erosion is also ongoing. Even minor changes, such as the application of organic compost to agricultural fields could be classified as Ha under restoration.

Agricultural land can be protected in a number of ways, such as by construction of progressive or radical terraces. The total ha of radical terraces have been mapped and are taken into account in the area under restoration. The total ha of land under restoration in Sebeya Catchment is therefore 5227 ha. This value was cross checked with the ARCOS

(2018) FLR Stocktaking report. The ha of restored land in the period of 2011-2018 in Sectors part of Sebeya catchment was reported as 5139 ha in total.

Furthermore, there are ongoing (small) catchment restoration activities reported by the participants to the FGDs and key informants' interviews:

- the activities being implemented as part of the IUCN project, where terraces are currently being built in areas such as the Muhanda, and Murunda Sector.
- In the downstream area such as Kanama Sector, community members had an initiative of planting trees along the Sebeya river, but they were damaged by flooding.
- There has been an initiative of a Mining Company that planted bamboo trees along the Sebeya river (near the source) to protect the river
- Reforestation, agroforestry, and terracing are in most cases done through joint action between community members and the local leadership; and the activities are done mostly during monthly community work (Umuganda).
- In some areas, afforestation is being adopted by many community members since the ownership of a forest is considered as an important asset, that later becomes a source of income through selling trees, and can even serve as collateral for a small loan in micro-financial institutions and SACCOs.
- Community members' initiatives in landscape restoration and management are limited to some measures such as digging contour trenches, planting grass around their plots on hills, and a very small number of people, with financial means, make terraces in their plot.

4.8 Challenges with Land/Water governance

4.8.1 Village and micro catchment plans developed

With the EWMR project, two slightly different approaches will be used. Village Land Use and Action Plans (VLUAPs) will be developed for all villages to support the community approach. But where there are Micro-catchment Action Plans MCAPs (W4GR project), the VLUAPs will build on, enrich and validate the MCAPs available.

This project will build on the work of W4GR in terms of taking the MCAPs and using them for the VLUAPs which will be implemented by the villages based on performance contracts. W4GR had developed a total of six MCAPs for Karambo Subcatchment.

The VLUAPs will make it easier to validate where "actions" will happen. Implementation of VLUAPs started in the second half of August 2019, and at the end of November 2019, 0 VLUAPs have been completed but the process of the developments in Rubavu and Rutsiro is ongoing.

4.8.2 Villages implementing restoration actions

In the villages were the VLUAPs are under development, implementation of these plans could start. These plans and actions will be integrated into the village performance contracts (*imihigo*). The villages and the project will monitor the work as a basis for performance-based incentive payments.
VLUAPs are following administrative boundaries and are implementing restoration activities based on Villages performance contracts when issues of degradations, pollution are beyond administrative boundaries. This is still a challenge for sustainable land and water resources management that is related to ongoing resources governance which in turn tied to political governance.

VLUAPs are putting focus on terracing activities in targeted agriculture fields. It is also important for people in the basin to understand and learn on the various causes and factors that degrade or can restore their resources. This allows for example also farmers up stream to assess the impact of non-action on downstream infrastructure such as Water treatment or a hydropower plant. With the realisation and understanding of these interdependencies throughout the basin, mitigation and restoration actions will have more success.

It is recommended to strengthen the villages leaders in understanding the concepts of basin or catchment approach and to move gradually towards catchment or basin planning and implementation of restoration activities that are holistic and sustainable. It is through catchment basin that root causes for degradation are analysed, discussed with all stakeholders and translated in a transparent plan which then could be implemented with support of the district officers and private operators.

4.8.3 Catchment committees in Sebeya catchment

According to the Water law of 2018, catchments committees need to be put in place at each catchment level according to the Master plan for water resources. Sebeya Catchment has been delineated according to the current master plan of water resources of 2015 and efforts were deployed to come up with a catchment plan with assistance of the Water for Growth Program by 2018.

However, in terms of governance, an overall Catchment Committee for Sebeya Catchment, with day-to-day guidance of water resource management related activities, was not in place in 2019.

In some areas, the existence of local committees or task force for landscape governance and management were reported, but they are not well functioning due to a lack of financial incentives. The committees are existent in the areas where the catchment restoration activities are already ongoing, while in the other areas, they rely on the local and community leadership that is built from the village level. "*We have voted a committee, they worked only a few days and then stopped because they invest their time and effort but do not get any incentive; so, they got discouraged*". Said, one of the participants in the focus group discussion in Muhanda Sector.

It is recommended to fill the gap of land and water governance by working intensively with Rwanda Water Board, concerned districts in the catchment, such as districts of Rutsiro, Ngororero, Rubavu and partly of Nyabihu to set up a functioning catchment committee in order to effectively address issues of land and water governance in Sebeya catchment and its restoration. The catchment committee is set up to strengthen existing structures in terms of effective planning, monitoring the implementation and fund mobilisation. It will be important also to work together with concerned sectors in sub catchments of Sebeya which are Karambo, Bihongora and Pfunda in order to come up with improved governance system at sub catchment level of land and water.

4.9 Sustainable practices for livelihoods, communities, and enterprises

Sustainable practices to improve livelihoods, empower communities and private sectors are part of the government policies and strategies. Government through various agencies, Districts, and development partners are working hard to come up with such practices and emphasizing sustainability aspect as recommended by SDG commitment.

4.9.1 Livelihood

Access to information value chain improvement

Community members in the catchment mainly rely on the information provided by local/community leaders regarding value addition technics and opportunities as well as market opportunities. Approximately, 10 % of the surveyed households practice activities that involve value addition/ value chain improvement and confirmed that they still need to get more information and knowledge regarding value chain improvement.

Status of Payment for Ecosystems Services

The Payment for Ecosystems Services (PES) is a new approach that has not been adopted yet in the Sebeya catchment as reported by most of the key informants. "*PES is a new approach, so there is no such mechanism in place in this section of Sebeya catchment*" said the Environment and Natural Resources Officer of Rutsiro District.

Some opportunities can be seized to introduce the PES approach though. With most of the population having noticed the damages caused by disasters in this area, it allows introducing the ecosystem conservation that may focus on agroforestry and reforestation. The local community members with tree nurseries may be given an incentive to produce tree seedlings that can be planted by other community members as part of agroforestry initiatives.
There is a mining company that took the initiative to plant bamboo trees along the Sebeya river (near the source). Such initiatives involving private sector actors may be redirected into a PES approach to have these companies pay an incentive to the community members to do such initiatives on their own.

People living in the downstream areas (close to the Sebeya river) have reported that flooding is in some cases caused by the sand that fills the river and reduces its depth, and proposed that having a group of people (maybe a cooperative) constantly removing that sand from the river could reduce the issues of flooding. That sand is needed for construction activities and can be considered as a natural commodity that can be used to provide an incentive in a PES mechanism.

Downstream companies that are being more affected especially during flooding and also which benefit from upstream farmers' efforts include Bralirwa, WASAC Ltd, Hydropower plants such as Keya or Gisenyi, and Tea companies. Those companies are ready to support upstream farmers with improved activities of mitigating flood, reducing the turbidity and sediment load which keep affecting their business. They had already started with some support activities of afforestation, tree nurseries development and improved land management. Mechanisms to formalize those initiatives need to be well defined, funds to support their activities need to be well designed together with more involvement of Districts, local banks, FONERWA and PES will be effectively implemented.

4.9.2 Community Work

Community erosion control measures

The current HIMO approach (High Intensity Main d'oeuvre) of community work promoted by MINALOC in many parts of the country including Sebeya Catchment is widely appreciated by the community since they get paid for some work of landscape restoration, road maintenance or other infrastructures development. The Community is financially and technically empowered. Under Sebeya project a national guideline incorporating

aspects of HIMO approach, with more focus on Land scape restoration and Integrated Water Resources is being tested and will be further duplicated to other catchments.

The community members' initiatives in erosion control are limited to some measures such as digging contour trenches, planting grass around their plots on hills, and a very small number of people, with financial means, make terraces in their plot. The most common limiting factors are a low level of knowledge in landscape restoration and management, and lack of financial means for the activities that require a significant budget such as terracing.

Reforestation, agroforestry, and terracing are in most cases done through joint action between community members and the local leadership; and the activities are done mostly during monthly community work (Umuganda), but with a very limited technical knowledge in this domain.

As an effort of the government through Ministry of Agriculture and Animal Resources (MINAGRI), Districts, and the Rwanda Reserve Force in some activities like reforestation, terracing and planting grasses for land cover were implemented in the catchment but did not cover a large area.
Participants reported that the catchment restoration activities implemented have contributed significantly to the decrease in cases of disasters such as erosion and landslide and hence an increase in agriculture productivity. “Looking at how people are getting a good production of Irish potatoes from the terraced plots, some people have even started to request the District official to be helped to get terraces on their land.” Said, one of the respondents during the focus group discussion in Arusha Cell (Bigogwe Sector).

4.9.3 Enterprises

Major private companies involved in the catchment

There are a mostly a good number of cooperatives which are involved in various activities in Sebeya catchment. There are mining cooperatives which operate like companies such as CEMIIYAKI, sand extraction cooperatives, gravel cooperatives, there are companies dealing with treatment and distribution of drinking water from Sebeya river such as WASAC LTD; Hydropower companies such as Keya Hydropower plant, Gisenyi Hydropower plant. Bralirwa company that produce Mutzig beer, Tea company such as Pfunda tea ltd. Other entrepreneurial activities include mostly cooperatives that deal with agriculture activities, production of Irish potatoes, horticulture or milk and cheese or honey processing and handcraft making.

New entrepreneurial activities

As discussed in the section on livelihoods, most of the households earn their income from agriculture and livestock. Approximately 3% of the surveyed households reported that they earn an income from new entrepreneurial activities such as mining, modern horticulture, various crafts related businesses, and other professional services such as veterinary services.

Table 31 percentage of households involved in entrepreneurial activities

Involvement in new entrepreneur activities	Number of Households	Percentage
Yes	14	3%
No	414	97%
Total	428	100%

New entrepreneurial activities are noticed in peri-urban areas (Kanama and Rugerero) and are mostly service businesses such as mobile money transfers, and online service application assistance (IREMBO) which are mainly adopted by the youth.

In the rural areas of the catchment (mostly in Murunda and Muhanda) the most prevalent new business activity is mining, and the mining companies are mainly owned by external investors that employ local people. Milk and honey processing are the most common value chains that provide an opportunity for employment with a likelihood of promoting new business opportunities in the catchment. There is a ready market for milk as farmers sell to milk collection centres available in their proximity, before the milk is sold to big processing plants in the neighbouring cities and in Kigali. Honey undergo primary processing and packaging and a small portion of the products is sold locally while the largest portion is sold to other cities.

People coming from the city to Sebeya for business

The availability of mining sites mostly concentrated in the upstream areas especially in Murunda and Muhanda Sectors attracts mining companies from urban areas to start investing in this area and hence provide employment to local community members.

The middle stream is suitable for agriculture production and livestock, compared to the rest of the areas in the catchment. The area is favourable for Irish potato production and cattle rearing (especially in Bigogwe Sector); and this attracts investment in rural-urban trade, with individual traders buying Irish potatoes from this area to be resold to neighbouring urban areas. Milk is mainly sold to milk collection centres available in the vicinities of the catchment.

5 Knowledge management systems

Knowledge management systems (KMS) is the process of creating, sharing, using and managing the knowledge and information of an organization.
Here below we assess the status and level of implementation of several key aspects of the KMS status (through SWOT approach) regarding landscape restoration, IWRM, and climate change adaptation. For example, how are the use of GIS tools such as community mapping, CROM DSS and other software tools and techniques? Level of efforts to building capacity of the local officers and community (since W4G program), etc.

5.1 Data, information, and knowledge

Rwandan knowledge management systems (RKMS) are imperative for:

1 Transferring knowledge from project experts/owners/developers/implementers to local communities for them to be or become empowered, inspired and contribute to the implementation and management of that in a sustainable and restorative way.
2 Identifying information gaps, required level of education. Experience/expertise for setting up and managing for example nurseries, terracing, manure production, water drainage technology other etc. and subsequent
3 Other knowledge to move from traditional agriculture to something resilient i.e., the transition to new more resilient futures.

In this baseline study we have looked in particular at the present status, functionality and main gaps in relation to required information needs of the current KMS, the RWB data needs and disclosure, monitoring Project impact and communication, and the landscaping actions and opportunities and their supporting policies.

The assessment, findings and definition of any type of improvements were the results of discussions (direct or through focus group sessions) with relevant staff, key informants as well as technical experts such as district's agriculture site technicians and community population representative. Furthermore, also SWOT analyses were carried out in particular for the evaluation of the KMS and the current policies in line with catchment management at policy level.

5.2 Status of knowledge management systems

With regard to the baseline status of data collection, storage, dissemination, sharing and communication and as to what exists at present, and gaps, the findings of the KMS SWOT analyses is presented in Table 32 followed by other reports, input and recommendations collected during the HH survey.

Table 32. SWOT analyses outcome on KMS and underlying Monitoring & Management networks

Strengths	Weakness
The existence of Rwanda Water Resources Board that is directly linked to Prime Minister's office **Existing of Good Hydrological Database Aquarius** **Existence of Good Geoportal Database Framework** **Availability of a functioning Water Portal** **Existence of good network of Telemetric Hydro stations** **Existence of designed Water Permit System** **Dedicated Staff operating the existing Management Systems** **Local staffs trained on some aspects of community mapping, IWRM, landscape restoration**	Lack of equipment's, tools at district level Lack of continuous capacity building programs at community, district level Lack of integrated systems for GIS data at districts levels Lack of planning guidelines based on catchments limits but on administrative boundaries Inadequate coordination of data from other users Lack of sufficient funds to support the Telemetric hydro stations Lack of data sharing on rainfall from Meteorology agency Lack of Licences for existing software especially for GIS Use of Commercial software that limit the wider usage at district level Low involvement of districts officers in existing Management System (see below) Inadequate capacity to analyse, process and transform water data into policy briefs and management decisions Lack of regular monitoring of water quality data Poor monitoring of groundwater system Lack of regular monitoring on Ecosystem health Lack of involvement of communities in their water resources (see below) Insufficient knowledge and skills on GIS, Remote Sensing, water modelling, flood early warning Lack of harmonized interests and approaches at institutions dealing with water quality monitoring and surveillance
Opportunities	**Threats**
Existence of CROM DSS on erosion issues by Districts Delineation of Catchment boundary **Designing of Flood Early Warning system for Sebeya by World Bank through LAFREC Project** **Existence of dedicated stakeholders at Meteorology, Ministry of Disaster, and Districts** **Existence of Government structures reaching every community at village level**	More water pollution of Sebeya river and all tributaries Increased flood, landslides and droughts related calamities Decreased agriculture productivity due to flooding, Human loss during the flash floods Increased insecurity due to frequent floods events Increased human pressure on limited water resources Pressure on land leading to conflicts

Generally, despite all efforts in capacity building received by previous programs on Land scape restoration, planning and implementation in context of IWRM, at all visited areas,

citizens seem to be working business as usual. They are involved in restorative activities such as terracing or tree planting according to the usual implementation approach. At community level, the population has a representative at each site and the district is represented by an agronomist who supports them in all aspects of Landscape restoration. There is a structure in place for locals and their communities to be involved.
Nonetheless, it is found challenging for many of them to practice the activities supporting the improved & integrated landscape restoration through the acquired knowledge due to the following reasons:

- Knowledge transfer through the meetings at district level is often structured (and felt) in a way where the agronomists instruct and tell team leaders on the hills, what needs to be done.

- It seems challenging to hire capable and well-trained locals who are often not available. Outside workers are mostly hired and recruited to build terracing or a number of drainage system techniques and so on in the area of concern.

- The local team leaders in the communities have very little means with low mobilisation to implement work and compensate their workers.

An example was put forward, on several occasions, concerning the production of seedlings. Often companies or corporates are hired that produce seedlings from seeds produced elsewhere. It was pointed out by the local communities that they can also organise their own nurseries and incubate the production of their own seeds that can stimulate the local community development better.

A similar issue was perceived for the production of manure or organic fertilisers. There is the opinion that it also can be produced by the locals themselves. Now, a company is often hired to collect organic material to a central production location, then processes it to fertiliser and soil improvers and then brought back into the region. It is believed that if communities could produce themselves locally then the local structures and households could be involved more cost effectively.

An improved and collaborative partnership between the communities, the experts and districts heads can help to mobilise better the knowledge at local level and develop local ownership of the restoration projects, improving in turn the local desire to get more involved and being really a part of it. However, it is important for the 'empowerment of resource-users' through 'community participation' and 'livelihood security' that it is driven by the right socio-ecological and socio-economic considerations supported by secure evidence in time allowing communities to move from a plethora of (expensive) planning, to implementation.

We stress that independent science, its application, and learning, plays an important role in the fate of catchment restoration. The interest of politically engaged experts or heads, policy makers and international donors is important but usually temporary in nature and the duration of their involvement in a policy or project may be short, and thus implementation is often frustrated by lack of continuous commitment. Catchment restoration, conservation, poverty alleviation and also environmental monitoring are vulnerable to shifts in fashions of thinking, and at local level, trained and experienced personnel responsible for management, monitoring and/or research get confused and

often lose commitment to project objectives by interruptions and switches of policy and financing.

Creating continuity is therefore key and an opportunity. It was remarked that at schools there are some good possibilities to be regularly taught on restorative techniques. To train local communities (e.g., at Ngororero), the University of Rwanda could also be involved to train in applied sciences even at dedicated places where restorative approaches or interventions can be demo-ed and further developed as teaching element for long time to come.

5.3 RWB data needs and disclosure

5.3.1 RWB data needs

To identify the current needs of RWB in modelling, monitoring, remote sensing, etc, we have assessed the available, and under development, data collection and monitoring systems.
Discussions were held with experts and practitioners on modelling needs, on use of remote sensing in water resource development, drone technology, on use of Google Earth and other tools such as QGIS in hydrology and flood mitigation.

As noted, there is a lack of regular monitoring of both surface and ground water quality. Seemingly, the Sebeya catchment is monitored for water flow and precipitation only through (BRL,2020):

- Two automatic water level station:
  - Nyundo with 15-minute time-steps, start of time series in 2017.
  - Pfunda with 10-minute time-steps, start of time series in 2020.
  - 3 others (Sebeya Mahoko, Karambo, Bihongora) are to be functional in 2020.
- Two daily water level stations:
  - Gisenyi-Kivu / Gisenyi-Sebeya, with a 40-year long time series (1974-2014, with an overall data availability lower than 60%, and a 9-month time series 2016-2017)
  - Nyundo with a 40-year long time series (1974-2014, with an overall data availability lower than 70%)
- 6 automated rain gages at 10-minute time step but with numerous gaps. Most are located in the downstream part of the catchment.
- 5 other automated weather station (with rain gauges) located in the vicinity of Sebeya catchment (from the Rwanda Meteorology Service)
- 1 groundwater monitoring station in Gisenyi, active since 2018

Figure 36. Locations of the monitoring stations in Sebeya catchment and vicinity. Monitoring stations and locations (for field surveys) of the Rwanda Water Board and the Rwanda Meteorology Service.

Given the size of the catchment, the heterogeneity of the rainfall spatial pattern and the response time of the river, these data are not sufficient to monitor the hydrological driving and response parameters completely. Historical hydrological data is available but not suitable for all applications. For example, the historical discharge data is available mainly on a daily interval which is insufficient to capture the typical duration of flood events occurring in the Sebeya catchment. The duration of flooding is considered to be in the

order of hours. Daily data may then miss the peak flows that are important for flood analysis (BRL, 2020).

Concluding, there is a need for regular basic monitoring on surface and ground water quality. Also a structural screening of indicator aquatic species and biodiversity is lacking and should be recommended as part of the catchment conservation and restoration. A monitoring program carried out by for example in close cooperation between REMA and RWB should be tested and implemented to develop a more focused biodiversity monitoring system.

Lastly, an adapted monitoring program for water quantity throughout the Sebeya catchment is recommended. Current activities are not sufficient to elaborate on and follow the hydrological cycles, dynamics and future drivers impacting that.

Modelling

With regard to the basic inputs needed for proper modelling of the water resources, it was noted that there is a need for so-called open software sources such as QGIS and use of the licensed GOOGLE engine (e.g., https://aqua-monitor.appspot.com/), and a need to have licences for WEAP at operational level not only at planning level. There is also a need to validate (i.e., ground-truthing) the rainfall data collected through remote sensing techniques with rainfall data collected in the field at dedicated locations throughout the catchment.
Furthermore, there is a need for the practical use of the existing Flood Early Warning system as developed through LAFREC project with assistance of the World bank.

5.3.2 Disclosure of data and information

To summarise the baseline for key information portals on catchment related issues discussion have been held with technical experts who are involved in the water resource database AQUARIA, GEO and WATER-portal and the Water permit portal. The general description and the findings on their status, their current functioning, and developments as well as recommendations are presented here below. Also, guidance and matters to consider for future evaluation on data platforms and web portals are provided in Appendix 5.

5.3.3 Water permit system

The Water Permit System, https://www.waterpermit.rwb.rw , is an online system through which water permits are applied for, granted and registered. This is a system seem to have been developed by a freelance consultant following a model of Land Information System which is not suitable for the public Water System. There are several shortcomings of the current system:

- The Water Permit System does not seem to function properly and there is no source code accessible by RWB to make necessary adjustments. This severely limits responsiveness to address issues and poses a serious sustainability risk as long as IT/programming skills are not available in-house.
- The system was designed following the water law of 2008. Since then the water law has been revised making this system somewhat outdated and ready for an update.
- The system and its design is found not user friendly due to the use of technical jargon with regard to water catchments, waterflow, proportional water allocation and monitoring details.

Currently, the system is not serving its purpose and staff at RWB are using excel sheets to record and manage their water permits. Currently, the upgrade of the water permit system is planned, and the process has already started with the assessment of its current status, process of gathering inconsistencies, and the required improvements in close collaboration with RWB.

As for the EWMR project in Sebeya Catchment, we would recommend a user-friendly design including a simple database recording all Water Users in the catchment acquiring a water permit as required in the revised water law of 2018.The system should be sufficiently generic to become applicable to other Rwandan catchments.

5.3.4 Water permit system

The Geoportal system, https://www.geoportal.rwb.rw, of the RWB can store all useful GIS layers required for proper planning and management of water resources country wide. There are several challenges in the management and usage of the Geoportal:

- The Geoportal is currently empty (no layers or maps available) to visitors of the portal but there is a roadmap to update the spatial data for visitors. A start will be made by entering most of the layers available at RWB such as erosion risks, restoration opportunity maps, land use and cover map of 2018, catchment boundaries, water bodies and other important features and projects going on in RWB such as the Volcano flood management project and the hydrogeology assessment in Eastern Province. Many spatial data layers and documents are already uploaded to the Geo-Portal by RWB staff and these data are accessible by all RWB staff with authentication. However, these data are not yet accessible to the public by they must first go through a validation process and have to be provided with all the necessary meta data.
- The main challenge is the general lack of skills in GIS and Earth Observation (EO). There is a need for capacity building by specialised trainings on GIS, Google earth Engine, image processing and other spatial tools at governmental and district levels.
- The layers containing spatial information are currently stored at RWB in the form of GIS maps using ArcGIS Software. ArcGIS is a good GIS software used but it requires an annual license. This is a financial challenge for the RWB in using and displaying various GIS layers stored in the Geoportal system. Discussions with RWB staffs indicated that it would be good to explore the use of open sources software such as QGIS. The spatial data that are to be stored and shared through the Geo-Portal will be downloadable in open formats usable with commercial software like ArcGIS or free software like QGIS.
- The RWB is also receiving real time satellite imageries from the National Institute of Statistics Rwanda (NISR) however they are in use by only a few staff members and not readily known and used by the RWB.

