Policy brief on environment and climate change

1. Introduction

Changes in precipitation and temperature patterns accentuate the risks on environment degradation in Rwanda. Due to the elevated relief in the northern and western parts of the country, hazards of soil erosion, landslides, water bodies siltation and water borne diseases are common. In the southeast and the eastern parts which are of a plain relief and lower in elevation, rainfall shortage and long periods of drought lead to water scarcity, food shortage, soil depletion, heat stress to livestock, and increased vulnerability to invasive species and pests.

The risks of these climate change related risks are exacerbated by anthropogenic activities, mostly related to high demographic increase, pressure on land and natural resources and scattered settlements, etc.

This policy describes major issues related to climate change and environment, and elaborates on proposed solutions to address the issues, with emphasis on ecosystem-based adaptation to climate change approach. Ecosystem-based adaptation contributes to reducing vulnerability and increasing resilience to both climate and non-climate risks and provides multiple benefits to society and the environment.

A review of available reports and the knowledge of the reviewer of this policy brief constitute the primary source of information for its development.

2. Overarching issues

Land, soil, water, and biodiversity are among the main environmental and natural resources on which social economic development of Rwandan people depend[1]. These bio-physical components of the environment coupled with well-functioning ecosystems and a stable climate are the foundation for development and all human life. Human pressure on these resources increases their vulnerability to climate change in reducing their capacity to provide goods and services. In turn, the pressure leads to increased vulnerability of communities to the effects of climate change, and this continues in a chain of impacts and consequences[2].

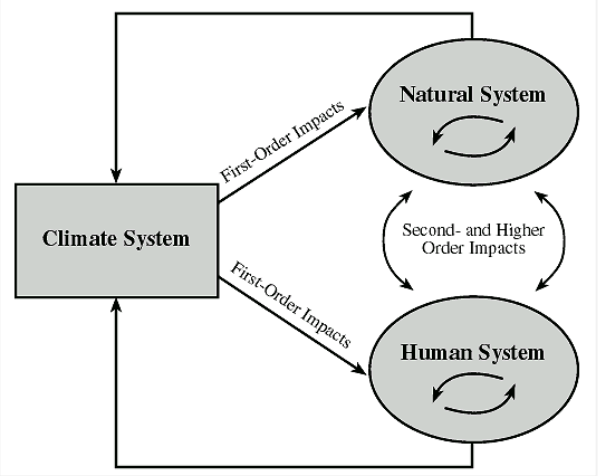

Figure1: Chain of impacts and consequences

Source: The Regional Impacts of Climate Change (grida.no), accessed on Feb 17th, 2022.

[1] Republic of Rwanda (2018). Third National Communication: Report to the United Nations Framework Convention on Climate Change, Republic of Rwanda, Kigali.

[2] Watson, R.T., Zinyowera, M.C., Moss, R.H. IPCC Special Report on the Regional Impacts of Climate Change. An Assessment of Vulnerability (The Regional Impacts of Climate Change (grida.no). Accessed on Feb 17th, 2022.

Priority environmental sectors for climate change adaptation interventions in Rwanda include water, land (with focus on land use and scarcity and losses in soil quality) and biodiversity (with emphasis on forestry)[3]. This policy addresses those environmental aspects and proposes EbA solutions on issues related to land use changes, soil and water quality.

3. Land use change

a. Current situation and linkage with climate change

Increasing population size has led to a decreasing farm ownership per household over the years. Total arable land is estimated at 14,000 km² or 52% of the country's total surface area (26,338 km²). However, in 2014 the total cultivated area increased to 1,747,559 hectares or 66% of the national territory.

