Scoping study on Green Roads for Water in Sebeya catchment

Final Report
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IUCN | National Committee of The Netherlands

META

GREEN ROADS FOR WATER

Final Report:

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1 Introduction

Green Roads for Water is a smart way of

meeting climate resilience of roads

collecting and using the road run-off for various purposes

reducing adverse weather impacts on road bodies and the surrounding of the road's environment

Protecting roads and securing transport

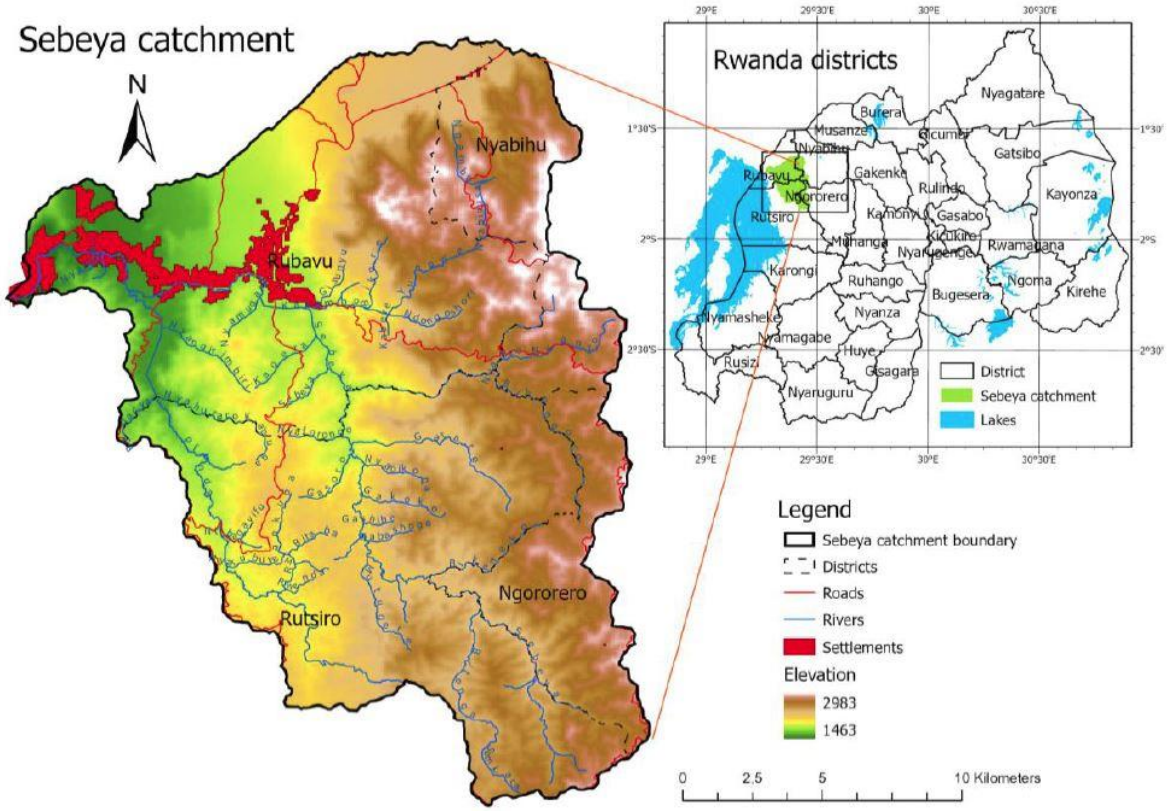
Towards
Green Roads
for Water

Study area

Sebeya Catchment, Rwanda

Main problems:

- Deforestation
- Unsustainable agricultural practices
- Mining exploitation
- Poorly designed road network
- Densely populated
- Climate change on the top of the above



Objective of the study

Provide an additional support measure to Integrated Water Resources Management and reduce landscape degradation in Sebeya catchment

Scope of the study

Assess the contribution of roads to landscape degradation and the potential of using the roads as instruments for beneficial water management and landscape restoration in Sebeya catchment.

One important component of this study is the identification of suitable GR4W measures and recommendations for minimizing the negative impact of roads on the landscape and safeguarding the road infrastructure as well as the development of an implementation plan for applying GR4W measures on a selected pilot road within the Sebeya catchment.