To summarise, awareness of the importance of spatial data in achieving development strategies seems high in Rwanda. There is a need for capacity building for both government and non-governmental institutions to use Geographic Information Technologies (GITs) in their daily routines.
More specifically, there is a need to compile all layers for the Sebeya EWMR project and upload them in the Geoportal. This, along with the general desire to switch to open source software, will facilitate better a future project continuation and analysis.
The non-existence of a National Spatial Data Infrastructure (NSDI) in Rwanda is worrying and also a spatial data policy relating to spatial data use is still lacking. A mechanism as in other African countries to ease spatial data access and sharing is imperative. For

example in Kenya and Benin were the use of Free and Open Source Software (FOSS) and spatial data infrastructures (SDI) for sharing open access data, Citizen Observatories (a.k.a. Citizen Science) and remote sensing for water productivity and water accounting are being implemented (Along with QGIS OpenCourseWare, Online courses, short courses and tailor made trainings in GIS).

5.3.5 Water portal

The waterportal (www.Waterportal.rwb.rw) contains verified but limited information, on water quality, and water levels. The available information on field validation appears to be added on *adhoc* basis depending on projects coming. The data on water quantity (stage and discharge) coming from the telemetry stations are inserted into the database automatically real time.

For now, there are recent updates on some data sets and experts involved are to be working on improvements of the site and the amount of available quality data as well as content for example the improvements on coefficients and equations at local catchment level to improve on the hydraulic calculations required.

The institution is in transitional phase with relatively high number of new staff and young technicians.

The Water Portal can provide more data based on the actual needs of the water Users, for this can carry out a water users assessment and adapt the portal design accordingly.

It is recommended that the RWB is to soonest organise- along with sufficient budgeting - a regular monitoring on key parameters. There are good opportunities since the institution is linked to the Prime Minister Office.

5.3.6 Water Resources database (Aquarius)

Aquarius (www.Aquarius.rwfa.rw) is the database for storage of water resources data (quantity, quality, groundwater, surface water, and meteorology as well) and accessible through the Water Portal: https://waterportal.rwb.rw/data/. Some data is uploaded into the database from automatic monitoring stations through a telemetric system (SMS/GPRS); Manual *in-situ* measurements are uploaded by various staff members of the RWB. Historical datasets can also be downloaded. More regular data from the Hydrological and Meteorological stations could be uploaded when communication facilities and ICT are improved.

Data is easily downloaded though the portal and metadata are clearly displayed on the download page. We observed however that the metadata quality can be improved by providing a more detailed situation description of the measurement locations (include picture, riverbed profile and changes in river bed profile through the years, description upstream situation and river banks) and to provide the Q-h relation (formula to calculate the discharge based on velocity and river level) for the monitoring station.

One of the challenges discussed with staff of RWB was related on how data and information from Aquarius could further be processed to meet multiple needs by different Water Users. This requires not only additional license for data processing but also improved skills for hydrologists at RWB in order to be able to develop appropriate tools for handling the recorded data in Aquarius. The purchase of an additional license for AQUARIUS Workstation is planned and a subscription to the SMA (Support and

Maintenance Agreement) has been taken out in order to strengthen RWB's capacities in the use of the various tools provided in AQUARIUS.

For the case of Sebeya Catchment, data is recorded and available from Aquarius Database. How this data could be of use in terms of planning, water supply and demand, reporting and usage is unclear.
Capacity building and training on the analyses, aggregation, interpretation, and translation of hydrological data into the proper design of various hydraulic infrastructures (such as bridges, culverts, storage ponds, dikes, gabions walls) is recommended.

5.4 Project impact and communication

Rwanda's hilly landscapes and ecosystems are degrading at unprecedented rate. It is important to build resilient landscapes, restore healthy and productive ecosystems and create regenerative business for generations to come. Improving economic, social and ecological restoration through the transformation of the food and agriculture systems is however a complex and major undertaking. This baseline study shows that Rwanda needs viable solutions based on social and ecological needs, science and entrepreneurship.
Practical holistic approaches need to be demo-ed in Sebeya Catchment, they need to be produced on location and shown and communicated in such a way that the stakeholders understand and feel inspired about and join in.

Our survey showed that currently there is no existing communication strategy implemented. This allows the design of a cost-efficient and modern strategy that can inform the problem owners and other stakeholders. Here below we present several options and suggestions to build up the communication strategy allowing a better disclosure and uptake of project related impacts.
Firstly, it was noted that use of social media for water resources related issues of all sorts is welcomed and can be encouraged further by the use of Instagram, Twitter, Facebook. Regular updates of what is going on in the relevant institutions is important and seems interesting for the public and the authorities. There is a demand for disclosing information on in particular the weather (rainfall), water quality and quantity (prevention and mitigation). Observing the current information sharing practices and flaws, this can be relatively easily improved and possibly as a next step also be extended on information on groundwater issues as well as activities affecting that such as mining activities.

Secondly, to circumvent communication on the complexities of the intrinsic relation between environmental health and resilience and productive, healthy communities, and improvements on that, one could take note of the publications of the health sector for health education and information dissemination (booklets, magazines, leaflets, posters and flip-charts, billboards, billboards, etc) and radio programmes written and presented either in English or Kinyarwanda. The publications could then also be focussing on carrying communicable information on preventing damage to the environment (landslides, erosion, pollution, etc) rather than only warnings on certain possible dangers and fragile areas in the basin.
For the radio programmes the Community Radio Rubavu (https://www.rba.co.rw/radio might be an appropriate medium that, through podcast and educational broadcasts, could reach out to the communities and people on a more regular basis.

Our study showed that, through reports and the occasional news items, the people are aware of projects coming and going in their region but that they are not strongly

sensitised to be involved. Radio is a very strong medium in Rwanda, accessible to virtually everybody, and we suggest that regular broadcasts, as part of the communication strategy, could help providing the information the communities and people need on a daily basis but also helps determine the positive impacts by project interventions.

We also suggest that in order to reach as much as possible the relevant stake and shareholders with new approaches that improve on the agricultural performance while safeguarding the environment it might be interesting to look at possible synergies with the Market Infrastructure Master Planning of the Internal Trade Unit (Directorate Ministry of Trade and Investment- MINICOM). In Rwanda there are many markets and traders fulfilling an essential economic function. They constitute a meeting point for sellers and buyers and allow an easy exchange of agricultural and manufactured goods. These markets are being modernised and upgraded to become vibrant markets and nodal points (MINICOM, 2014) with healthy competition between traders also allow consumers to compare the quality of offered goods and their prices.
We suggest that these common markets may present a good opportunity to demonstrate land and water use techniques (including services and related products) to specific focus groups like farmer associations or product developers.

Another approach for reaching out and involving communities is the use of *theatre for Development* for community mobilization, which represents a type of community-based or interactive theatre practice that aims to promote civic dialogue and engagement. Work in community mobilization in rural development and poverty reduction is about community participation, from the bottom -up. The involvement of the community in making decisions and taking their own restorative actions aimed at improving their lot and their environment is here key.

Theatre for Development is also employed as a research tool for getting to know a community before actually settling in with a project. At other times it has been used as a way of creating awareness across the key stakeholders about development issues, climate change, environmental issues, restorative catchment actions, and engaging the community in a dialogue promoting grassroot involvement.
Theatre for Development has been employed as a way of mobilizing communities to rally behind some development activities and carry out related activities. It has also been used in evaluation of projects that has been done in a participatory manner.

5.5 Landscaping and supporting policies

In chapter 4.2 we identified important policies that support or provide opportunities for more sustainable landscape and catchment management, local rights, and land tenure and related governance institutions. On overall opportunities lie ahead, several good policies are enacted and in place or in the process of being implemented.
Analyses on the current policy opportunities for improved landscape and catchment management that support or impeded good practice options, and dialogue with government about policy improvement, are presented here below in a SWOT analyses.

Table 33. SWOT analyses outcome on Policy on improved landscape and catchment management.

Strengths	Weakness
Existence of NST1 that calls for middle income society for Rwanda in coming years **Existence of Low Carbon and green growth strategy for Rwanda up to 2050** **Existence of appropriate policies related to landscape and catchment management** **Policy on Water Resources Management,** **Policy on Water supply and sanitation** **Policy on Health and environment** **Policy on Sustainable Agriculture** **Policy on Sustainable Mining** **Commitment to SDG 6** **Existence of Strategy on IWRM, for water and sanitation, for Environment** **Commitment to Paris Agreement**	Lack of harmonised policy on Landscape and catchment management Lack of harmonized strategies for agriculture, mining and water resources Lack of monitoring system to assess the progress in landscape and catchment management Poor coordination in implementation of various policies related to agriculture, mining, environment and water resources Lack of well-designed landscape programs at village level, sectoral and district level Lack of incentives for up-stream farmers in landscape restoration Lack of regular funds to support landscape activities
Opportunities	**Threats**
Existence of Performance Contract policy **Empowered districts to deal with implementation of all government policies** **Existence of Performance contract at each district** **Existence of ranking system at all districts in line with NST1 implementation**	Increased pollution from mining, poor agricultural practices High soil loss Decreased agricultural productivity Lack of potable drinking water Lack of reliable hydroelectricity Lack of resilience to impact of the floods Increased poverty Deforestation (including pressures and drivers) Lack of harmonized good governance for the landscape and catchment Environment degradation due to increased non sustainable mining activities

6 Way forward

6.1 Agribusiness development

As we can conclude that the main source of income derives from agricultural activities, the first step to improve livelihood and incomes start by improving agribusiness. Expanding agribusiness is in line with the currently executed activities. There are both regional strengths as there are limiting factors towards expansion of agribusiness.

There are many opportunities for expansion of the agricultural sector and implementation of innovative and sustainable technologies. But there are some major systematic problems that keep the farmers from collective change and investments. Poverty, lack of awareness and knowledge and lack of financial resources to invest is what keeps the real change from happening. The ideas and innovations to bring about change are presented here below, but for real and sustainable change to happen a turning point must be enforced. The necessary changes are costly and require brainpower, creativity, entrepreneurship and time. This process is one that must be guided in a systematic way and needs financial and institutional support.

In this chapter recommendations are done on how to increase income, better livelihood circumstances and build a resilient environment.

All recommendations eventually must be executed in an integral manner. The recommendation is to build up implementation in a step-by-step approach.

6.1.1 Agribusiness and off-farm job development

The current agricultural sector is neither economically nor biophysically sustainable. The (too) small fields on which agriculture is practiced do not support families towards expansion of the business and economic development. At the same time, most farmers depend on these plots as their primary source of income. Which, together with the lack of skills and knowledge, causes intensive cultivation and thereby loss of soil fertility and erosion.

During the survey it was concluded that most farmers use the yields of the land for their own consumption. What remains for sale on the local market is insufficient to earn seed capital for an actual business. To generate development and create an increasing spiral of revenue
and investment, we recommend focusing on the following sectors:

- Agroforestry
- Coffee and tea production
- Terracing and permanent agriculture
- Composting and irrigation
- Off-farm job creation and value chain improvement
- New energy sources

- Payment for Ecosystem services

6.2 Agroforestry

Agroforestry is recommended as major solution for soil protection and provision of wood while maintaining conservative agricultural practices in place. Agroforestry could be one of the major opportunities for Sebeya catchment to provide restoration to land degradation and benefit from its' multiple advantages. Agroforestry increase agricultural production, reduces soil loss, increases soil biomass, carbon and nutrients and supports in essential farm resources like fuel wood, timber, fruits and livestock fodder (FAO).

Applying agroforestry will increase resilience and sustainable economic growth on multiple levels in the catchment. An interesting option to explore is the use of fruit trees. With this the knife cuts both ways, the soil is better retained, and the farmers can benefit from the sale of fruit. Fruit consumption is identified as a growth market in Rwanda. Direct consumption as well as export and processed fruit are growing.

In addition to fruit, the market for wood that is suitable for making furniture is also growing. Due to the trend of urbanization, the demand for furniture rises, and those who have forests from which good quality wood can be harvested have an advantage.

An interesting option to explore is creating a local market for trees. There are tree nurseries in the catchment where local trees are sold. For the earnings of the agroforestry practices to land entirely in the region, these entrepreneurs must be involved in the activities.

Even though agroforestry it is not a new solution, investments and activities that lead to change are still lacking, in the questionnaire only 18% of the respondents say reply they practice agroforestry in some extent (Figure 37). These activities mostly take place on project basis and are subsidized by the government. Mainly the small plot size and the lack of financial resources keep farmers from agroforestry. But also the lack of knowledge, coordination and poor dissemination are drivers. For implementation of agroforestry in Sebeya catchment focus must be on mapping existing activities, organizations and improving actions on the ground.

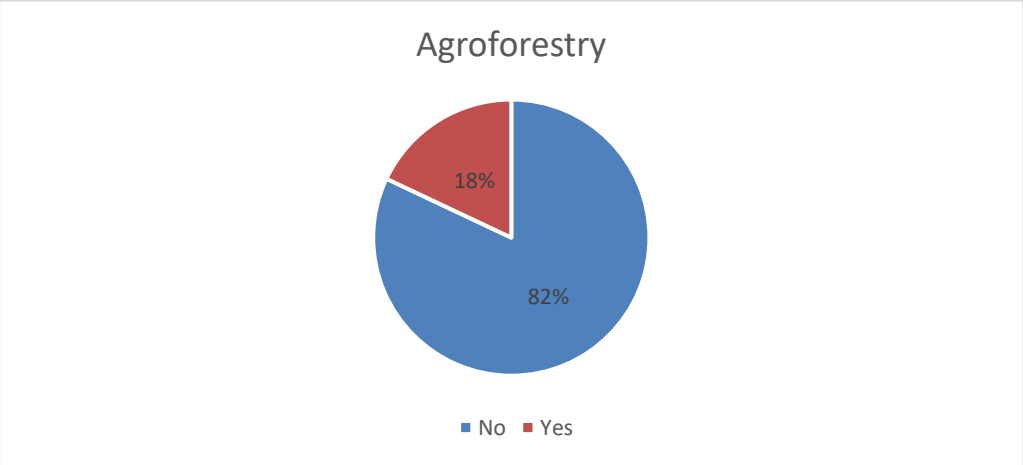

Figure 37. Best practices and activities adopted in farming activities/Agroforestry

From the early lessons learned from the VLAUP process it was clear that currently forestry and afforestation are not popular at the people of Sebeya catchment, as farmers do not

have redundant land to plant forests. However, agroforestry and fruit tree are in high demand and perhaps there is also demand for boundary planting and trees along terraces (EWMR, 2019).

6.3 Coffee and tea production

Increasing coffee and tea production is recommended as solution for both increasing activities in the agricultural sector as to restore land degradation and soil erosion. Coffee trees and tea plants are perennial plants with the capacity to hold the soil. In addition, coffee and tea are doing well on the export market. Integrating coffee or tea production with agroforestry is another option to be explored. Planting N-fixing trees in tea plantations enhance crop productivity and soil microbial biomass in tea plantations (Mortimer et al., 2015 and Iiyama et al. 2018). Researchers concluded that combining coffee farming with planting trees creates protection on multiple levels (Gomes, 2020). The trees provide shade, cooling and protection of extreme rainfall, while still allowing sufficient light to pass through. In the meanwhile, the trees increase all the above-mentioned benefits like fuel wood, timber, fruits etc.

Although many of the local development policies are focusing on increasing coffee and tea production, from the questionnaire and the interviews not much activity on coffee and tea was noticed. Therefore, the first step is to investigate the possibilities to grow coffee and tea well in the area. Another important factor to focus on value chain development and financial support in the form of subsidy or payment for ecosystem services.

The average age of Rwandan coffee farmers ranges from 50 to 60 and the youth are pursuing jobs outside agriculture (Newtimes, PerfectDailyGrind). Coffee prices are low, the work is hard and risky and most value is added outside the farms. which makes development of knowledge and skills important to improve the famers business model and sustain the sector in the future. If production increases and value chain development is practiced there are opportunities for off-farm jobs in the washing stations, roasting coffee and packing.

Nevertheless, coffee and tea trees have to grow for a number of years before production starts. Which means development of appropriate financial instruments is importance. This can possibly be combined with Payment for Ecosystem Services because planting perennials supports soil retention and development.

Another crop that was largely found in Sebeya is sugar cane and this crop is very much appreciated by farmers. Encouraging Sugar cane and tea at various buffers zones of Sebeya river and areas with steep slopes will certainly contribute in increasing farmers revenues and reduce erosion considerably.

6.4 Terracing and permanent agriculture

Bare soils on steep hills in combination with rainfall decreases the soil fertility and productivity. Under several governmental projects, terracing seems to be successful to increase crop productivity and incomes for Rwandan farmers (WOCAT, 2014). Important advantages of terracing are the possibility to increase resilience towards erosion, increase productivity and farm income and have the ability stay with the conventional crops like Irish potatoes, maize, cassava, and vegetables. Figure 38 shows there is a big window of opportunity for terracing a as 86% of the respondents are not practicing terracing.

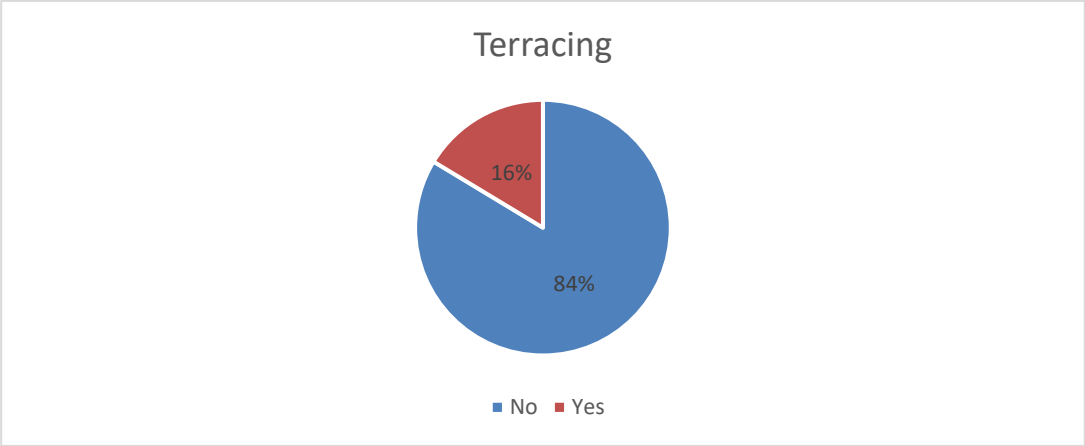

Figure 38. Best practices and activities adopted in farming activities/ Terracing

Although terracing comes with great opportunities to decrease erosion, increase soil fertility, and increase income on the long run, terracing also comes with extra costs for labour and farm inputs. Initial costs for construction but also yearly maintenance increases the investment by the farmer. The revenue must be higher than the extra costs. There are opportunities for the farmer to raise their income by using terracing which could repay the investment. Terracing increases the soil moisture but also the soil biomass, carbon and nutrients. This, in combination with the decreasing risk of erosion creates the opportunity to produce more and higher-yielding crops. But to invest most farmers need financial support from subsidy, knowledge and awareness raising from a well-established program and probably multi-year support in the form of PES.

Terracing doesn't only come with benefits. There is a major risk, which asks for good integration with the financial part. Poor design and maintenance of the terraces increase the risk of landslides. This is a high risk not only for the value of the fields and the crops on it, but also for the downstream settlements.

Concluding, terraces is an interesting opportunity for sustainable agriculture both from an economic as biophysical perspective. Although, the financial part and knowledge development of terracing must be well established beforehand.

6.5 Off-farm jobs and value chain improvement

There is a demand from the younger generation towards the so called 'off-farm jobs', not only would this generate more income, it also relieves the pressure on agricultural land use. When creating off-farm jobs, the knife cuts both ways. On the one hand, fewer people depend on the land as a source of income, which means that the plot-size can increase or at least do not have to shrink further. On the other hand, it is the agricultural sector that can provide the raw products for the off-farm industry, it creates more opportunities for development of the local value chain.

Even though few people seem to be involved in off-farm activities that add value to the raw products (Figure 40), there are some trends noticed of upcoming activities like mobile money transfers and online services. These activities are mainly adopted by the youth. Other new activities noticed are still in the field of farming, e.g., pig and chicken farming and avocado farming. These activities lend themselves for value chain development like milk and honey production and processing are the most noticed value chains in Sebeya Catchment. Milk for example is collected and transported to small factories that treat the milk and sell it directly to customers or big processing plants. Also, there are local cheese

processing factories in the catchment as well as beekeeping cooperatives that process and package the honey end sell it to various markets.

There are development opportunities and market demand for value chain development of other agricultural products such as potatoes, maize and vegetables. The most popular crops differ per region within the catchment and must be determined the moment value chain activities are planned.

Value chain development will mainly benefit by training, awareness raising and knowledge sharing. Both financial and technical knowledge will support the people.

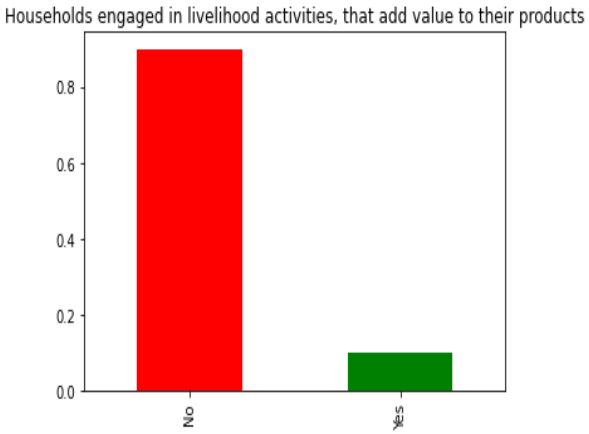

Figure 40. Households engaged in livelihood activities that add value to raw products, only 10% of the households are involved

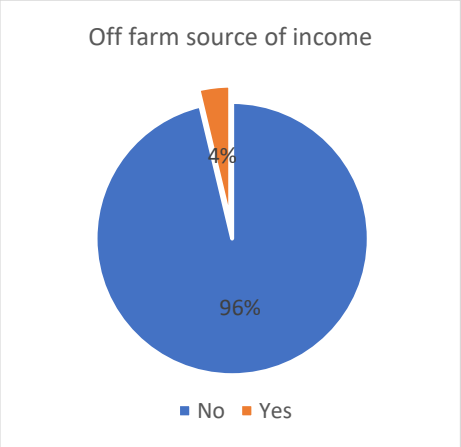

Figure 39. Off-farm activities source of income

6.6 New energy sources

One of the driving forces of erosion and flood risk is deforestation. 98% of Rwandans depend on wood/charcoal for cooking, energy and timber. This dependency and demand keeps deforestation going. A solution would be the introduction of other sources of energy like LPG gas or solar panels. A shift which is now being made in the urban areas. But for the majority of people living in the rural areas there is still a long way to go. In most cases the financial assets are not available for people as shifting to gas or solar panels is costly. Apart from the initial investment it also requires owning other assets households didn't have before like gas or electric stoves. The recommendation is to start looking for technologies that doesn't use so much wood or charcoal, with a strong focus on the rural areas. The first steps can be to

Improve current toxic and inefficient charcoal production techniques (through uncontrolled pyrolysis) and focus on improved quality cooking stoves that can handle a more efficient use of wood and charcoal.

6.7 Payment for Ecosystem Services

Within this analysis, the issue of financial resources has been raised several times. Moving towards big changes in landscape and agricultural practices, which will not always show its benefits in situ or at the same geographical place are very challenging. The approach of 'Payment for Ecosystem Services' could support the change and facilitate the necessary 'turning point' towards a resilient landscape.

The Payment for Ecosystems Services is a new approach that has not been adopted yet in the Sebeya catchment as reported by most of the key informants in the questionnaire. With most of the population having noticed the damages caused by unsustainable

landscaping there is a window or opportunity for ecosystem conservation and possibly also a joint payment system like PES.

The recommendation is to start exploring options for PES systems. Possibilities could be a combination with existing taxes spread over people in the catchment. There is also the recommendation to start the process of discussion with Key Private Companies such as Bralirwa, Tea Company, Mining Companies, WASAC , Hydropower plants all those companies that benefit from upstream efforts in landscape conservation and come up with a joint arrangement for them to invest substantially in conserving the ecosystem.

