Republic of Rwanda

Forest Landscape Restoration Opportunity Assessment for Eastern Province of Rwanda

FLR Implementation strategy (2024 – 2029)

IUCN

AREECA

On behalf of
Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety
of the Federal Republic of Germany

TREPA
Transforming Eastern Province through Adaptation

GREEN CLIMATE FUND

Forest Landscape Restoration Opportunity Assessment for Eastern Province of Rwanda

And

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This Eastern Province Landscape Restoration Strategy has been prepared by the International Union for Conservation of Nature (IUCN) in collaboration with Rwanda Forestry Authority and Districts under TREPA and AREECA projects funded by the Green Climate Fund (GCF)

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List of Abbreviations and Acronyms

AFR100	African Forest Landscape Restoration Initiative (for restoring 100 million hectares of land in Africa
AREECA	Alliance for Restoration of Forest and Landscape Ecosystems in Africa
AUDA-NEPAD	African Union Development Agency - New Partnership for Africa's Development
DEM	Digital Elevation Model
FAO	Food and Agriculture Organization of the United Nations
FGD	Focussed Group Discussion
FLR	Forest Landscape Restoration
GHGs	Green House Gases
GIS	Geographic Information Systems
IUCN	International Union for Conservation of Nature
LULC	Land Use Land Cover
NGO	Non-Governmental Organisation
NPV	Net Present Value
PES	Payment for Ecosystem Services
REDD+	Reducing Emissions from Deforestation and forest Degradation
ROAM	Restoration Opportunities Assessment Methodology
RUSLE	Revised Universal Soil Loss Equation
SOC	Soil Organic Carbon
SRTM	Shuttle Radar Topography Mission
TREPA	Transforming Eastern Province through adaptation
WRI	World Resources Institute

Executive summary

Rwanda's forest landscapes are important locally, regionally and globally by virtue of diverse environmental services they provide. In its updated Nationally Determined Contribution (NDC) 2020-2030, Rwanda has committed to increasing and maintaining its forest cover at 30% of national land area and reducing emissions across all sectors of its economy. The country has established a national climate fund (FONERWA) as a strong commitment to support all efforts that lead to mitigation and adaptation to climate change in order to build a resilient nation and sustainable economy.

However, the country continues to face deforestation and land degradation due to high population pressure in the search of biomass energy and forest conversion to other land uses, coupled with climate change effects. This pauses a threat to both the functioning of ecosystems and the well-being of communities.
To reverse the aforementioned drivers of degradation in Eastern landscapes and accrue the multiple benefits that come with functional landscapes, Rwanda made a commitment to restore about 2 million hectares of deforested and degraded land, a pledge towards the Bonn Challenge which is a global effort intended to restore 350 million hectares of the World's deforested and degraded land by 2030 of which 100 million hectares are in Africa. In line with these commitments, International Union for Conservation of Nature (IUCN) in collaboration with Rwanda Forestry Authority (RFA), through The Alliance for Restoration of Forest Landscapes and Ecosystems in Africa (AREECA) and, TREPA is implementing a Large-scale Forest Landscape Restoration and climate adaptation programmes in Eastern Province. The project is expected to restore about 25,000 hectares by 2025.

In order to identify deforested and degraded lands in Eastern Province, the project used the Restoration Opportunities Assessment Methodology (ROAM). ROAM uses geospatial techniques to quantify the restoration opportunity areas, and rapid restoration diagnostic approach to identify restoration options that offer multiple benefits. The entry point consists of understanding the landscape challenges, degradation drivers, define the restoration objectives and identify suitable restoration interventions that could reverse the degradation and accrue multiple benefits including livelihoods. The restoration interventions are selected based on economic and financial analysis and the best restoration options are those with a positive Net Present Value (NPV) and competitive return on investment at a pre-defined discount rate and a time period of production. Rapid restoration diagnostic appraisal is also used to assess the success factors of restoration implementation as well as determine enabling institutional and policy conditions for the sustainability of restoration investments. Key findings are summarized as follow:

Landscape challenges

Land degradation in Eastern Province is mainly characterised by

Current state on forest landscape degradation

Restoration interventions and opportunity areas

Economic and financial Analysis

The restoration assessment also covers the economic and financial analysis to estimate the costs and benefits of restoring degraded land. A model of each land use and restoration intervention is created by combining the results from the ecological modelling with market prices and an enterprise budget to account for the direct and indirect financial costs of restoring land. Selected FLR interventions are profitable with a positive NPV and favourable return on investment at a discount rate of 7.5%.

Enabling Environment for EP-FLR implementation strategy

1. Introduction

1.1. Background

The Eastern Province is the driest region of Rwanda and prone to a high level of degradation leading to poor land productivity. Agriculture is practiced by the majority of the population. Increased frequency and magnitude of recurrent droughts and floods, and more erratic precipitation, both caused by climate change, are resulting in degraded lands, stressed food insecurity levels for poor households negatively impacting their livelihoods, and loss of biodiversity.

In order to deal with these issues and make the eastern province more resilient, the International Union for conservation of Nature (IUCN) in collaboration with Rwanda Forestry Authority (RFA) is leading the implementation of a project dubbed Large-scale Forest Landscape Restoration (FLR) in Africa (AREECA), which aims at increasing the economic, ecological, and climate-related benefits in Kirehe and Nyagatare Districts in Rwanda. At Africa level, the programme focuses on the development of participatory FLR interventions and implementation in selected areas in the partner countries. The project prepares additional areas for FLR interventions by implementing further measures, obtains further FLR funding, improves knowledge management and strengthens South-South exchanges, including impact monitoring and capacity building.

The programme was commissioned by German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) as an IKI collaborative project and implemented jointly with collaborative partners under the leadership of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. The partners include the African Union Development Agency (AUDA-NEPAD), the Food and Agriculture Organization of the United Nations (FAO), the International Union for Conservation of Nature and Natural Resources (IUCN), the World Resources Institute (WRI), the World Bank Group and the World Wide Fund for Nature (WWF).

Within the same framework, GCF and IUCN have signed an other funding agreement for the project “Transforming Eastern Province through adaptation” (TREPA) with a GCF contribution of $ 33,783,755 and an additional $ 15,839,042 mobilized as co-financing from the Government of Rwanda and other Project Executing Entities. The implementation of the six-year investment is jointly executed by IUCN in collaboration with Government of Rwanda through Rwanda Forestry Authority (RFA), Enabel, the Belgian development agency, as Executing Entities with other partners including ICRAF, World Vision, and the CORDAID International. The overall goal of this TREPA project is to transform the drought-degraded Eastern province into restored, productive and climate-resilient ecosystems and communities through promoting best forestry and agroforestry practices. The project intends to restore over 60,000 ha of drought-degraded landscapes into climate resilient ecosystems through re-forestation, agroforestry, restoration of pasturelands, and erosion control measures in seven districts of the Eastern Province of Rwanda, namely Bugesera, Kayonza, Kirehe, Gatsibo, Ngoma, Nyagatare and Rwamagana districts.

In particular, the TREPA will contribute to the rehabilitation of approximately 6,545 ha of degraded smallholder forests and their sustainable management under PFMU approach

(Private Forests Management Units). The project will develop climate resilient markets and supply chains to incentivize public and private investments in forests, increase the capacity of communities to renew and sustainably manage forests and agroforestry resources, and support smallholder farmers to adopt climate-resilient agriculture. The agriculture value chains that face key constraints at different stages will be supported. It will also promote improved clean and efficient cooking energy technologies to more than 100,000 households in the Eastern Province of Rwanda.

The project will finally support the national and local institutions to effectively plan, manage and monitor climate adaptation outcomes from improved land use at national and decentralized levels. In this framework, TREPA supported the elaboration of FLR strategy spanning the period of a second edition of the national strategy for transformation (NST2). In orde to elaborate a sound strategy build on the current situation, an assessment of restoration opportunity was carried out using ROAM methodology earlier developed by IUCN and WRI in 2014.

1.2. What is Forest Landscape Restoration (FLR)?

Forest Landscape Restoration (FLR) is defined as a process that aims to regain ecological functionality and enhance human well-being in deforested or degraded landscapes. FLR is not an end in itself, but a means of regaining, improving, and maintaining vital ecological and social functions, in the long-term leading to more resilient and sustainable landscapes.

1.2.1. FLR guiding principles

Box 1. FLR guiding principles[1]

Focus on landscape. FLR takes place within and across entire landscapes, not individual sites, representing mosaics of interacting land uses and management practices under various tenure and governance systems. It is at this scale that ecological, social and economic priorities can be balanced

Engage stakeholders and support participatory governance. FLR actively engages stakeholders at different scales, including vulnerable groups, in planning and decision making regarding land use, restoration goals and strategies, implementation methods, benefit sharing, monitoring and review processes.

Restore multiple functions for multiple benefits. FLR interventions aim to restore multiple ecological, social and economic functions across a landscape and generate a range of ecosystem goods and services that benefit multiple stakeholder groups.

Maintain and enhance natural ecosystems within landscapes. FLR does not lead to the conversion or destruction of natural forests or other ecosystems. It enhances the conservation, recovery, and sustainable management of forests and other ecosystems.

Tailor to the local context using a variety of approaches. FLR uses a variety of approaches that are adapted to the local social, cultural, economic and ecological values, needs, and landscape history. It draws on latest science and best practice, and traditional and indigenous

[1] Besseau, P., Graham, S. and Christophersen, T. (eds.), 2018. Restoring forests and landscapes: the key to a sustainable future. Global Partnership on Forest and Landscape Restoration, Vienna, Austria.

knowledge, and applies that information in the context of local capacities and existing or new governance structures.