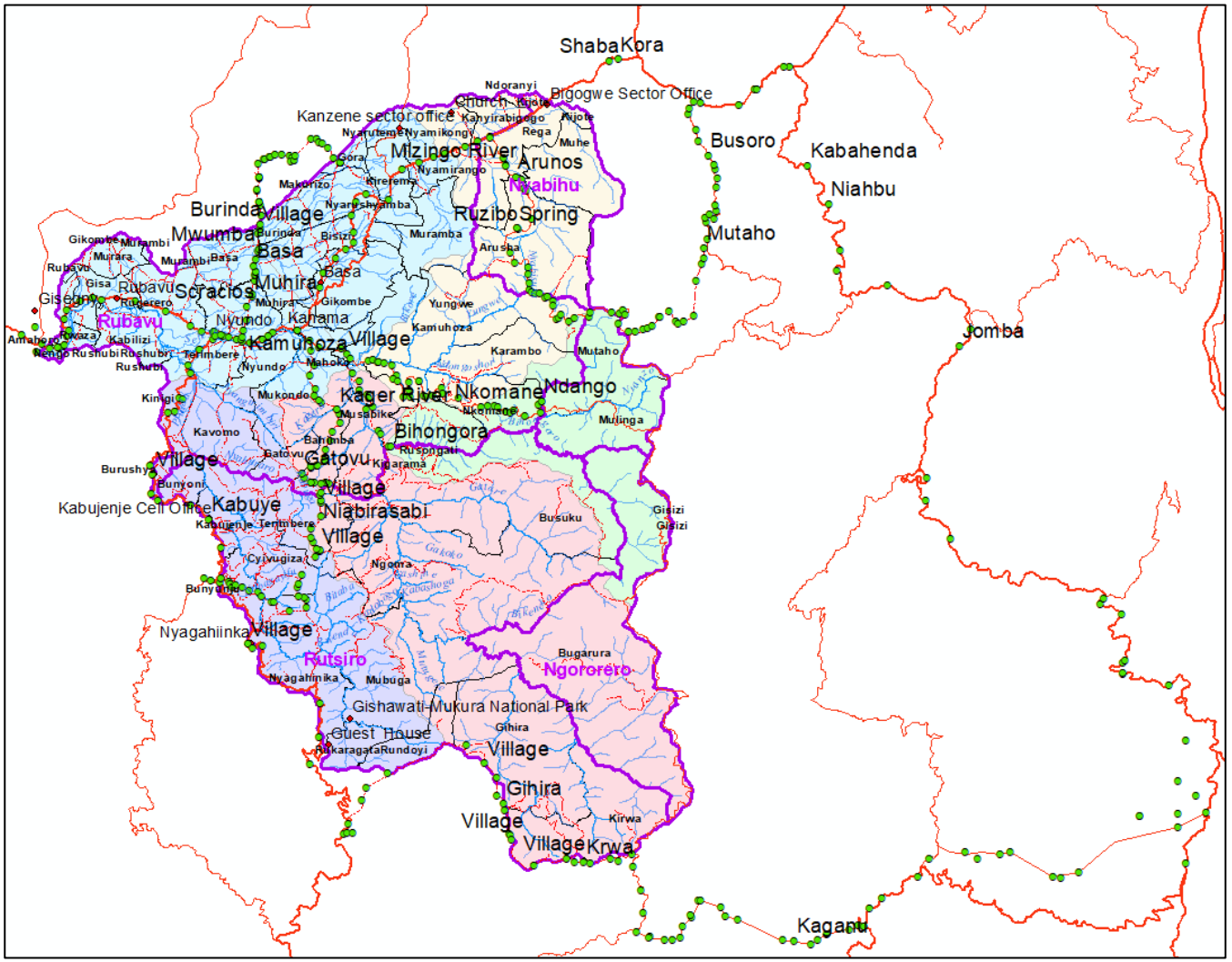
2 Methods of the Study

Desk review
Review of background information documents and reports, collection of secondary data on the road network and biophysical conditions of the study area from various sources

Field Survey
- Road assessments
  - Rapid Road Assessment: Transect drive along 120 kms of tarred highway and 185 kms of district and feeder road within and around Sebeya catchment (Duration: 3 days).
  - Detailed road assessment: Transect walk for data collection along the feeder road identified for piloting GR4W interventions (Duration: 1 day).
- Interviewing community member along the visited roads
- Meetings/workshops with key stakeholders

Data analysis
- Data generation/interpretation and development of thematic layers for Sebeya such as sub and micro catchments, topography, geology, slope, soil, and land-use land-cover (use of secondary local data and satellite data, ERDAS IMAGINE, ArcGIS and field validation)
- Selection of suitable GR4W measures for Sebeya based on biophysical characteristics and stakeholders' priorities
- Assessing the hydraulic capacity of the pilot road
  - Hydrological study of the pilot road
    - Determination of catchment area and its characteristics (catchment delineation and calculation of its characteristics by using Arc Hydro tools integrated into Arc GIS software)
    - Determination of time of concentration (by using Kerby-Kirpich Formula for small catchments and Passini formula for big catchments)
    - Estimation of peak discharge (by using Rational method for areas up to 10km^2 and modified rational method for areas larger than 10km^2)
    - Determination of rainfall intensity (by using Montana-type IDF-curve)
  - Assessment of hydraulic capacity of existing structures (formula of Manning-Strickler)