A special program on water and sustainable mining needs to be designed and implemented accordingly since mining is one of the source of pollution in the catchment. Discussions on field with Miners and officials working in the Rwanda Mining Board are encouraging and are calling for more cooperation with Rwanda Water Board on aspects related to enforcement of regulations concerning sustainable mining, capacity building of miners on waste water and reuse, monitoring of waste water.

6.8 Conclusion

There are multiple options for the Sebeya catchment to move towards sustainable ecological conservation while increasing income and livelihood levels. Most options face the same problems which are I) awareness; II) availability of knowledge and III) availability of financial resources. There is little room for investment as most households rely on subsistence farming on small and degraded plots. To shift this situation for the better investments and structural changes need to be made. Financial resources, time and space to try it out are most of the time lacking, which keep real change and development out of reach. There are currently 4 IWRM packages prioritized, this will help focus time and resources.

A turning point must be enforced by introducing a step-by-step and multilevel approach towards change.

7 Targets

7.1 Introduction targets

Long term management targets will be set for the achievable outcome and output after finalisation of the EWMR project in Sebeya catchment in 2023. Clear objectives are a prerequisite to assess the degree to which stakeholders have achieved their own objectives. With regard to the developed indicators listed, for the more performance related outcome and output indicators (communities, HHs, management organizations, villages), initial realistic targets (objectives) can be set by contract agreements between stakeholders, practitioners, users and mandated institutes for regional and national coordination.

For some indicators used in this baseline study it is best not to set a stringent target as they are influenced too much by the surrounding drivers or a combination of those (demography, general biodiversity loss, climate change) on which the project implementation will have no effect.

An example is the Turbidity of river water. As indicated in our inception report (Langenberg et al., 2020), while turbidity is related to anthropogenic activities including land use, overgrazing or mining and erosion, other environmental factors (weather, turbulence, re-suspension) and local system run-off characteristics and basin properties (transport, recreation, cattle, fisheries) may contribute to the response as well. Consequently, turbidity may at times and place not relate strongly or directly to human activities. In the meantime, however provisionary targets form other works and official bodies can be suggested at the start of the adaptive monitoring and management process. It remains nonetheless key that the risk of misinterpretation of this cause/effect relationship is substantially reduced when a coherent monitoring is performed of all relevant parameters involved along the DPSIR chain.

7.2 Methodology setting targets

For the other biophysical state indicators (f.e. vegetated riverbanks), especially those that have a stronger link with the system's behaviour to natural and anthropogenic pressures, a benchmarking procedure is required. A benchmarking procedure will be necessary, so that when water resources and catchment management is being implemented, one can systematically and objectively determine when to intervene (or not) in the catchment and communities. Intervention can then be planned and carried out required when a discrepancy between the current system state and a desired or reference system state surpasses predefined threshold.
The benchmarking procedure should ideally include a pragmatic analysis on what is biophysically possible looking at the target. These proposed targets can then be discussed what is feasible looking at many different factors: the resources (time, money) available, accessibility by the local field team, willingness to participate by communities, etc.

To approach this, we intend to advice on objectives for some indicators where sufficient information allows setting of realistic biophysical targets. In addition from peer-reviewed literature and nearby comparable river and catchment studies from official regulatory bodies we will deduce critical threshold levels for several drafted indicators (water quality, grazing pressure, etc) and assess how the key catchment pressures and impact in time and space are likely correlated. From there indicative indicator targets can be suggested.

In those cases, where the information remains too vague or providing too little guidance for selecting appropriate indicators and targets, we will determine a range that takes the uncertainty into account. Also, the detailed implementation plans of IUCN will be analysed to understand and specify what is feasible in the coming years.

A work session together with IUCN technical team and field hub teams and RWB will be held to set the final targets for the coming years.

7.3 Targets

As elaborated in chapter 3.4 “Baseline indicators” of the inception report of this assignment, indicators need to be justified if they want to serve as the sound reference to which future outcomes, outputs are to be benchmarked.
Our objective was to apply the criteria for SMART indicators that can be used for monitoring changes in system health (and improvements) and the communities therein and acting upon it.
Unfortunately, several indicators - due to lack of information - cannot be made sufficiently SMART. In these cases, we constructed an accurate as possible narrative that provides boundaries of argumentation and reasoning within a pragmatic and provisional target could be set. Table 34 is the overview of all indicators with baseline values, targets and recommendations.

Table 34. Narratives for Targets, Targets set and recommendations. In **green** colour the recommended SMART indicators for operational monitoring and adaptive management.

No.	Baseline indicator	Baseline value	Narrative target	Target	Recommendations
1	**Household size**	5 p. per household on average	The project is not directly targeting changes in household size, since it is beyond the scope of the project	No target	
2	**Male or Female head of household**	29.2% of the households are female-headed and 70.8% are male-headed	The project is not directly targeting changes in the number of male/female heads of households, since it is beyond the scope of the project	No target	There is a difference in the wealth status of households headed by male or female parents/guardians. Female-headed households seem more likely to be vulnerable, and hence this needs to be considered for any livelihood improvement initiative.
3	**Physical characteristics of dwelling**	Roof (metal sheets: 38.1%; local tiles: 40%, plastic sheeting: 0.5%, other: 21.5%) Wall (mud bricks: 72.9%; wood and mud: 5.8%; fired bricks: 1.2%; other: 20.1%) Floor (beaten earth: 68.2%; concrete with cement: 10.7%; concrete with tiles: 0.2%; stones: 0.2%; timber: 0.2%, other: 20.3%)	Quality dwelling of importance for livelihood quality & health. Nonetheless we assume that the EWMR project will likely not result in an upgraded dwelling in the coming 3 years	No target	
4	**Household with safe water for domestic use**	86.6% of the population in the Western province have access to clean water 5.9% of the	According to the latest EICV5 the percentage of households with improved drinking water source is 86.6%, and the target as of Rwanda vision-2050 is set to 100%	Rwanda vision-2050 is set to 100% by 2024	We recommend RWB to work closely with WASAC in providing clean water, preventing the pollution from

		households have water piped into home	by 2024. Target depends on efforts by the Gov of Rwanda. Implementation done by District. Executed by WASAC.		upstream and monitoring the efforts carried out
5	**Main and alternative source of energy used by household for cooking**	Firewood: 85.5% Charcoal: 14.3% Other: 0.2%	Just over 71% Surveyed HHs in the catchment are willing to shift to a more efficient energy source, of which 50% are even willing to invest own resources/ money to get a more efficient energy source (average amount of money a household is ready to invest in is 12774 Frw). The target can be set by IUCN depending on the households that will be provided with improved (clean) cookstoves.	Provide Improved cooking stoves to 2000 HH and to 10 communities (Schools, ..) in the four districts of Sebeya	Considering the community setting in the catchment and the financial means of the community members; the first step should be to consider promoting the use of improved cookstoves; and shift to a more clean and efficient charcoal making process.
6	**Wealth index**	Wealth category 1 (very poor): 17.1% of the households Wealth category 2 (poor): 46% of the households Wealth category 3 (better-off): 36.9% of the households	wealth index is part of livelihood quality. We suggest a pragmatic target but an absolute target cannot be set on how many people to lift from the very poor and poor category in a 3 years period; but an improvement in welfare and livelihood will reflect the impact and change in the wealth index will change. The project activities will contribute to a positive change. External factors are influencing this value.	Lower than 17 % on category 1 of total households. Improve category 3 to more than 37%.	
7	**Household finance**	Average seasonal income from agriculture-related activities (Livestock sale: 176074 Frw; crop sale: 95585 Frw; livestock products sale: 29750 Frw)	Improved HH financial management is now only expressed as % households involved in savings. Important is also diversifying income generating activities; and this will help the households to have an extra income that can be saved for future investment. Uncertain on the government support	TBD	Payment of project through banks for project implementation activities will contribute to Improvement in financial inclusion; and hence increase the percentage of households with a financial account (increasing the

		Average monthly income from other sources (self-employment: 47388 Frw; Salaries/wages: 31197 Frw) Percentage of households with a saving plan in place: 45.3% (66% of the HHs save less than 5000 Frw)	for long term savings in Sebeya (e.g., pension) Target to be set up by IUCN. The project may not have a clear target on how many people will be helped to acquire loan from formal financial institutions. However, a contribution to financial inclusion is possible, by providing payments to workers in different activities of the project through banks and sharing knowledge on financial literacy.		likelihood of eligibility to loan from formal financial institutions).
8	**Source of Employment**	Primary employment of the HH head: Farming (own): 38.3% of the HH heads Livestock rearing: 4.2% Farming (as a worker): 14% Self-employment: 4.4% Mining: 4.2% Petty trade: 2.8% Civil servant: 1.4% Other: 11% Unemployed: 18.9%	From the EWMR recordings, 7,394 green jobs were created in the four districts, including site technicians, surveyor, capital and man-power. Targets for coming years can be set depending on efforts planned for job creation, (both jobs created due to project activities and lasting sustainable jobs created due to value chain activities).	Unemployment rate is higher than Country baseline (14%). Government targets further decrease of unemployment rates from 7% (2035) to <1 % (Vision 2050).	
9	**Household water use**	• Average daily per capita water use for domestic activities: (10.5 litres: middle stream zone, 9.7 litres in the downstream and 8.1 litres in the upstream zone) • Average daily water	Currently the average daily per capita water use is 9 litres. A use of 9 litres is way below the WHO target of 20 l/p/day. WHO states that 20 liters per capita per day is the minimum quantity of safe water required to realise minimum essential levels for health and hygiene (WHO, 2003). The project activities related to RWH tanks will contribute to an increase in the	20l/p/day	

		use for livestock per household: 35 litres in the downstream zone, 65.9 litres middle stream; 53.8 litres in the upstream zone • Average daily water use for irrigation per household: 100 litres in the downstream zone, 64.4 litres in the middle stream and 64 litres in the upstream zone.	average daily water use. But it is highly likely that the project activities will not ensure an increase of average water use to 20/l/p/d in 2023. Setting a target below WHO standards on water quantity is not desirable. Therefore, a target will not be set for this indicator. Besides water quantity, the water quality for domestic use is of great importance and could be monitored in the project.		
10	**Rain water harvesting (RWH)**	28% of the HHs have a RWH system in place (roof water harvesting system with a closed tank)	Currently 28% of the households has a rainwater harvesting system in place. Additional rainwater harvesting system (tanks of 2 m3 for domestic use) are part of the implementation plans of the project. Distribution and implementation will be funded by the project. For the year 2021 alone, 525 tanks in total will be distributed and installed. Therefore, an estimated 1500 RWH tanks of 2 m3 for household use seems a feasible target for the project. A full water tank of 2 m3 could provide a household of 5 persons with 20 l/day/person for 100 days. The RWH tanks will contribute to an improved daily water use for domestic use. 1500 tanks, for 1500 households, is 2,5 % of the total households in Sebeya catchment. If 1500 RHW tanks to households are distributed in each of the	4500 additional RWH tanks of 2 m3 for households (and 40 of 5 m3) in Sebeya Catchment, this will bring the percentage of the HHs that have a RWH system in place to 36%	Many systems are present in Sebeya catchment. people need finances to invest in these systems. Implementing more RWH systems is recommended. RWB and IUCN can jointly work with Private Operators and design sustainable fit4 purpose systems.

			coming 3 project years, 8% additional households will own a RWH system due to project activities.		
11	**Flooding**	21% of the HHs indicates that they have experienced a flood	A target will not be set for the frequency, intensity or impact of flooding characteristics. This indicator is too much influenced by external factors (e.g. climate change and erratic rainfall patterns) and in catchment dynamics such as demographics (urban expansion characteristics, or replacement initiatives by government), sand transport (upstream vs downstream) and the structures in place to regulate river flow. Flood risk can be calculated if more information is known about the probability of flood events and their impact (risk = likelihood event x impact). The plans for an improved monitoring network of river characteristics will contribute to calculations on the likelihood of a certain type of flood. The impact of flooding events in Sebeya catchment can be reduced by the initiatives of the parallel project to the EWMR for a flood EWS (FEWS) in Sebeya catchment. The FEWS should be operational in 2020.	No target	We recommended RWB with MInema to set up a robust system of early warning of flash floods based on improved monitoring covering river and flood dynamics in time and place, including Meteorological forecast stations is needed. This allows proper flood risk calculations and setting of targets.
12	**Droughts**	17 % of the HHs indicate that they have experienced a drought	A target will not be set for the frequency, intensity or impact of droughts. This indicator is too much influenced by external and internal factors in the catchment. There are	No target	

			different types of droughts (Meteorological drought vs Soil moisture drought vs hydrological drought). Farmers in Sebeya catchment experience soil moisture drought resulting in lower yields and crop damage. A late onset of rains (meteorological drought) cannot be influenced by the EWMR project activities. Efficient irrigation, improved technology and higher water availability for agriculture will reduce the impact of drought. The impact of a meteorological drought (soil moisture drought in the root zone) and resulting crop damage can be reduced by project activities. Improved soil moisture conditions by practicing mulching, adding compost and change from annual crops to permanent vegetation. Also rainwater harvesting systems for agriculture could reduce the impact of droughts. The impact of a drought will also be determined by the actions of the farmers (crop selection, land management etc.)		
13	**Best Agricultural practices**	49% of the HHs have adopted a type of best agricultural practices: 1) 48,8 % in Composting; 2) 34% with Chemical fertilizer; 3) 26.6% with use of improved seeds; 4) 26,6%	The project activities have an implementation target for radical and progressive terraces combined with agroforestry. On these new terraces, the project could also target also the application of other best agricultural practices (composting, improved seeds, mulching). For the year	Target for 60% of the HHs have adopted a type of best agricultural practices. Target of 60% of the households making their own compost. Target of 22% of the	Good to focus on agroforestry and terracing, as they reduce soil erosion most. It is very important to include communities in landscape restoration activities. Not inform but involve them, through

		with Crop rotation; 5) 23.1% with intercropping; 6) 16.8% with integration of livestock and crops; 7) 16.4% Terracing; 8) 2.6% with Mulching; 9) 18% with Agroforestry	2021, 1484 ha of new radical and progressive terraces are planned (4% of Sebeya catchment). For the subsequent years of the project, it is recommended that the new terraces are monitored to see if the tree seedlings are successfully growing and if other best practices in land management are applied. Composting is already applied and could be upscaled by farmers themselves to a 100% of households. The average area of land allocated for agriculture by households is 0.75 ha. 1484 ha of new radical terraces with agroforestry is 4 % of Sebeya catchment, and provides on average 1900 households with agroforestry plots. Also combined with the plans for agroforestry on farmland, at the end of the project 2335 additional households will be practicing agroforestry on average. This means in increase of 4 % in households involved for agroforestry & composting due to direct project activities.	households involved in Agroforestry. Target of lower than 34% for of chemical fertilizers.	bottom up approaches.
14	**Agricultural landholding and profit**	Land ownership (60.5% of the Households in the upstream area; 68.5% in the middle stream and 31.1% in the downstream) Area of land allocated to agriculture per household: (0.25 ha in	The Rwandan government has invested in rural development. Starting in 2007, under the Crop Intensification Program (CIP) a long running program has been implemented to increase agricultural productivity while aiming at far-reaching land consolidating, provision of better seeds and change farming	No target. There is ongoing land consolidation and seed improvements, and strong increase of fertilizer use	Focus should be on the improvement of yield and profit. Average plot size is small looking at profit rates. Land consolidation could help as well. Combine practices. Plot size should be larger than 1 ha (Nilsson, 2018). Increase % use of organic

		downstream; 0.47 ha in the middle stream and 0.44ha in the upstream)	practices. Farmers under CIP are helped with fertile land seeds, and fertilisers to reach certain targets for six priority crops namely maize, wheat, rice, Irish potato, beans and cassava. Production increased and there is positive association between land use consolidation and crop yields, but only among farm households with landholdings greater than one hectare, which is well above the average farm size in Rwanda		fertiliser and irrigation can augment production.
15	**Yield, Agriculture commercialization**	Most grown crops (Irish potatoes: 39.3% of the HHs; maize: 26.4%; beans: 24.1%) Average yield irish: 11882 kgs/ha in Nyabihu and 11350 ha/kgs in Rubavu (Data from the seasonal agricultural survey) Average yield maize: 1277 kgs/ha in Nogorero and 1501 kgs/ha in Rutsiro (Data from the seasonal agricultural survey) Average yield beans: 12061ha/kg in Rubavu (Data from the seasonal	Yearly targets set by district by cumulating profits for many crops and are often indicated in Performance contract with Rwanda Agricultural Board. As well depending on plot size and further land-consolidation policy. Profit for farmers depends also on price fluctuations and crop loss, but also on access to irrigation.	Districts yearly target set: Increase Crop production for Maize (22%), beans (18%), and banana (21%) (above national average) in all districts.	

		agricultural survey) 57% of the households have an extra production that can be sold to the market and 48% of these make less than 5000 Frw a season.			
16	**Livestock rearing**	Among the 246 households that have access to land for agriculture and farming activities, 52% own at least one animal.	Targets have been set for the distribution of livestock among the people of Sebeya catchment. Target set for the year 2021: Distribution of small livestock (pig, goat, sheep) at households level Ubudehe category 1&2, 2 animals for 1597 households and 699 cows for households in Ubudehe category 3 without livestock at the moment. Currently 66% of the households in wealth Category 3 do not have a cow. 82.2% of the households in Category 1 and 74.1% of households in category 2 do not have any animal (livestock).	Provide 1000 cows to category 3 households and 2 small animals to 1600 HH	We recommend RWB and IUCN to allocate budget for supporting the Girinka program for especially linking the program with active farmers or miners that contribute in reducing river pollution.
17	**Turbidity**	Monthly Average Turbidity in rainy season from 853-1478 NTU and in dry season from 444 -1139 NTU (WASAC data)	Earlier reports indicate Turbidity to be of major concern and mostly out of the acceptable range for natural potable water (<25 NTU set by FDEAS 12:2018). High NTUs are indicative for high soil erosion causing disturbed sedimentation and siltation processes in the catchment. Very high values occasionally disrupt the WASAC water intake up to 5 hrs. a day (2020).	25NTU target of the FDEA seems unreachable with current drivers	needs improved structured monitoring at unstable sites with better temporal and spatial coverage for determining impact, key drivers seem clear.
18	**River Water quality status**	Insitu values of key	According to available data there are water	EC. <2500uS/cm,	needs improved structured

		physicochemical variables: EC 17-1000 µS/cm, pH (5,5-7,9), DO (75-119 % sat.), Temperature (16.1-19.9 C), Turbidity (61-1118 NTU). Due to sediment loads and microbiological contamination values, the water body is outside acceptable range of FDEAS for natural potable water.	quality concerns related to high influx of silt and sediment and microbial contamination as result of poor WASH conditions. Other physicochemical and nutrient parameters are within the good quality status compared to the FDEAS (targets set for natural untreated potable water.	pH 5.5-9.5, DO >68% Sat., Temp <25oC, TDS < 1500mg/l, FC and E. coli 0 cfu/ml	monitoring at polluted sites with better temporal and spatial coverage, although influenced by external factors, key drivers are clear.
19	**River Water quantity status**	Average outflow (mean daily discharge) into lake Kivu (Sebeya outlet) is in the range of 2.8 m3/s - 5.3 m3/s, and therefore in the range of 1,4 million m3/year and 2,8 million m3/year. Average 10% low flows Nyundo station: 0.5 m3/s Average 10% peak flows Nyundo station: 8.3 m3/s	No target will be set for the average outflow. Before targets can be set for the outflow of Sebeya River, it is recommended to make an environmental flow assessment. AIs monitoring with a telemetric gauging station at Sebeya outlet is necessary to create a detailed dataset of river height level, debit and peak flows in order to set targets.	No target	Carry out Environmental base flow assessment to describe quantity, timing, and quality of water flows required to sustain riverine ecosystems, and adjacent waters and the human livelihoods and wellbeing that depend on these ecosystems, as well as minimise inputs' impacts to fragile Lake Kivu system.
20	**Structures (hard and NBS) build to manage peak flows in main river and tributaries**	1 concrete channel, multiple gabion walls and multiple raised bridges are in place	Target set by RWB and IUCN for drainage trenches in forests and agricultural areas. Target was set for 1134 ha land supported by drainage trenches. Parallel to the project, a lateral retention dyke and a flood retention pond will be implemented.	1100 ha of Forestry supported by trenches in Rutsiro and Ngororero and three ponds in Rubavu districts	We recommend the RWB and IUCN to work closely with concerned districts for an investment plan considering the whole catchment.

21	**Mining areas**	12 mining cooperation sites were identified with licenses (active in cassiterites, wolfram, tin mining). 15 sand and gravel mining companies are operational in Rubavu. According to RMB there are around 400 small mining areas of which ~250 are still operational.	The project activities could focus on working with Rwanda Mining Board on sustainable mining activities. The target could focus on improving collaboration and jointly define tangibles actions on wastewater reuse, and reduction of pollution	MOU with Rwanda Mining Board, Action plan for wastewater management	We recommend the RWB to work closely with Rwanda Mining Board to setup an approach for waste water management
22	**Land sensitivity to soil erosion**	The area sensitive to soil erosion is 5009 ha	The area sensitive to soil erosion is 5009 ha (14% of Sebeya catchment), this is seasonal agriculture on sloping land (> 10%) that is not radical terraces or landslide areas. The project activities will target land to be covered year-round with vegetation (perennial agriculture, reforestation or afforestation) and agroforestry, thereby reducing land sensitive to erosion. From the 5009 ha, 2191 ha is located on sloping land with >20% slope. It is recommended to target that land first for restoration activities as this is highly sensitive to soil erosion.	2100 ha of seasonal agriculture on steep sloping land (>20%) covered permanently by vegetation due to project activities	We recommend the RWB to work closely with districts and map clearly areas sensitive to soil erosion and include in their annual performance contracts
23	**Stable riverbanks**	52% of all streams have vegetated riverbanks with a 5 m buffer and 63% of the main riverbanks are vegetated based on a 10 m buffer zone.	There is 600 km of river bank in total, of which 321 km is currently vegetated and stable (forested or natural vegetated bank). The project targets to stabilize another 155 km of river bank. a 10 m buffer zone of the main rivers and a 5 m buffer zone of small rivers is	75% of the river banks is vegetated	We recommend the RWB to work with concerned districts and include in their performance contracts for each year specific areas of rivers banks to be protected

			necessary provided in the law for environment, to protect the banks that are currently vegetated. It is recommended to check if the 321 currently vegetated riverbanks currently meets the official criteria for a vegetated buffer zone. A target can be set up to 75% of river banks with vegetated river banks if an assessment was made to see if the current vegetated river banks comply with the official buffer requirements.		
24	**Landslides**	86 ha of bare land	External factors and internal factors and catchment processes are influencing the number of landslides. Currently the landslides (bare land) areas identified by google earth imagery. This way, only the recent landslides were mapped and historical (overgrown) landslides not. Currently the landslides (bare area) seems to occur mostly around mining areas.	No target	Minimise bare land exposure and stabilise direct surroundings during Build and operational phases of infrastructure, mining, other construction
25	**Forest cover**	26% of catchment area covered by Natural forest and 23% is Plantation forest	A division was made in forest cover in plantation forest and naturally covered land with trees. The targets set by the project for agroforestry and afforestation/reforestation in Sebeya catchment is 1860 ha of land for the year 2021. 1860 ha of land is 5 % of Sebeya catchment. The results of the reforestation project (target is 110 ha, or 0.3% of Sebeya) will be a dense forest (to be when fully grown) more similar	Increase Natural forest cover to 27% and plantation forest cover to 27%	Consider dense reforestation in vicinity of national protected parks to increase ecological connectivity and support biodiversity and forest production

			to a natural forest than a plantation forest.		
26	**Perennial agricultural crops**	17% of total cropland area or 1810 ha	IUCN has set a target for the year 2021 for terraced land with agroforestry. This could include perennial corps such as tea, nut trees, fruit trees and banana. The target for agroforestry set is 1751 ha and 5 % of Sebeya catchment. There is an increasing trend of ha land for tea plantations, however precise expansion plans are not publicly known. There are also national plans to increase the quantity and quality of black tea export. Newly established tea plantations in the future could be located further upward in the catchment due to (unfavourable) rising temperatures downstream. To incorporated tea in agroforestry is not yet done in Rwanda (coffee combined with agroforestry is). It is also possible to plant nitrogen fixating trees in tea plantations for improved soil quality.	1751 ha terraces or farmland with perennial plants (agroforestry) incorporated	Assess the feasibility of the sustained adoption of Tree-Based Ecosystem Approaches (TBEAs) with perennial crops
27	**Area of degraded land under improved landscape governance & management, and restoration**	5227 ha of land under restoration	We made the assumption that on the 3072 ha of land where the project will be implementing activities such as reforestation and terracing, the land will be under improved governance & management at the end of the project. The project activities will restore the land and agreements should be made with the farmers and communities on	8300 ha of land under improved governance and management.	Performance Contracts with Cells, villages on restoration of land can be designed and signed with Chief of villages with their superiors

			sustainable land management and governance.		
28	**Mines complying with environmental and mining standards**	All mines are requested to comply by the environmental and mining standards by their license. But no strict compulsory monitoring and management of the activities seems to be in place.	The desired state would be that all mine companies comply for efficient use of water and reuse wastewater. Target can be set up together with Rwanda Mining Board, Districts, REMA, RWB. Some resources are required to support the process of surveillance, monitoring and certificates for good performance	No target	We recommend the RWB to initiate with REMA, Rwanda Mining Board and Concerned districts a collaboration for reinforcing the inspection of Mine companies that are operating in Sebeya catchment
29	**Old mining area rehabilitated (post-closure rehabilitation)**	0 old mining areas rehabilitated. An impact and mining assessment is needed to check mines that need post closure rehabilitation.	There should be a MOU of collaboration with Rwanda Mining Board, Policy change on closing mines, guidelines for rehabilitation of old mines, investment activities of rehabilitation. The project needs to provide some resources for policy change in terms of old mines, closing mines, provide support activities on awareness and proposals for rehabilitation of old mines	No target	We recommend the RWB to work with Rwanda Mining Board and setup procedure guidelines for closing old mines including a rehabilitation program for area left.
30	**Gully area**	15 gully areas	A target was set by IUCN for gully rehabilitation. The unit of measure of the gully rehabilitation plans are in ha and km, this differs per district. These values will be the target as we do not have detailed information on small gully areas. They are not visible on google earth imagery and could not be mapped for the baseline.	Rehabilitation of 1) 4,6 km of stretched gully areas & 2) gully area of 19,85 ha	Improved gully descriptions are required following assessment of gully dynamics over the years including their causes
31	**village & micro-catchment plans**	6 MCAPs (from W4GR project) and 0 VLUAPs	Target set by IUCN	20 MCAPs & 200 VLUAPs, 220 plans in total.	