Manage adaptively for long-term resilience. FLR seeks to enhance the resilience of the landscape and its stakeholders over the medium and long-term. Restoration approaches should enhance species and genetic diversity and be adjusted over time to reflect changes in climate and other environmental conditions, knowledge, capacities, stakeholder needs, and societal values. As restoration progresses, information from monitoring activities, research, and stakeholder guidance should be integrated into management plans.

1.2.2. The Benefit of FLR

Investing in restoration brings many economic benefits, both direct and indirect. For example, restoration creates jobs on the land and in tree nurseries; farms and timber industries can enjoy higher and more sustainable yields; and the costs of repairing flood damage to infrastructure, dredging lakes and rivers to remove silt, and of filtering drinking water are avoided. In agricultural lands, adding trees agroforestry brings benefits including enhanced productivity and soil fertility, erosion control, shade and fodder. In forests, restoration can mean improving the availability of forest products from timber to game animals, stabilizing drinking water supplies for burgeoning cities, and countering biodiversity loss.

By one estimate, restoring 350 million hectares of degraded and deforested lands around the world would create up to $9 trillion in net benefits[2]. Many would accrue to poor rural communities, helping alleviate poverty. The wider benefits include social and environmental gains in water and food security, biodiversity conservation and climate protection that help us all. Restoration and other natural solutions could, for instance, offer more than one third of the solution to the climate crisis. Investments in natural climate solutions are also safer, less costly and more beneficial to society than many technological alternatives that are currently being discussed[3].

1.3. Overview of the Eastern Province of Rwanda

[2] Verdone, M. and Seidl, A., 2017. Time, space, place, and the Bonn Challenge global forest restoration target. Restoration Ecology, 25: 903-911

[3] Griscom, B.W., et al, 2017. Natural climate solutions. Proceedings of the National Academy of Sciences. Oct 2017, 201710465.

Table 1. Socio-economic and Land Use characteristics of Eastern Province

Socio-economic & Indicators	Bugesera	Rwamagana	Kayonza	Gatsibo	Nyagatare	Ngoma	Kirehe	EP (% to National)	National
Size (Km^2)								9,813 (37%)	26,338
LU=Forests (Km^2)									
LU=Agriculture (Km^2)									
LU=residential (Km^2)									
Total Population[4] (inhab.)	551,103	484,953	457,156	551,164	653,861	404,048	460,860	3,563,145 (26.9%)	13,246,394
Population density (inhab/Km^2	450	740	338	435	373	498	398	433	503
Male	271,468	243,794	221,448	264,461	318,740	192,720	221,763	1,734,394 (26.9%)	6,429,326
Female	279,635	241,159	235,708	286,703	335,121	211,328	239,097	1,828,751 (26.8%)	6,817,068
Urban population	221,227	180,056	65,071	55,351	157,894	37,297	29,039	745,935 (20%)	3,701,245
Rural population	329,876	304,897	392,085	495,813	495,967	366,751	304,897	2,817,210 (29.5%)	9,545,149
Total Households[5]	137,777	121,051	114,186	136,208	160,435	102,589	113,886	886,132 (26.7%)	3,312,743
Labor force[6] (>16)	120,669	153,947	156,580	188,212	169,192	123,962	122,654	1,035,216 (23%)	4,463,296
- Employment	92,044	123,759	131,666	145,820	136,485	104,590	102,948	837,312 (24%)	3,546,352
- Unemployment	28,625	30,188	24,914	42,392	32,707	19,372	19,706	197,904 (21.5%)	916,944
Outside labour force[6]	101,882	131,172	159,255	125,323	148,586	85,737	109,528	861,483 (25%)	3,500,290

[4] National Institute of Statistics (NISR), Fifth Rwanda Population and Housing Census, 2022.
[5] National Institute of Statistics (NISR), Fifth Rwanda Population and Housing Census, 2022, Districts Profiles
[6] National Institute of Statistics of Rwanda (NISR), Labour Force Survey, 2022

Table 2. Employment by gender and branch of economic activity in Eastern province[7]

Economic activities in which people are employed (source of livelihoods)	Total	Male	Female	Rwamagana	Nyagatare	Gatsibo	Kayonza	Kirehe	Ngoma	Bugesera
Employed population 16 years old and over	837,313	469,687	367,625	123,759	136,485	145,820	131,666	102,948	104,590	92,044
Agriculture, forestry and fishing	499,079	247,845	251,234	58,987	93,672	101,665	85,108	72,817	55,372	31,458
Mining and quarrying	2,938	2,569	369	911	0	304	0	610	155	958
Manufacturing	34,406	20,964	13,442	4,859	6,274	2,419	6,160	4,204	6,351	4,138
Electricity gas stream and air conditioning supply	464	464	0	0	0	0	0	0	0	464
Water supply, gas, and remediation services	940	940	0	0	232	0	0	0	708	0
Construction	70,992	61,627	9,365	10,895	10,454	9,677	9,046	6,682	9,523	14,715
Whole sale and retail trade; repair of motor vehicles and motorcycles	69,377	29,870	39,507	12,351	7,531	10,550	5,551	5,771	13,587	14,037
Transportation and storage	35,038	34,298	740	9,104	4,259	5,286	4,366	2,802	3,530	5,692
Accommodation, and food services activities	12,382	6,412	5,970	1,779	1,065	1,956	3,077	296	1,691	2,517
Information and communication	464	0	464	0	0	0	0	0	0	464
Financial and insurance activities	3,285	725	2,560	1,093	0	476	0	364	0	1,351
Professional, scientific and technical activities	3,565	2,003	1,562	1,923	0	0	512	589	541	0
Administrative and support activities	13,490	10,390	3,099	2,915	2,352	2,518	1,601	418	2,741	945
Public administration and defense; compulsory social security	12,286	9,117	3,170	2,388	797	2,207	1,184	1,051	1,876	2,784
Education	34,795	18,419	16,376	6,364	3,829	5,415	7,481	5,300	3,788	2,620
Human health and social work activities	3,291	1,259	2,032	999	186	476	596	0	252	784
Arts, entertainment and recreation	1,391	659	732	0	732	0	0	0	157	502
Other services	21,633	13,500	8,133	3,771	2,653	1,543	6,314	883	2,374	4,095
Activities of households as employers	16,482	7,852	8,631	4,643	2,451	1,329	672	1,162	1,708	4,519
Activities of extraterritorial organizations and bodies	1,013	776	237	776	0	0	0	0	237	0

[7] National Institute of Statistics of Rwanda (NISR), Labour Force Survey, 2022

1.4. Restoration Opportunities identified by the National ROAM for Eastern Province

The national ROAM identified five broad restoration interventions and opportunity areas that could be used to improve the ecological and economic productivity of degraded land uses are: 1) Agroforestry on steep sloping land in conjunction with other soil conservation measures such as radical and progressive terracing 2) Agroforestry on flat or gently sloping land, including those areas principally managed as pasture and rangelands 3) Improved silviculture and rehabilitation of existing, sub-optimally managed woodlots and plantations, including very small (<0.5ha)areas, 4) Protection and restoration of existing areas of natural forests, mainly in or around protected areas but also extending to small isolated fragments, 5) Establishment or improvement of protective forests on important and sensitive sites such as ridge tops with steep (20-55%) and very steep sloping land (>55%), riparian zones and wetland buffer zones and margins[8].

Table 3. Eastern Province restoration opportunities earlier identified by the National ROAM (2014)

Restoration interventions	National	Eastern Province	Percentage (%)
Agroforestry on steeply sloping land (Ha)	705,162	272,723	38.7%
Agroforestry on flat and gently sloping land (Ha)	405,314	231,855	57.2%
Improve management of existing woodlots (Ha)	255,930	32,816	12.8%
Improve management of existing timber plantations (Ha)	17,849	1,214	6.8%
100m buffer of closed natural forest (Ha)	3,456	557	16.1%
Restore degraded forest in parks/reserves (Ha)	10,477	-	-
Protective forests on ridgetops with very steep slopes (>30°/55%) (Ha)	10,745	462	4.3%
Protective forests on ridgetops with steep slopes (12-30°/20-55%) (Ha)	31,695	5,702	18.0%
20-m riparian buffer – replace eucalyptus with native species (Ha)	3,152	151	4.8%
20-m riparian buffer – reforest non-forested areas (Ha)	19,586	3,861	19.7%
50-m buffer of wetland perimeters (Ha)	57,362	23,337	40.6%

[8] The Ministry of Natural Resources, Rwanda (2014). Forest Landscape Restoration Opportunity Assessment for Rwanda, MINIRENA, IUCN, WRI. ISBN: 978-2-8317-1712-8

2. Application of ROAM methodology

The Restoration Opportunities Assessment Methodology (ROAM) is an approach that was developed by IUCN and the World Resources Institute (WRI) to guide the processes of developing forest restoration interventions at the landscape level. It is a stepwise and iterative application of a series of analyses used to identify the best set of Forest landscape restoration (FLR) opportunities applicable to a specific geographic area.

Implementation of ROAM requires a systematic and rigorous assessment and quantification of restoration opportunities available in the target landscapes. The first step is to identify the main environmental challenges in the assessment area leading to landscape degradation and identify the drivers of degradation, identify site-specific priorities, and landscape intervention options available in the landscape. ROAM uses geospatial, economic, and rapid restoration diagnostic analyses to map, quantify, and assess the restoration potential, cost and benefits, and institutional readiness and success factors of restoration in place. The implementation of ROAM requires a set of fields of knowledge and expertise ranging from GIS, Agricultural and environmental sciences, REDD+ and carbon market, ecosystem services modelling and valuation, economics, and policy analysis. The flow diagram (Figure 1) summarises the ROAM process and workflow.