2 Methods of the Study

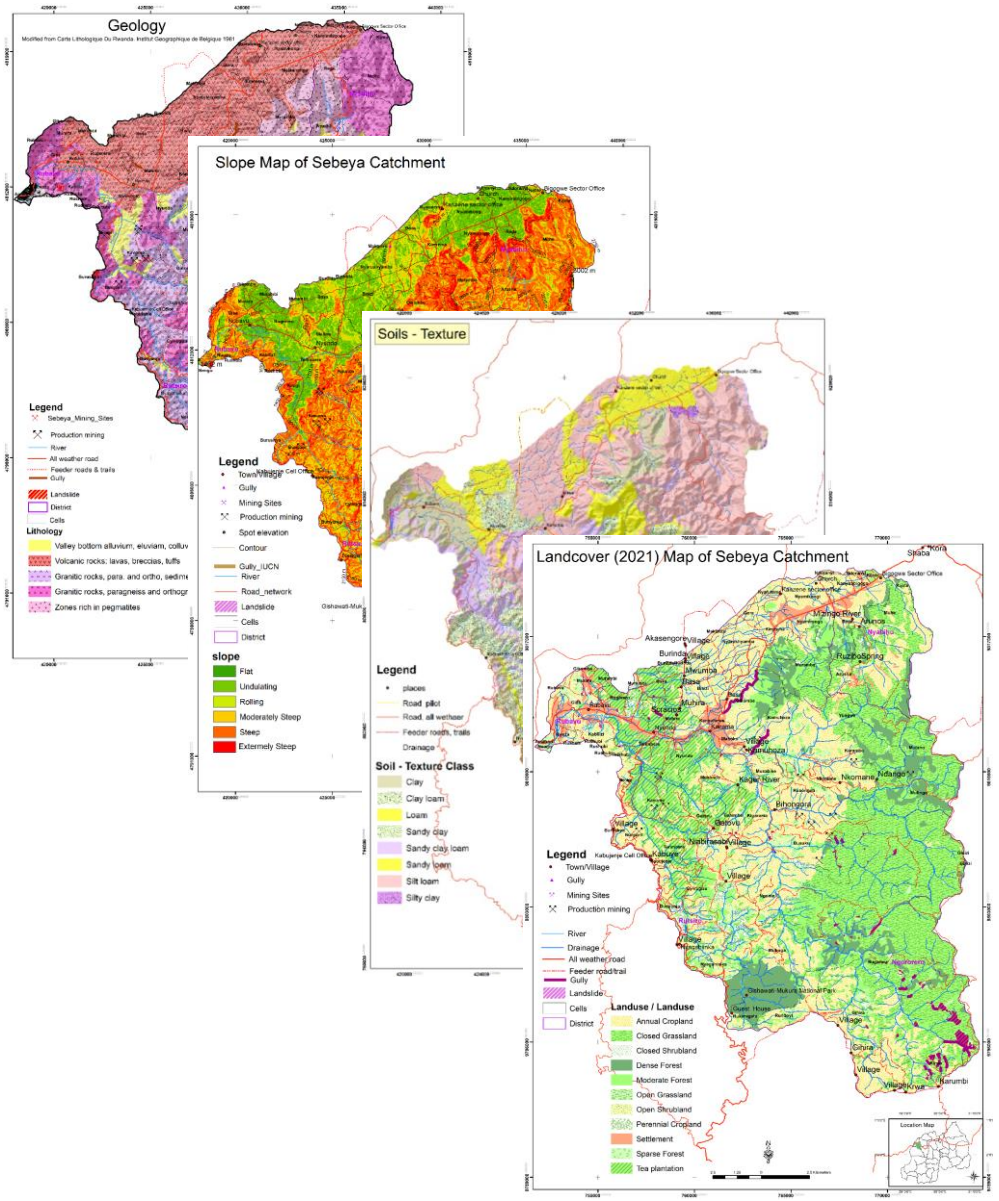


Transect drive and walk routes within and outside of Sebeya catchment. Green dots on the road indicate the observation points collected during the fieldwork (427 control points were collected).

3 General bio-physical characteristics

Generation of Thematic layers on:

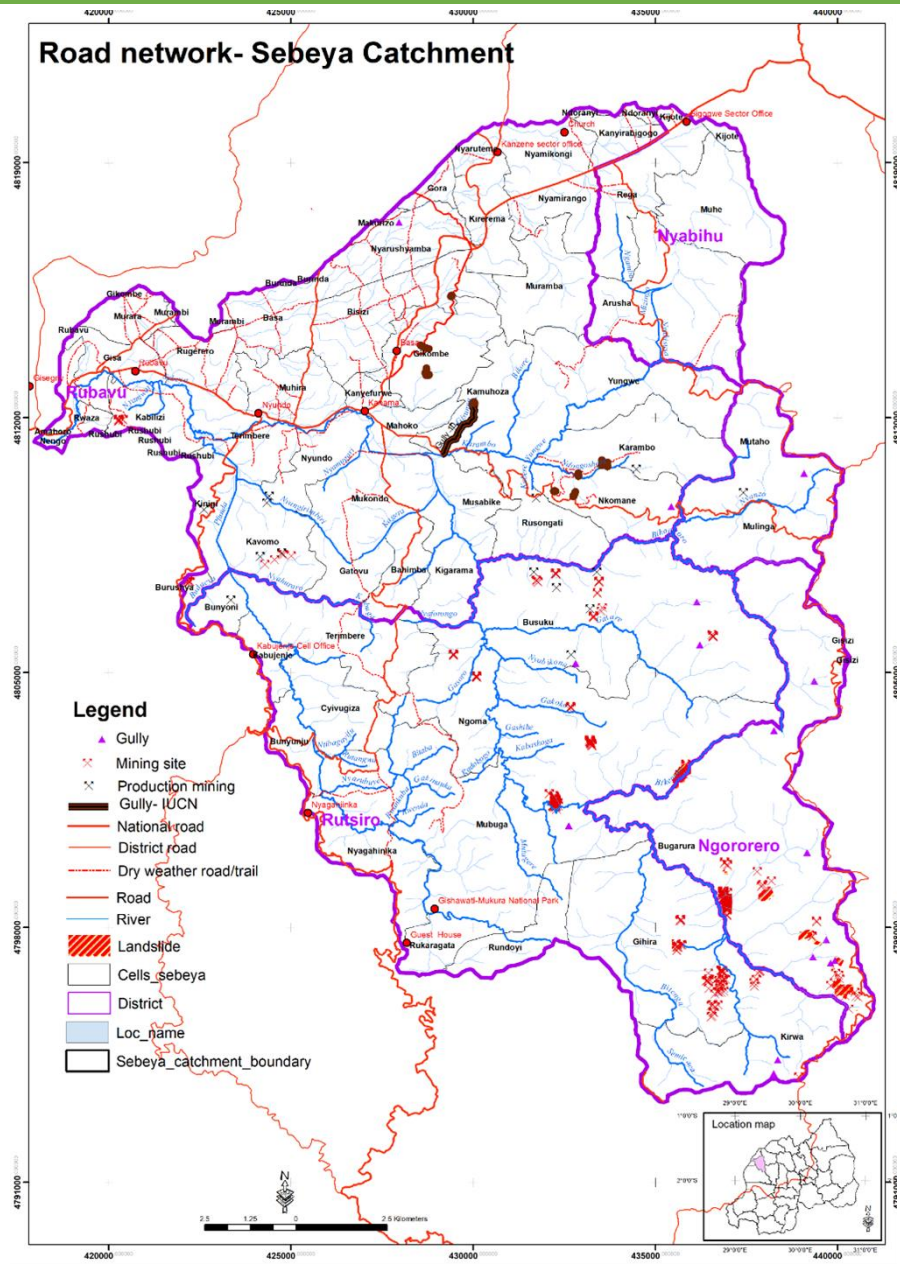
- ✓ **Sebeya Catchment and Sub & Micro catchments**
  For the hydrological analysis and the assessment of the drainage capacity of the pilot road
- ✓ **Geology and structures**
  Important factor for selecting appropriate GR4W measures
- ✓ **Hydro-geomorphology**
  Slope, aspect and elevation are decisive elements for the sustainability of roads and implementation of GR4W measures
- ✓ **Soils**
  Understanding the nature and types of soils and the soil forming processes are among the important factors to consider in any road construction, and associated GR4W implementation
- ✓ **Land-use landcover**
  To locate gullies and landslides but also LULC maps is important for selecting GR4W measures for effective water and nutrient stress mitigation.