32	**Number of villages implementing restoration actions as per the performance contracts**	0 villages	Target set by IUCN. Including the identification of Villages, drafting of performance contracts with Sectors and districts, providing resources to districts and follow up activities of monitoring.	100 villages	
33	**Community erosion control measures**	18% of the households are involved in agroforestry. And, 16.4% of the households have terraced plots.	No construction of terraces as erosion control measure on individual basis noted, likely because of limited financial means. Maintenance of terraces done by communities. More information is to be collected for the VLUAPs.	No target	There is a need for knowledge dissemination on biological soil conservation measures and other erosion control measures apart from terracing.
34	**People to whom knowledge or skills have been effectively transferred**	0 people by the EMMR project	Target to be set by IUCN. There are currently not yet people trained on knowledge or skills.	No target	
35	**households engaged in sustainable livelihood activities**	•0.7% of the households involved in beekeeping •18% of the households are involved in Agroforestry	Target set by IUCN	40%	This target seems too narrow. As we mention in chapter 6, sustainable activities is more than agroforestry or beekeeping. Sustainability also differs very much per situation in what terms of the practical outcome. In some cases agroforestry is very sustainable, but in other terracing is needed or in others only a more diverse crop rotation pattern is enough.
36	**Status of Payments for Ecosystem Services schemes (PES)**	0 PES schemes established	Target to be set by IUCN and RWB. PES is a new approach and needs to be developed in close collaboration with District officials, Private operators and communities. Start by	1 PES system in place	Little knowledge available on PES in catchment. Required is an in-depth analysis integrated with value chain development and

			identifying key stakeholders, Villages upstream, private companies downstream, establish MOU of collaboration, carrying out some conservations activities, come up with appropriate institution for funds flows between Private operators and farmers upstream. Target should be to come up with a running system at the end of the project.		finances - then design and implementation of PES. Then target setting is appropriate.
37	**Access to information on value chain improvement**	10% of the households have information on value chain and are involved in value addition activities	Target to be set up by IUCN	TBD	No clear insight in value chain development options, there are some activities left and right, but real development with the goal to enrich the national market but also for export. More focus on value chain development will help this
38	**Commercial tree farming**	4% of households are involved		TBD	Payment of project through banks for project implementation activities will contribute to Improvement in financial inclusion; and hence increase the percentage of households with a financial account (increasing the likelihood of eligibility to loan from formal financial institutions).
39	**Alternative energy sources for charcoal and firewood**	0.7% of the households use other energy source than	Just over 71% Surveyed HHs in the catchment are willing to shift to a more efficient energy source, of which 50% are	Provide Improved cooking stoves to 2000 HH and to 10	Considering the community setting in the catchment and the financial

		charcoal and firewood.	even willing to invest own resources/ money to get a more efficient energy source (average amount of money a household is ready to invest in is 12774 Frw). The target can be set by IUCN depending on the households that will be provided with improved (clean) cookstoves.	communities(Schools, ..) in the four districts of Sebeya	means of the community members; the first step should be to consider promoting the use of improved cookstoves; and shift to a more clean and efficient charcoal making process.
40	**People coming from the city to Sebeya for business**	Community members during focus group discussions mentioned rural – urban trades mainly involving people coming from neighbouring cities to by agricultural commodities (Irish potatoes and milk) to resale them in other cities.	Movement of people is beyond control of the project implementation; movement of people will depend on other multiple factors.	No target	
41	**Enterprises supported within targeted Value Chains**	0 Enterprises	This baseline informs on which areas to focus for what activities knowing that the intent of EWMR interventions are more livelihood focused than value chain development. We however provide information on proportions of population that are involved in the mentioned activities.	TBD	Determine HHs involved in the mentioned activities preferably across the different zonings. Then best chances what best chances for livelihood options can become clear.
42	**Major Private Companies involvement in the catchment**	32 Enterprises	Involvement of Private sector in Sebeya catchment needs to be given high importance since they play an important role in conserving , developing resources, and improving livelihood of the population.	Set target of 25 % involvement of Private companies in efforts of conservation and sustainable development	We suggest to set a target on how they should be involved more actively through agreed joint activities formalized in MOU.

				of Sebeya catchment	
43	**Income generated by new businesses/ entrepreneurial activities.**	•3% of the households are involved in new business activities. •Average monthly amount generated by new business activities is 80391 Frw.	Target to be set by IUCN	TBD	Target is more households involved in diversified income activities.
44	**Catchment committees (Nbr of catchment committees established and operational).**	0 Catchment committees in place	A catchment committee for sebeya catchment will improve and guide the implementation process. However, we need further action in terms of governance, and hence an authority for the catchment needs to be proposed. Even so a committee is not enough, problems of erosion due to poor agricultural practices, mining activities, deforestation due to lack of fire wood, will continue to degrade unless if there is catchment authority to balance and guide better the implementation of development targets. The Project needs to suggest elaboration of ministerial order for improving water governance through catchment boundaries	5 catchment committees for Sebeya	There is an urgent need to improve land and water governance through set up of catchment committee for Sebeya. RWB can finalize the legal framework for setting up catchment committee and provide guidance
45	**IWRM Packages prioritized (Nbr of IWRM Package elaborated with feasibility studies)**	4 packages prioritized	To be set up by IUCN and RWB, Action plan for IWRM packages indicating which IWRM packages, where and when will be implemented	4 additional packages are planned	IWRM package needs to contain aspects of ecosystems rehabilitation, economic development and equity
46	**Applied knowledge and skills**	0 people trained by the EMMR project	Target to be set by IUCN and RWB ,Need to carry out an inventory of all existing groups in the catchment, and	TBD	To prepare a capacity building plan and monitoring framework

			constantly record all formalized capacity building activities carried out and keep monitoring the impact on existing groups to see if there are changes		
47	**Knowledge products**	0 knowledge products by the EMMR project	To be determined by IUCN, No KMS in the catchment, we recommend to put in place a KMS which will contain all ongoing studies, research reports, GIS data on environment, biodiversity, water quality etc...	TBD	To design a web platform for Sebeya catchment containing useful products related to Sebeya Catchment
48	**communication products**	0 communication products by the EMMR project	To be determined by IUCN and RWB together with Districts, based on activities defined in agreed strategy of communication	TBD	IUCN and RWB to design a communication plan together with concerned districts

8 Conclusions and recommendations

For the implementation of EWMR by the Government of Rwanda (RWFA) Technical assistance is provided by the "***Landscape Restoration and Integrated Water Resources management and in Sebeya and other Catchments"*** project.
EWMR has four key outcome areas focussing on:

1. Reduced land and soil degradation, river sedimentation and flooding;
2. Improved incomes and resilience based on sustainable use of landscape resources;
3. Empowered landscape governance and management institutions; and
4. Evidence-based guidelines for the landscape approach.

Here below you will find per key outcome area the main conclusions and recommendations as assessed and formulated during this baseline study.

8.1 Reduced land and soil degradation and flooding

- In 2020 The Gishwati-Mukura National Park became part of the World Network of Biosphere Reserves. The park has been named a "biosphere reserve" by UNESCO providing support to the ex-situ conservation of indigenous species.

- From the seasonal and perennial agricultural lands, a part was converted to terraced agricultural lands. There is 2607 ha of radical terraces in Sebeya catchment, equivalent to 7% of the Sebeya catchment.

- The Sebeya river characteristics indicate that measures like dispersed water storage and rainwater harvesting can substantially lower peak discharges and chances of flooding.

- Current water resources utilisation cannot be quantified due to unregulated water use and limited water users' information. It is recommended to research the domestic water demand in more detail.

- A natural vegetation cover improves riverbank stability. Vegetative cover has decreased to ca. 60% (main river) and 50% (stream network) and indicates great potential for riverbank revegetation.
- Of a total of 36252 ha Sebeya catchment area 56% is and covered by either Natural forest (27%), Plantation forest (23%), Riverbank trees (1%) or Perennial agriculture (5%) and less vulnerable to erosion, while 14% of Sebeya catchment is very sensitive to soil erosion.

- Terracing combined with perennial agriculture is a suitable counter-erosion measure on steeper slopes. Combined with reforestation in erosion prone areas it will enhance the catchment's resilience.

- There are ca. 20 mining cooperation sites in the catchment and ca. 400 small mining areas of which ca. 250 are still operational. Around mining areas, many gullies are present, and landslides are favourable to occur.

- Despite efforts to lower mining wastes' impacts there is a need to cooperate with commercial and artisanal miners to design site rehabilitations plans to mitigate Sebeya system degradation and monitor progress.

- There are multiple options for the Sebeya catchment to combine sustainable ecological conservation while increasing income and livelihood levels. A lack of I) awareness; II) availability of knowledge and III) availability of financial resources are key bottle necks.

- We recommend a step-by-step and multilevel approach delivering durable proof first then stimulate required change.

Terracing and permanent agriculture

- Terracing increases crop productivity (Irish potatoes, maize, cassava and vegetables) and farm incomes, and lower erosion sensitivity. Ca. 90 % of respondents are not practicing terracing indicating opportunities.

- Terracing requires investing, but to invest most farmers need financial support from subsidy, knowledge and awareness raising and probably multi-year support in the form of PES.

- Poor terrace design and sustained maintenance increase the occurrence of landslides. This is a high risk for land value and crops and also for downstream settlements.

- Terraces is an interesting opportunity for sustainable agriculture both from an economic as biophysical perspective. Although, the financial part and knowledge development of terracing must be well established beforehand.

- Payment for Ecosystem Services (PES)

- PES systems are not adopted yet in the Sebeya catchment. However noticeable damage caused by unsustainable landscaping helps to create a window or opportunity for ecosystem conservation and also joint payment systems like PES.

- We recommend to first start exploring options for PES systems by engaging with key private companies that benefit from Sebeya's resources that are affected by upstream developments. We recommend then to come up with a joint arrangement for them to invest substantially in conserving the ecosystem.

8.2 Improved incomes & resilience based on sustainable use of land resources

Agribusiness development

- The main source of income derives from agricultural activities, therefore the first step to improve livelihood and incomes start by improving agribusiness.

- There are many opportunities for improving the agricultural sector by the implementation of innovative and sustainable technologies. The necessary changes are costly and require brainpower, creativity, entrepreneurship and time. This process is one that must be guided in a systematic way and needs financial and institutional support.

Agribusiness and off-farm job development

- The current agricultural sector is neither economically nor biophysically sustainable. The small agriculture plots hardly support families towards expansion of the business and economic development.

- Most farmers depend on these plots as their primary source of income. Which, together with the lack of skills and knowledge, causes intensive cultivation and thereby loss of soil fertility and erosion.

- To create an increasing spiral of revenue and investment, we recommend focusing on the following sectors agroforestry, coffee and tea production, Terracing and permanent agriculture, Composting and irrigation, Off-farm job creation and value chain improvement, New energy sources and Payment for Ecosystem services

- When the program creates more green jobs we recommend that information regarding the number of persons employed, the salaries they got and how the money was used to improve on their livelihood should be collected as part of the project monitoring process.

Off-farm jobs and value chain improvement

- There is a demand from the younger generation towards the so called 'off-farm jobs', but few people seem to be involved in off-farm activities (mostly mobile and online services)
- New activities noticed are still in the field of farming, e.g. pig and chicken farming and avocado farming and value chain development like milk and honey production and processing are the most noticed value chains in Sebeya catchment.
- There are development opportunities and market demand for value chain development of potatoes, maize and vegetables.

Agroforestry

- We recommend agroforestry as key solution for soil restoration protection and provision of fuel wood, timber, fruits and livestock fodder while maintaining conservative agricultural practices in place.

- Only 18% of the respondents practice agroforestry in some extent and then mostly on project basis, subsidized by the government.

- We recommend to explore the creation of a local tree market and involve these entrepreneurs in the foreseen restorative measures.

- Coffee and tea production

- Increasing perennial coffee and tea production is recommended as solution for both increasing activities in the agricultural sector as to restore land degradation and soil erosion.

- We recommend exploring the integration of coffee or tea production with agroforestry.

- Despite good interest not much activity on coffee and tea was noticed. We recommend to investigate the possibilities to grow coffee and tea well in the catchment and develop new value chains and required finances.

- The development of knowledge and skills important to improve the coffee and tea farmers business model. If production increases and value chain development is practiced there will be opportunities for off-farm jobs in the washing stations, roasting coffee and packing.

- Encouraging Sugar cane and tea at various buffers zones of Sebeya river and areas with steep slopes an contribute in increasing farmers revenues and reduce erosion.

New energy sources

- 98% of Rwandans depend on wood and charcoal for cooking energy and timber. Because a market for alternative energy sources is underdeveloped and are still for most out of reach. This dependency and demand keeps deforestation going.

- We recommend an improved and controlled charcoal production and more fuel efficient stoves might be an intermediate solution in the transition to green energy sources.

8.3 Empowered landscape governance and management institutions

- Governance of land and water is one of the critical aspect to be strengthened all along with the implementation of ''the landscape restoration and Integrated Water resources Management Project.''

- The project is operating following normal structures of administrative governance where the lowest administrative unit of a village is given high importance. Nonetheless, the governance structure with District, Sector, Cell and Village is the one that is currently operating due to success in the political mobilisation, flow of information, and organization of various programs. Approaches should be geared to combine both from top to lowest of even from bottom to the top.

- In order to increase ownership of the farmers and local leaders of their natural resources and get significant impact on downstream catchments, we recommend to gradually empower governance systems that are linked to hydrological rather than administrative boundaries.

8.4 Empowered Evidence-based guidelines for the landscape approach

- Baseline assessment on Knowledge Management and SWOT analyses on the existing KMS indicated a lot of weaknesses in various tools for landscape approach.

- There is lack of regular and continued monitoring and modelling by FOSS of the key Sebeya's resources above and below ground.

- We recommend to establish an adaptive monitoring and management system allowing the continued benchmarking of progress by project management and decision makers and supporting a communication strategy that inspires, involves and empowers others.

- There is a good enabling environment, and there are good policies in line with landscape approach from various institutions. Nonetheless, there are large gaps in terms of harmonising those policies, lack of agreed targets by different districts and effective guidelines for landscape approach.

- We recommend the provision and deployment of simple tools in local language to involve and empower citizens and their local leaders in their efforts of landscape restoration.

- We recommend vocational capacity building is given high priority to accompany all efforts of landscape restoration approach at the involved institutions, organisations and other stakeholders.

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Annex 1 The EWMR M&E plan

Results/Indicators	Unit of measure	Baseline November 2019 - Sebeya catchment	Targets	Comments
Impact: Increased livelihood and conservation benefits from restoration & improved local land management in Sebeya catchments				
Impact Indicator 1: Number of households (of which 45% are female headed) in target area with improved livelihoods (e.g. food, water, health) due to project activities	# Households. Disaggregation by Gender.	0 households Female headed, 0 households Male headed	11435 households in total of which 5146 are female headed and 6289 are male headed.	Baseline is 0 as project implementation activities had not yet started before November 2019. Target: The average area of land allocated for agriculture by households is 0.75 ha. 1484 ha of new radical terraces with agroforestry is 4 % of Sebeya catchment is planned, and provides on average 1900 households with agroforestry plots. Also combined with the plans for agroforestry on farmland, at the end of the project 2335 additional households will be practicing agroforestry on average. There are plans for 4500 additional RWH tanks of 2 m3 for households in Sebeya Catchment. Also Improved cooking stoves will be provided to 2000 HH. Livestock will be provided to households: 1000 cows to catergory 3 households and 2 small animals to 1600 HH of category 1 & 2. The question remains if there is any overlap in these separate project activities to improve the livelihoods of households. The target value only needs to be corrected for double counting errors.
Impact indicator 2: Area (Ha) of degraded lands under restoration	Area (Ha)	2607 ha of land under restoration	additional 3072 ha under restoration due to project activities	baseline: This land under restoration is the area covered with radical terraces. The Gishwathi National Park is not considered under restoration but considered nature conservation. Target: The assumption was made that on the 3072 ha of land where the project will be implementing activities such as reforestation and terracing, the land will be restored to a good functioning system.

Impact Indicator 3: Reduced turbidity of water.	NTU (turbidity units)	Values ranged from 61-1118 NTU (in situ) and 10-3500 NTU (WASAC data from Gihira intake drinking water)	Long term target is 25 NTU	Earlier reports indicate Turbidity to be of major concern and mostly out of the acceptable range for natural potable water (<25 NTU set by FDEAS 12:2018). 25 NTU target of the FDEAS seems unreachable with current drivers.
Outcome 1: Degraded lands in Sebeya Restored				
Indicator 1.1: Area (Ha) of degraded land under improved landscape governance & management	Area (Ha)	2620 ha	additional 3072 ha under improved landscape governance & management	Baseline: Area of land under improved management. Data source: REMA. Target: The assumption was made that on the 3072 ha of land where the project will be implementing activities such as reforestation and terracing, the land will be under improved governance & management at the end of the project. The project activities will restore the land and agreements should be made with the farmers and communities on sustainable land management and governance. There is a possibility to complement this target value with the areas restored by the VLUAPs and MCAPs, if the VLUAPs and MCAPs contain a good land management and governance and maintenance plan and communities are committed now and in the future.
Output 1.1: Village & Micro-catchment land use planning improved to enhance overall catchment management				
Indicator 1.1.1: Number (#) of village & micro-catchment plans developed **in Sebeya**	# Plans Disaggregation: Plan type – MCAP, VLUAPs Catchment	6 MCAPs (from W4GR programme), 0 VLUAPs	220 plans (200 VLUAPS and 20 MCAPs) and 30 Hydrological maps at catchment level	
Output 1.2: Priority landscape restoration & management actions implemented and monitored				
Indicator 1.2.1: Number (#) of villages implementing	# villages. Disaggregation by catchment.	0 villages	100 villages	

restoration actions **as per the performance contracts**				
Indicator 1.2.2: Percentage (%) of people to whom knowledge or skills have been effectively transferred through training	# People. Disaggregation by gender	0 men, 0 women.	75%	Target set by IUCN
Outcome 2: Innovative investments promoted for improved livelihoods and conservation benefits				
Indicator 2.1: Percent (%) increase in the number of targeted households engaged in sustainable livelihoods activities	% Households. Disaggregation by gender.	•0.7% of the households involved in beekeeping •18% of the households are involved in Agroforestry	40%	
Output 2.1: Sustainable livelihood options expanded				
Indicator 2.1.1: Number (#) of enterprises supported within targeted Value Chains	# Enterprises. Disaggregation by Catchment and Gender	0 enterprises	2 enterprises	TBD by the project
Output 2.2: Inclusive financing mechanisms established				
Indicator 2.2.1: # of people accessing financing **as a result of project support**	# People	0 people	TBD by EWMR project	
Indicator 2.2.2: Number of people (45% female) with improved knowledge from training in sustainable enterprise development and financial management.	# People	0 people	TBD by EWMR project	
Outcome 3: Scale up to entire Sebeya and to other 3 other Catchments				
Output 3.1: Catchment committees established or strengthened				
Indicator 3.1.1: Number (#) of catchment committees **(with 45% female representation) established and actively involved in catchment & village land use management activities**	# Committees	0 Catchment committees	5 catchment committee	
Output 3.2: Catchment Plans elaborated				
Indicator 3.2.1: Number (#) of IWRM Packages prioritized for livelihood promotion	# IWRM Packages prioritized	4 packages prioritized	4 additional packages are planned	
Outcome 4: Knowledge management System implemented for improved & integrated landscape restoration				

Indicator 4.1: Number (#) of organizations/ community groups applying/using knowledge or skills **provided or promoted by the project**	Organizations /groups	0 Organizations /groups	TBD by EWMR project	
Output 4.1: Knowledge-management system developed and operationalized				
Indicator 4.1.1: Number (#) of knowledge or communication products/outputs developed **and shared through various channels/means**	# knowlegde products	Several existing water information systems are supported by TA	TBD by EWMR project	To be determined by IUCN, No KMS in the catchment, we recommend putting in place a KMS which will contain all ongoing studies, research reports, GIS data on environment, biodiversity, water quality etc...
	# communication products	0 products	TBD by EWMR project	
Indicator 4.1.2: Monitoring, Evaluation, Accountability and Reporting System developed and regularly updated.	Qualitative YES/NO	NO	YES	
Output 4.2: Programme Governance Structure in place for overall management and coordination of the project				
Indicator 4.2.1: Programme management structures **(including Project Steering Committee, Project Advisory Committee, staff recruitment) established**	Qualitative YES/NO	YES	YES	

Annex 2 Survey tools

I. Guide for the Key informants' interviews (KII)

Specific sections of the questionnaire can be selected for KII of different backgrounds. If applicable, the questions will be related to the first half of the year 2019.