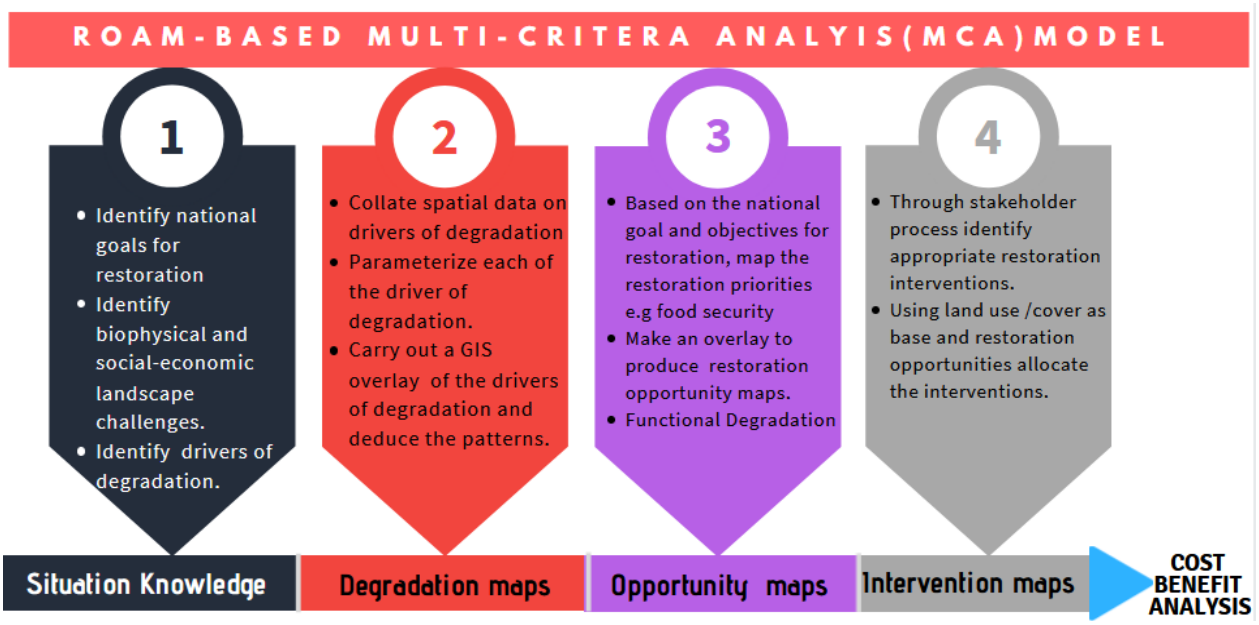


Figure 1. Restoration Opportunities Assessment Methodology (ROAM) and workflow

2.1. Stakeholder consultations

The primary data collection was carried out through field focus group discussions with the communities and key informants in the villages, and stakeholder workshops held in each landscape. Guiding questions were set to guide the discussion in the three thematic working groups (GIS and Monitoring Working Group, Social-economic Working Group, Policy and Governance Working Group). Three main stakeholder workshops held in each landscape were critical for ROAM. Detailed primary data continued thereafter at the field, visiting and meeting local communities in various villages within the landscape in order to collect the view of communities around restoration objectives. The primary data were supplemented by a desk review of baselines, reports, project documents, available policy documents.

Figure 2: Stakeholder consultations in plenary discussions at District level

Blending local and scientific knowledge in a ROAM process is critical not only to create restoration ownership among the land owners/users but also to validate scientific observation and or results. Using FGDs communities were engaged in identifying landscape challenges and defining restoration strategies and transitions. The local knowledge is used to build a restoration theory of change, that critical in geospatial multi-criteria analysis and defining restoration strategies and transition. A summarised ROAM questionnaire was then used to gorge critical local knowledge from communities.

2.2. Geospatial analysis

2.2.1. Mapping land degradation

Land degradation is defined as the long-term loss of ecosystem function and productivity caused by disturbances from which the land cannot recover unaided (Bai and others 2008). Land degradation occurs slowly and cumulatively and has long lasting impacts on rural people who become increasingly vulnerable (Muchena 2008). In line with the ROAM protocols, Forest Landscape Restoration uses land degradation as an entry point to restoration where drivers of degradation are identified to map out degradation hotspots and consequently the priorities. In what is referred to as multi-criteria degradation mapping, drivers of degradation are parametrized and stacked together to generate a map showing the number of coincident criteria.

Using local knowledge and ground control mapping, overlapping criteria are reclassified to generate the final degradation map showing the degradation scale from very low to severe degradation. In this assessment, eight drivers of degradation were identified through a stakeholder consultation process. By stacking their GIS layers (parameterized layers at a

standard resolution of 50 m) together, a multicriteria degradation map was generated. The resulting map comes with coincident criteria, which are then reclassified/calibrated using local knowledge and field observations. Table 4. below shows details of the drivers of degradation including justification, GIS proxies, and parameters used.

Table 4. Drivers of degradation and GIS data proxies (Joseph and Lamek to update)

Driver	Description/justification	Spatial proxy/data & source	Parameters
Bare land	Bare lands are usually susceptible to soil erosion and loss of soil nutrients. This could be associated with human activities leading to vegetation cover loss. Such activities may include; mining, infrastructure, and development.	Land cover data. (2020 Global European Space Agency)	Bare land areas as observed in the LULC data.
Slope	According to FAO, runoff evacuation system on slopes of more than 20%, removes particles of all sizes (up to 5 or 10 mm in diameter) and digs out grooves, so that the soil surface becomes extremely uneven, with deep rills (5-20 cm) and numerous humps chiselled by rain and runoff and protected by objects such as seeds, roots, leaves, bits of pottery and even hardened or crusted clouds (Eric Roose, 1996)	30M SRTM from U.S. Geological Survey	Slope>20%
Low soil organic carbon	Soil Organic Carbon (SOC) is important in soil formation. Low soil carbon usually translates to low soil fertility and loss of biodiversity. Soil carbon is important in soil formation. Low soil carbon usually translates to low soil fertility and loss of biodiversity. (FAO 2017:Soil Organic Carbon has hidden Potential) COP21 resolutions recommended 4millie (48 tonnes/ ha) of carbon.	Soil carbon (15-30cm depth) data from ISRIC	SOC < 48 tonnes/ Ha
Low tree cover	Low tree cover may lead to soil loss and consequently low soil productivity.	Hansen/GFW data 2020	Tree cover<10%
Forest Loss	Forest loss is a physical indication of forest cover degradation/depreciation.	Hansen/GFW data 2020	Forest loss areas
Soil Erosion	Some soils are naturally prone to soil erosion due to their physical and chemical composition. (Bonilla and Johnson 2012)	Global EU soil erosion data and IUCN InVEST Model, 2020.	As observed in the RUSLE map scale. (> 40 tonnes/ ha/Year)
Populated areas/Built up areas/Settlement	Areas with higher population pressure in comparison to others in a landscape are likely to face degradation due to increased demand for natural resources. (Bai et al. (2008), Tiffen et al.1994, Boserup1965,Grepperud 1996)	Land cover data. (2020 Global European Space Agency)	Built up areas

2.2.2. Mapping restoration opportunities

In the context of the restoration's multiple benefits, and identifying priority areas of restoration, ROAM geospatial protocol requires that degradation hotspots be plummeted through each restoration objective to produce functional degradation maps, which upon their overlay produces an overall opportunity map. Further, the opportunity hotspots in the assessment were defined as areas with more than half the number of coincident criteria. Each restoration objective was mapped using GIS proxies indicate where such an objective would be achieved. While each objective might have different mapping proxies in a different context, FLR focuses on critical proxies that provide leads to areas satisfying the in a given restoration objective.

There are six FLR objectives used in this assessment and as and agreed upon through stakeholder consultation. These are; biodiversity conservation, resilience to climate change, improved food security, increased water yield, soil erosion control, and increased carbon sequestration. Food security was spatially defined as water-stressed croplands where low rainfall and soil water capacity are leading factors. Finding local continuous raster data on rainfall was difficult and so Worldclim data was used. Croplands were extracted from the LULC data (2020 Global European Space Agency).

Figure 3 below summarises the workflows used in developing the aforementioned maps that a critical in landscape restoration:

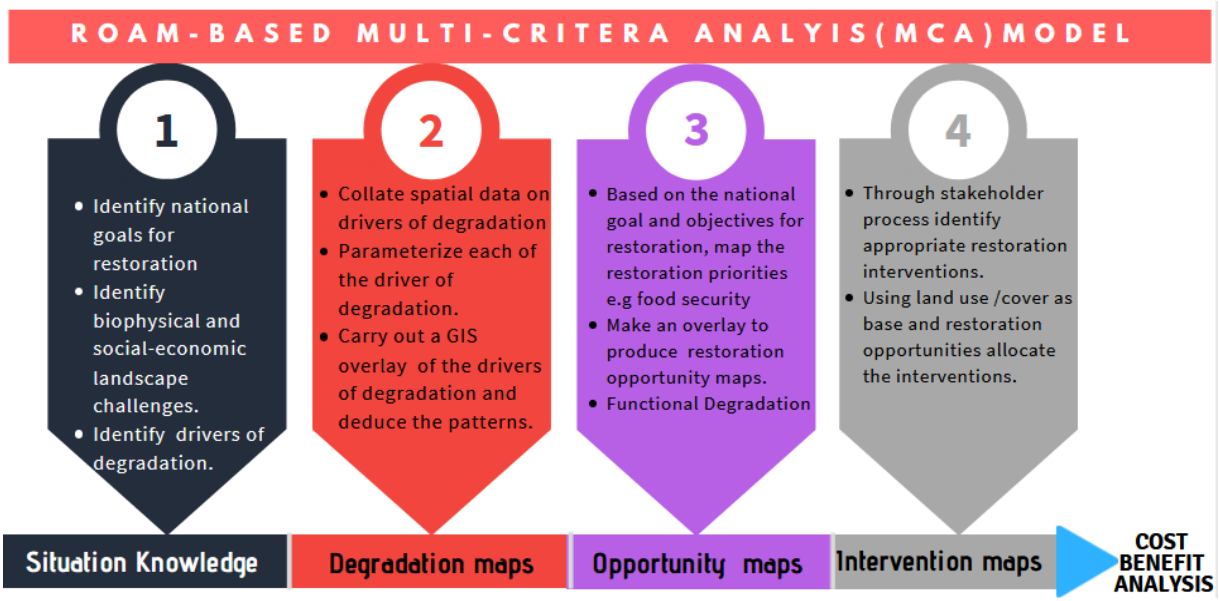


Figure 3. ROAM-based Multi-Criteria Analysis workflow

2.2.3. Ecosystem service modelling

Ecosystems services are central in defining restoration pathways. More often, they consequently define restoration objectives when it comes to accruing restoration multiple benefits such as water yield, soil erosion control, soil fertility, clean air and so on. To quantify them, their InvEST[9] models are run to generate spatially explicit data for restoration prioritization. Ecosystem services considered in this assessment are; carbon, sediment delivery ratio, and annual water yield. Key input data for the three models are shown in Table 5 below.