4 Road Development Status and its condition in Sebeya

Road Development Status in Sebeya:

- Apart from 2 paved roads, other roads are earthen made and vulnerable to be damaged by heavy rainfall, floods, and landslides.
- The first paved road is located in the Northern part of the catchment between Rubavu and Musanze, while the second one connects Rubavu and Rutsiro Districts through Pfunda Tea Factory.
- The remaining part of the catchment is served by the unpaved road network which is not accessible all year round. Although those roads carry a low volume of traffic, they are very important for the local community for selling their livestock and agricultural products but also for accessing services such as education and health care.



4 Road Development Status and its Condition in Sebeya

Road Drainage Conditions in Sebeya:

- Varying degrees of water-related road damage have been observed along the roads.
- Gully development along roads that are lacking in water guidance structures, erosion downstream of drifts and culverts, and water-related slope failures are the most dominant forms of road-related damage.
- Other issues:
  - Culverts are clogged fully or partially,
  - many road sections do not have the side drain and some available side drains are not connected to the culverts or any other good location for runoff discharge
  - water crosses roadway and goes to communities building
  - the road banks are not protected






5 Water management practices in Sebeya

WM practices in Sebeya:

- Water managements practices in Sebeya area are correlated with the agroclimatic nature of the catchment
- Water management practices observed consist mainly in draining the water that is running from the runoff towards the lowland of various rivers in the catchment and finally towards Lake Kivu.
- WM practices include:
  - Drains
  - Culverts and channels
  - Dykes, dams and retaining walls
  - Terraces
  - Biological measures using grasses and indigenous tree species
  - Roadside tree planting






6 The potential for GR4W in Sebeya

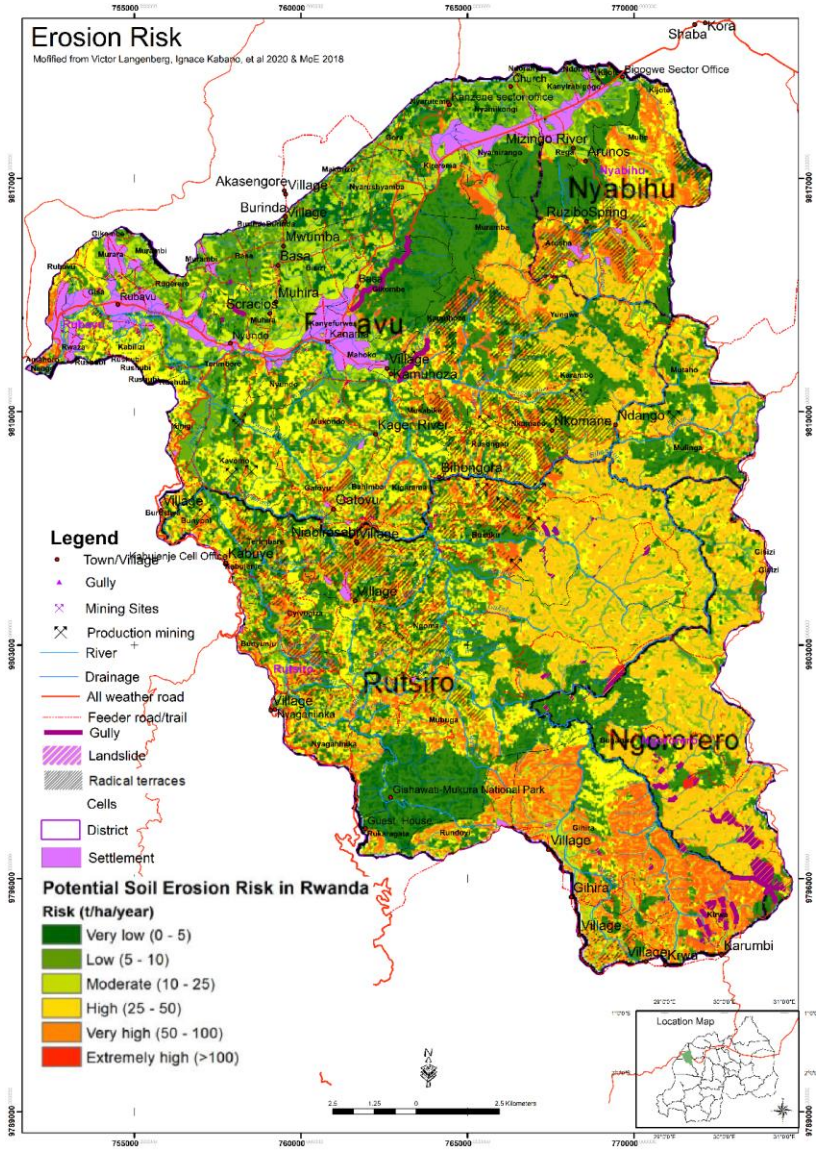
The need for GR4W in Sebeya:

- Through discussions with communities and farmers in Sebeya, we found out that they are not interested in harvesting water from roads since there is plenty of water in the area. However, further research is required because **inadequate water for human consumption was observed in the area.**

- **The main demand of communities was to see the water-related road damages and the landscape erosion around roads to be reduced**. GR4W interventions could address the needs of communities if integrated in the planned land restoration programs and sustainable development agendas of the catchment. Additionally, GR4W interventions could also reduce the flood risk for downstream areas.

- After mapping exercise, we found that **the development of most gullies in the area is related with poorly designed roads** (maybe not as the main factor but has exacerbated the problem)

- **Increased need for GR4W due to the alarming trend in rainfall, temperature and consequential environmental impact.** Temperature rise and change in rainfall pattern (the forecast shows increase in rainfall with short duration of extreme events, which will lead to water, soil and soil nutrient loss creating problems to the socio-economic condition of the fast-growing population of the catchment).