A. Livelihood in Sebeya catchment

1. What are the main economic activities practiced by the population in Sebeya catchment? /Ni iyihe mirimo ibyara inyungu ikorwa n'abaturage mu cyogogo cya Sebeya (nkengero z'umugezi wa Sebeya)?
2. To what extent is the population engaged in sustainable livelihood activities? Percentage if possible. (examples are: beekeeping, sustainable agricultural practices, aquaculture, compost making, etc.) And could you specify the sustainable livelihood activities in this sector? / Ni ku kihe kigero abaturage bitabira gukora imirimo igendanye n'imibereho irambye? Bishyire ku ijanisha niba bishoboka. (Ingero: ubworozi bw'inzuki, gukora ubuhinzi ku buryo burabye, ubworozi bw'amafi, gukora ifumbire y'imorera, n'ibindi) Ese watubwira imirimo igendanye n'imiberehe irambye ikorwa muri uyu murenge?
3. What is the unemployment rate among youth and women in this sector? / Ni ikihe kigero cy'ubushomeri ku rubyiruko n'abagore muri uyu murenge?
4. How does Sebeya river provide opportunities to the population having economic activities in Sebeya catchment? / Ni mubuhe buryo umugezi wa Sebeya ufasha (utanga amahirwe) abaturage bakorera imirimo ibyara inyungu mu cyogogo cya Sebeya (inkengero z'umugezi wa Sebeya)?
5. In what way have the communities in Sebeya Catchment benefitted from conservation areas such as the National Park? / Ni mu buhe buryo ibyanya bikomye nka pariki bigirira akamaro abaturage batuye mu cyogo cya Sebeya (baturiye umukezi wa Sebeya)?
6. What are the threats caused by Sebeya river to the population living or practicing income generating activities in Sebeya catchment? / Ni izihe mbogamizi zituruka ku mugezi wa Sebeya zibangamira abatuye cyangwa bakorera imirimo ibyara inyungu mu cyogogo cya Sebeya?
7. Do you sometimes experience disasters in the catchment area of Sebeya river? If yes, what do you think are the main causes? / Hari ubwo mujya muhura n'ibiza muri kano gace kegereye umugezi wa Sebeya? Niba ari yego, ni izihe mpamvu zibanze zitera ibi biza?
8. To what extent are the damages caused by such disasters (human lives losses, livestock losses, crop damages … in numbers)? / Ese iyangiza riturutse kuri ibi biza riri ku ruhe rugero? (imfu z'abantu, imfu z'amatungo, iyangirika ry'umusaruro … mu mibare).
9. What do you recommend should be done to prevent such disasters? / Ni iki wumva cyakorwa mu kurwanya ibi biza?
10. Is the population in this section of Sebeya catchment involved in generating alternative income by new activities (compared to more traditional livelihoods), if yes, could you specify the activities and to what extend? / Ese abaturage batuye mu cyogo cya Sebeya (baturiye umugezi wa Sebeya) baba bagira uruhare

mu guhanga imirimo mishya ibyara inyungu (ugereranyije n'imirimo ya gakondo)? Niba ari yego, mwatubwira iyo mirimo n'ikigero cy'ubwitabire bw'abaturage?

11. Are these alternative income by new activities successful? If not successful, why not? Could you specify? / Ese iyi mirimo mishya yaba itanga umusaruro ugaragara? Niba idatanga umusaruro ugaragara, mwadusobanurira impamvu?
12. Are these new activities in rural areas coming from locals or does it come from city entrepreneurs? Can you estimate the number of entrepreneurs from city active in this section of sebeya river? / Ese iyi mirimo yaba ari iy'abantu batuye hano hafi cyangwa ni iya ba rwiyemezamirimo baturuka mu mugi? Mwaduha ikigereranyo cy'umubare wa ba rwiyemezamirimo baturuka mu mugi bafite ibikorwa muri aka gace kegereye umugezi wa Sebeya?

B. Agriculture and livestock

1. What are the main crops grown in the catchment area? / Ni ibihe bihingwa by'ingenzi bihigwa mu nkengero z'umugezi wa Sebeya?
2. What are the main livestock are reared in the catchment area? Ni ayahe matungo y'ingenzi yororwa mu nkengero z'umugezi wa Sebeya?
3. What is the estimated agriculture production for the main crops in this Sector (Depending on the season)? / Ni ikihe kigereranyo cy'umusaruro w'ubuhinzi ku bihingwa by'ingenzi muri uyu murenge (Ugendeye ku bihembwe by'ihinga)?
4. What is the estimated area of consolidated agricultural land in the catchment area in this sector? / Ni ikihe kigereranyo cy'ubuso buhingwaho mu buryo bwo guhuza ubutaka mu kace kegereye umugezi wa Sebeya muri uyu murenge?
5. What is the estimated area of arable land is covered by terraces in Sebeya catchment area in this Sector? / Ni ikihe kigereranyo cy'ubuso bw'ubutaka buhingwaho bwaba buriho amaterasi mu nkengero z'umugezi wa Sebeya muri uyu murenge?
6. To what extent do farmers in the catchment area practice market-oriented agriculture as opposed to subsistence agriculture? / Ni kuruhe rugero ubona abahinzi batuye mu nkengero za Sebeya bakora ubuhinzi bugamije isoko ugeneranyije n'ubuhinzi nganduragugo?
7. How are farming activities in the catchment area affecting the environment and natural resources? Are there environmental degradation issues happening in this area that you can link to farming (crops and livestock) activities? / Ni gute imirimo y'ubuhinzi mu nkengero za Sebeya igira ingaruka ku bidukikije n'umutungo kamere? Haba hari ibibazo byo kwangirka kw'ibigukikije n'ibikorwaremezo bituruka ku mirimo y'ubuhinzi muri aka gace?
8. To what extent (ha land and/or % of households) are these agricultural best practices adopted in the farming activities in this section of the Sebeya catchment? / Ni ku kihe kigero (hegitari z'ubutaka cyangwa ijanisha ry'ingo) iyi mirimo igendanye n'ubuhinzi yaba ikorwa muri aka gace kegereye umugezi wa Sebeya (Icyogogo cya Sebeya)?
    - *Mulching / Gusasira*
    - *Compost making / Gukora ifumbire y'imborera*
    - *Conservation agriculture (i.e. no tillage and permanent vegetation cover)/ Ubuhinzi bubungabunga ibidukikije*
    - *Use of chemical fertilizers / Gukoresha ifumbire mvaruganda*
    - *Intercropping / Guhinga ibihigwa bijyanye mu murima umwe*
    - *Use of improved seeds / Gukoresha imbuto z'indobanure*

- *Conservation tillage /Gutunganya ubutaka mu buryo bububgabunga ibidukikije*
- *Terracing / Gukora amaterasi*

9. What percentage of the households in the Sebeya catchment in this sector is involved in commercial tree farming? / Mwatubwira ijanisha ry'ingo zikora ubuhinzi bw'ibiti bugamije isoko muri aka gace kegereye umugezi wa Sebeya (icyogogo cya Sebeya)?
10. How many ha of land in the Sebeya catchment in this sector is in use for tree farming? / Ni hegitari zingahe z'ubutaka mu gace gaturiye umugezi wa Sebeya (Icyogogo cya Sebeya) zikorerwaho ubuhinzi bw'ibiti muri uyu murenge?

C. Basic Infrastructure availability

1. What are the main infrastructures are available in the catchment area in this Sector? / Ni ibihe bikorwaremezo by'ingenzi bigaragara mu nkengero z'umugezi wa Sebeya muri uyu murenge?
2. To what extent is clean water available to people living in the catchment area in your Sector (percentage if possible)? / Ni ku ruhe rugero abaturage batuye mu nkengero z'umugezi wa Sebeya babasha kubona amazi meza (ijanisha niba bishoboka)?
3. To what extent is electricity available to people living in the catchment area in your Sector (percentage if possible)? / Ni ku ruhe rugero abaturage batuye mu nkengero z'umugezi wa Sebeya babasha kubona amashanyarazi (ijanisha niba bishoboka)?
4. How many schools and health centers/ health posts are in Sebeya catchment in this Sector? / Ni amashuri angahe ndetse n'amavuriro abarizwa mu cyogogo cya Sebeya muri uyu murenge?

D. Community engagement in the catchment restoration management activities

1. What are people currently doing to restore the landscape and natural resources in the catchment area of Sebaya river? / Ni iki kuri ubu abaturage bari gukora mu kubungabunga imisozi n'indi mitungo kamere mu nkengero z'umugezi wa Sebeya?
2. How would you rate the knowledge of the population about landscape restoration and water resource management? / Ubona ubumenyi abaturage bafite mu bijyanye no kubungabunga imisozi n'indi mitungo kamere nk'amazi buri ku ruhe rugero?
3. How do you think people in the community could be engaged in the restoration of the landscape and water natural resources to ensure future ownership of the activities? / Ubona ari gute abaturage bafashwa kugira uruhare mu kubungabunga imisozi n'umutungo kamere w'amazi kugira mu nkengero z'umugezi wa Sebeya?
4. What do you think people in this Sector will benefit from catchment restoration activities and what threats do you think they may encounter? / Ni izihe nyungu utekereza abaturage bo muri uyu murenge bazakura mu mirimo yo kubungabunga imisozi n'indi mitungo kamere mu nkengero za Sebeya? Ese ni izihe mbogamizi ubona zazaterwa n'iyi mirimo?

5. To what extent are communities (% or number of communities) in this section in Sebeya catchment involved in Community erosion control measures such as: Ni kuruhe rugero abaturage (ku ijanisha cyangwa imibare y'abaturage) batuye mu cyogo cya Sebeya (baturiye umugezi wa Sebeya) bagira uruhare mu ngamba zo ku rwanya isuri, nka:
6. Agroforestry activities; / Gutera ibiti bivangwa n'imyaka
7. Construction and maintenance of radical terraces, / Gukora no kubungabunga amaterasi y'indinganire
8. Biological soil conservation measures, / Ingamba zo kubungabunga ubutaka (utunyabuzima tuba mu butaka)
9. Reforestation activities, / Imirimo yo kuvugurura (Kongera gutera) amashyamba.
10. Other erosion control measures / Izindi ngamba zo kuryanya isuri.
11. Do you have any lessons learned from community engagement or catchment restoration that you would like to share with us? / Haba hari amasomo mwungukiye mu gufatanya na baturage mu bikorwa byo kubungabunga icyogogo (imisozi n'umutungo kamere bituriye umgezi) mwumva mwadusangiza?

E. Improved landscape governance & management

1. Are there any Sebeya catchment restoration activities/projects carried out in this area before September 2019? If yes what are some of those activities? / Haba hari imirimo yo kubungabunga icyogogo cya Sebeya yakorewe muri kano gace mbere ya Nzeri 2019? Niba ari yego, ni iyihe mirimo yaba yarakozwe?
2. What have been the positive impacts of these activities/ projects to the population in this area? / Ni izihe ngaruka nziza iyi mirimo yaba yaragize ku baturage batuye muri kano gace?
3. What have been the negative impacts of these activities/ projects to the population in this area? / Ni izihe ngaruka mbi (imbogamizi) iyi mirimo yaba yaragize ku baturage batuye muri kano gace?
4. Are there any Sebeya catchment restoration activities currently taking place in this area? / Haba hari imirimo yo kubungabunga icyogogo cya Sebeya ikorerwa muri kano gace kuri ubu?
5. How are these activities affecting the population in this area (positively and negatively)? / Ni izihe ngaruka mbi cyangwa nziza iyi mirimo iri kugira ku baturage batuye muri kano gace?
6. Are there any existing committees or task force for landscape governance and management in Sebeya catchment? / Haba hari za komite zikurikirana imirimo yo kubungabunga icyogogo cya Sebeya?
7. How are community leaders collaborating with the population for landscape governance and management in Sebeya catchment? Any suggestion on how this collaboration can be strengthened or improved? / Ni gute abayobozi bo mu nzego z'ibanze bafatanya n'abaturage mu kubungabunga icyogogo cya Sebeya? Hari icyo mubona gikwiye gukorwa kugira ngo ubwo bufatanye burusheho kugira imbaraga?
8. In this section of the Sebeya catchment, how many Ha of degraded land is under improved landscape governance & management? Please specify type of degraded land and type of improved governance and management. / Muri aka gace k'icyogogo cya Sebeya ni hegitari zingahe z'ubutaka bwangiritse ziri kuvugururwa (kubungabungwa)? Sobanura uburyo bwo kwangirika ndetse n'uburyo bwo kuvugurura (Kubungabunga)

9. In this section of the Sebeya catchment, how much Ha land is under restoration, and on how many different locations are landscape restoration activities ongoing? / Muri aka gace k'icyogogo cya Sebeya ni hegitari zingahe z'ubutaka ziri kuvugururwa, ese haba ari mu duce tungahe iyi mirimo yo kuvugurura yaba iri gukorwa?
10. How many old mining areas are rehabilitated post-closure (for example: revegetated, fenced or other erosion control measures applied) in this section of the Sebeya river? / Ibirombe by'amabuye y'agaciro bitagikoreshwa byaba byaravuguruwe (ingero: Kongera kuhatera ibiti cg ibindi bimera, kuhazitira cyangwa kuhakorera imirimo yo kurwanya isuri) nyuma yo gufungwa muri aka gace kegereye umugezi wa Sebeya ni bingahe?
11. How many active mines are present in this section of the Sebeya River? Are they complying with the environmental and mining standards? What type of product is mined in these active mines? / Ibirombe by'amabuye y'agaciro bigikoreshwa muri kano gace kegereye umugezi wa Sebeya ni bingahe? Ese byaba bikurikiza amabwiriza yo kurengera ibidukikije n'agenga ubucukuzi bw'amabuye y'agaciro? Ni ubuhe bwoko bw'amabuye y'agaciro bucukurwa muri ibyo birombe?
12. How many areas with gullies are well managed in this section of the Sebeya river (e.g gully plug, enclosed area, revegetation)? / Ibice bifite imikoki bitunganyijwe neza muri iki cyogo cya Sebeya ni bingahe (urugero: gusiba imikoki, gutera ibimera, kuzitira ahari imikoki ,)?

F. Payments for Ecosystem services and Value chains

1. What PES (payment for ecosystem services) mechanisms are in place in Sebeya catchment? Could you shortly introduce these PES mechanisms (who is involved, what payment agreements are in place etc)? / Ni ubuhe buryo bwo kwishyura serivisi zo kubungabunga/ gufata neza urusobe rw'ibinyabuzima buhari muri kano gace ka Sebeya? Mwadusobanurira muri macye uko ubu buryo bukora (Amasezerano /ubwumvikane mu kwishyura, n'ibindi)?
2. Is there any existing collaboration with the private sector for PES (payment for ecosystem services)? If yes, what is the nature of that collaboration (what are the involved parties, what roles do they play, etc)? Do you see any add value from working with the private sector? Haba hari ubufatanye/ imikoranire mufitanye n'abikorera mu kwishyura serivisi zo kubungabunga/ gufata neza urusobe rw'ibinyabuzima? Niba ari yego iyo mikoranire iteye ite (Ni bande babigiramo uruhare, ni uruhe ruhare bagira n'ibindi)? Ese hari inyungu mubona mu gukorana n'abikorera ku giti cyabo?
3. What natural commodities (i.e., all the things nature provides) could be exploited for a potential PES mechanism in Sebeya Catchment? Specify, why you think so. / Ni iyihe mitungo kamere ishobora kwifashishwa mu buryo bwo kwishyura serivisi zo kubungabunga urusobe rw'ibinyabuzima muri iki cyogo cya Sebeya? Mwatubwira impamvu mubibona mutyo?
4. What Value Chains are in place in this section of the Sebeya catchment? Could you specify the role the population in this sector plays in the value chain? / Ni ubuhe bwoko by'iyongeragaciro bugaragara muri aka gace k'icyogogo cya Sebeya? Sobanura uruhare abaturage bagira muri iri yongeragaciro?
5. Does the population in this section of Sebeya Catchment require information (or more that they currently have access to) to improve their income by applying value chain activities (i.e., activities to increase the value of produce)? / Ese abaturage batuye mu cyogo cya Sebeya baba bakeneye amakuru (arenze kuyo

babasha kubona ubu) kugira ngo bongere amafaranga binjiza binyuze mu kunoza iyongeragaciro?

6. In what ways is the population informed on value chain activities? / Ni mu buhe buryo abaturage bagezwaho amakuru ku bikorwa bijyanye n'iyongeragaciro?

G. Entrepreneurial activities, markets and innovation

1. To what extend do households in this sector of Sebeya catchment have access to loan from formal financial institutions? / Ni kuruhe rugero abaturage batuye mu cyogo cya Sebeya babasha kubona inguzanyo mu bigo by'imari?
2. Which entrepreneurial activities are noticed in the area related to tree/ wood production? / Ni iyihe mirimo y'ubucuruzi igendanye no kugurisha cyangwa gutunganya ibiti igaragara muri aka gace?
3. To what extend do households in this sector of Sebeya catchment use other energy sources than charcoal? If they use other sources than charcoal, what sources do they use and how often? / Ni kukihe kigero abaturage batuye mu cyogo cya Sebeya bakoresha ubundi bwoko bw'ingufu butari amakara? Niba bakoresha ubundi bwoko bw'ingufu, ni ubuhe bakoresha, ese ni kangahe babukoresha?
4. Which new activities are noticed replacing charcoal for other energy sources? Specify / Ni iyihe mirimo mishya iri kugaragara mu gusimbuza amakara ubundi bwoko bw'ingufu? Sobanura.
5. What are the new business trends in Sebeya? And what is the assumed market potential for new business types? If known, what is the average monthly income for the new business activities? Ni iyihe mirimo mishya y'ubucuruzi igezweho muri aka gace gaturiye umugezi wa Sebeya? Ese mubona isoko rihagaze rite kuri ubwo bucuruzi? Niba bishoboka, mwatubwira ikigereranyo cy'amafaranga yinjizwa n'ubwo bucuruzi ku kwezi?
6. Can the local population of this section of the Sebeya river easily participate in the market? If no, why not? /Ese abaturage baturiye umugezi wa Sebeya babasha guhangana ku isoko? Niba ari hoya, kubera iki?
7. In general, are there investments needed to start a new business in the Sebeya catchment? If known, could you specify how much for threshold value to start a business for a certain business type. / Ese muri rusange haba hari ishoramari rikenerwa mu gutangira ubucuruzi mu cyogo cya Sebeya? Niba bizwi, mwatubwira nk'amafaranga bisaba kugira ngo umuntu atangire ubucuruzi ufatiye urugero ku murimo w'ubucuruzi runaka?

II Guide for the focus group discussion (FGD)

1. What are the main income generating activities do people in this Sector practice in Sebeya catchment? /Ni yihe mirimo y'ingenzi ibyara inyungu abaturage batuye muri uyu murenge cyogogo cya Sebeya?
2. How does Sebeya river serve as an opportunity to people living or practicing income generating activities in Sebeya catchment? /Ni mubuhe buryo mubona umugezi wa Sebeya ufasha abawuturiye cyangwa abakorera imirimo ibyara inyungu mu cyogogo cya Sebeya?
3. Have you ever experienced any disaster in in Sebeya catchment? If yes, what type of disaster and when was the last time you have experience such a disaster? What was the impact of the disaster in this section of the Sebeya river? / Ese haba hari Ibiza mwigeze muhura nabyo hano mu nkengero z' umugezi wa Sebeya? Niba ari yego, ni ibihe biza mwahuye nabyo? Ese mwaba muheruka guhura n'ibyo biza ryari? / Ni izihe ngaruka zaba zaratewe n'ibi biza?
4. How do you collaborate with local leaders to prevent disasters in this area or limit the damages when such disasters happen? / Ni gute mukorana n'inzego z'ubuyobozi mu gukumira ibyo biza ndetse no kugabanya ingaruka ziterwa n'ibyo biza.
5. Are there any Sebeya catchment restoration activities/projects carried out in this area before September 2019? If yes what are some of those activities? / Haba hari imirimo yo kubungabunga icyogogo cya Sebeya yakorewe muri kano gace mbere ya Nzeri 2019? Niba ari yego, ni iyihe mirimo yaba yarakozwe?
6. What have been the positive impacts of these activities/ projects to the population in this area? / Ni izihe ngaruka nziza iyi mirimo yaba yaragize ku baturage batuye muri kano gace?
7. What have been the negative impacts of these activities/ projects to the population in this area? / Ni izihe ngaruka mbi (imbogamizi) iyi mirimo yaba yaragize ku baturage batuye muri kano gace?
8. Are there any Sebeya catchment restoration activities currently taking place in this area? / Haba hari imirimo yo kubungabunga icyogogo cya Sebeya ikorerwa muri kano gace kuri ubu?
9. How are these activities affecting the population in this area (positively and negatively)? / Ni izihe ngaruka mbi cyangwa nziza iyi mirimo iri kugira ku baturage batuye muri kano gace?
10. What are people currently doing to restore and maintain landscape and water natural resources in the catchment area of Sebeya river? / Ni iki muri gukora nk'abaturage mu kubungabunga imisozi n'umutungo kamere w'amazi mu nkengero z'umugezi wa Sebeya?
11. How do you think people living in Sebeya catchment can take part in the restoration of the landscape and natural resources in the catchment area? / Mwumva ari mu buhe buryo abaturage baturiye umugezi wa Sebeya bagira uruhare mu kubungabunga imisozi n'indi mitungo kamere biri mu cyogogo cya Sebeya?
12. What are the main agriculture-related activities practiced in Sebeya catchment? / Ni ibihe bikorwa by'igenzi bigendanye n'ubuhinzi n'ubworozi bikorerwa mu cyogoo cya Sebeya?

13. How does Sebeya river provide opportunities to farmers (irrigation, drinking water for livestock …)? / Ese ubona ari gute umugezi wa Sebeya ufasha abahinzi (Kuhira imyaka, amazi yo kunywa ku matungo…)?
14. What challenges do farmers practicing agriculture activities in this catchment area face? / Ni izihe mbogamizi abahinzi bakorera imirimo yabo mu nkengero z'umugezi wa Sebeya bahura nazo?
15. Are the livelihoods activities in this section of the Sebeya river part of a Value Chain? If yes, please specify. Do people need improved access to information on value chain activities? / Ese mubona imirimo itanga imibereho ku baturiye umugezi wa Sebeya ifite aho ihuriye n'uruhererekane rw'iyongeragaciro? Niba ari yego, mwadusobanurira. Ese abaturage baba bakeneye amakuru yisumbuyeho kubijyanye n'iyongeragaciro?
16. Do people in this area have access to clean water? / Ese abaturage muri aka gace babasha kubona amazi meza?
17. In average, how much time does it take people in this area to reach to the main infrastructures such as schools and Health centers? / Mugeranije, abantu batuye muri aka gace bibatwara igihe kingana gute ngo bagere ku bikorwaremezo by'ibanze nk' amashuri n'ibigo nderabuzima?
18. In this section of the Sebeya catchment, are there areas of degraded land under improved landscape governance & management? Please specify type of degraded land and type of improved governance and management. / / Muri aka gace k'icyogogo cya Sebeya haba hari ahantu ubutaka (imisozi n'umutungo kamere) bwangiritse buri kuvugururwa (kubungabungwa)? Sobanura uburyo bwo kwangirika ndetse n'uburyo bwo kuvugurura (Kubungabunga).
19. To what extend are households in this sector of Sebeya catchment involved in commercial tree farming? / Ni kukihe kigero ingo (abaturage) zikora ubuhinzi bw'ibiti bugamije isoko muri aka gace kegereye umugezi wa Sebeya (icyogogo cya Sebeya) ?
20. Are there old mining areas in this section of the Sebeya river, that are rehabilitated post-closure (for example: revegetated, fenced or other erosion control measures applied)? What differences can be seen with non-rehabilitated old mining areas? / Haba hari ibirombe by'amabuye y'agaciro bitagikoreshwa byaba byaravuguruwe (ingero: Kongera kuhatera ibiti cg ibindi bimera, kuhazitira cyangwa kuhakorera imirimo yo kurwanya isuri) nyuma yo gufungwa muri aka gace kegereye umugezi wa Sebeya? Ese mubona bitandukaniye hehe n'ibirombe bitigeze bivugugururwa (bitunganywa)?
21. How are the active mines present in Sebeya catchment affecting the population and the environment (positively or negatively)? / Ni gute mubona ibirombe by'amabuye y'agaciro bigikoreshwa muri kano gace k'icyogogo cya Sebeya bigira ingaruka (nziza cyangwa mbi) ku baturage cyangwa kubidukikije?
22. How are the areas with gullies managed in Sebeya catchment (e.g gully plug, enclosed area, revegetation)? / Ni gute Ibice bifite imikoki bitunganywa neza muri iki cyogogo cya Sebeya (urugero: gusiba imikoki, kuzitira ahari imikoki, kongera kuhatera ibimera)? Mwadusobanurira uburyo iyi mirimo yo kubibungabunga/ kubitunganya (inshingano n'ishyirwamubikorwa) ikorwa?
23. To what extend do households in this sector of Sebeya catchment use other energy sources than charcoal? If they use other sources than charcoal, what

sources do they use and how often? Which new activities are noticed replacing charcoal for other energy sources? / Ni kukihe kigero abaturage batuye mu cyogo cya Sebeya bakoresha ubundi bwoko bw'ingufu butari amakara? Niba bakoresha ubundi bwoko bw'ingufu, ni ubuhe bakoresha, ese ni kangahe babukoresha? Ni iyihe mirimo mishya iri kugaragara mu gusimbuza amakara ubundi bwoko bw'ingufu? Sobanura.