[9] https://naturalcapitalproject.stanford.edu/software/invest

Table 5. InVEST models input data: Carbon, sediment Delivery Ratio, and Annual Water Yield (Joseph & Lamek)

Ecosystem Service	**Input data**	**Source**	**Data Resolution**
Carbon	Land cover	2020 Global European Space Agency	20m
	Carbon pools/biophysical table	InVEST Guide	-
Sediment Delivery Ratio (SDR)	Land cover	2020 Global European Space Agency	20m
	Digital Elevation Model (DEM)	Shuttle Radar Topography Mission (SRTM)	30m
	Rain Erosivity	Resampled WorldClim data	100m
	Soil erodibility (K)	Wischmeier and Smith, 1978	100m
	Watersheds	Calibrated hydrosheds using the 30m DEM	-
	Biophysical table	InVEST Guide	-
Annual Water Yield	Land cover	2020 Global European Space Agency and	20m
	Rain Erosivity/Precipitation	Resampled WorldClim data	100m
	Evapotranspiration	International Soil Reference and Information Centre (ISRIC)	250m
	Plant Available Water	International Soil Reference and Information Centre (ISRIC)	250m
	Depth to root restriction	International Soil Reference and Information Centre (ISRIC)	250m
	Watershed and sub-watershed	Calibrated hydro sheds using the 30m DEM	-

2.2.4. Mapping restoration interventions

For each of the proposed interventions, a spatial criteria matrix is set to optimize landscape suitability. The design of the restoration package informs both the number of criteria and the parameters used to define their spatial extent. In this assessment, the spatial definition of each intervention (and consequently GIS mapping layers) is drawn from National ROAM (2014) that provides a set of criteria for mapping various opportunities/interventions including rangeland management, agroforestry, the restoration of degraded natural forest etc. In an effort to inform decisions on prioritization, both potential and priority areas are indicated in the mapping process. Priorities are further set by multiplying each intervention with restoration opportunities so that their

implementation assures multiple benefits.

2.3. Economic and financial analysis

The objective of the economic and financial analysis is to calculate the costs and benefits of the restoration interventions identified and use them in return-on-investment (ROI) and policy frameworks to addresses four questions: (1) What are the estimated returns on investment of restoration interventions from the perspective of private landowners? (2) Based on the distribution of private and public benefits produced by intervention that occur on private land, what policies can be used to encourage private landowners to restore degraded land? (3) Where are these opportunities to invest in the restoration value chain? (4) Which restoration interventions store the most carbon for the largest benefit and at lowest cost?

2.3.1. Cost and benefit analysis (CBA)

The economic analysis used cost-benefit analysis (CBA) to assess the contribution of restoration interventions. CBA is an economic evaluation method where benefits and costs of interventions are identified, measured (normally in monetary terms) and compared to determine whether the benefits of an intervention exceed its costs (EFCCC, 2019; IUCN, 2018b). CBA is used to determine whether an intervention is economically justified (Nurmi & Ahtiainen, 2018), and can also be used either to rank projects/interventions or to choose the most appropriate option. The ranking or decision is based on expected costs and benefits (Saarikoski et al., 2016)
To understand the real profitability of the different proposed restoration interventions, the CBA compared the costs and benefits from implementing restoration actions in Eastern province of Rwanda. This analysis was limited to financial analysis to demonstrate the benefits from different restoration processes to attract private investors.

2.3.2. Net Present Value –NPV

The net present value is the difference between the sum total of the present value of discounted benefits and the discounted value of costs over a specific life period of a project or intervention (Krieger, 2001). The NPV allow various sums of money to be compared over time by discounting values that occur in the future so they are comparable with the current values. The first principle of NPV reflects the fact that usually people prefer money in the present than money that comes in the future. Hence, future cash flows are discounted each year and the discount rate represent the opportunity cost of the capital mobilized. The second principle of NPV is to consider all the future net cash flows linked to the project intervention opportunity. The formula for the NPV is as follows (Balana et al., 2012):

$$\left[NPV = \sum_{t=0}^{n} \frac{B_t}{(1+i)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+i)^t}\right] eq.1$$

Where: NPV: Net Present Value; Bt : Benefit at time t ; Ct: Costs at time t ; i: Discount rate t: Time in years (1,2,…n)

2.3.3. Benefit-Cost Ratio

The benefit-cost ratio is the total discounted benefits divided by the total discounted costs. It is another decision rule, which is, in effect, another way of comparing the present value (PV) of project's cost with the present value of its benefits. The BCR formula is as follows (Litman, 2009):

$$BCR = \sum_{t=0}^{n} \left(\frac{\frac{B_t}{(1+i)^t}}{\frac{C_t}{(1+i)^t}} \right) \quad eq.2$$

Where: Bt = the benefit at time t, Ct = the cost at time t, i = the discount rate, t = time in year, n= number of years over which the future costs or benefits are expected to occur (the current year t being year 0).

2.3.4. Return on Investment

Return on investment (ROI) is a measure that investigates the amount of profits produced per unit of a certain investment. It can be used to compare different scenarios for investments. This ROI calculates the amount of value that was generated from every Rwandan Francs invested in restoration activities, where the total cost in year 1 is considered the investment. The formula is as follows (Moore, Boardman, Vining, Weimer, & Greenberg, 2004):

$$ROI = \left(\sum_{t=0}^{n} \frac{B_t}{(1+i)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+i)^t} \right) \Big/ \sum_{t=0}^{n} \frac{C_t}{(1+i)^t} \quad eq.3$$

2.3.5. Sensitivity analysis

Sensitivity analysis is used to examine the results to changes of model parameters to assess the robustness of the analysis (Saarikoski et al., 2016). In a sensitivity analysis, critical components or inputs in the calculations should be changed and the results recalculated to determine how much the results vary, that is, how sensitive the results are to changes in these inputs (Phillips et al., 2003). Like other investments, investing in forest landscape restoration is not risk free. Investments are subject to changes in ecological and economic situations. Therefore, the cost and benefit streams of restoration transitions are subject to changes in variables such as market prices of crops or crop yields, as well as the discount rates. For the first NPV a 7.5%, which is the current public discount rate, was used. To evaluate the sensitivity to the discount rate, rates of 3%, 7.5%, 15% and 25% were used to recalculate NPVs and assess how sensitive the results were to different discount rates. Also included were the maximum and minimum yields from crops to assess how sensitive the results were to changes in yields. With these maximum and minimum prices and yields an optimistic (high price and high yield) and a pessimistic (low price and low yield) scenario were created to provide a range of NPV estimates for the sensitivity analysis.

2.4. Carbon sequestration modelling

Deforestation and forest degradation, as well as forest landscape restoration activities, play a

principal role in the global carbon cycle[10]. Preventable deforestation, sustainable forest management and natural regeneration of second-growth forests provide a low-cost mechanism that yields a high carbon-sequestration potential with multiple benefits for biodiversity and ecosystem services (Chazdon et al., 2016).

In collaboration with IUCN, Winrock International developed two comprehensive databases: (1) a global forest greenhouse gas emissions database and (2) a global FLR carbon dioxide removals database. These databases give information at both national and subnational scales on the greenhouse gas impacts that specific land-use activities have and thus provide a new resource to policy makers, donors and researchers for science-based decision-making. The FLR Climate Impact Tool aims to support practitioners estimating and visualising the carbon dioxide impacts of past and planned FLR activities. The FLR removal calculation tool was developed using data from the global removals database (Bernal et al., 2018). The FLR Climate Impact Tool estimates tCO_2 per hectare based on the type of FLR, location and age of the plantation.

Table 6. Estimated Carbon sequestration capacity of suggested FLR interventions

Interventions	Carbon sequestration capacity tCO2/ha/year	Rotation period (years)	Total tCO2
Fruits orchard and fodder	11	23	253
Agroforestry	39	20	780
Rangeland/ranches	11	10	280
Riparian forest	39	20	780
Roadside tree planting	39	25	700
Forest stands		8-10	

2.5. Rapid restoration diagnostic

There are a number of factors that, when present, increase the likelihood that forest landscape restoration will successfully occur. In order to assess the state of these "key success factors" a "Rapid Restoration Diagnostic" developed by WRI and IUCN was used to identify which success factors already exist and which are currently missing (or partially missing) within landscapes being considered for restoration. The assessment team conducted desk research, key informant interviews and workshop sessions to better understand the situation related to the key success factors for forest landscape restoration in Rwanda. First, an assessment was conducted to identify the relevant governmental and non-governmental institutional stakeholders that are currently involved in restoration activities. Stakeholders were consulted to produce preliminary results of the assessment of key success factors for forest landscape restoration in Rwanda.