35 big gullies that are big enough to be mapped from satellite images are shown in the graph – most of them close to roads

7 Benefits from implementing GR4W in Sebeya catchment

Expected benefits from implementing GR4W interventions in Sebeya:

- Reduced water-related road damage; reduced road maintenance costs; reduced down-time of roads; improved road safety
- Healthier landscape around roads; reduced erosion and sedimentation upstream and downstream of the roads
- Reduced flood risk downstream
- Improved hydrological connectivity
- Employment opportunities in road maintenance by local community members linked to GR4W
- Improved access to water for consumption and productive use

Institutional arrangement and stakeholders' interest

Institutional arrangement:

Roles	National Roads	District Roads 1	Districts Roads 2	Feeder roads	Level
Policy formulation	Mininfra, Minirena, Minagri, Minaloc, Minema, MiniCT				National
Sector Planning, Coordination, M and E, Capacity building	Mininfra, SWAP Secretariat Transport, RTDA,				
Financing	Minecofin, RDB, Dev. Partners,				
Regulation	RURA		REMA, RWB, RSB		
	RNP				
Project planning and implementation	RTDA	Districts, COK, RTDA			District
Service Provision, O and M	RMF	LODA			
		Districts, Communities			

Stakeholder's interest:

The GR4W concept was highly appreciated, and the consulted organizations showed willingness to play their roles towards the implementation of GR4W in Sebeya catchment. Very conducive environment for the implementation of GR4W interventions was observed in Rubavu district.

Recommended GR4W measures for Sebeya

Recommended GR4W measures focus on three main purposes:

1. Maintaining hydrological connectivity across the landscape
2. Reducing/avoiding the damage from road-water on the landscape around roads
3. Increasing the sustainability of roads and reducing their maintenance cost

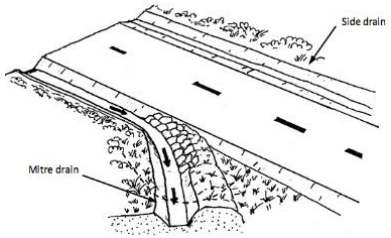
Extra focus which needs further investigation: Increased water availability for consumptive and productive use through Roads Water Harvesting

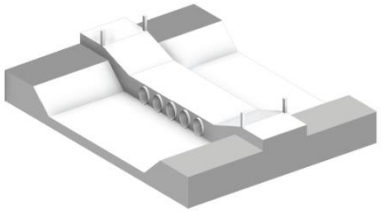
Main Recommendations:

- ✓ Follow is a **landscape approach for selecting appropriate GR4W measures based on slope, type of rocks, soil and land use & landcover conditions**. Factors like permeability, erodibility, saturation limits, soil thickness, slope and road safety need to be considered.
- ✓ Selected GR4W measures need to be **in harmony with existing policies, strategies and regulatory framework of the country**.
- ✓ Sometimes **revision of the regulatory framework for infrastructure development is required for the implementation of GR4W measures**.
- ✓ **Prioritize GR4W measures that can be constructed through the labor-intensive method which can reduce the costs, provide new green jobs** and be incorporated in the existing Pilot Payment for Ecosystem Services (PES) scheme implemented by the EWWM project

Recommended GR4W measures for Sebeya

- **Erosion protection and water guiding systems**
  - Packed or dumped dry riprap
  - Check dams
  - Dry stone wall
  - Stilling basin
  - Cascades
  - Chutes
- **Surface drains**
  - Furrow/intercepting ditches
  - Mitre drains/ditch out
  - Earthen or grouted stone pitched side drains
  - French drain
  - Slotted or perforated uPVC pipes
- **Cross-drainage for crossing over streams and riverbeds on the crystalline basement rock areas**
  - Drifts/fords
  - Vented Fords/causeways
  - Sand dams (combined with road crossings)
  - Culverts (with improved culvert's outlets)
  - Bridges
- **Water storage systems**
  - Detention/retention basin
  - Micro basin from soil berm
  - Ponds
  - Recharge wells
- **Roadside tree planting**





