



The State of Soil Erosion Control in Rwanda

Background

Soil erosion is the most serious environmental problem in many landscapes' areas in Rwanda. The main factors affecting the amount of soil eroded include land use and vegetation cover, topography, soil and climate. In order to identify areas at risk to soil erosion and to develop adequate erosion prevention measures for Rwanda, a National erosion risk map (Figure 1) was generated and validated in July 2018 based on a methodology known as "Catchment Restoration Opportunity Mapping (CROM)" - a spatial model developed by the government through the former Rwanda Water and Forestry Authority (RWFA). The CROM model identified six erosion risk classes, namely: (1) No risk, (2) Low risk, (3) Moderate risk, (4) high risk zones, (5) very high risk and (6) the extremely high-risk zones of erosion.

The erosion risk map shows only the potential soil erosion risk, but fails to show areas already protected against erosion or erosive features proofing the risk. This information gap makes it hard for the government to track the progress made to fight against erosion. Moreover, the plan for the future interventions becomes difficult because the erosion risk map shows only the potential risks while districts need to know where exactly the problem lies and is the appropriate measures to combat soil loss considering different land uses. Hence, to make the soil erosion risk map more informative and useful - for multi-scale planning and the decision-making process for sustainable management of land and water resources - it was deemed essential to take the erosion risk map into a ground truthing process using most recent World View images available at National Institute of Statistics of Rwanda (NSIR). Using World View images with a spatial resolution of 30 cm to 30 cm and applying visual image interpretation techniques and onscreen digitization of erosion risk areas already affected by erosive features (gullies, landslides, rill erosion etc.) and erosion control measures in place were identified and mapped and where such measures are lacking appropriate measures were recommended.

the district land) while Rutsiro district comes third with 48,143 hectares prone to erosion estimated at 73% of the district land. Other districts such as Karongi, Gakenke, Huye, Nyaruguru, Rulindo and Nyamagabe districts needs considerable attention as the risk accounts for more than 60% of the district land.