Changes in various land use types from 1990 to 2010 (Figure 2) indicate that agricultural lands have substantially increased (+19%) while forested lands, both forest and savanna types, incurred most decline (-13% and -6% respectively).[4]

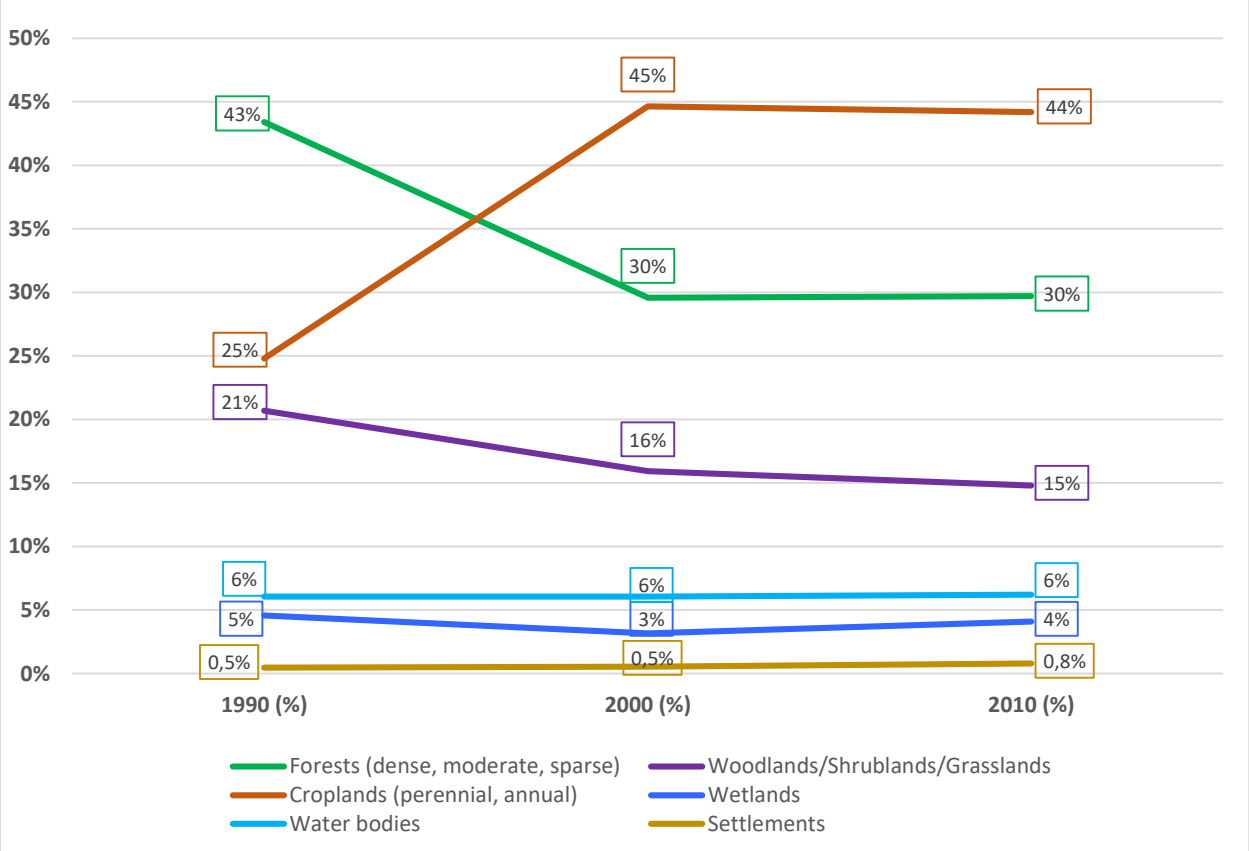

Figure 2: Rwanda Land Use Change (1990-2010) (Source: RoR, 2015)

[3] Republic of Rwanda (2020). Updated Nationally Determined Contribution. Kigali, Rwanda.

[4] Republic of Rwanda (2015). Rwanda Sectoral Analysis. Assessment of Sectoral Opportunities for the Development of Nationally Appropriate Mitigation Actions (NAMAs) in Rwanda. Kigali, Rwanda.

However, although MINILAF (2018)[5] reports a net increase in forest cover between 2000 and 2015 (3%), by considering grasslands as in the overall tree-covered areas (such as the case of wooded savannas), the net annual changes of forest cover has declined of 1.15% between 2000 and 2015. Although the figures differ from RoR (2015), an overall trend looks similar for most land cover types. Tree-covered areas are amongst affected land types, due mostly to human activities, whereby the conversion of natural ecosystems (forests, wetlands) into artificial surface (roads, house settlements…) greatly contributes to their degradation (Figure 3).