[10] https://winrock.org/document/forest-landscape-restoration-climate-impact-tool/

3. Forest Landscape Challenges, and Restoration opportunities

3.1. Chronic forest degradation issues in Eastern Province

Rwanda's forest degradation is rooted from unbalanced between supply and demand of forestry resources and this hinder development of the forest sector in general and the situation is accentuated in Eastern Province compared to other province of Rwanda. A wide range of similar issues influencing forest sector development has been repeated in the three consecutive national forestry policies (NFPs) from the 2004, 2010 and 2018 NFPs. Each NFP cited a few statistics that demonstrate how some of these degradation issues have worsened from one period to the next.

Even today, forest landscape degradation issues from previous eras remaining relevant and have been demonstrated through mapping degradation (Figure 4) and the forest cover map (2020)[11] has witnessed the overcutting of existing forests at level of 15.7% over one decade (2009 – 2019) and the deforestation rate in Eastern province, unfortunately, surpasses the one of afforestation. Deforestation happened on about 65,807ha meaning 9% higher than afforestation. The results indicate that overall trend in Eastern Province forest cover is negative up to 20% for the past ten year which is about 2% of forest loss every year. Underlying driving forces are fundamental social processes, such as human population dynamics and agricultural expansion. Agricultural expansion is, by far, the leading land-use change in this province associated with nearly all deforestation cases. It includes forest conversion for permanent cropping, and cattle ranching with clear cutting practices of indigenous savannah trees. Except Ngoma and Rwamagana Districts, in other districts of eastern province, the deforestation and tree removal in ranches has by far surpassed the afforestation. Ngoma is also the least forested district at national level. Policy change, new guidance and innovative strategies are required to accelerate afforestation and tree planting n Eastern Province to catch the balanced forest coverage across the country, otherwise this part of Rwanda is pushed towards drought risks and the cost of reversing the situation will definitely be higher than of prevention if not irreversible. Therefore, the EP-FLR position itself as an instrument to accelerate restoration of Eastern Province

3.2. Challenges

Rwanda' forests do still feature a number of chronic challenges impeding efforts to manage and increase forest and forest land vitality and productivity – and increasing private sector participation – two of the major goals set for the forest sector. Their importance rests with their significance in attempts to increase overall forest sector contribution to national development targets.
Population pressure on forest resources leads to unsustainable utilization patterns and practises.

[11] MOE (2019). Rwanda Forest Cover Mapping report

It means stands are harvested prior to reaching their planned rotation age. It means trees are planted on marginal land where soils are less productive, slopes are less stable, water may be scarce, and stand productivity is low. It means investments are generally difficult to justify because of relatively high risks and uncertainties and relatively low returns.

A non-exhaustive list of significant challenges that have in the past – and potentially continue to threaten and impede forest sector development include:

1. limited institutional capacity for comprehensive forest planning & management
2. limited capacity to produce adequate volume, species and quality of seedlings
3. relatively inadequate forest budgetary resources
4. relatively very large number of small private land holdings – with proportionately high aggregate management costs
5. uneven distribution of forest resources across the country
6. systematically low level of professional capacity at district level
7. unregulated unsustainable forest exploitation for all wood forest products
8. unsustainable growing demand on forest biomass energy
9. inadequate data on forest harvest levels and use
10. absence of systematic uniform Annual Plans and Annual Reports
11. inadequate forest extension capacity
12. inadequate forest research capacity
13. inadequate capacity for supporting agroforestry species
14. relatively excessive reliance on monoculture plantations
15. relatively low forest land productivity
16. low harvesting rates in over-mature stands led to unplanned deforestation of public forests
17. limited available land for afforestation due to over competing land uses
18. limited experience comprehensive forest economic analysis and modelling
19. low levels of infrastructure to support the development of forest products manufacture
20. limited incentives for the private forest sector investment
21. very limited opportunities for viable larger scaled forest tenure arrangements.
22. Limited experience in managing natural forests and trees outside parks
23. Lack of harvesting guidelines for protective trees around roads, ecosystems and buffers where exists.

3.3. Opportunities

Through a concerted effort of effective high-level planning and political commitment, in recent years Rwanda has had relatively high levels of economic growth. In various sectors it has demonstrated an ability for the types of transformations needed to increase those sectors' contribution to the country's overall social and economic development.

The forest sector does feature attributes and opportunities favourable to the development of a productive and profitable forest and timber sector – and eventually increased levels of contribution to national level development targets. These include:

1. Political will to manage natural resources sustainably
2. Overarching policies and strategies prioritise green development, biodiversity, climate change and afforestation/reforestation
3. Compliance with international conventions will lead to access to Green Climate Fund (GCF) and Green Environmental Facility (GEF), and other programmed funding sources
4. Rwanda Green Funds (FONERWA) exists

5. Environmental protection ranked among national priorities
6. Other sectors recognize significance of natural resources sector
7. Many sector policies, programmes and projects deal with environment, biodiversity, food security, energy, watershed management, land management or landscape and forest restoration with forestry as one of the key interventions
8. Government supports private-sector lead sector development
9. Demand for forest products and increasing
10. Increasing awareness of environmental services of forests and trees
11. Forest Sector Strategic Plan (FSSP) and National Forestry Management Plan (NFMP) exist to guide sector development
12. DFMPs to improve forest management planning at district level
13. Linkages to integrated programmes (e.g. RAB FFS-Twigire Muhinzi) in other sectors involving landscape restoration, water resources management and agroforestry programmes involve afforestation, reforestation and forest rehabilitation.

3.4. Land Degradation and Restoration Opportunity Mapping

3.4.1. Mapping land degradation in Eastern Province

To quantify degraded land use (equivalent to opportunity areas for forest and landscape restoration), a geospatial analysis was performed incorporating sub-national datasets representing the geographic and topographic features of Cameroon. Datasets including elevation, slope, land cover, forest cover, water bodies, parks and reserves, and administrative areas, were consolidated into a geographic information system (GIS), where criteria associated with each type of potential restoration intervention were applied to identify the area's best suited for implementing the intervention. The spatial multi-criteria techniques were used to combine multiple layers representing criteria to consider in order to identify opportunity areas for restoration. The spatial data are overlaid and combined with each other, and areas where they intersected were identified as opportunity areas. This process was replicated for each of the restoration interventions to create maps of opportunity areas. Areas were summarized at various administrative levels (e.g. Region and Subdivision) to convey the level of opportunity within an applicable context.

The level of degradation in Eastern Province is presented in Figure 4 and Table 7. The map was generated by overlaying eight drivers of degradation. These are: high population and built-up areas, low soil carbon, bare land, slopes above 20%, tree cover below 10%, High evapo-transpiration, High soil erodibility, and forest loss 2021.

The analysis shows that 182,176 hectares (about 20% of the total EP land) are highly or severely degraded the largest degraded areas being in Nyagatare (41,070ha), Kayonza (41,036ha), and Bugesera (38,454ha) About 312,545 hectares are moderately degraded (35%), while approximately 403,693 hectare of lands (45%) are not degraded.