Recommended GR4W measures for Sebeya

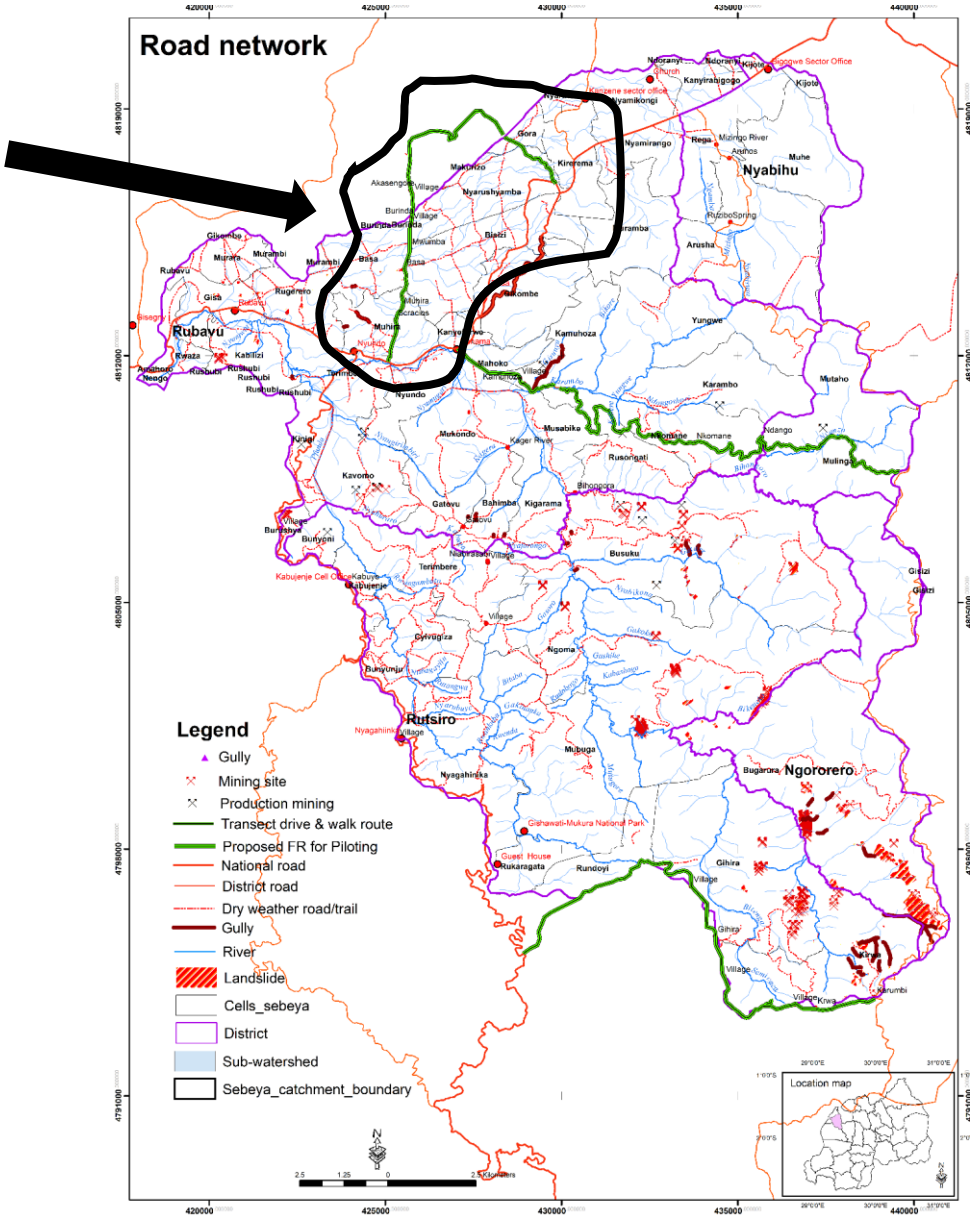
Where to apply GR4W measures

Parent Rocks			Major derived soil texture type	Recommended GR4W Measures and Most Suitable Areas				Allowable rainfall Range in mm	Slope range
Rock Group	Rock Type	Potential Threat for GR4W measure		Technology type (in priority order)	Aridity zone class: Dry Sub-humid	Semi- arid	Arid		
Crystalline Basement/Metamorphic Rocks									
Acid metamorphic rocks	– Schist, quartzite, gneiss, migmatite, slate, phyllite, pelitic	– Leaking Structures- faults, joints fractures	Unconsolidated soil layer &	• Sand dams, check dams, lined ponds, recharge wells, others	✓	✓	✓	<1200	0 to 50%
			Hard rock surface	• Rock surface water harvesting	✓	✓	✓	All range	0 to 50%
Basic metamorphic rocks	– Schist, slate, phyllite, pelitic rocks, green, schist, gneiss rich in Fe–Mg minerals, marble,	– Leaking Structures- faults, joints fractures	Unconsolidated soil layer &	• Sand dams, lined ponds, recharge wells, check dams, others	✓	✓	✓	<1200	0 to 50%
			Hard rock surface	• Rock surface water harvesting	✓	✓	✓	All range	0 to 50%
Ultrabasic metamorphic rocks	– Serpentinite, greenstone,	– Leaking Structures- faults, joints fractures (check for heavy metal concentration, objectionable test & odor) – Water logging, – Check for WQ	Coarse-grained sand/Sandy soils/sandy loam	• Sand dams, lined ponds, check dams & others		✓	✓	<1200	0 to 50%
			Hard rock surface	• Rock surface water harvesting		✓	✓	All range	0 to 50%
Igneous Rocks									
Acid igneous rocks	– Rhyolite, dio rite, grano-diorite, quartz- diorite, ...	– Leaking structures- faults, joints fractures	Sandy soils - soils that contain full range of particle sizes, from gravel and sand to very fine clays.	• Ponds with lining, surface spread and GW recharge depending on soil conditions & others	✓	✓	✓	<1000	0 to 5%
				• percolation pits, check dams, and bunds in areas of shallow bedrock conditions	✓	✓	✓	<1000	5 to 50%
Intermediate igneous	– Andesite, trachyte, phonolite, diorite- syenite	– Leaking structures- faults, joints fractures	Sandy loam to clay soils	• - Same as above	✓	✓	✓	<1000	5 to 15%
Basic igneous rocks	– Gabbro, Basalt, dolerite	– Leaking structures- faults, joints & fractures – Increased evaporation in arid areas as the black color of basalt causes the soil to warm quickly – Water logging,	Clayey and sticky alkaline soils.	• Ponds with special design consideration to clayey wall and evaporation	✓	✓	✓	<1000	0 to 5%
				• check dams& other moisture harvesting methods	✓	✓	✓	<1200	5 to 50%
Ultrabasic igneous rocks	– Peridotite, pyroxenite, ilmenite, magnetite, ironstone, serpentinite	– Structures- faults, joints fractures – Water logging, – Increased evaporation in arid areas – Check for WQ	Clayey and sticky alkaline soils.	• Ponds with special design consideration to clayey walls, water quality and evaporation	✓	✓	✓	<1000	0 to 5%
				• check dams & other moisture harvesting methods	✓	✓	✓	<1200	5 to 50%
Pyroclastic rocks	– Volcanic scoria/breccia, volcanic ash	– High permeability, piping and dispersion during high flood	most of it develops into good-quality sandy loam soils	• Ponds with lining, percolation pits, check dams, surface spread and GW recharge	✓	✓	✓	<1000	0 to 5%
	– Ignimbrite, tuff	– Water logging,	Clay/Clayey soils/	• Ponds with special design consideration to clayey walls	✓	✓	✓	<1000	0 to 5%
				• Check dams & & other moisture harvesting methods	✓	✓	✓	<1200	5 to 50%
Consolidated Sedimentary Rocks									
Clastic sediments	– Conglomerate, breccia, sandstone, greywacke, arkose,	– Highly permeable- Porosity Erodible; depending on the mineral composition of the cement. physical weathering can crack rock along	Sandy soils, Sandy- loam soils	• Ponds with lining, percolation pits, check dams, surface spread and GW recharge, if bed rocks are shallow	✓	✓	✓	<1000	0 to 5%
				• Check dams & & other moisture harvesting methods	✓	✓	✓	<1200	5 to 50%
	– Silt, mud claystone, shale, ironstone		silts produce fertile agricultural soils with excellent water-holding capacities	• Ponds with special design consideration to clayey wall	✓	✓	✓	<1000	0 to 5%
	– Shale	Rapid disintegration generally leads to deep soils, high in clay-size particles, so slow permeability for water.	Small particle size and poor cementation leads to rapid physical and chemical weathering.	• Ponds with special design consideration to clayey wall	✓	✓	✓	<1000	0 to 5%
Unconsolidated Sedimentary Rocks									
weathered residuum	– Bauxite, laterite	Poor water quality-acidity objectionable test/odour	Clayey soils	Not recommended for direct use					
Fluvial	– Sand and gravel, clay, silt and loam	forms soils rich in topsoil materials brought	Sandy loam	• Ponds, diversions to farms, bunds with special design consideration to structure failures	✓	✓	✓	<1000	0 to 5%
Lacustrine	– Sand, silt, and clay	– possibility of salinity problem	Sandy loam, Sandy clay	• Ponds, diversions to farms, bunds with special design consideration to structure failures	✓	✓	✓	<1000	0 to 5%
Colluvium	– Slope deposits, lahar	– Porosity	Sandy soils, sandy loam	• Ponds with lining, percolation pits, check dams, surface spread and GW recharge, if bed rocks are shallow	✓	✓	✓	<1000	0 to 5%