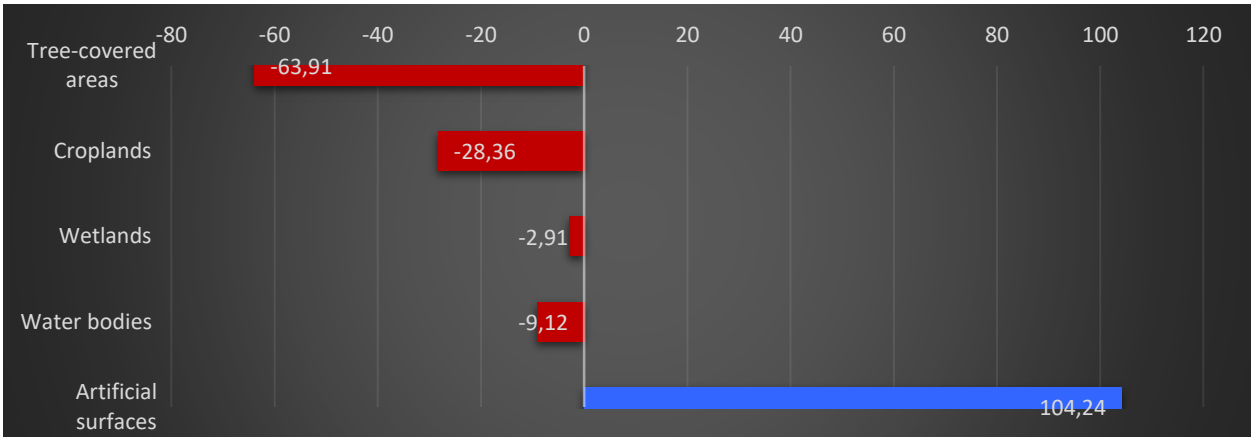

Figure 3: Net Area Change (2000-2015) (ha). (Source: MINILAF, 2018)

This conversion of forests to other land uses mainly constructions and agriculture, and from woodlands to grasslands through cutting regimes, exposes the country to more climate change and climate variability impacts[6]. The loss in forest cover ultimately constitutes the main source of land degradation. More than half the total area experiencing conversions in land use and land cover types occurs in the forestland (19.4%), of which most converted to cropland (16.0%)

[5] MINILAF (2018). Final Country Report of the LDN Target Setting Programme in Rwanda. Kigali: Ministry of Lands and Forestry. Accessed Feb 22, 2022, at https://knowledge.unccd.int/sites/default/files/ldn_targets/2019-01/Rwanda%20LDN%20TSP%20Country%20Report.pdf, Kigali, Rwanda.

[6] Republic of Rwanda (2018). Third National Communication: Report to the United Nations Framework Convention on Climate Change, Republic of Rwanda, Kigali.