III HOUSEHOLD SURVEY QUESTIONNAIRE

I. Identification / Umwirondoro

	Responses	**Code**
I01	Enumerator's name / Izina ry'umukarani w'ibarura	_____
I02	Enumerator's code / Ikirango cy'umukarani w'ibarura	/__/
I03	Supervisor's name / Izina ry'umuyobozi w'abakarani b'ibarura	_____
I04	Household ID / Ikrango cy'urugo	/__/__/__/
I05	Name of respondent / Izina rya nyiri urugo	_____
I06	Province / Intara	/__/
I07	District /Akarere	/__/__/
I08	Sector / Umurenge	/__/__/__/__/
I09	Cell / Akagari	/__/__/__/__/__/__/
I10	Village / Umudugudu	/__/__/__/__/__/__/__/__/
	Consent Hello, my name is ..... I am a representative of the ACACIA/CIDRA Ltd IUCN Sebeya Catchment Restoration project. We are conducting a socio-economic baseline study for the implementation of an Integrated Water Resource Management project. This survey is part of a study aiming to collect socio-economic information on the population surrounding Sebeya river. We would like to ask you to participate in this study. Do you agree to participate? Muraho, Nitwa ……. *noherejwe na IUCN/ACACIA Ltd mu mushinga wa IUCN ukora inyigo ijyanye no kubungabunga Icyogogo cya Sebeya. Turi mu gikorwa cyo gukusanya amakuru ku bijyanye ni imibereho y'abaturage baturiye umugezi wa Sebeya uteganywa gukorerwaho imishinga ibungabunga ibidukikije kandi ikanafasha abawuturiye mu iterambere.* Tukaba tubasaba kutwemerera kuduha amakuru. Mwaba mwemeye kuduha amakuru?	
I11	Date of interview / Itariki yo gukusanya amakuru	___/_____/_____/
I12	Time of interview / Igihe kubazwa byatwaye	___/_____/
I13	Household GPS coordinates	_____/: _____/

A. Household Identification / Umwirondoro wa Nyiri Urugo

	Identification / Umwirondoro		**Responses / Ibisubizo**	Code
A01	Sex of Household Head / Igitsina	1	Male / Gabo	/__/
		2	Female / Gore	
A02	Age of Household head / Imyaka ya nyiri urugo		.....	/__/__/
A03	Marital status of household head/ Iranga mimerere rya nyiri urugo	1	Single / Ingaragu	/__/
		2	Married / Yarashatse	
		3	Widow/widower / Umupfakazi	
		4	Separated (*separated*) / Yaratandukanye	
		5	Divorced (*legally separated*)/ Baratandukanye byemewe n'amategeko	
A04	Wealth category of household / Icyiciro cy'ubudehe cya nyiri urugo	1 2 3 4	Category 1/ icyiciro cya mbere Category 2/ Icyiciro cya kabiri Category 3/ Icyiciro cya gatatu Category 4 / Icyiciro cya kane	/__/
A05	For how long have you lived in this area? / Mumaze igihe kingana gite mutuye hano?	1. Less than one year (write the number of months)/ munsi y'umwaka		/__/__/

	Choose from the options provided to the right, if less than 1 year write number of month / Hitamo kimwe muri ibi biri iburyo, niba ari munsi y'umwaka andika umubare w'amezi.	umwe (Andika umubare w'amezi) 2. Between one and Five/ Hagati y'umwaka umwe n'itanu 3. Between five and ten/ Hagati y'imyaka itanu n'icumi 4. More than ten years/ Hejuru y'imyaka icumi		
A06	How many persons live in this household? / Muri uru rugo habamo abantu bangahe			/__/__/

B. Demographics Information (*All persons living in the household*) / Umwirondoro w'abatuye muri uru rugo

	B01.Names/ *Amazina*		**B02. Sex/ *Igitsina***	**B03. Age / *Imya ka***	**B04. Relationship with HH /*Isano na nyiri urugo***	**B05 Employment Code (6)/ *Umurimo***		**B06. Estimated monthly income both primary and secondary occupation code (7)/ Ikigereranyo cy'umushahara abona ku mirimo ye yose**		**B07. Education level/ Amashuri yize**	
PID			*(1=Male, /Gabo 2=Femal/Gore)*		code (5)/Ikirango	*(Primary occupation/ Umurimo w'ingenzi*	*Secondary occupation/ umurimo w'inyongera*	Before September 2019/ Mbere ya Nzeli 2019	Between September 2019 and June 2020/ Hagati ya Nzeli 2019 and Kamena 2020	Code (8)/ Ikirango	1. Yes, /Yego 2. No/Oya
1											
2											
3											
N+											
	(5)		(6)			(7)				(8)	
	1 = Head of household/ *Nyiri urugo* *2* = Spouse */Uwo bashakanye* *3* = Son/daughter/ *Umuhungu/umukobwa* *4* = Father/mother */ ise/nyina* *5* = Grand parent */ se kuru cyangwa nyurakuru* *6* = Grandchild, */ umwuzukuru* *7*=Permanent Employee/ *Umukozi uhoraho* *8* = Other relation (Specify)/*irindi sano rivuge*		*1 = None/ Nta kazi* *2= Unpaid domestic work/ Imirimo yo murugo idahemberwa* *3 = Student/ Umunyeshuri* *4=Farmer (Agriculture/Umuhinzi/* *5= Livestock)/ Umworozi* 6= Farming (own)/Umuhinzi wihingira 7= Industrial worker / Umukozi wo mu ruganda 8= Paid farming / Umuhinzi ubihemberwa *9*= Self Employed */Crafts/Uwikorera/ Umunyabukorikori* *10*= Trader */Umucuruzi*			1. Less than 5000Frw munsi ya 5000 2. [5000- 10000] 3. [10000- 20000] 4. [20000-50.000] 5. [50.000-100.000] 6. [100.000-500.000] *7.* 500.000 and plus 500.000 narenga			*1= None/ntayo* *2 = Attended primary school only/ amashuri abanza* *3 = Attended vocational school (Artisanal, CERAI, CFG, Familial)/amashuri y'imyuga* *4 = Completed high school (D4, D5, D6, D7)/Amashuri yisumbuye* *5 = Graduate (A1, A0, Masters, PhD)/Kaminuza*

		11 = Mining / ubucukuzi bw'amabuye y'agaciro *12*=Civil servant*/ local Authorities/ Umukozi wa leta/Inzego z'ibanze* *13*=Non-government Organisation/ *Umuryango utari uwa leta* *14*= Retired*/ Mu kiruhuko ki zabukuru* *15*=Other specify */ ikindi kivuge*			

C. Agriculture activities / Ibikorwa by'ubuhinzi (All the questions refer to <u>the period before September 2019</u>)

C01 *Do you have access to land? / Waba hari ubutaka ufiteho uburenganzira 1=Yes/Yego 2=No/Oya* *If the response is 2 go to D01/ Niba igisubizo ari oya jya kuri D01*		
C02 *How do you use that land? / Ubwo butaka ubukoresha iki:* *1. Residential / gutura* *2. Commercial/ ubucuruzi* *3. Agriculture/ ubuhinzi* *4. Combined agriculture and residential / Ubuhinzi buvanze no gutura* *If the response is 3 or 4 go to D03* *If the response is 1 or 2 go to E01*		
C03	What is the total size of that land / *Ubwo butaka bwose bufite ubuso bungana bu*te	*1.One hectare/ hegitari imwe* *2.Less than a hectare/ munsi ya hegitari* *3.20 by 30 Meters/ Metero 20 kuri 30* *4.Others/ ikindi kivuge*
C04	What is the total size of land on which you practice agriculture (in acres)? / *Ubuso bw'isambu yawe buhinze bwaba bungana bute (muri are)?*	*Specify*
C05	What crops do you mainly cultivate on your land? (Tick all that are apply*)/ Nibihe bihingwa by'ingenzi uhinga mu mirima yawe (hitamo ibyo ahinga byose)*	*1.*Banana*/ Ibitoki 1=Yes/yego 2=No/oya* *2.* Beans*/ Ibishyimbo 1=Yes/yego 2=No/oya* *3.*Cassava*/ Imyumbati 1=Yes/yego 2=No/oya* *4.*Maize*/Ibigori 1=Yes/yego 2=No/oya* *5.*Irish potatoes*/ Ibirayi 1=Yes/yego 2=No/oya* *6.* Sweet potatoes*/ Ibijumba 1=Yes/yego 2=No/oya* *7.*Fruits*/ Imbuto 1=Yes/ yego 2=No/oya* *8.*Vegetables*/ Imboga 1=Yes/yego 2=No/oya* *9. Tea/ Icyayi 1=Yes/yego 2=No/oya* *10. Rice/ Umuceri 1=Yes/yego 2=No/oya*
C06	What is the estimated production in Kgs of these crops per season? / *Umusaruro w'ibihingwa byawe ungana iki muri Kg mu gihe cy'isizoni?*	*1.* Banana*/ Ibitoki* *2.* Beans*/ Ibishyimbo* *3.* Cassava*/ Imyumbati* *4.* Maize*/ Ibigori* *5.* Irish potatoes */ Ibirayi* *6.* Sweet potatoes */ Ibijumba* *7.* Fruits*/ Imbuto* *8.*Vegetables */ Imboga* *9. Tea/ Icyayi 10. Rice/ Umuceri*
C07	How much of your production in kg is domestically consumed? Ku musaruro	1. Less than 50kg/ munsi yibiro 50

	mweza mu gihe cy'isizoni uwo mukoresha mu mafunguro yo mu rugo ungana iki, muri kg? / *Reference to the answers in CO6.*	2. Between 50kg and 100kg/ Hagati y'ibiro 50 na 100 3. Between 100kg and 200kg /Hagati yibiro 100 na 200 4. Between 200kg and 500 kg/ Hagati yibiro 200 na 500 5. Between 500kg and 1000Kg/ Hagati yibiro 500 na 1000 6. Greater than 1000kg / ibiro birenze 1000
C08	What is the estimated value of crops in Frw sold on the market? / *Umusaruro w'ibihingwa wagurishijwe ku isoko waba ufite akahe gaciro mu mafaranga?*	*1. Less than 5000Frw munsi ya 5000Frw* *2. [5000- 10000]* *3. [10000- 20000]* *4. [20000-50.000]* *5. [50.000-100.000]* *6. [100.000-500.000]* *7. 500.000 and plus / 500.000Frw no kurenga*
CO9	What food items do you require to buy from the market (that you do not produce from your own farm or produce in unsufficient amount)? / Ni ibihe biribwa mukenera kugura ku isoko (ibyo mutihingira mu mirima yanyu cyangwa mweza ibidahagije)?	*Specify / Bivuge*
C10	How much do you spend monthly on such food items? / Ese ibyo biribwa bibatwara amafaranga angana ate mu gihe cy'ukwezi?	
C11	Do you practice your agriculture on a consolidated land? / Ese mwaba mukorera ubuhinzi bwanyu ku butaka bwahujwe? If yes continue to C12, if no skip to C14 / Niba ari yego komeza kuri C12, niba ari hoya simbuka ujye kuri C14	*1=Yes/yego 2=No/oya*
C12	What is the size of land under consolidation (in acres)? Ubuso bw'ubutaka bwanyu bwahujwe burangana bute (muri are)?	
C13	What crops do you produce in the consolidated land in each season? Ni ibihe bihingwa mohinga kubutaka bwahujwe, kuri buri gihembwe cy'ihinga?	*1. Season A, _September to February (specify the crops) / Igihembwe A (vuga ibihingwa)* *2. Season B, March to June (specify the crops) / Igihembwe B (vuga ibihingwa)*

		3. *Season C, July to September (specify the crops) / Igihembwe C (vuga ibihingwa)*
C14	Which of the following best practices and activities have you adopted in your farming activities? / Ni ibihe muri ibi bikurikira waba ukora mu mirimo yawe y'ubuhinzi?	*1. Mulching / Gusasira* *2. Compost making / Gukora ifumbire y'imborera* *3. Use of chemical fertilizers / Gukoresha ifumbire mvaruganda* *4. Intercropping / Guhinga ibihingwa bijyana mu murima umwe* *5. Use of improved seeds / Gukoresha imbuto z'indobanure* *6. Terracing / Gukora amaterasi* *7. Bee keeping / Ubworozi bw'inzuki* *8. Aquaculture / Ubworozi bw'amafi* *9. Crop rotation / Guhinduranya ibihingwa* *10. Integrating livestock and crops / Guhuza ubworozi n'ubuhinzi* *11. Agroforestry / Gutera ibiti bivangwa n'imyaka* *12. Other (Specify) / Kindi (Kivuge)*
C15	Do you own any livestock? / *Waba hari itungo ugira*?	*Yes/ yego* *2. No /Oya*
C16	If yes, indicate the number of livestock you own among the following/ *Niba ari yego waba ufite amatungo angahe muri aya akurikira.*	Livestock / Quantity/umubare Cow/*Inka* Goats/*Ihene* Pigs/*Ingurube* Rabbits/*Inkwavu* Chikens/*Inkoko* Other / irindi tungo rivuge

D. Seasonal changes and and natural disasters/ Ihinduka ry'ibihe n'ibiza *(All the questions refer to <u>the period before September 2019</u>)*

D01	Have you ever experienced a disaster such as drought, flooding or landslide in this area? / Haba hari ubwo mujya muhura n'ikiza nk' amapfa, imyuzure cg inkangu muri aka gace mutuyemo? *If the response is 1 go to E02 / Niba igisubizo ari 1 komeza kuri E02* *If the response is 2 go to F01/ Niba igisubizo ari 1 jya kuri F02*	*1=Yes/yego* *2=No/oya*

D02	What type of disaster have you experienced? Ni ikihe kiza mwaba mwarahuye nacyo?	*1. Drought/ amapfa* *2. Flooding/ umwuzure* *3. Landslide/ Inkangu* *4. Other (Specify)/ Ikindi (Kivuge)*
D03	When was the last time you experienced such a disaster? / Ni ryari muheruka guhura n'icyo kiza?	1. Less than one year ago/ munsi y'umwaka umwe 2. Between 1 and 3 years ago / Hagati y'umwaka umwe n'itatu 3. Between 3 and 5 years ago/ Hagati y'imyaka itatu n'itanu 4. More than 5 years ago/ Hejuru y'imyaka itanu
D04	How often do such disaters happen? / Ni kangahe ibi biza bikunze kuba?	1. More than once a year/ Inshuro zirenze imwe mu mwaka 2. Once a year / rimwe mwaka 3. Once every 2 years/ Rimwe mu myaka 2 4. Once every 3 to 5 years / Rimwe mu myaka 3 kugera kuri 5.
D05	The last time you experienced such a disaster what type of damages did it cause to your family? Igihe muheruka guhura n'ibi biza, ni iki byaba byarabangiririje?	1. House destruction / Gusenyerwa inzu

		2. Crops damages or yield loss/ Kwangirika kw'ibihingwa 3. Livestock loss/ Gupfa kw'amatungo 4. Human death / Urupfu rw'abantu 5. Other (Specify) / Ikindi (Kivuge)
D06	What is the estimated value (in frw) of the assets damaged or lost when you experienced that disaster? / Ni ikihe kigereranyo cy' agaciro (mu frw) k'ibyangiritse ubwo muheruka guhura n'icyiza?	*1. Less than 5000Frw munsi ya 5000Frw* *2. [5000- 10000]* *3.[10000-20000]* *4.[20000-50.000]* *5.[50.000-100.000]* *6.[100.000-500.000]* *7. [500.000-1000.000]* *8. 1000.000and plus / 1000.000Frw no kurenga*
D07	What was the estimated production in Kgs of these crops per season, the last time you experience the disastors above? Ikigereranyo cy'umusaruro wanyu kuri sizoni (muri kg) cyanganaga gite ubwo muheruka guhura n'ibi biza twavuze haruguru?	*1.* Banana*/ Ibitoki* *2.* Beans*/ Ibishyimbo* *3.* Cassava*/ Imyumbati* *4.* Maize*/ Ibigori* *5.* Irish potatoes */ Ibirayi* *6.* Sweet potatoes */ Ibijumba* *7.* Fruits*/ Imbuto* *8.*Vegetables */ Imboga* *9. Tea/ Icyayi*

		10. Rice/ Umuceri
D08	Are there any Sebeya catchment restoration activities carried out in this area before September 2019? / Haba hari imirimo yo kubungabunga icyogo cya Sebeya yakorewe muri kano gace mbere ya Nzeri 2019? If No, skip to Section E/ Niba ari Oya, Komereza ku gice cya E	*1.Yes/ yego* *2. No /Oya*
D09	What are those activities? / Iyo mirimo ni nk'iyihe?	*Specify*
D10	What are the positive impacts of such activities to your household (land, agriculture activities, wellbeing…)? / Ni izihe ngaruka nziza iyi mirimo yaba yaragize ku muryango wanyu (ubutaka, imirimo y'ubuhinzi, imibereho n'ibindi…)?	*Specify*
D11	What have been the negative impact of such activities to your household (land, agriculture activities, wellbeing…)? / Ni izihe ngaruka mbi iyi mirimo yaba yaragize ku muryango wanyu (ubutaka, imirimo y'ubuhinzi, imibereho n'ibindi…)?	*Specify*

E. Value Chains (actitivities to improve the value of goods)/ Iyongeragaciro (Imirimo igamije kongerera agaciro ibicuruzwa). ***(All the questions refer to <u>the period before September 2019</u>)***

E01	In your livelihood activities, are there things you do to add value to your products? / Mu mirimo ukora ikubeshejeho, waba hari ibyo ukora ngo wongerere agaciro ibicuruzwa cyangwa umusaruruo wawe? If yes, continue to E02 / Niba ari yego, komeza kuri E02 If no, skip to Section F / Niba ari oya, komereza kuri F	*1.Yes/ yego* *2. No /Oya*
E02	What activities do you do to add value to your products or produce? / Ni ibihe bikorwa ukora mu kongerera agaciro ibicuruzwa cyangwa umusaruro wawe?	Specify: / Sobanura
E03	How do you access information related to value addition practices (Techniques, inputs, markets etc)? / Ni gute mubona amakuru ajyanye n'imirimo yo kongerera agaciro ibyo mukora (Uburyo bw'imikorere, inyongeramusaruro, Ibyerekeye amasoko, n'ibindi…)?	1. Local leaders / Abayobozi mu nzego z'ibanze 2. Community member/Neighbour / Abaturanyi 3. Program in the community / Gahunda zibera aho utuye 4. Radio/TV / Radiyo cyangwa televiziyo 5. Business representatives / Abahagarariye abacuruzi **6.** Other, specify / Ahandi, havuge

F. Alternative income generating activities/ Indi mirimo itanga amafaranga (All the questions refer to the period before September 2019).

F01	Do you generate alternative income by any new activities (activities different from traditional activities? examples are: diversified tourism, IT services, agribusiness, bee keeping, aquaculture, new horticultural products, local industries, mining activities)? / Haba hari indi mirimo mishya ikwinjiriza amafaranga (imirimo itari iya gakondo. Urugero: Ibijyanye n'ubukerarugendo, Serivisi z'ikoranabuhanga, ubworozi bw'inzuki, ubworozi bw'amafi, Ubuhinzi bushya bw'imboga, imbuto cyangwa indabyo, inganda zicirirtse, ubucukuzi bw'amabuye y'agaciro)? If no, Skip to F10 / Niba ari hoya, komeza ku kibazo cya F11	*1=Yes/Yego* *2=No/Oya*

F02	What are those activities? / Iyo mirimo ni iyihe?	*Specify / Yivuge*
F03	Are these activities succesfull? / Iyo mirimo yaba itanga umusaruro ugaragara? If No, continue to F04/ Niba ari oya komeza kuri F04 If yes, skip to F05/ Niba ari yego jya kuri F05	*1=Yes/Yego* *2=No/Oya*
F04	Why do you think they are not successful? / Utekereza ari ukubera iki idatanga umusaruro ugaragara?	*Specify: / Sobanura*
F05	Did you need to invest to start these activities? / Byaba byaragusabye gushora imari yawe ngo utangire iyi mirimo? If no, skip to F07	*1=Yes/Yego* *2=No/Oya*
F06	How much did you invest (in Frw) / Waba warashoyemo amafaranga angahe (mu Frw)?	
F07	What is your average monthly income from these new activities? / Ikigeranyo cy'amafaranga ukura muri iyi mirimo mu gihe cy'ukwezi ni angahe?	*in Frw / Mu mafaranga y'urwanda*
F08	What is assumed market potential for these activities? / Ese isoko rihagaze rite muri ubu bucuruzi?	
F09	Can you easily access the market with these activities? / Waba ubona isoko (abaguzi) ku buryo bworoshye muri iyi mirimo?	*1=Yes/Yego* *2=No/Oya*
F10	Are you involved in commercial tree farming? / Waba ukora ubuhinzi bw'ibiti bugamije isoko?	*1=Yes/Yego* *2=No/Oya*

G. Energy and water use/ Imikoreshereze y'amazi n'ingufu *(All the questions refer to the period before September 2019)*

<table>
<tr><td>G01</td><td>What is the main source of energy do you use for cooking? / Ni ubuhe bwoko bw'ingufu bw'ibanze mukoresha mu guteka?</td><td>Firewood / inkwi
Charcoal/ amakara
Biogas/ biyogazi
LPG / Gase
Electricity / Amashanyarazi
Solar / Ingufu ziva ku zuba
Other (specify) / Ikindi (kivuge)</td></tr>
<tr><td>G02</td><td>What other energy sources do you use for cooking? / Ni ubuhe bwoko bw'ingufu bundi mukoresha muguteka?</td><td>Firewood / inkwi
Charcoal/ amakara
Biogas/ biyogazi
LPG / Gase
Electricity / Amashanyarazi
Solar / Ingufu ziva ku zuba
Other (specify) / Ikindi (kivuge)</td></tr>
<tr><td>G03</td><td>And how often per month do you use these energy sources for cooking? / Ni kangahe mukwezi mukoresha ubu bwoko bw' ingufu mu guteka?</td><td>
<table>
<tr><td>Energy source / Ubwoko bw'Ingufu</td><td>Times per month / Inshuro mu kwezi</td></tr>
<tr><td>Firewood / inkwi</td><td></td></tr>
<tr><td>Charcoal/ amakara</td><td></td></tr>
<tr><td>Biogas/ biyogazi</td><td></td></tr>
<tr><td>LPG / Gase</td><td></td></tr>
<tr><td>Electricity / Amashanyarazi</td><td></td></tr>
<tr><td>Solar / Ingufu ziva ku zuba</td><td></td></tr>
<tr><td>Other (specify) / Ikindi (kivuge)</td><td></td></tr>
</table>
</td></tr>
</table>

G04	Are you interested in switching from your current main energy source to a more efficient energy source? / Waba wifuza guhindura ubwoko bw'ingufu ukoresha ubu ugatangira gukoresha ubwoko bw'ingufu bukora neza kurushaho? If yes, continue to G05. If no, skip to G07 Niba ari yego, komeza kuri G05. Niba ari oya, simbuka ujye kuri G07.	*1.Yes/Yego* *2. Non/ Oya*
G05	Are you willing to pay a certain amount for an alterantive more efficient source of energy? / Wumva witeguye kuba wagira amafaranga wishyura kugira ngo ubone ubwoko bw'ingufu bukora neza kurushaho? If yes, continue to G06. If no, skip to G07. Niba ari Yego, komeza kuri G06. Niba ri Oya, simbuka ujye kuri G07.	*1.Yes/Yego* *2. Non/ Oya*
G06	How much will you be willing to pay for a more efficient energy source for cooking? / Wumva ari amafaranga angahe wakemera gutanga kugira ngo ubone ubwo bw'ingufu bukora neza kurushaho mu guteka?	
G07	Do you have a rainwater harvesting system? / Mwaba mufite uburyo bwo gufata amazi y'imvura? If yes, continue to G08 / Niba ari yego, komeza kuri G08 If no skip to G09/ Niba ari oya, komereza kuri G09	*1.Yes/Yego* *2. Non/ Oya*
G08	What do you use the harvested rain water for (choose all that apply)? / Amazi y'imvura mufata muyakoresha iki (Hitamo ibiri ukuri byose)?	*1. Domestic use / Kuyakoresha mu rugo* *2. Irrigation / Mu kuhira* *3. In Hillside fish ponds / Mu byuzi by'amafi by'imusozi* *4. Livestock watering / Kuhira amatungo* *5. Other (specify) / Ikindi (Kivuge)*
G09	How many liters of water do you use daily, in the following activities? / Mukoresha litiro zingahe z'amazi ku munsi mu mirimo ikurikira?	Activity / Umurimo | Number of liters / Umubare wa litiro

		Domestic use (drinking, cooking, sanitation...) / Mu mirimo yo mu rugo (Kunywa, guteka, isuku n'isukura…)	
		Irrigation / mu kuhira imyaka	
		For livestock / mu kwita ku matungo	

H: MONTHLY INCOME & EXPENDITURE/ *UMUTUNGO N'IMIKORESHEREZE YAWO* (All the questions refer to <u>the period before September 2019</u>).