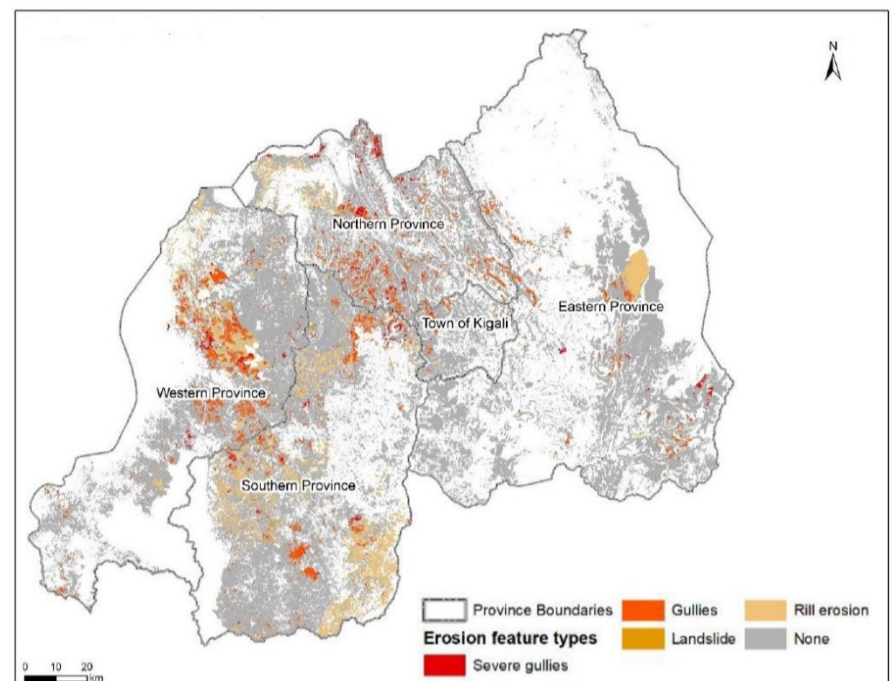


Figure 2: Erosion features in Rwanda

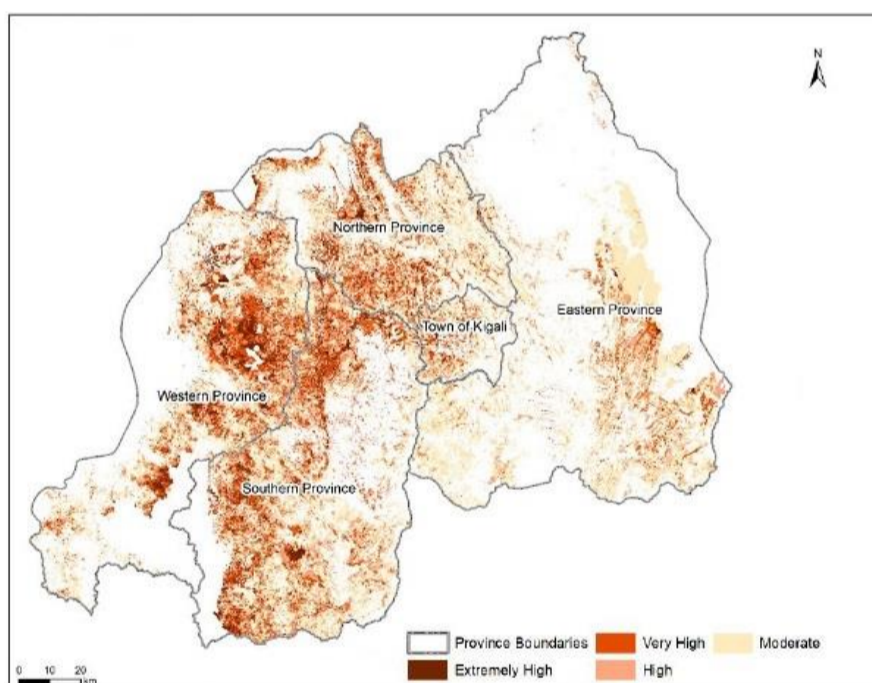


Figure 1: Erosion risk in Rwanda

In order to serve its purpose in sustainable land and water resources management, the erosion control mapping produces 5 thematic maps: 1) erosion risk distribution, 2) existing erosive features, 3) Land use and vegetation cover in high erosion risk areas, 4) existing erosion control techniques and 5) recommended erosion control practices in the view of unprotected land located at erosion risk. The data provided in this report will serve as benchmark for better monitoring of erosion control progress in Rwanda.

Erosive features in risk areas

The results of the erosion control mapping (Figure 2) shows that of the 30 districts of Rwanda, land under high erosion risk is about 1,080,168 hectares (45% of the total provinces land which is estimated to 2, 385, 830 hectares) of which 71 941 hectares (7% of the total risk areas) are at extremely high risk, 190, 433 hectares are at very high risk (18% of the total land at erosion risk), 300,805 hectares are at high risk (28% of the total risk identified), and 516,999 hectares (48% of the total land at risk) are at moderate risk. Ngororero District has the highest risk with a total of 58,003 hectares i.e. 85% of its land at high erosion risk. Muhanga district is ranked the second highest in erosion risk with 53, 352 hectares under risk (82% of

The observed erosive features in risk areas have shown that about 70,433 hectares (17% of the country land at risk) are affected by Gullies (39% of the affected land), severe gullies on 13,584 hectares (8% of the land-affected land), landslides on 2,823 hectares (2% of the affected land) and rill erosion (93,831 hectares, i.e. 52% of the affected land). The upper Nyabarongo is the worst affected with 45,961 hectares affected of which 28,123 hectares are affected by rill erosion, 14,337 hectares are affected by gullies, and 2,353 hectares are affected by severe gullies, while 1,148 hectares are affected by landslides. Kivu catchment area follows with 34,050 hectares affected of which 15,085 hectares are affected by rill erosion, 16,033 hectares are affected by gullies, 2,426 hectares are affected by severe gullies and 506 hectares affected by landslides.

Land Use and Vegetation Cover in area at risk

Land in the high-risk areas is mostly used for agriculture with seasonal crops accounting for 61% of the high-risk areas identified (Figure 3).