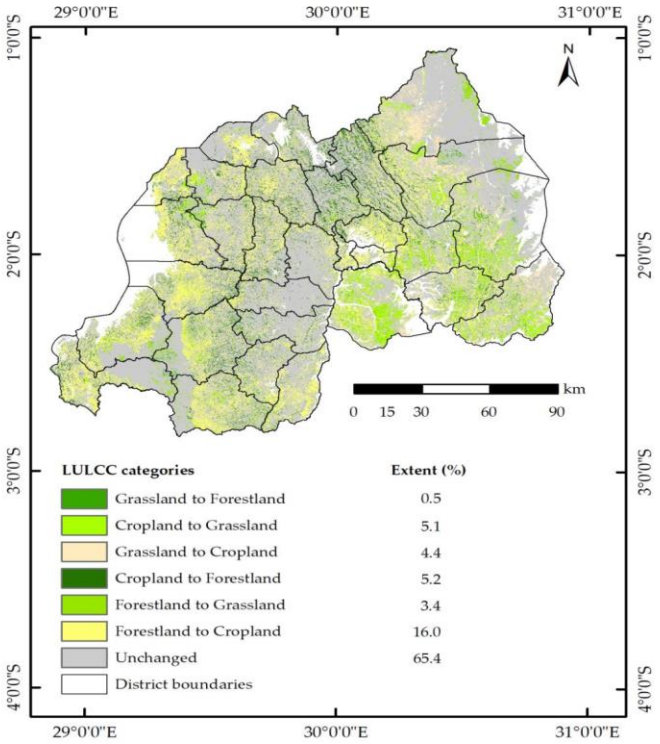

Figure 4: Change in land use and land cover categories for erosion-prone lands (2000-2015). (Source: Nambajimana, 2019).

Land use changes affecting mostly forests have contributed to low forest stocking. In 2016[7], the average stocking was only 50 m^3/ha for all public forests, and the maximum above ground stocking was recorded in Nyabihu District (285 m^3/ha). However, the recorded carbon values for Nyungwe National Park (very well conserved and less disturbed forest) were up to 185 tons/ha[8], a great indication of an impact of forest cover in carbon stocking, and consequently a big contribution to mitigation of climate change impacts.

Another key land use change is related to wetlands. Wetlands in Rwanda have been used in different ways and have a great role to play in the national economy. Main functions of wetlands in Rwanda include agriculture production, hydrological functions, biodiversity reservoirs, peat reserve, mitigation of climate change, leisure and tourism and cultural value, etc.

From recent inventories, the total number of wetlands in Rwanda are 935, covering a total area of 176,337 ha[9]. Rwanda's wetlands are under great pressure due to population growth, urbanization, pollution, and degradation from numerous economic activities. Human activities threatening wetlands in Rwanda include settlements and road construction, drainage, unplanned conversion to agriculture, industrial pollution sewage

[7] MINILAF (2017). Forest Investment Program for Rwanda. Ministry of Lands and Forestry, Kigali, Rwanda.

[8] Nyirambangutse, B., Zibera, E., Uwizeye, F. K., Nsabimana, D., Bizuru, E., Pleijel, H., Uddling, J., and Wallin, G.: Carbon stocks and dynamics at different successional stages in an Afromontane tropical forest, Biogeosciences, 14, 1285–1303, https://doi.org/10.5194/bg-14-1285-2017, 2017.

[9] REMA. (2020). Environment and Natural Resources Management (ENRM): National Wetlands Management Framework for Rwanda. Rwanda Environment Management Authority. Kigali, Rwanda.

and excessive harvest of products, etc. In particular, the conversion of wetlands to agricultural production has increased rapidly over the last two decades due the acute scarcity of agricultural land.

The over-exploitation of plant and animal biodiversity in wetlands is also an issue impacting negatively on the services of the swamps. The reduction of vegetation cover leads to evaporation of water by direct radiation, a reduction of the function of sediments retention and flood control, a gradual erosion of biodiversity…[10].

Many of Rwanda's wetlands were converted to other land uses, where wetland coverage decreased from 276,488 ha in 1988 to 176,337 ha in 2016 representing 36% of the wetland ecosystem lost in just 28 years. This increase of intensity and frequency of threats to wetlands continue to decrease, and mostly attributed to threats coming from agriculture. Cultivation of wetlands affects their chemical, physical and hydrological nature. The use of agro-chemicals seeping through the wetlands and joining other water sources most of which form rural domestic water supply points such as wells and streams affect chemical properties of wetlands. The physical and hydrological modifications mainly relate to erosion due to inappropriate agricultural practices. Drains and channels constructed to divert or to increase water out-flow from wetlands lower the water table and can lead to loss of biodiversity through drying out of the wetlands. All these pressures degrade the quality of wetlands and increase vulnerability to effects of climate change.