I	INCOME SOURCE/ *INKOMOKO Y'umutungo*			Rw
H01	Agriculture/ Ubuhinzi	1	Livestock sales/ *Amatungo yagurishije*	/_____/
		2	Crop, vegetable, fruit sales/ *ibihingwa, imboga , imbuto*	/_____/
		3	Animal products sales/ *Ibikomoka ku matungo (amagi, amati, inyama……)*	/_____/
		4	Tea production/ Icyayi	/_____/
		5	Coffee production/ Ikawa	
		6	Other (specify)/ *Ibindi bivuge*	/_____/
H02	Off-farm sources of income/ *umutungo ukomoka ku murimo utari uwubuhinzi*	1	Self-employed/uwikorera: petty trading, hairdresser, seamstress, carpentry etc., sale of handicrafts: *ubucuruzi bucirirtse, gutunganya imisatsi, ububaji ……*	/_____/
		2	Salaries wages of resident household members/ *Imishahara yabagize urugo*	/_____/
		3	Small scale mining/ *ubucukuzi bw'amabuye y'agaciro*	/_____/
		4	Charcoal/ fuel, wood sales/*ubucuruzi bw'amakara n'inkwi*	/_____/
		5	Pension allowances, social welfare grants and insurance payments/*Umushahara wa pensiyo, amafaranga y'ingoboka, amafaranga y'ubwishingizi*	/_____/
			Housing and land rent */ Ubukode bw'inzu /isambu*	/_____/
			Other income sources (specify)/ *Ahandi hakomoka umutungo havuge ……*	/_____/
H03	Migrant remittances/transfers from another household/ *Amafaranga yoherejwe akomoka mu kindi gihugu/ cyangwa yoherejwe avuye mu rundi rugo*	1	From elsewhere in Rwanda/ Amafaranga aturutse ahandi mu Rwanda	/_____/ /_____/
		2	From another country (specify)/ *Amafaranga akomoka mu kindi gihugu (kivuge)……*	
II	**Expenditure/ Imikoreshereze y'amafaranga aboneka buri kwezi**			Rw
H04	What is the average monthly expenditure on the following items (1) */ Shyira mu kazu kabugenewe amafaranga yakoreshejwe buri kwezi?*	1	Food / *Ibiribwa*	/_____/
		2	Education/ *Uburezi*	/_____/
		3	Health / *Ubuvuzi*	/_____/
		4	Transport / *Ingendo*	/_____/
		5	Clothes/ *Imyenda*	/_____/
		6	Hire of labour */ guhemba umukozi*	/_____/
		7	Agricultural/ *Ubuhinzi*	/_____/
		8	Water / *Amazi*	/_____/
		9	Electricity / *Amashanyarazi*	/_____/
		10	Communication / *Itumanaho*	/_____/
		11	Other (specify)/ *Ikindi kivuge*	/_____/
	(1)			
	1. Less than 5000Frw munsi ya 5000 2. [5000- 10000]			

	3. [10000- 20000] 4. [20000-50.000] 5. [50.000-100.000] 6. [100.000-500.000] 7. 500.000 and plus/ 500.000 narenga			

J. Saving and investment / ubwizigame n'Ishoramari *(All the questions refer to the period before September 2019)*.

J01	Do you save money */ Waba wizimaga?* If no skip to J04/ Niba ari Oya jya kuri J04	*1.Yes/Yego 2. No/Oya*
J02	If yes, how much money do you save on a monthly basis*? / Ni amafaranga angahe waba uzigama mu gihe cy'ukwezi?*	*1 Less than 5000Frw munsi ya 5000Frw* *2.[5000- 10000]* *3.[1000- 20000]* *4.[20000-50.000]* *5.[50.000-100.000]* *6.[100.000-500.000]* *7. 500.000 and plus/ 500.000Frw no hejuru yayo*
J03	Which saving mechanisms do you use / *Ni ubuhe bwoko bw'ubwizigame waba ukoresha?*	*1. Commercial Bank/ Banki y'ubucuruzi* *2. SACCO/ Umurenge SACCO* *3. Other Micro finance institution/ ibindi bigo by'imari bicyiritse* *4. VSLA / Ibibina* *5. Mobile Money/Tigo cash/ Airtel Money/ Ikorana buhanga ry'itumanaho MTN /Tigo* *6. Home / Nyabika mu rugo* *7. Not saving / Sinjya nizigama*
J04	Do you own an account in a financial institution? / *Waba ufite konti mu kigo cy'imari?* ***If no, skip to J10 / Niba ari Oya jya kuri J10***	*1. Yes /Yego* *2. No/Oya*
J05	If yes which financial institution do you use? *Niba ari yego, ukoresha ikihe kigo cy'imari*	*1. Commercial Bank / Banki y'ubucuruzi* *2. SACCO/ Umurenge SACCO* *Other Micro finance institution/ Ibindi bigo by'imari bicyiritse.*
J06	Have you applied for a loan before September 2019? */ Waba warasabye inguzanyo mbere ya Nzeri 2019?* ***If no, skip to J10/ Niba ari Oya jya kuri J10***	1.Yes/ Yego 2. No /Oya

J07	Was your loan application successful/ *Ese ubusabe bwawe bwaremewe?* ***If no, skip to J10/ Niba ari Oya jya kuri J10***	1. Yes / Yego 2. No / Oya
J08	What was the Loan amount in FRW*? / Waba warabonye inguzanyo y'amafaranga angahe?*	1. [100.000-500.000] 2. [500.000- 1000000] 3. [1000000- 1500000] 4. [1500000- 2000000] 5. [2000000- 5000000] 6.> 5000000
J09	Did you pay your loan according to instalments agreed upon by the financial institution? /*Waba wirishyuye neza ideni wafashe mu byiciro wunvikanye n'ikigo cy'imari*?	1. Yes / Yego 2. No / Oya
J10	Do you belong to any VSLA (Voluntary Saving and Lending Association)? / *Waba uri umunyamuryango w'ikibina?* ***If no, skip to section K/ Niba ari Oya jya ku gice cya K***	1. Yes / Yego 2. No / Oya
J11	*How much do you save with your VSLA on a monthly basis/ Waba uzigama amafaranga angahe mu kibina buri kwezi?*	*1 Less than 5000Frw/ munsi ya 5000Frw* *2. [5000- 10000]* *3. [1000- 20000]* *4. [20000-50.000]* *5. [50.000-100.000]* *6. [100.000-500.000]* *7. 500.000 and plus/ 500.000Frw no hejuru yayo*
J12	Have you applied for a loan with your VSLA before September 2019? */ Waba warigeze gusaba inguzanyo mu kibina mbere ya Nzeri?* ***If no, skip to section K/ Niba ari Oya jya ku gice cya K***	1. Yes / Yego 2. No / Oya
J13	Was your application successful */ Ubusabe bwawe bwaba bwaremewe?* ***If no, skip to section K/ Niba ari Oya jya ku gice cya K***	1. Yes / Yego 2. No / Oya
J14	How much FRW did you get? / *Waba warabonye inguzanyo y'amafaranga angahe?*	*1 Less than 5000Frw munsi ya 5000Frw* *2. [5000- 10000]* *3. [10000- 20000]* *4. [20000-50.000]* *5. [50.000-100.000]* *6. [100.000-500.000]*

		7. 500.000 and plus/ 500.000Frw no hejuru yayo
J15	Have you paid your loan according to instalments agreed upon by the VSLA*/ Waba wishyura inguzanyo wabonye mu kibina ukurikije ibyiciro mwunvikanye?*	1. Yes / Yego 2. No / Oya

K. Ownership of assets / KUGIRA UMUTUNGO *(All the questions refer to the period before September 2019).*

K01	Which of the assets listed on the right do you own? / *Ni uwuhe mutungo cyangwa Igikoresho waba utunze muri ibi bikurirkira*?	*1. A house (any type of house) / Inzu* *2.Land / Isambu* *3.Mobile phone / Telefone ngendanwa* *4.Foam Mattress/ umufariso* *5.Radio/ radio* *6.TV/ televiziyo* *7.Motorcycle/ moto* *8.Bicycle / igare* *9.Car /Truck/ imodoka / rukururana* *10Refrigerator/deep freeze / firigo (icyuma gikonjesha)* *11.Sawing machine/ imashini yo kudoda (Icyarahani)* *12Milling machine / imashini yo gusya* *13.Kitchen equipment/ ibikoresho byo mu gikoni* *14.Furniture / Ibikoresho byo mu ruganiriro (intebe, ameza, akabati ……)* *15.Others specify/ ibindi bivuge*

L. Physical structure of the house. / *IBIKORESHO BYUBAKISHIJE INZU*

L01	Roof / Igisenge	1. Local Tile */ amategura* 2. Iron sheet*/ amabati* 3. Industrial tile*/ Amategura yo muruganda* 4. Asbestos */ Asbestos* 5. Plastic sheeting*/ shitingi* **6.** Others specify */ ikindi kivuge*
L02	Wall/ Inkuta	*1. Timber / Imbaho* *2. Stone / Amabuye* *3. Wood/mud / Ibiti nibyondo* *4. Plastic sheeting / shitingi* *5. Burn bricks / amatafari ahiye* *6. Mud bricks / amatafari ya rukarakara* **7.** *Others specify/ ibindi bivuge*
L03	Floor/Hasi	*1. Earth/sand / igitaka* *2. Concrete with ciment / beto iriho sima* *3. Concrete with tile/ beto iriho amakaro* *4. Concrete/ beto yonyine*

		5. *Stone/ amabuye* 6. *Timber/ imbaho* **7.** *Other specify / ikindi kivuge*

IV Field data collection forms

1. General site description

1.1 Site Description

Date:		Time:	Unique site no:	
Surveyor(s):				
Main landcover type:				
Main land use or land management type:				
UTM zone: 36N	E:		N:	Alt.:
Location description:				
Location sketch:				
General remarks				

Pictures:		Description of picture		
N	E	Name	Remark	Picture number

1.2 Landcover assessment

Unique site no (from site description):		Landcover plot no:	Date:
UTM zone: 36N	E:	N:	Time:
Picture number(s)		Total plot size for assessment:	
Main land cover		Main land management practices:	

Specifics points of interest:

Coordinates		Description of land cover		
N	E	Main land cover	Remark or issue	Picture number
General remarks				

1.3 Riverbank assessment

Riverbank vegetation assessment

Unique site no (from site description):			Vegetation plot no:		Date:
UTM zone: 36N	E:		N:		Time:
Picture number(s)			Total length riverbank assessment for (m):		
% Cover by layer	Tree (A):	Shrub (B):	Herb (C):	Grass/moss (D):	Bare/other:

Trees				Shrubs			
Layer	Species	% Cover	Height	Layer	Species	% Cover	Height
	If known, describe species name						

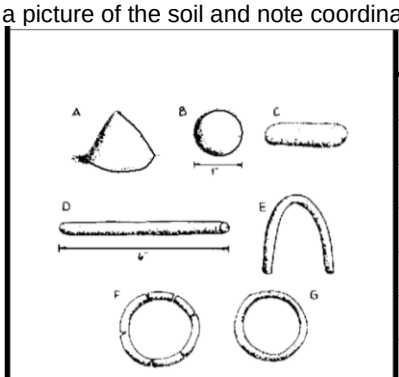
Herb layer			Grass/moss layer		
Layer	Species	% Cover	Layer	Species	% Cover

Notes on erosion characteristics:

General remarks:

Riverbank assessment continued - Soil description

Describe the soil texture of the main soil type. Estimate sand content of the soil if any (<10%, 10-30%, 30-50%, 50-70%). For sands estimate the grain size and sorting. Write down the color of the main soil type, take a picture of the soil and note coordinates. .



- A ball of about 2-5 cm is formed from approximately 1 tablespoon of soil
- Water is slowly added until it becomes sticky

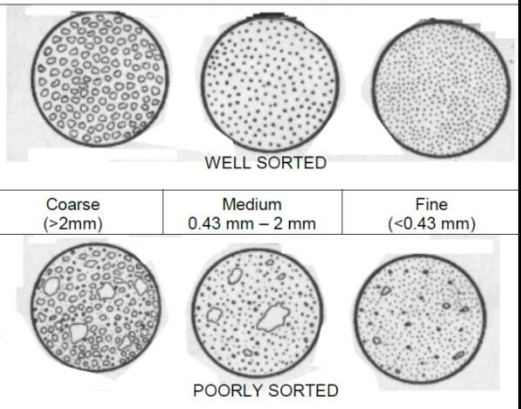
A	Sand	The soil remains loose and can only be heaped in a pyramid.
B	Loamy sand	Can be shaped in a ball that easily falls apart
C	Silt loam	Can be shaped into a short (2-3 cm), thick cylinder
D	Loam	Can be rolled into a long (15 cm) cylinder that breaks when bent
E	Clay loam	As for loam, but can be bent into a U, but no further without being broken
F	Light clay	Can be bent into a circle that shows cracks
G	Heavy clay	Can be bent into a circle without showing cracks

Wet loam feels soapy, when rubbed between fingers leaves dust on the skin (clay doesn't).

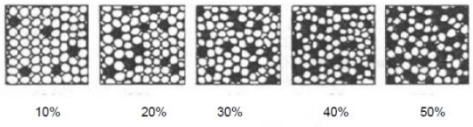
GRAIN SIZE ESTIMATES (also use for particle size)

NAME	BOULDERS	COBBLES	GRAVEL		SAND (also see table below)			FINES (not visible)	
			Coarse	Fine	Coarse	Medium	Fine	Silts	Clays
mm	>300	75-300	75-19	19-4.8	4.8-2.0	2.0-.43	0.43-0.08	< 0.08	< 0.08

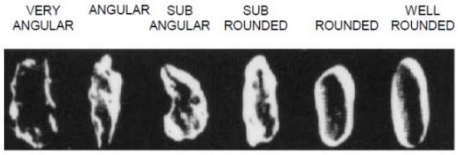
SAND GRAIN SIZES AND SORTING



PERCENTAGE DARK MINERALS



ROUNDNESS (for grains and large cuttings)



Unique site no *(from vegetation description):*				soil description no:						
Horizon/layer		Soil texture		Coarse fragments		Org matter		Roots		
Hor/ layer	Depth (cm)	Main soil type/ texture	Sand content (%) and grain size (µ)	% coarse material	Type	% dark minerals	Type	Rooting depth (cm)	Roots description	Color (put some wet soil below with your finger)

General remarks:										

2 Flooding areas

2.1 Flooding areas characteristics

Interviews with local people to inquire about area flooded and flood levels (cm above ground, max, average, low), how often, for how long, flooding issues etc.

Flooding area characteristics

Name flooding area		General description of area	*For example:. nr of households in this section, closeness to raods or bridges, etc*			
Surveyor name and contact: Date & time of site visit:						
Mapping of different parts within the flooding area						
Coordinates		Land use and land cover (specify vegetation)	Type of soil	Describe river banks (stability, vegetation, signs or erosion yes/no, etc)	Write down dates of flooding events for this location over the last 5 years	Picture number
N	E					
General remarks						

2.2 Flooding areas water needs

Visit to different flooding areas in the catchment area, especially the areas at the outflow of the catchment area. Interviews with local people to inquire: importance of the area (grazing, farming, harvesting of natural products such as grass cutting, reeds and wood), is flooding required? What is the optimal flooding situation (define years that were good, problematic wet/dry events/months).

Mapping of flooding area water needs

Name flooding area	
General description of area	

Are there any activities depending on flooding (grazing, farming, natural products, water sources etc.)? If yes describe, and note down coordinate.	

Mapping of specific flood related activities/needs within the flooding area								
Coordinates		Type of activity/ water demand	Is flooding required?	What is the optimal flooding situation?	Indicate year/month that flooding was:			Picture number
N	E				Good	Too dry	Too wet	
General remarks								

2.3 Flooding problems

Visit areas where flooding has cause problems and interview people. Map problem areas, such as damage to property, land, infrastructure etc. Indicate problem areas and notes on land use and flooding area map.

Coordinates		Type of problem	Describe flooding situation	What has been the damage?	Which years has flooding been a problem?	Picture number
N	E					
General remarks						

3 Water Quality

In situ water quality measurements of Sebeya river

Unique sample nr.								
Name of river or tributary								
Coordinates		River width (m)	Seasonality notes	EC (uS/cm)	Notes on visual sediment load	Temp. (Celsius)	Turbidty NTU	Picture number
N	E							
General remarks:								

4 Environmental issues

Mapping of environmental issues in the catchment such as land degradation, erosion, deforestation, invasive species. Visit to catchment areas for on-ground observations.

Coordinates		Name of area	Type of problem	Description of issue and remarks	Picture number
N	E				
General remarks					

5. Agricultural practices

Name of village and area		General description of area	*Example: distance to sebeya river and roads, surrounding field, fencing etc.*
Surveyor name and contact:			Date & time of site visit:
Ownership of land:			
Main landcover and vegetation: *If vegetation differs per growing season, please specify*			
Applied land management activities If applicable describe: - Land preparation: - Tillage (ploughing activities): - Fertilizer (Chemical or organic or animal manure): - Planting: - Weeding: - Harvest: - Crop processing:			
Soil erosion: If applicable describe the signs of soil erosion: - Topsoil erosion: - Drainage patterns: - (small) gullies: - Other:			
Soil quality: Considered by farmer: High/Medium/Low			
Irrigation and water need: - Select: rainfed / irrigated If irrigated, please specify irrigation needs: *(amount of water/plot size/ time span)* Water source for irrigation: - On site water harvesting pond - River - Other			
Knowledge and Adoption of Agricultural Technologies - Applied agricultural technologies on this plot: (mulching; compost making; conservation agriculture; fertilizer; intercropping; improved seeds; conservation tillage; terracing, other)			
Coordinates			Picture number
N	E		

General remarks:

6. Landslides

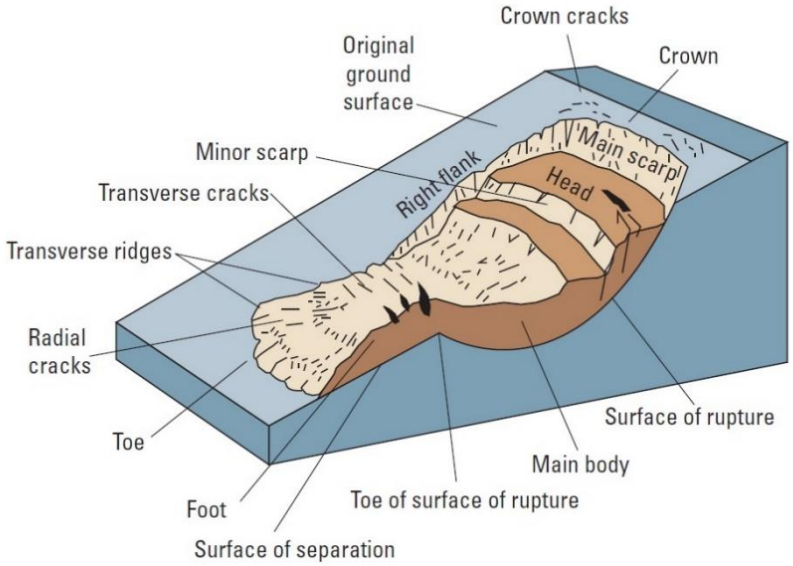


Figure 41. A simple illustration of a rotational landslide that has evolved into an earthflow. Image illustrates commonly used labels for the parts of a landslide (from Varnes, 1978, highland and Bobrowski, 2008)

Name area of landslide		General description of area	*For example:. nr of households in this section, closeness to raods or bridges, etc*
Surveyor name and contact:			Date & time of site visit:
Date of the landslide event:			
State of activity: active yes/no.			
Estimated distance (m) from crown to toe:			
Current stability of the landslide: *(for example, Current vegetation cover yes/no, specify)*			
Impact of the landslide (Fatalities, Affected, Injured, Homeless, etc):			

Coordinates		Land use and land cover above the crown of the landslide *(specify vegetation)*	Land use and land cover above the crown of the landslide *(specify vegetation)*	Type of soil	Type of landslide *(see fig. 2*) *Note down material and movement type*	Picture number
N	E					
General remarks						

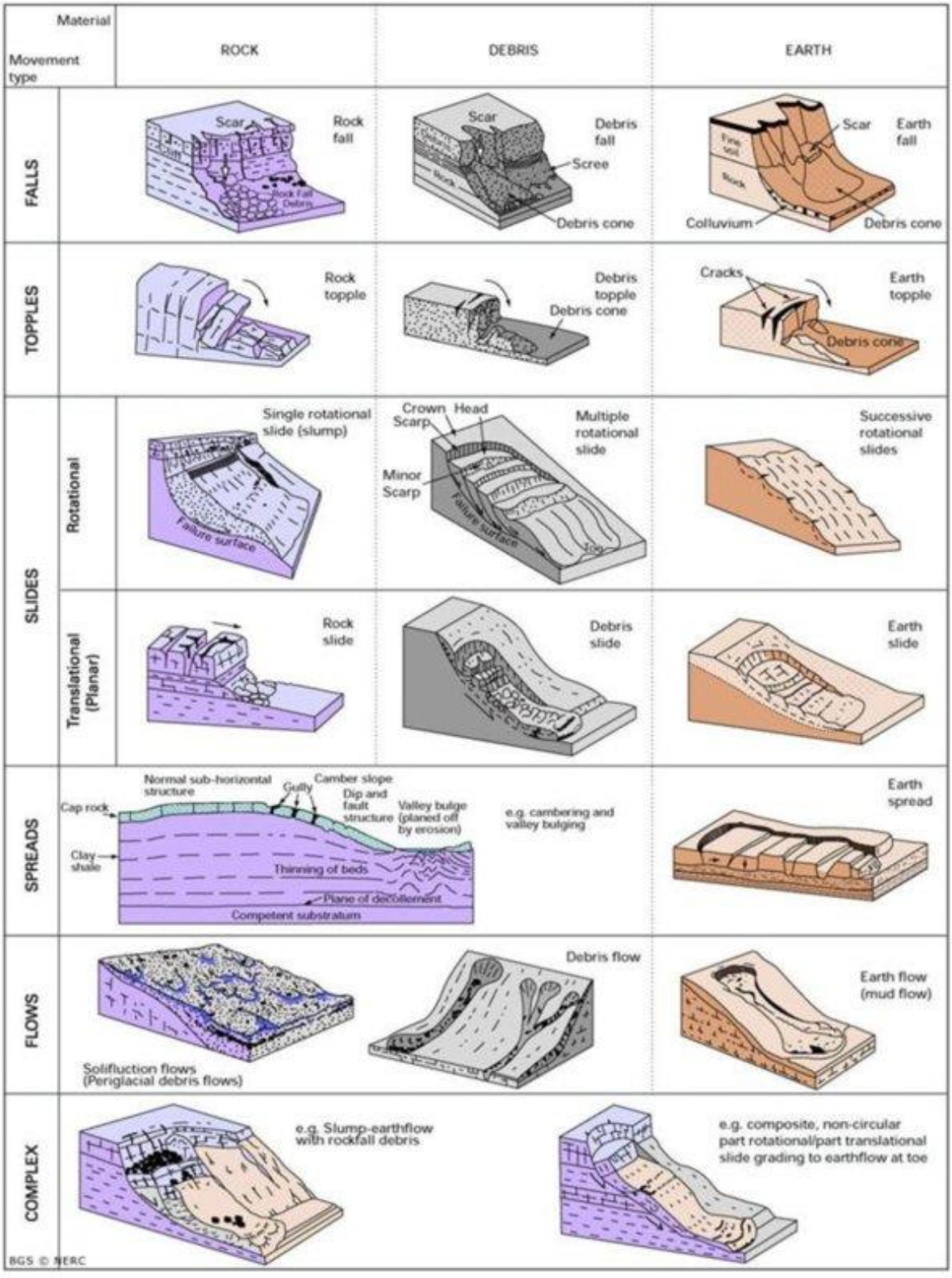


Figure 42. landslide classification by Varnes (1978) and Cruden and Varnes (1996) based on the type of movement and material.