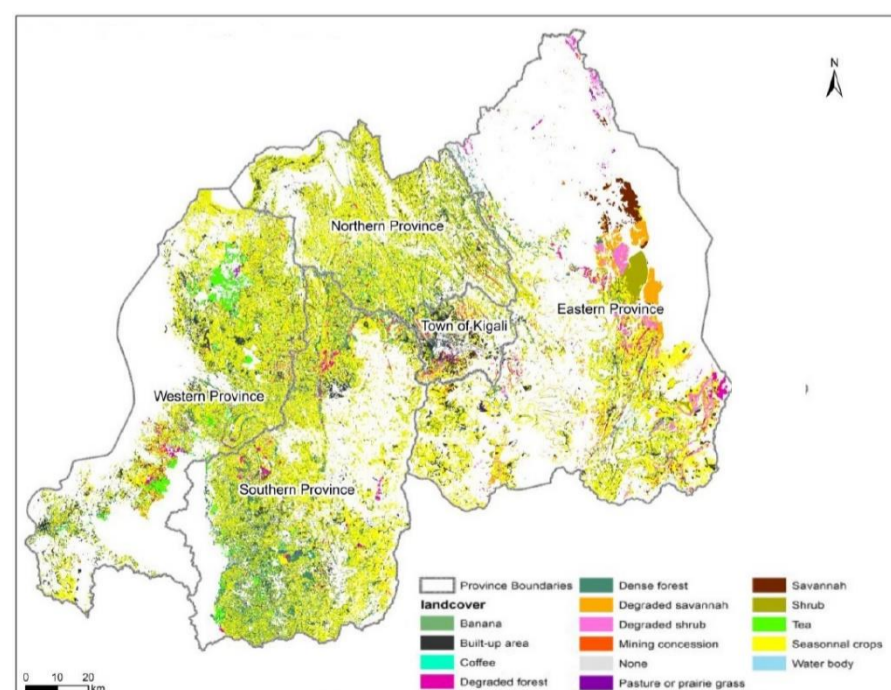


Figure 3: Land cover in areas at risk

Seasonal agriculture exposes soil to splash erosion and further detachment as land is not permanently covered. In fact, the crop management and cover factor (C) is very high for seasonal crops with conventional (regular) tillage. Forests with high canopy density occupy only 188,904 hectares (17% of the risky areas) while seasonal crops occupy 656,304 hectares (61%) and built-

up areas occupy 89,595 (8% of the land at risk). Others like banana, coffee, mining and quarry sites, and tea cover less than 2% each. This means that land will continue to be eroded if measures are not implemented.

Mining areas in high-risk zones account for 0.3%. Built-up area, although relatively small (8%), accelerates water velocity, runoff, and flow accumulation which creates severe gullies downstream. In such areas, storm-water management facilities, as well as the rainwater harvesting infrastructure, should be established to collect storm water from houses in agglomerated zones, while best practices in mining are also reinforced to stop dumping soil sediments from mining in rivers and streams as they fill the river beds or streambeds which in turn expose the river bank to erosion and flooding.

Efforts in controlling erosion in Rwanda

The proportion of land at erosion risk, which is currently protected, is very low (Figure 4). In fact, of 1,080,168 hectares of land at risk in all provinces, only 282,352 hectares are protected against erosion (26% of the country land at risk). Of this amount, 28,870 hectares are protected by contour bank terraces (progressive terraces) covering 10% of the land protected while forests protect about 190,011 hectares at risk (67 % of land protected). There are other practices like bench terraces (42,379 ha: 15%), hedgerows and shrubs (318 hectares), etc. About 797,816 hectares are not protected yet, which is about 74 % of the total country land at risk.

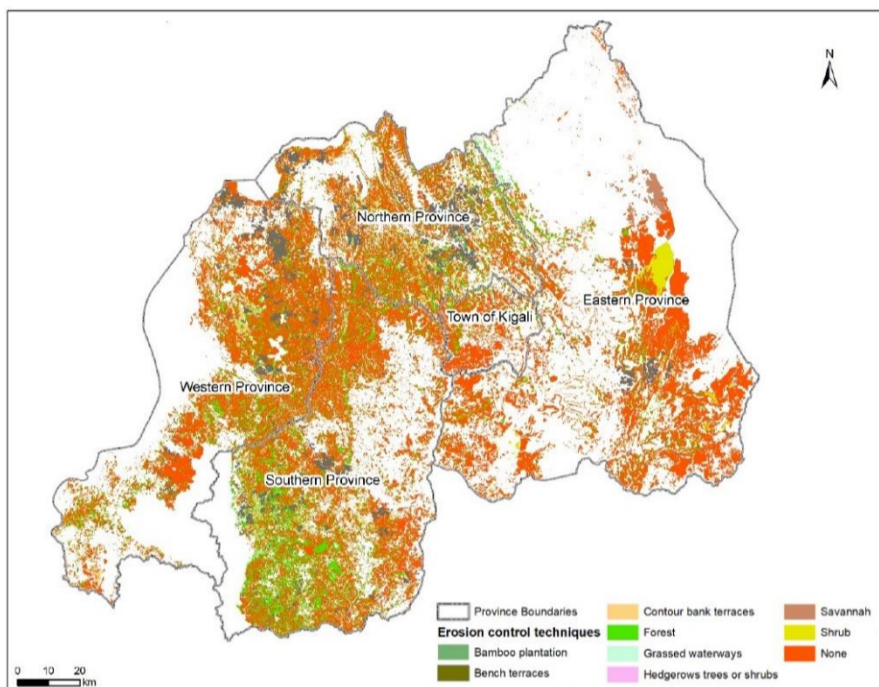


Figure 4: Erosion control measures in Rwanda

Recommended erosion control practices

Based on analysis and impacts from previous implementation of erosion control measures, the following recommendations were made:

- The contour bank terraces are recommended in high-risk agricultural lands while ditches in the forested area.
- Bench terraces are recommended in areas at high to extremely high risk where there has been started the bench terracing but which did not complete the entire area which is suitable for that recommendation.
- Grassed waterways are recommended for existing terraces, which was made without waterways or with, but no grasses can cause severe gullies and destruction of bench terraces created.
- No-till agriculture (zero tillage) is recommended for perennial crops on the extremely high-risk area while Storm-water management facilities (SWMF) or water harvesting facilities is recommended in built-up areas.
- Bamboo establishment is recommended to close gullies or to protect rivers. Forests (Afforestation or reforestation) are recommended in extremely high-risk areas.