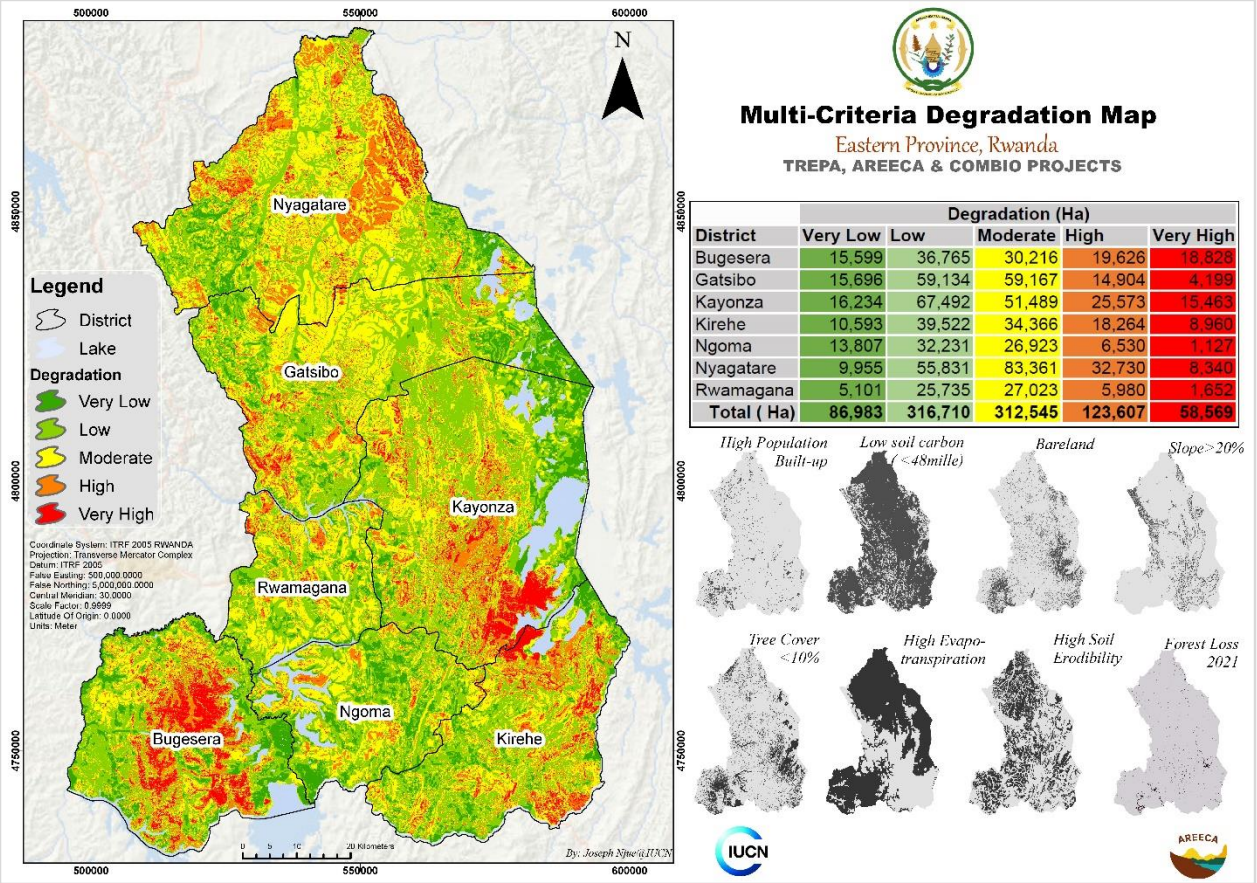


Figure 4. Land degradation map of Eastern Province landscape

Table 7. Degraded areas in Eastern Province

	Degradation (Ha)				
District	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
Bugesera	15,599	36,765	30,216	19,626	18,828
Gatsibo	15,696	59,134	59,167	14,904	4,199
Kayonza	16,234	67,492	51,489	25,573	15,463
Kirehe	10,593	39,522	34,366	18,264	8,960
Ngoma	13,807	32,231	26,923	6,530	1,127
Nyagatare	9,955	55,831	83,361	32,730	8,340
Rwamagana	5,101	25,735	27,023	5,980	1,652
Total (Ha)	**86,983**	**316,710**	**312,545**	**123,607**	**58,569**

3.4.2. Restoration opportunity areas in Eastern Province

To restore degraded lands, six restoration goals/objectives were set. One of these goals is to improve water yield and or restore the water levels in the sub-country. Although exact replicas of past conditions are hardly possible, deploying nature-based solutions such as planting native trees and shrubs, and establishing gully plugs would be a long-term intervention that ensures maximum ecological benefits and minimum alteration of ecosystems. In this case, the proposed interventions are therefore aimed to enable groundwater recharge, be sustainably cost-efficient and encourage community participation. Other objectives set in this assessment include improved

food security, soil erosion control, resilience to climate change, carbon sequestration, and improved biological diversity.

An overlay of the objectives in a GIS environment produces an opportunity map that is critical for restoration prioritization. Suitable areas for each restoration objective are also presented as functional degradation maps that can always be used by actors to restore landscapes for specific objectives. According to the analysis, the total area suitable for restoration is about 247,768 hectares of which 42,179 hectares are priority areas for restoration with regard to the food security objective (Figure 5).

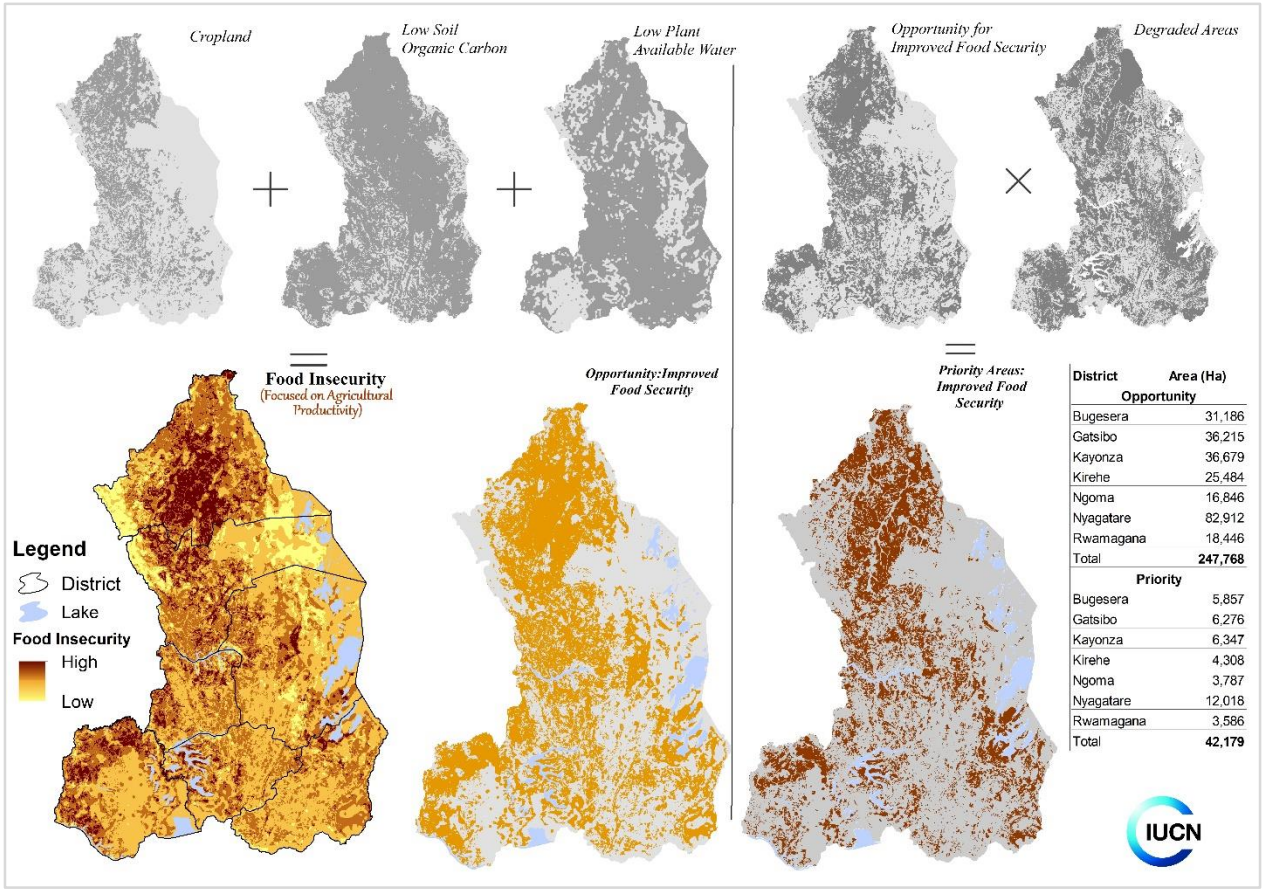


Figure 5. Opportunity map for improved food security in Eastern Province

To assess the opportunity for Increased Woody Biomass (IWB) Concerning the biofuel objective of restoration, the mapping of opportunity consisted of overlaying the forest cover loss and tree cover loss and the results present opportunity area for restoration from the supply point of view. By overlaying the Biofuel opportunity map and the population distribution map, the biofuel restoration opportunity map obtained