Annex 3 List of the Key Informants

No	Name	Position	Institution/affiliation	Contact
1	Nizeyimana Aimee Adrien	Environment Officer	Rutsiro District	0788873199
2	Harerimana Innocent	Environment Officer	Rubavu District	0788776202
3	Rwandanga Augustin	Agriculture and Natural Resources Officer	Rubavu District	0782104622
4	Kalisa Robert	Livestock Officer	Rubavu District	0788324049
5	Uzaramba Jacques	Social Affairs Officer	Murunda Sector	0788875069
6	Dieudonne Tuyishimire	Forestry Officer	Murunda Sector	0786239537
7	Sindikubwabo Esperance	Executive Secretary	Arusha Cell	0782003127
8	Uwanyirinka Marie Aimee	Agriculture and Natural Resources Officer	Bigogwe Sector	0783313624
9	Kavamahanga Jean Claude	Agriculture and Natural Resources Officer	Kanama sector	0788868528
10	Evariste Buregeya	Land, infrastructures, and community settlement Officer	Kanama sector	0788634822
11	Nzakamwita Liliane Sarah	Social Affairs Officer	Kanama sector	0788506908
12	Ngabonzima Jean Dieu	Executive Secretary	Kinigi Cell	0781034781
13	Hategekimana Leonard	Social Economic Development Officer	Kinigi Cell	0782088377
14	Ayinkamiye Odile	Land, infrastructures, and community settlement Officer	Nyamyumba Sector	0785220541
15	Mateme Claudie	Social Affairs Officer	Nyamyumba Sector	0788835529
16	Uwamariya Jacqueline	Forestry Officer	Muhanda Sector	0783310181
17	Nsengiyaremye Fulgence	Private Sector Federation Representative	Muhanda Sector	0786865865
18	Baziruwiha Jean Claude	Social Affairs Officer	Muhanda Sector	0783366099
20	Namenye Sanyu Isabel	Agriculture and Natural Resources Officer	Nyakiriba Sector	0788222904
21	Tuyishime Jean Bosco	Executive Secretary	Nyakiriba Sector	0784277895
22	Joseph Murinda	Land, infrastructures, and community settlement Officer	Nyakiriba Sector	0788543877
23	Mukashema Donathee	Agriculture and Natural Resources Officer	Rugerero Sector	0788695501
24	Biseruka Evariste	Business Development Advisor	Rugerero Sector	0788467047
25	Barigora Rwemera	Land, infrastructures, and community settlement Officer	Rugerero Sector	0788603158
26	Semucyo Leonidas	Social Affairs Officer	Rugerero Sector	0782015036

Annex 4 Focus Group Discussion Attendance Lists

District: Ngororero Sector: Muhanda
Cell: Rutagara Village: Bambiro

S/N	NAMES	OCCUPATION	PHONE NUMBER
1.	Nizeyimana Jeanette	Opinion giver	0782437558
2.	Nyirasinamenye Bonifride	Opinion giver	0784023544
3.	Ndayazi Shadrack	Village leader	0787007668
4.	Ndusengumukiza Thomas	Opinion giver	0782651529
5.	Tuyisenge Jean Claude	Opinion giver	0786694842
6.	Nzayisenga John	Opinion giver	0785694281
7.	Habimana Emmanuel	Opinion giver	0782651588
8.	Bazikwinshi Felecien	Village's agricultural helper	0784608204
9.	Akimanimpaye Olive	Opinion giver	0780607752

District:Rustiro Sector: Murunda
Cell: Kirwa Village: Karumbi

S/N	NAMES	OCCUPATION	PHONE NUMBER
1.	Samoya Théogene	Opinion giver	0788674134
2.	Sendegeya Eric	Opinion giver	0780667937
3.	Dukuzumuremyi Mark	Village's agricultural helper	0782011587
4.	Habanabakize Thomas	Opinion giver	0787002073
5.	Nyirabutembo Lidia	Opinion giver	0782571473
6.	Ayingeneye valentine	Opinion giver	0781613125
7.	Nyirarukundo Denise	Opinion giver	0783394333
8.	Ngerero Pierre	Village leader	0788339137

District: Nyabihu Sector: Bigogwe
Cell: Arusha Village: Busasamana

S/N	NAMES	OCCUPATION	PHONE NUMBER
1.	Tegera Benjamin	Businessman	07885993624
2.	Ibambasi Dieu donne	Village's agricultural helper	0783232766
3.	Mukamwiza Liberathe	Opinon giver	0787994117
4.	Sekibibi Thomas	Opinon giver	0788472218
5.	Nakaderi Alvera	Opinon giver	0781322078
6.	Nyiravumera Edith	Opinon giver	0780373255
7.	Nyirabarasi Mukabaseka	Opinon giver	0787433770
8.	Nzitonda Gafuraha	Opinon giver	0786777973
9.	Manzi Benjamin	IT assistant at cell's office	0782979774
10.	Micomyiza Zacharie	Youth leader at village level	0783829447

District: Rubavu Sector: Kanama
Cell: Mahoko Village: Nyamugari

S/N	NAMES	OCCUPATION	PHONE NUMBER
1.	Uwamahoro Louise	Opinion giver	0781119826
2.	Mukandutiye Alphonsine	Opinion giver	0784656304
3.	Mukangango Catherine	Opinion giver	0789410635
4.	Muzungu John	Opinion giver	0787037448
5.	Muhorakeye Fillete	Opinion giver	0780552496
6.	Bavugamenshi Claudine	Opinion giver	0722716696
7.	Murerwa Farasie	Opinion giver	0781606383
8.	Kuradusenge Alphonsine	Opinion giver	0783775133
9	Tuyisabe Consolate	Opinion giver	----------
10	Twagirayezu Innocent	Village leader	0788435450

District: Rubavu Sector: Nyakiriba
Cell: Bisizi Village: Kingoma

S/N	NAMES	OCCUPATION	PHONE NUMBER
1.	Nyiramaguru Peruth	Opinion giver	----------
2.	Mutuyimana Agnes	Opinion giver	0780035384
3.	Nyirangirimana Sophia	Opinion giver	0784739129
4.	Ayingabiye Madeline	Opinion giver	----------
6.	Habimana Joseph	Opinion giver	----------
5.	Tuyiringire Theogene	Opinion giver	0787270799
7.	Kayiranga Innocent	Opinion giver	0781799211
8.	Byukusenge Samuel	Opinion giver	0780345697
9.	Ntawizigirabo Mustapha	Opinion giver	----------

District: Rubavu Sector: Nyamyumba
Cell: Kinigi Village: Gatyazo

S/N	NAMES	OCCUPATION	PHONE NUMBERS
1.	Mutuyimana Innocent	Opinion giver	0789591167
2	Nyirambonyayabo Dorothee	Opinion giver	0784638688
3.	Ntamukunzi Gaudance	Opinion giver	----------
4.	Ikimaningeneye Theodosie	Opinion giver	----------
5.	Ikimaningize Domina	Opinion giver	----------
6.	Karimunda Bartheromeo	Opinion giver	0786508513
7.	Mujamariya Epiphanie	Opinion giver	0785852649
8.	Habimana Jean Damascene	Opinion giver	0782685190
9.	Harerimana Jean Damascene	Village leader	0788339522
10.	Renzaho Tharicise	Opinion giver	0783426473

District: Rubavu Sector: Rugerero
Cell: Rugerero Village: Nyantomvu

S/N	NAMES	OCUPATION	PHONE NUMBER
1.	Nshimiyima Modeste	Security agent	----------
2.	Uwayezu Roger	Businessman	0783060184
3.	Harerima Phenias	Opinion giver	0781649414
4.	Maniriho Florence	Opinion giver	0785502637

5.	Masengesho Leonard	Opinion giver	0783609006
6.	Uwamahoro Jeannine	Opinion giver	0789749400
7.	Uwimana Jean Claude	Opinion giver	0788854069
8.	Nyiransabimana Marceline	Opinion giver	----------
9.	Uwimana Jeannine	Opinion giver	----------
10.	Sinabahamagaye Billie	Opinion giver	----------
11.	Nsabimana Edison	Village leader	0788867104

Annex 5 Technical methodology for GIS map development

Sebeya landcover map

Land cover in Sebeya catchment has been analysed in ArcGIS to create a map of the current land cover in the catchment. The land cover map of the W4GR project (MINENV, 2018) was compared to satellite imagery on google earth to find discrepancies in the W4GR land cover map. The land cover map was then updated with the newly acquired information, representing the current land cover in the catchment better. Changes were most dominant in the settlements class due to urbanisation. Afforestation in the Gishwati forest national park and perennial agriculture on terraces were also observed. Furthermore, the classes riverbank trees and landslides (where observed) were added. Landslides were visible as bare land on the map. Therefore, only relatively recent landslides are visible on the landcover map.

Vegetated riverbanks

For the analysis of the vegetated riverbanks, the polyline feature of Sebeya river (from W4GR, created through orthophotos from 2008/2009), was buffered with a 10m buffer (on both sides) to find the total area that is forested around this river. Furthermore, an analysis was carried out on a more detailed representation of the stream network. Through hydrologic analysis using the SRTM DEM (from the W4GR database) a stream network was created that represents tributaries wider than 5m. This hydrologic analysis is less accurate in the exact pathways of streams as deviations of the flow paths were not corrected with google earth imagery, but does show the rough locations of the complete channel network in the catchment, whereas the original polyline river shows just the main tributaries of the Sebeya river. In the hydrologic analysis flowpaths are generated when more than 10 (upstream) cells flow into a cell. Then a STRAHLER stream order is assigned to the channels, combining channels of the same value to a higher value (channels merging with values 1+1 become 2, 2 and 2 become 3, but 2 and 3 remains 3). Then a buffer of 10m was put around these channels to find the part of the buffer being vegetated (by intersecting with the LC map).

Soil erosion sensitivity

From the SRTM DEM map a slope map was created, which was then reclassified into 3 classes based on the percentage of rise of the terrain: low slope, 0-10% (1); medium slope, 10-20% (2); steep slope, >20% (3). These slope classes are based on the average slope found in the catchment and the erosion risk assigned to such slopes in similar studies, with similar agro-ecological/climatic conditions (Sebeya CMP, 2018). Areas of land cover are calculated by multiplying the pixels of a certain class with cell size, which is 400m2 (pixels are 20mx20m).

Erosion risk map

The table below shows the reclassification that was used to create the erosion risk map. The erosion risk of every land cover type was assessed for every slope class and was given a value for the erosion risk. A higher number represents a higher risk. Landslides that are identified on the land cover map are a clear representation of erosion and therefore have the highest value (20). The steepest slopes with settlements, seasonal agriculture and grasslands come next, followed by perennial agriculture and plantation forest. The lowest risk is assigned to the gentle slopes with dense forests. The (open) water class is almost absent in the catchment and has no coverage in the second and third slope classes (represented by x in the table).

Table 35 Reclassification table of landcover per slope class. 0 = low erosion risk, 20= high erosion risk.

	Slope class		
Land Cover	1 (0-10%)	2 (10-20%)	3 (>20%)
Natural forest	0	1	2
Open areas or grass	5	13	14
Agriculture (seasonal)	7	16	18
Settlements	8	17	19
Water	0	x	X
Plantation forest	3	9	11
Agriculture (perennial)	4	10	12
River bank trees	0	2	2
Land slides	20	20	20

Annex 6 - Guidelines for review of web portals

The following table gives direction to structure the questioning at institutions and the quality functioning of their data platforms and webportals.

Table 36. Guidelines for review of web portals

Outcomes & outputs	Indicators	Achieved score	Source of Verification	Issues & Risk
Outcome 1: Improved management and sharing of (spatial) data in priority river basins and regions	Number of projects using webportal data		progress reports, expert inputs?	Lack of interest from thematic projects? Lack of cofounding? Data handling and use is arranged per department and not centralised
Outcome 2: Convergence of technology for managing and sharing of spatio-temporal data	Implemented web portals for sharing spatio-temporal data use limited number of different technologies, standards, etc.		How is the sharing of spatio-temporal data among other portals and related tools, if applicable?	
Outcome 3: Improved access to and knowledge of webportals for managing and sharing data among project partners and beyond	Number of active users of the implemented webportals			
Outcome 4: Sustainable webportals implemented and partners stay engaged	Number of active users of the implemented webportals		Any stats available?	Any activity indicators (views, uploads, downloads) or number of users
Outcome 5: Awareness of data sharing as a driver for use of webportals and innovation in the water sector	Number of tools for water resources management using webportal technology implemented		Projects? reports?	Any project that has established e.g. a citizen observatory? addressing restoration-biodiversity-livelihood conflicts?
Output 1: Implementation of operational webportals for priority regions/river basins	Geo- hydro env. spatial data needs assessed? Organisational framework for maintaining the webportals established Data policy defined Capacity development needs assessed		Application Matrix per webportal? Organogram? Data policy Plan for implementation of trainings? Strategic plan?	

	Strategic plan for the sustainability of webportal developed How many webportals/ websites are and will be implemented			
Output 2: Analysis and evaluation of spatio-temporal data-sharing and processing platforms produced both inside and outside RWB and partners.	Webportal-related developments evaluated and enhanced? Website with inventory of webportal modules and components used? Tools for presentation and dissemination of dynamic data being developed? Dynamic data visualisation and analysis tools and approaches implemented in projects?			
Output 3: the capacity building and training needs are defined. **For outcome 3, training modules developed under previous projects and are updated and made available as Open Courseware.**	Open Courseware developed for using/administrating spatio-temporal webportal ? Are people capacitated (enough capacity for maintenance and upkeep sites?)			Decentralised and only project-based efforts uncoordinated? Or organised centralised?
Output 4: It is important to monitor and evaluate the performance and use of the webportals.	The development of indicators is part of this outcome. The indicators below are examples. 1. Number of data suppliers 2. Number of users 3. Availability of the system 4. Cost/benefit		Are there Web statistics? Is RWB and key owners using the systems themselves? How often?	
Output 5: Are specific applications of webportals piloted following examples of previous experiences that have been developed into cases that are worth extending.	Tools, apps, services implemented Dissemination of successful applications		Project reports E Publications, social media, web sites	

Other elements on the functioning of the webportals that are important are:

- Are the sites (found) user-friendly?
- Easy download possible (int. formats?)
- Are there good descriptions of the information products?

- Is meta information available and complete?
- Do you need many links and clicks to get to the data?
- Is there a good search engine on site?
- Is the portal all open access or do you need special logins or memberships? costs? Etc
- Are there intros with objectives on thematic data areas for what targeted groups (PS, academic, government, commoners)
- Are type of information products indicated?
- Is it up to date?
- Are new data and information addition s to the sites announced to user group and beyond?
- Is the dataset well organised?
- Is origin of data clear (as element of meta information)?
- Are clear legends added (so raw data according to transparent protocol and methodology clearly cleaned/ flagged by whom? with what method aggregated/ extrapolated and translated into real parametric value not sensor signals (for status and trend overviews/ maps)?

Annex 7 Erosion control mapping

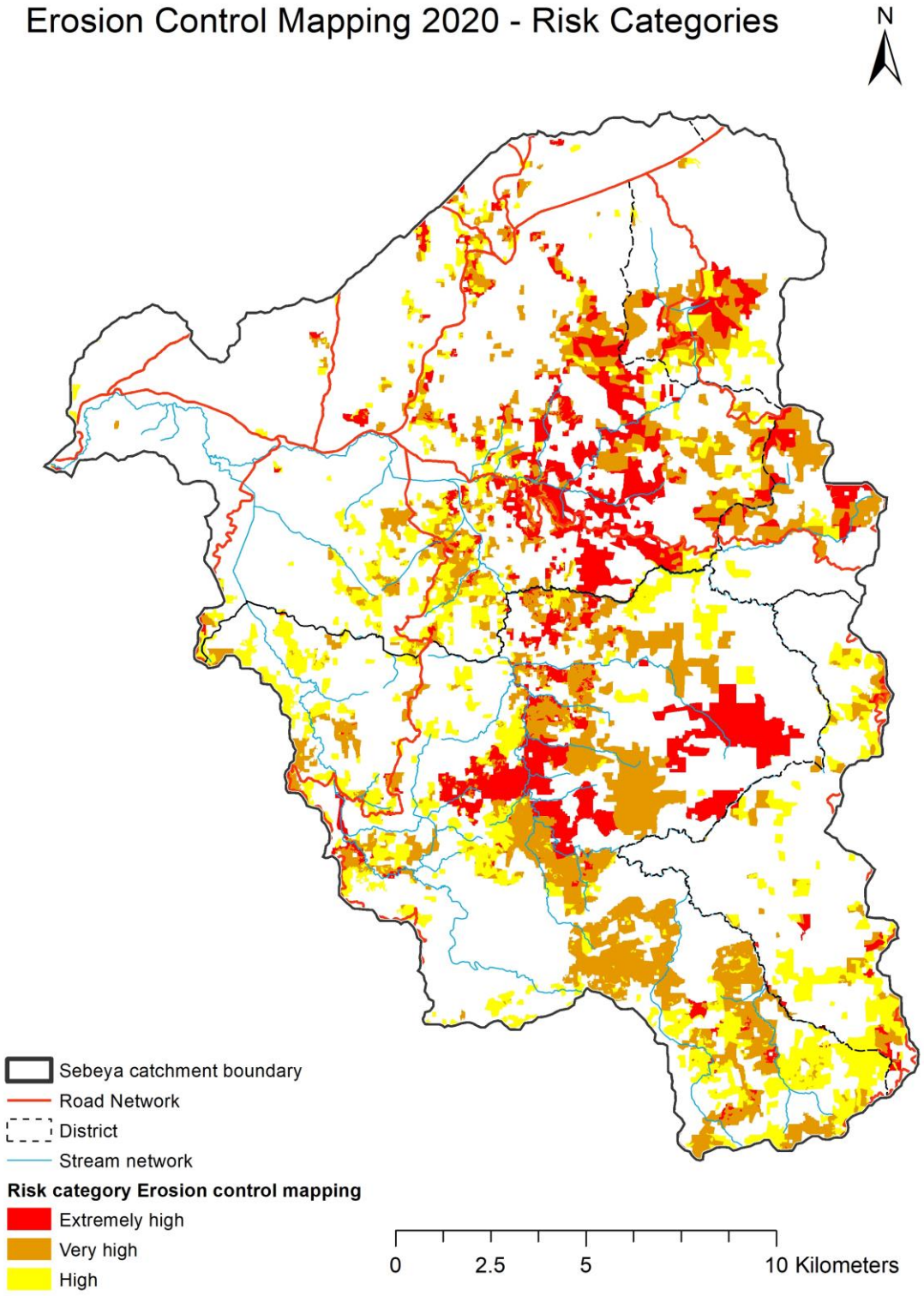


Figure 43. Erosion risk as determined in the Erosion Control Mapping study (MoE, 2020). The erosion risk map shows only the potential risk of erosion in different areas, however this map does not neither show areas already protected against erosion nor indicate the location of erosion features as proof of risk.

Annex 8 Agricultural land use and poverty headcount index

Table 37. Agricultural land use and poverty headcount index

Season B 2020_Agricultural land use per district (Ha)												
District	Total land area	Agricultural land	% of agricultural land	Arable land	Physical cultivated land	Area under seasonal crops	Area under permanent crops	Temporary fallow land	Temporarily midow and pasture	Area under permanent pasture	NO.HH PER SECTOR	Poverty Head count index (%)
Rutsiro	66.0	41.5	62.9	31.1	28.6	24.0	18.3	7.2	0.3	5.9	**71,267**	**49.5%**
murunda	20.9	13.1	19.9	9.8	9.1	7.6	5.8	2.3	0.1	1.9	4,110	47.3%
ruhango	31.3	19.7	9.4	4.7	4.3	3.6	8.7	3.4	0.1	2.8	6,166	49.4%
kigeyo	27.8	17.5	4.0	2.0	1.8	1.5	7.7	3.0	0.1	2.5	5,482	44.5%
nyabirasi	32.3	20.3	1.9	1.0	0.9	0.7	8.9	3.5	0.1	2.9	6,353	52.4%
kivumu	35.3	22.2	1.0	0.5	0.5	0.4	9.8	3.8	0.1	3.2	6,950	48.6%
Rubavu	33.8	23.8	70.5	22.2	23.0	20.7	6.0	1.4	0.7	0.2	**4,03,662**	**35.7%**
Kanama	12.3	8.7	25.8	8.1	8.4	7.6	2.2	0.5	0.2	0.1	29,220	41.2%
Nyundo	12.9	9.0	26.8	8.4	8.7	7.9	2.3	0.5	0.3	0.1	30,417	44.4%
Rugerero	18.0	12.7	37.5	11.8	12.2	11.0	3.2	0.7	0.4	0.1	42,574	32.4%
Rubavu	17.9	12.6	37.4	11.7	12.2	11.0	3.2	0.7	0.3	0.1	42,394	34.1%
nyamyumba	15.8	11.2	33.0	10.4	10.8	9.7	2.8	0.7	0.3	0.1	37,491	40.4%
Nyakiriba	12.7	8.9	26.5	8.3	8.6	7.8	2.2	0.5	0.2	0.1	30,068	34.7%
Nyabihu	53.6	36.3	67.8	31.4	24.7	24.3	6.2	7.1	0.5	4.2	**2,68,367**	**46.8%**
Bigogwe	21.7	14.7	27.4	12.7	10.0	9.8	2.5	2.9	0.2	1.7	32,317	36.0%
Ngororero	67.5	44.3	65.7	36.4	34.9	30.4	19.3	6.0	0.3	3.5	**3,33,713**	**47.7%**

kageyo	19.5	12.8	19.0	10.5	10.1	8.8	5.6	1.7	0.1	1.0	23,080	52.0%
kavumu	23.8	15.6	23.1	12.8	12.3	10.7	6.8	2.1	0.1	1.2	28,165	53.9%
matyazo	21.9	14.3	21.3	11.8	11.3	9.8	6.2	1.9	0.1	1.1	25,914	46.9%
muhanda	23.8	15.6	23.2	12.8	12.3	10.7	6.8	2.1	0.1	1.2	28,247	55.4%
muhororo	18.1	11.9	17.6	9.8	9.4	8.1	5.2	1.6	0.1	0.9	21,463	45.7%
ndaro	19.2	12.6	18.7	10.4	9.9	8.6	5.5	1.7	0.1	1.0	22,762	52.1%
nyange	18.5	12.1	18.0	10.0	9.6	8.3	5.3	1.7	0.1	1.0	21,932	46.1%
sovu	22.7	14.9	22.1	12.2	11.7	10.2	6.5	2.0	0.1	1.2	26,855	56.7%
Source: NISR, SAS 2020												Source : EICV5

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