Based on the erosion risk status for the country, contour banks terraces are required on 510,096 hectares (47% of the total country land at risk), while afforestation and reforestation are required on 39,901 hectares (4% of the country land at risk), Agroforestry and Hedgerows are required on 101,232 hectares (9% of the total country land at risk). Bamboo planting is required on about 14,915 hectares of land affected by gullies and on riverside. No-tillage agriculture is required on 43,552 hectares for perennial crops established on land at very high risk. Storm-water management facilities or water harvesting facilities are required in urbanized and settlement areas on about 89,679 hectares (8 % of the total land at risk).

Macroeconomic cost of soil erosion

- More than 745 thousand hectares of agricultural land in Rwanda are potentially eroded every year. Using a reference year of 2021A, above 3 million tons crop produces are estimated to be lost seasonally (6 million tons annually), of which 22 thousand tons of maize and 15 thousand tons of beans are estimated to be lost every season due to severe erosion. The total economic loss in agricultural productivity due to severe erosion in Rwanda is around 37.9 billion Rwandan francs (RWF) every season.

In term of GDP, in the first quarter of 2021, GDP at current market prices was estimated to be 2,579 billion RWF; agriculture sector contributed 27%, which is about 690 billion RWF. The crop productivity loss therefore translates into a loss of about 37.9 billion RWF (5.5%) of the agricultural sector contribution to Rwanda's GDP in the first quarter 2021.

- The national average for topsoil loss is approximately 25t/ha/year (27 million tons of top soil lost annually).
- Considering the market value of topsoil in Rwanda, a proxy for soil productive capability, which is between US\$34/ton (RwF30,000) and US\$57/ton (RwF50,000); the annual loss is therefore estimated to be RWf 810 billion on average, which is about one and half fold of what landscape restoration of the entire country would cost (RWf 513billion).
- Soil erosion removes the upper fertile part of soils that contains nutrients. considering that a ratio of soil carbon/nitrogen (C/N) ranges between 8 and 10 (an average ratio of 9) in arable land, one hectare (1ha) of agricultural field contains on average 2t C/ha/yr., and an amount of organic nitrogen is in the order of 0.2t N/ha/year. Considering 641,280 hectares affected by soil erosion and an average soil loss of 25t/ha/yr., it is estimated about 16Mt/yr. of soil displaced carrying about 1,282,560t C and 128,256t N loss per year.
- In order to compensate soil nutrient loss and improve land productivity, urea and di-ammonium phosphate (DAP) is applied. In the substitution of Nitrogen loss with urea, with an average price of RWf 564,000/t, it would cost a total RWf 72 billion per year to Rwandan farmers.

Cost and benefits of erosion control actions

- The total cost of erosion control actions is estimated to 514 billion Rwandan francs of which 323 billion are for protection of agricultural land against soil erosion (about 60% of the total risk areas) using bench terraces, contour bank terraces known as progressive terraces and agroforestry and hey plantation on contour banks. This requires about 8 years from 2022 to 2030 to complete the activity by investing at least 42 billion RWf every year to protect agricultural land against excessive erosion using community approach.
- In doing so, we would cut the productivity losses and therefore raise additional agriculture contribution to about 5.5% GDP that are lost every season as a consequence of inaction.
- However, because soil erosion itself is a symptom of poor land management, erosion control measures alone will remain insufficient to improve the management of land and water resources given the current agricultural land uses and related management. There should be a switch of emphasis to focus on the promotion of a high-quality integrated land management system rather than stand-alone erosion control measures in agricultural land.
- High quality land management could be achieved through an integrated conservation agriculture approach that provides profitable agricultural yields, while minimizing environmental damage. Rainwater harvesting in settlements and storm-water infrastructure in urban areas also has the potential to address accelerated erosion and other problems resulting from rainfall run-off across the country.

Conclusion

- Erosion and sedimentation problems remain a critical challenge for socio economic development in Rwanda
- Implementing erosion and Sediment control measures needs to be upscaled and prioritized at all levels from the local community level to national scales
- Developing national awareness and enhancing capacity of local communities to implement erosion control measures must be prioritized. Developing erosion control guide for local government and community participation

The full report for this assessment can be found at www.iucn.org