The percentage of the level of intensity and frequency of threats assigned following the state, pressure and response model and indicators measured is presented in Table 1[11]

Table1: Intensity and frequency of threats in Rwandan wetlands. (Source: REMA, 2021)

Wetland complexes	**Intensity and frequency of threats**			
	Low (20-40%)	*Medium (40-60%)*	*High (60-80%)*	*Very high (80-100%)*
Southern wetland complexes			X	
Eastern Kirehe wetland complexes			X	
City of Kigali				X
Akanyaru				X
Rweru-Mugesera				X
Muvumba				X
Rusizi			X	

[10] REMA (2009): Rwanda State of Environment and Outlook Report" Rwanda Environment Management Authority, Kigali, Rwanda

[11] REMA (2021). Rwanda State of Environment and Outlook Report 2021. Rwanda Environment Management Authority Kigali, Rwanda

Rugezi	X			

b. Proposed EbA solutions:

The best practice for preventing further loss and degradation of forests and wetlands is to remove non-climatic stressors or pressures on the ecological character of forests and wetlands and avoid further disturbance. The possibility to restore a wetland does not justify the trade-off for the continued degradation. Enabling conditions must be ensured for immediate and appropriate measures to recognize the full suite of environmental, cultural and socio-economic benefits from forests and wetlands restoration.

In this regard, alternative sources of livelihoods needs must be developed, accompanied with steady awareness raising and education on the importance of the protection and conservation of forests and wetlands.

Controlled tree planting through afforestation, reforestation, agroforestry and urban tree planting initiatives should be considered to provide wood for fuel and improve slope stability supports food security. These initiatives act as a carbon sink and can therefore earn carbon credits12. More specifically, an ecosystem-based approach should consider the following recommended protocol for restoration of degraded forest and wetland ecosystems (Table 2)[13]

[12] RoR (2011). Green Growth and Climate Resilience. National Strategy for Climate Change and Low Carbon. Kigali, Rwanda.

[13] REMA (2019). Ecosystem-Based Adaptation Guidelines for Climate Resilient Restoration of Savannah, Wetland and Forest Ecosystems of Rwanda. Rwanda Environment and Management Authority. Kigali, Rwanda.

Table 2: Recommended protocol for EbA restoration of degraded forests and wetlands. (Source: REMA, 2019).

No	Aspect	Description
1	*Scope*	Aim to cover the whole degraded zones, starting with the highly degraded zones or the most vulnerable to the current climatic and non-climatic stressors. Promote afforestation/reforestation of designated areas through enhanced germplasm and technical practices in planting and post-planting processes.
2	*Ecological adaptability*	- Choose the plants to grow, and each plant should be chosen according to its ecological requirements, and only ecologically adapted indigenous species should be planted. - Anatomical and physiological characteristics of identified plant species should be considered during the plantation (drought-resistance, growth rate, disease resistance, waterlogged areas, riparian zone, buffer zone...) - No exotic plant should be used, except in rare cases after careful judgment of the inevitability.
3	*Climate change adaptation/mitigation*	Species should be identified based on their potential contribution to climate change adaptation/mitigation
4	*Benefits to local communities*	Identify suitable climate-resilient but also beneficial indigenous species to local community's needs.
5	*Local knowledge and practices*	- Take into consideration local knowledge and traditional practices in terms of preferred plant species and planting/maintenance practices - Technical/scientific methods for planting/maintenance should supplement local knowledge/practices
6	*Care and maintenance*	- It is advised to avoid the use of fertilizers and other chemicals in wet places to prevent them from leaching - Take appropriate measures for the management to remove invasive species and prevent further propagation. - Protect the plants from damages (e.g. encroachment, uprooting…) - Regularly monitor the health status of the plants and take appropriate action

4. Soil degradation and soil erosion

a. Current situation and linkage with climate change

Rwanda has a heritage of fertile soils in some zones, though in many areas they are frequently high in acidity. Most soils in Rwanda are highly weathered, dominated by kaolinite in the clay fraction, have a low cation exchange capacity . . . and are acid to strongly acid (pH < 5.5 and often < 4.8) often with aluminium toxicity. This means that soils have low natural fertility and a low nutrient retention capacity. The hilly topography, with many steep slopes (Figure 5), has been conducive to depleting that heritage through rapid runoff of surface water and soil erosion[14].