Plan for Implementing GR4W in Sebeya on a pilot road

Characteristics of selected feeder road for piloting GR4W interventions

- Culverts are clogged fully or partially
- Many road sections do not have the side drain and some available side drains are not connected to the culverts or any other good location for runoff discharge
- Water crosses roadway and goes to communities building
- The road banks are not protected, and this is probably one of the causes of their failures
- No maintenance is done on existing hydraulic structures
- Mass movement blocked culvert and changed the road grade, consequently it became the flood prone area
- Rubavu district staff showed interest and are willing to implement GR4W interventions in their district



Plan for Implementing GR4W in Sebeya on a pilot road

Step 1

Data collection on existing hydraulic structures on the selected pilot road and their conditions through a detailed road assessment

No		X	Y	Type of structure	Size [mm]	Physical conditions
Crossing structures (culverts)						
1		425591.5941	4814245.311	Pipe culvert	800	Fully Clogged
2		425649.6259	4817112.958	Pipe culvert	800	Partially Clogged
3		426845.8539	4818281.697	Pipe culvert	800	Partially Clogged
4		427170.9202	4818594.375	Pipe Culvert	800	Partially Clogged
5		428547.1919	4818108.925	Pipe culvert	800	Partially Clogged
6		428830.1145	4817962.648	Pipe culvert	800	Partially Clogged
7		429381.1734	4817567.726	Pipe culvert	800	Good
8		429561.8453	4817369.336	Pipe culvert	800	Good
Side drains						
1	From	425088.1977	4811884.832	Trapezoidal ditch	400 x 700 x 450	Not maintained
	To	425095.2087	4811916.854			
2	From	425407.9209	4813252.032	Trapezoidal ditch	400 x 800 x 600	Blocked by landslide
	To	425449.0488	4813317.849			
3	From	425771.4254	4816027.933	Trapezoidal ditch	400 x 700 x 400	Good
	To	425777.4192	4816123.015			
4	From	425640.5004	4817171.972	Trapezoidal ditch	400 x 700 x 500	Good
	To	425709.3883	4817440.408			
5	From	425705.9652	4818136.714	Trapezoidal ditch	500 x 700 x 500	Good
	To	425839.2534	4818205.58			
6	From	426836.4382	4818181.434	Trapezoidal ditch	300 x 700 x 500	Damaged
	To	426825.3264	4818135.206			
7	From	428547.1919	4818108.925	Trapezoidal ditch	600 x 800 x 600	Good
	To	428604.1692	4818086.839			
8	From	429488.3768	4817465.712	Trapezoidal ditch	400 x 600 x 400	Not maintained
	To	429542.1353	4817446.638			
9	From	429561.8453	4817369.336	Trapezoidal ditch	600 x 800 x 600	Good
	To	429591.9544	4817335.53			
10	From	429784.0023	4816935.941	Trapezoidal ditch	400 x 700 x 800	Good
	To	429834.35	4816882.312			

Plan for Implementing GR4W in Sebeya on a pilot road

Step 2

Assessing the capacity of the hydraulic structures of the pilot road through following the formulas indicated in the methodology

Side drains	Estimated design runoff	Existing Dimensions		Slope	Height (m)	75%h	Area (m2)	Cross section (0.75h)	Slope distance	Wetted Perimeter	Hydraulic radius	Hydraulic Capacity	Difference	Observation
	Q (m3/s)	b	B		h			A2		Wetted P	Rh	Q (m3/s)		
1	**0.234**	0.4	0.7	0.03	0.6	0.45	**0.3**	**0.2**	**0.5**	**1.71**	0.145	**0.59**	**0.36**	Adequate
2	**0.05**	0.4	0.8	0.024	0.6	0.45	**0.4**	**0.3**	**0.5**	**1.73**	0.156	**0.61**	**0.56**	Adequate
3	**0.237**	0.4	0.7	0.051	0.4	0.30	**0.2**	**0.2**	**0.3**	**1.30**	0.127	**0.47**	**0.23**	Adequate
4	**2.186**	0.4	0.7	0.105	0.5	0.38	**0.3**	**0.2**	**0.4**	**1.50**	0.137	**0.89**	**-1.30**	Not adequate
5	**0.235**	0.5	0.7	0.068	0.5	0.38	**0.3**	**0.2**	**0.4**	**1.58**	0.142	**0.80**	**0.57**	Adequate
6	**0.265**	0.3	0.7	0.013	0.6	0.45	**0.3**	**0.2**	**0.5**	**1.63**	0.138	**0.34**	**0.08**	Adequate
7	**0.222**	0.6	0.8	0.016	0.5	0.38	**0.4**	**0.3**	**0.4**	**1.68**	0.156	**0.48**	**0.26**	Adequate
8	**0.474**	0.4	0.6	0.09	0.4	0.30	**0.2**	**0.2**	**0.3**	**1.27**	0.118	**0.54**	**0.07**	Adequate
9	**0.474**	0.6	0.8	0.078	0.6	0.45	**0.4**	**0.3**	**0.5**	**1.89**	0.167	**1.33**	**0.86**	Adequate
10	**1.159**	0.4	0.7	0.037	0.8	0.60	**0.4**	**0.3**	**0.6**	**2.12**	0.155	**0.92**	**-0.24**	Not adequate