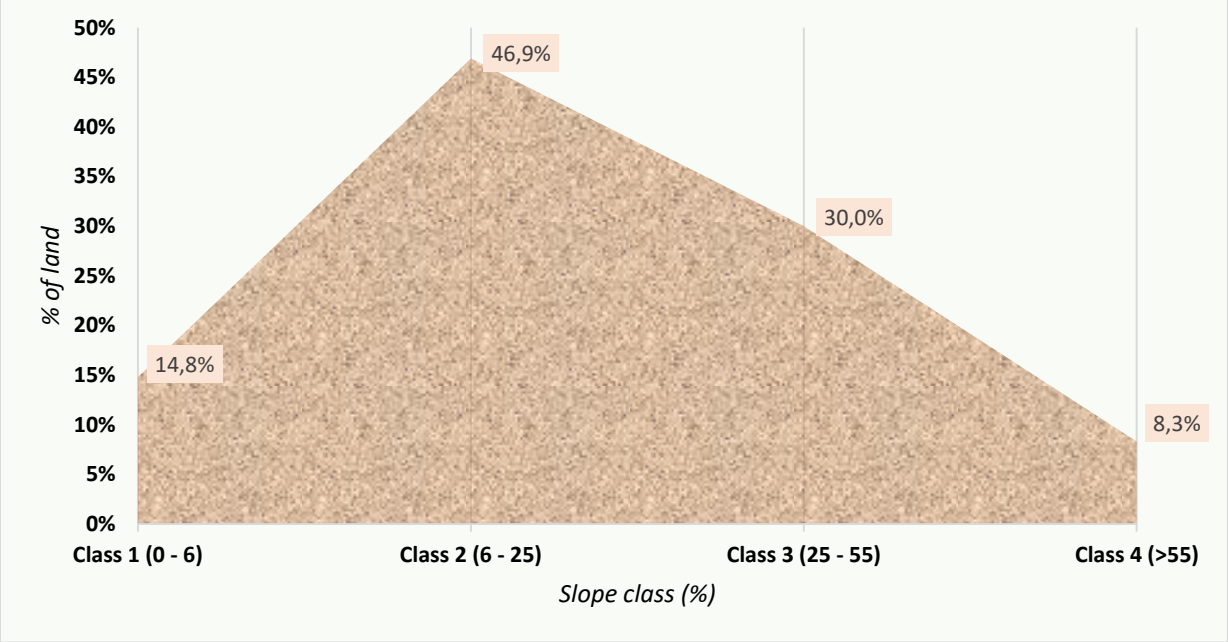

Figure 5: Slope Classes of Rwanda's Land Endowment. (Source: MINAGRI, 2009).

Because of the topography and the heavy population pressure on the land that pushes farming onto the steeper slopes, Rwanda has one of the highest soil erosion rates in Africa. Intensive cultivation without adding fertilizers also contributes significantly to soil depletion. Land use practices such as trampling of stocks, human disturbances, burning of vegetation, soil excavation processes have devastated vegetation cover to such an extent that the soil surface of areas has become susceptible to erosion. Increased housing developments associated with urbanization, directly affects the soils' physical characteristics thus lowering water infiltration and increasing runoff and soil erosion with increased potential for floods.

In 2005, about 77% of Rwanda's total surface area was threatened by soil erosion, of which 39% was at high risk. The studies indicate that a mean soil loss in Rwanda was estimated

[14] MINAGRI (2009). Strategic Plan for the Transformation of Agriculture in Rwanda – Phase II (PSTA II). Ministry of Agriculture and Animal Resources. Kigali, Rwanda.

to be **39.2 tons/ha per year** in 2015, resulting in total national losses of about **89 million tons of soil**[15]. Figure 6 shows the 4 most exposed districts to soil erosion in Rwanda: Ngororero, Muhanga, Karongi and Gakenke[16].