Culverts	Length	Slope	Strickler coeff	Diameter	Design discharge	Cross section	Wetted Perimiter	Hydraulic radius	Velocity	Velocity	Flow area	Estimated capacity of structure	Hydraulic capacity	Recommendation
	L	S	Ks		Q25	Aw	Pw	Rh	Vth	Vv				
N°	[m]	[m/m]		[m]	[m3/s]	[m2]	[m]	[m]	[m/s]	[m/s]	[m2]	[m3/s]	[m3/s]	
1	7.00	**0.020**	71	**0.800**	1.41	0.40	1.67	0.24	3.48	3.92	0.36	1.58	Sufficient	To be relocated
2	7.00	**0.020**	71	**0.800**	2.70	0.40	1.67	0.24	6.69	3.92	0.69	1.58	Not sufficient	To replace
3	7.00	**0.020**	71	**0.800**	1.09	0.40	1.67	0.24	2.71	3.92	0.28	1.58	Sufficient	To be maintained
4	6.00	**0.020**	71	**0.800**	1.23	0.40	1.67	0.24	3.04	3.92	0.31	1.58	Sufficient	To be maintained
5	6.00	**0.020**	71	**0.800**	0.55	0.40	1.67	0.24	1.36	3.92	0.14	1.58	Sufficient	To be maintained
6	6.00	**0.020**	71	**0.800**	0.98	0.40	1.67	0.24	2.42	3.92	0.25	1.58	Sufficient	
7	6.00	**0.020**	71	**0.800**	0.98	0.40	1.67	0.24	2.42	3.92	0.25	1.58	Sufficient	

Plan for Implementing GR4W in Sebeya on a pilot road

Step 3

Selection for suitable measures
(both under the protective and the adaptive approach – however, measures under the adaptive approach are less costly and bring more benefits than just protecting the road)

Protective approach Recommendations for improving the road drainage system based on the assessment of hydraulic structures of the pilot road	
Cross drainage structures/culverts	Cleaning of logged culverts number 2,3,4,5, and 6
	Relocating culvert 1 because it's no longer functioning as the mass movement totally covered (buried) it. Culvert 2 needs to be redesigned in order to meet the size which is able to drain to discharge or if possible, the water must be controlled upstream.
	Additional of culverts for catchment 7 and 20 at the crossing points with road. There is also a need of culvert in catchment 1 in connection with ditch 1 as the water remain stagnant in road. These catchments are very big and are missing the crossing structures.
Side drains	Cleaning non maintained ditches numbers 1, 2, 8. For 2, there is a need to protect the embankment as it is susceptible to landslide.
	Repairing the damage segment for ditch 6
	Connecting ditches 1 and 4 to culverts

Adaptive approach Recommendations for making the best use of and adapting to hydrological changes based on the observations from the road assessments			
Level/location of GR4W intervention	Purpose of GR4W intervention	GR4W strategy	Recommended GR4W measure
Upstream of the road	Stabilize the slopes upstream of the road, reduce the amount of water/runoff coming to the road and protect road infrastructure	Regreening	Planting grass, shrubs and trees (use of deep-rooted indigenous species – species to be selected in consultation with Rwanda Water Forestry)
		Water and soil conservation measures	Progressive terrace on high slopes, soil and stone bunds on the low slope areas on non-clay soils.
At the road	Protect the road infrastructure	Road embankment protection	Reducing the slope of the road embankment (optimum slope: 45°)
			Planting grass, shrubs and trees (use of indigenous species)
			Use of gabions
Downstream of the road	Better manage the road runoff coming from the culverts, protect landscape around road and the road infrastructure, increase water availability for farming and livestock and drinking purposes	Erosion protection and water guiding systems	Packed or dumbed dry rock riprap (see Annex 3.1)
			Check dams (see Annex 3.1)
			Stilling basin (see Annex 3.1)
			Cascades (see Annex 3.1)
			Chutes (see Annex 3.1)
			Planting grass (use of indigenous species)
			Roadside tree planting (see Annex 3.5)
		Channeling road runoff to farms along the pilot road or to surface storage/groundwater recharge	Mitre-drains for diverting water from main roadside drains
			Irrigation canals (lined or not) connected to side ditches or culverts
			V-shaped diversion structures constructed from soil and stones at culvert outlets
		Water harvesting/water storage/groundwater recharge (depending on the interest of farmers/communities along the rod)	Detention/retention basin (see Annex 3.4)
			Micro basin from masonry/soil berm (see Annex 3.4)
			Sand dams (see Annex 3.3)
			Recharge wells (see Annex 3.4)

Plan for Implementing GR4W in Sebeya on a pilot road

Step 4

Identify roles and responsibilities of key stakeholders towards the implementation of the recommended measures (very important component since GR4W is a multisectoral approach which requires coordination between various units (water, environments, agriculture, roads etc.) but also communities.

Approach to resilience	Key Actors at district level	Roles and responsibilities
Protective Approach (Basic resilience)	Infrastructures and One Stop Center Unit	• Identification of issues on roads, on culverts, designs • Formulation of TOR • Recruitment of Private Company • Monitoring the implementation • Coordinating the District Technical Management Committee
	Planning Evaluation and Monitoring Unit	• Compiling issues from one stop center and Agriculture and Natural Resources Units • Costing of required budget • Working with various partners for funds mobilization for implementation • Liaise with LODA in submitting the required budget for infrastructures and watershed management
Adaptive Approach (Resilience plus 1)	Agriculture and Natural Resources Unit	• Identification of issues on watershed that include the roads with issues • Identification of issues upstream and downstream of the roads • Planning and costing the measures for upstream and downstream based on watershed approach • Coordinating partners in the districts for the implementation of recommended measures in line with watersheds approach • Incorporate in District Plans the issues related to upstream and downstream culverts for LODA to provide resources
	Good Governance Unit (Joint Action Development Forum (JADF))	• Play an important role in coordinating all actors at district level • Raising awareness on importance of greening roads with other various actors at district level
	Communities	• Raising their voices on issues related to road infrastructures • Participating in communities works (Umuganda) for conserving upstream and downstream the culverts but also for harvesting water for various purposes depending on their needs


Thank you
Questions?