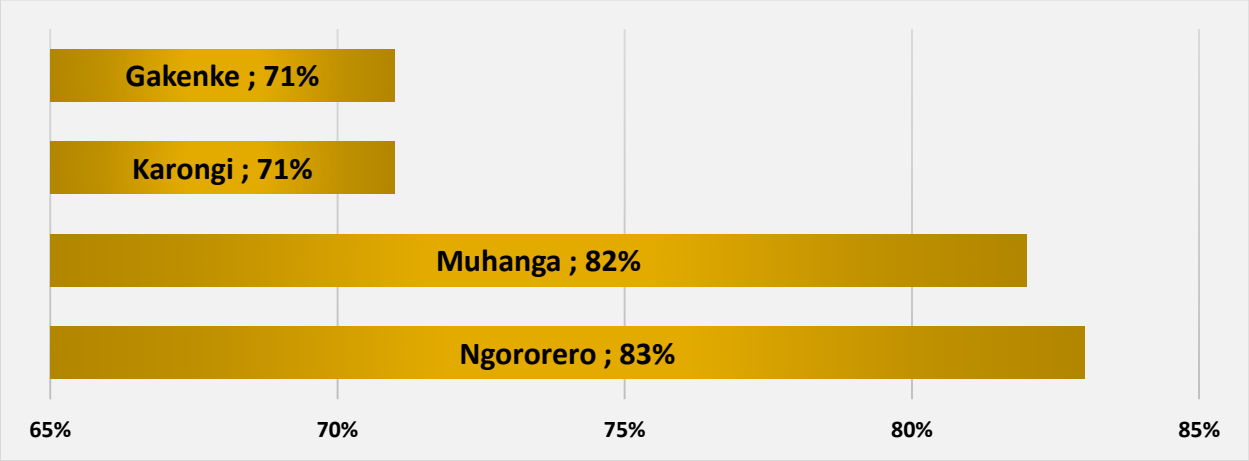

Figure 6 : Most risk affected districts in terms of % area to total area of the district (Source: RoR, 2021)

b. Proposed EbA solutions:

Because soil erosion itself is a symptom of poor land management, erosion control measures alone will remain insufficient. There should be a switch of emphasis to focus on the promotion of a high-quality, integrated soil management system rather than stand-alone erosion control measures in agricultural land.

High quality soil management could be achieved through an integrated conservation agriculture approach that provides profitable agricultural yields, while minimizing environmental damage. The agricultural intensification program in Rwanda is currently dependent on the application of inorganic fertilizer to increase crop yields. It is recommended to reduce the demand for inorganic fertilizers by applying an integrated approach to soil fertility and nutrient management, which employs:

- agroecology,
- resource recovery and reuse,
- and fertilizer enriched composts.

An integrated approach can significantly lower inorganic fertilizer demand, reduce GHG emissions and increase farm profitability due to reduced input costs for farmers. Such approaches also improve soil structure and the water retention capacity of soils leading to resilient agricultural ecosystems and sustainable food security.

Enriched compost fertilizers will add valuable organic matter to soils, which also maximizes terrestrial carbon in farm soils [17]

[15] Nambajimana, J.D., He, X., Zhou, J., Justine, M.F., Li, J., Khurram, D., Mind'je, R., Nsabimana, G. (2019). Land Use Change Impacts on Water Erosion in Rwanda. *Sustainability 2020, 12, 50*; doi:10.3390/su12010050.

[16] REMA (2021). Rwanda State of Environment and Outlook Report 2021. Rwanda Environment Management Authority Kigali, Rwanda

[17] RoR (2011). Green Growth and Climate Resilience. National Strategy for Climate Change and Low Carbon. Kigali, Rwanda.

Further recommended EbA solutions regarding soil preservation include[18]:

- Contour bank terraces in high-risk agricultural lands and contour banks in the forested area without ditches.
- Bench terraces in areas at high to extremely high risk.
- Grassed waterways for existing terraces which were made without waterways or with but no grasses which can cause severe gullies and destruction of bench terraces created.
- No-till agriculture for perennial crops on the extremely high-risk area
- Storm-water management facilities or water harvesting infrastructure in built-up areas.
- Bamboo plantations to close gullies or for riverside buffers.
- Afforestation in extremely high-risk areas as shown in mainly the western and northern parts of the country.
- Rainwater harvesting in settlements and storm-water infrastructure in urban areas.

[18] idem