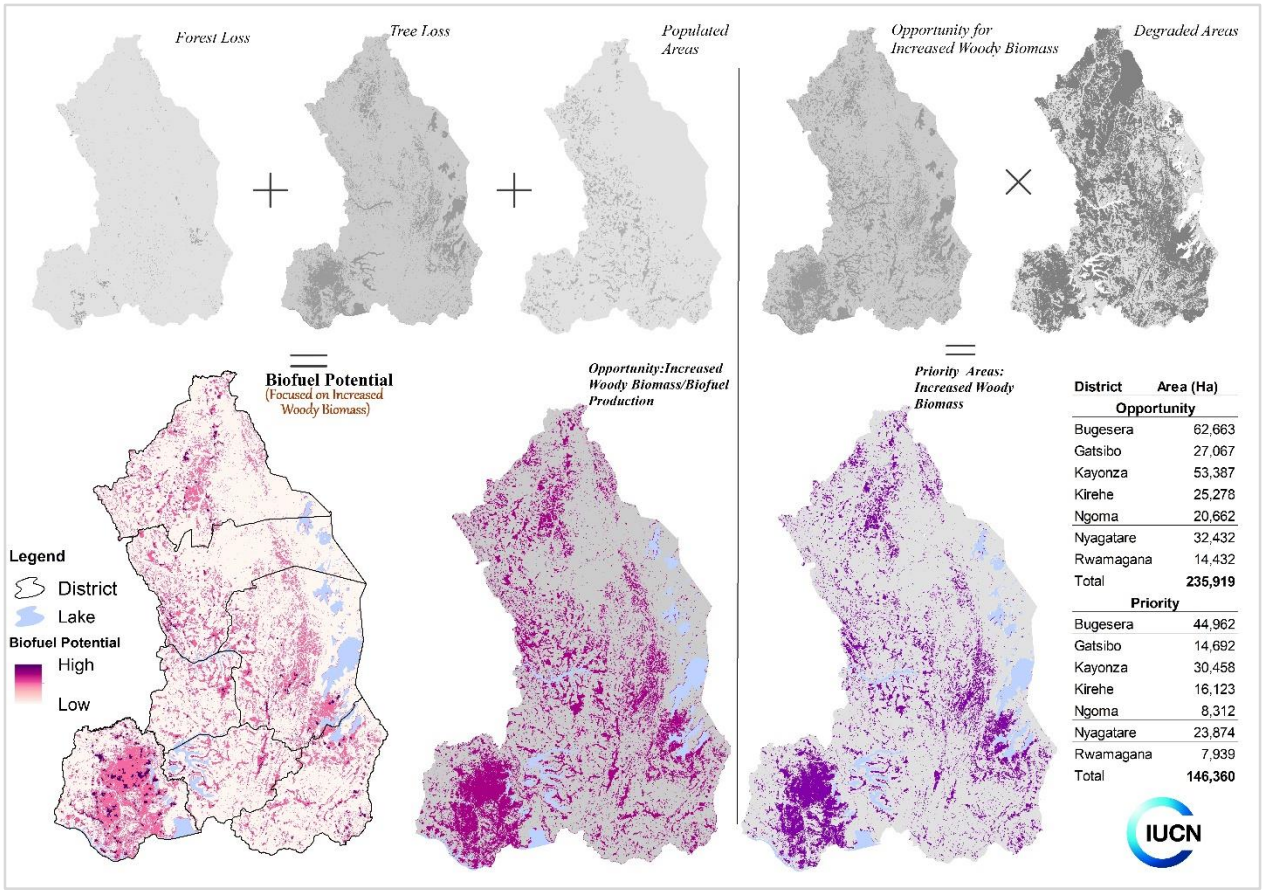


Figure 6. Opportunity map for improved woody biomass energy in Eastern Province

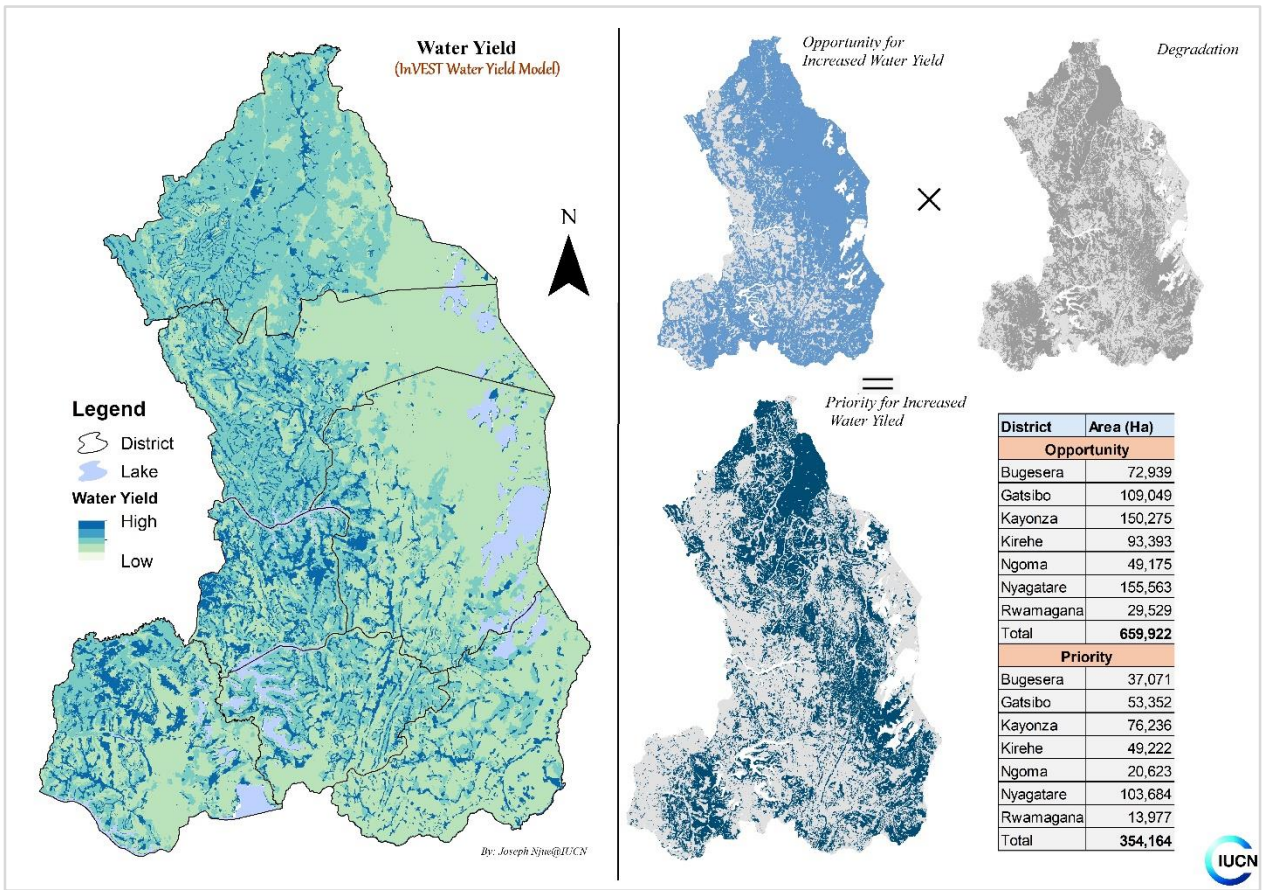
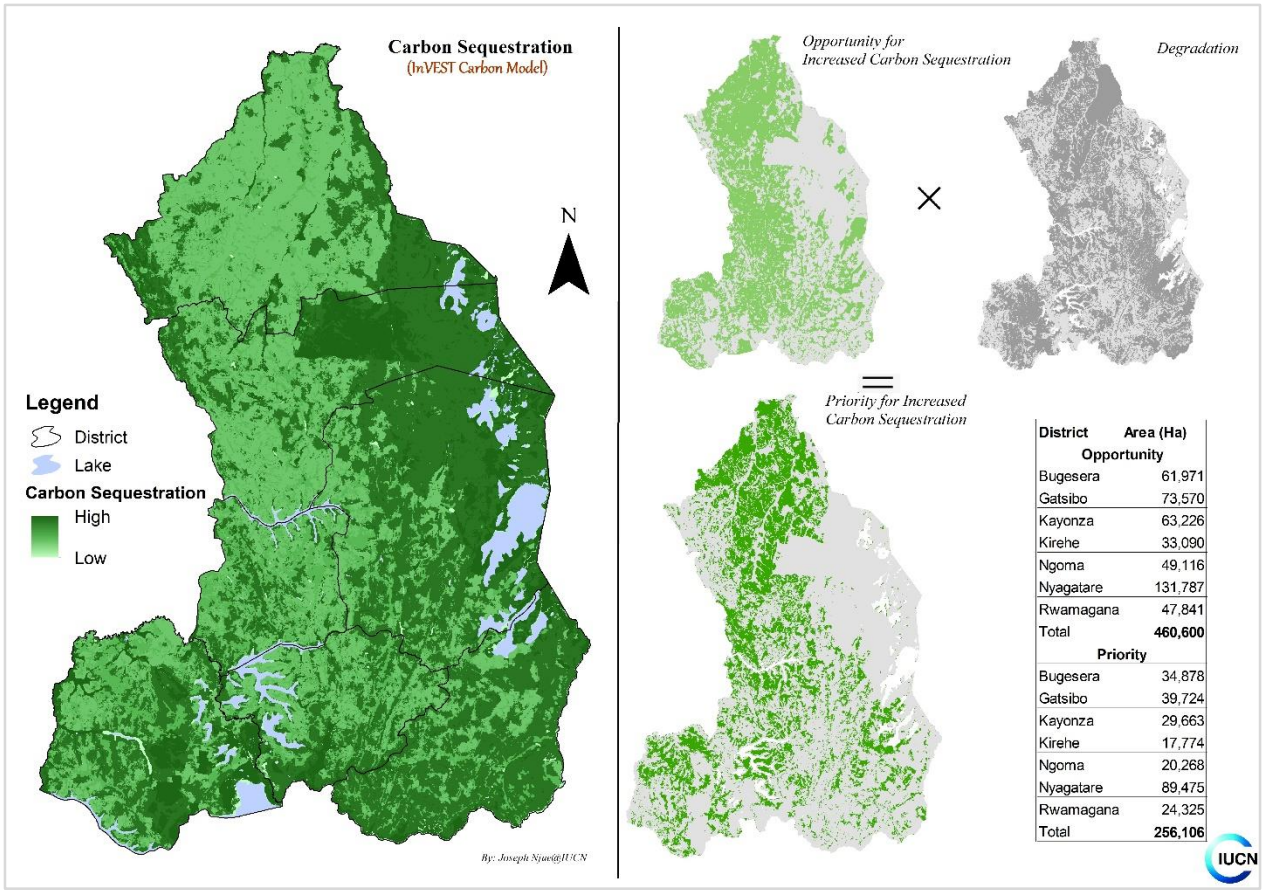


Figure 7. Opportunity map for increased water yield in Eastern Province



District	Area (Ha)
Opportunity	
Bugesera	61,971
Gatsibo	73,570
Kayonza	63,226
Kirehe	33,090
Ngoma	49,116
Nyagatare	131,787
Rwamagana	47,841
Total	**460,600**
Priority	
Bugesera	34,878
Gatsibo	39,724
Kayonza	29,663
Kirehe	17,774
Ngoma	20,268
Nyagatare	89,475
Rwamagana	24,325
Total	**256,106**

Figure 8. Opportunity map for increased Carbo sequestration in Eastern Province

4. Restoration Interventions and Benefits

The assessment team identified eight degraded land uses that could benefit from the restoration through the strategic introduction of trees (preferably natives) and management practices identified in the degraded landscape. Relevant governmental and non-governmental stakeholders in Eastern Province were consulted to identify the preliminary list of degraded lands. These are:

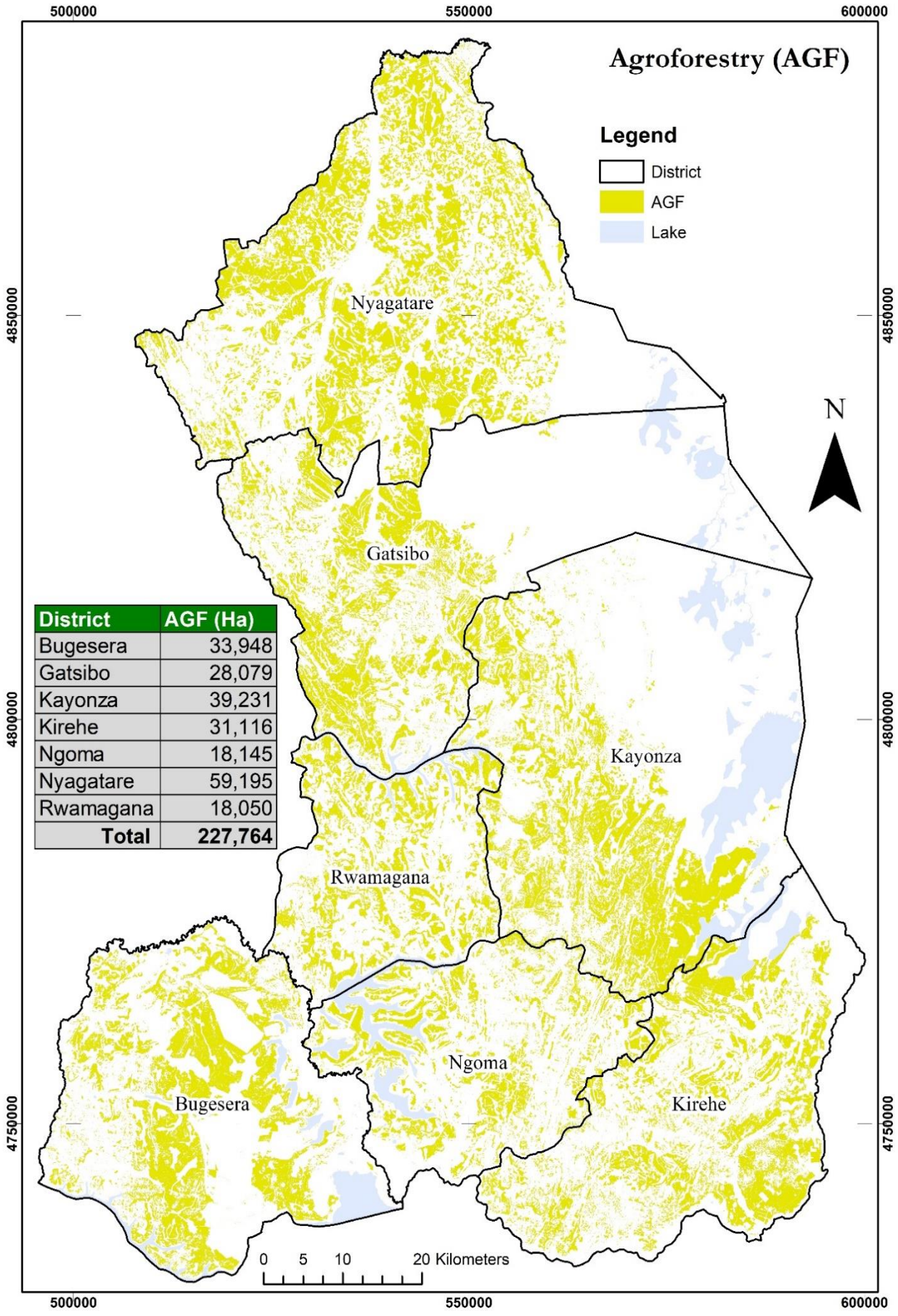
1) Degraded agricultural lands
2) Degraded and poorly managed forests and woodlots
3) Degraded bare and or stony lands
4) Poorly managed rangelands
5) Degraded protected areas
6) Unprotected roads
7) Unprotected water bodies; rivers and springs
8) Unprotected urban, settlement and populated areas

They also identified ten specific restoration interventions for different land uses. These are:

1) Agroforestry on agricultural land.
2) Rehabilitation of degraded and poorly managed forests and woodlots
3) Establishment of new forests (afforestation) on the bare/stony lands
4) Improvement of pasturelands
5) Rehabilitation of degraded parts of natural forests
6) Protective forests along rivers, wetlands, waterbodies, roadsides
7) Urban forestry / greening the populated areas
8) Assisted natural regeneration and farmer managed-natural regeneration

4.1. Agroforestry

Agroforestry has been identified as a measure to restore degraded agricultural land in all districts of Eastern Province. Spatially, these are croplands on a slope less than 20% and in areas with a tree cover of less than 10%. As shown in the map (Figure 9) , about 227,764 hectares are potential for agroforestry.



District	AGF (Ha)
Bugesera	33,948
Gatsibo	28,079
Kayonza	39,231
Kirehe	31,116
Ngoma	18,145
Nyagatare	59,195
Rwamagana	18,050
Total	**227,764**

Figure 9. Map showing intervention areas for agroforestry systems

4.2. Silvopasture and improved management of ranches

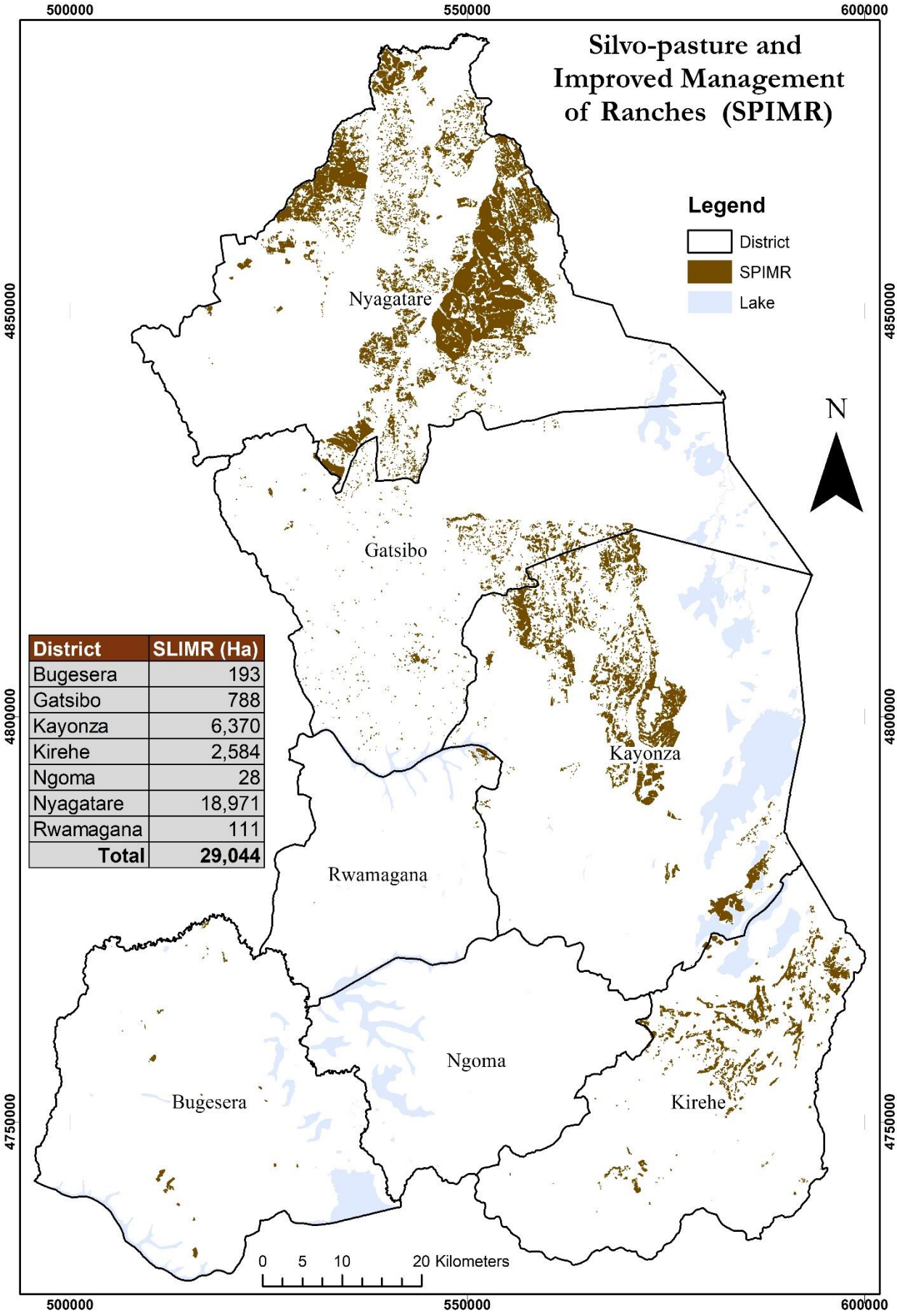
In Eastern Province, having cattle that graze is how many farmers provide additional income for their families. Continuous grazing has been the traditional way to graze cattle over generations, but there may be a way to improve this grazing system and make the operation more profitable. A rotational grazing method is recommended as alternative to continuous grazing. It is also to note that each farm is different, and a grazing system that works for one neighbour may not work for other.

Pasturelands are largely found in Nyagatare, Kayonza and Kirehe Districts. However, the land use master plan for other remaining districts may have a space reserved for livestock as well. Due to the frequent droughts and the continuous grazing method in these districts (specially in Nyagatare, Gatsibo, Kayonza, Bugesera and Kirehe) a big number of pastures look poor, abused and neglected and this requires the best plan of action to bring them back to full productivity.

After the discussion with pastoralists and the observations carried out in eastern province, the degradation of pastures is the result of a combination of several negative stresses including too much or too little water (Some parts of Nyagatare during rainy or dry seasons respectively); poor fertility or low soil pH (stony zones of Kirehe and Kayonza); poor grazing management; a poor choice of forage species; and an influx of weeds likely caused by one of the previously mentioned factors.

Recommended actions include:

- Silvopastoral systems;
- Soil improvement through leguminous and management of the above ground with good grazing techniques;
- Revegetate pastureland with grass and shrubs on bare land



District	SLIMR (Ha)
Bugesera	193
Gatsibo	788
Kayonza	6,370
Kirehe	2,584
Ngoma	28
Nyagatare	18,971
Rwamagana	111
Total	**29,044**

Figure 10. Map showing areas suitable for rangeland management

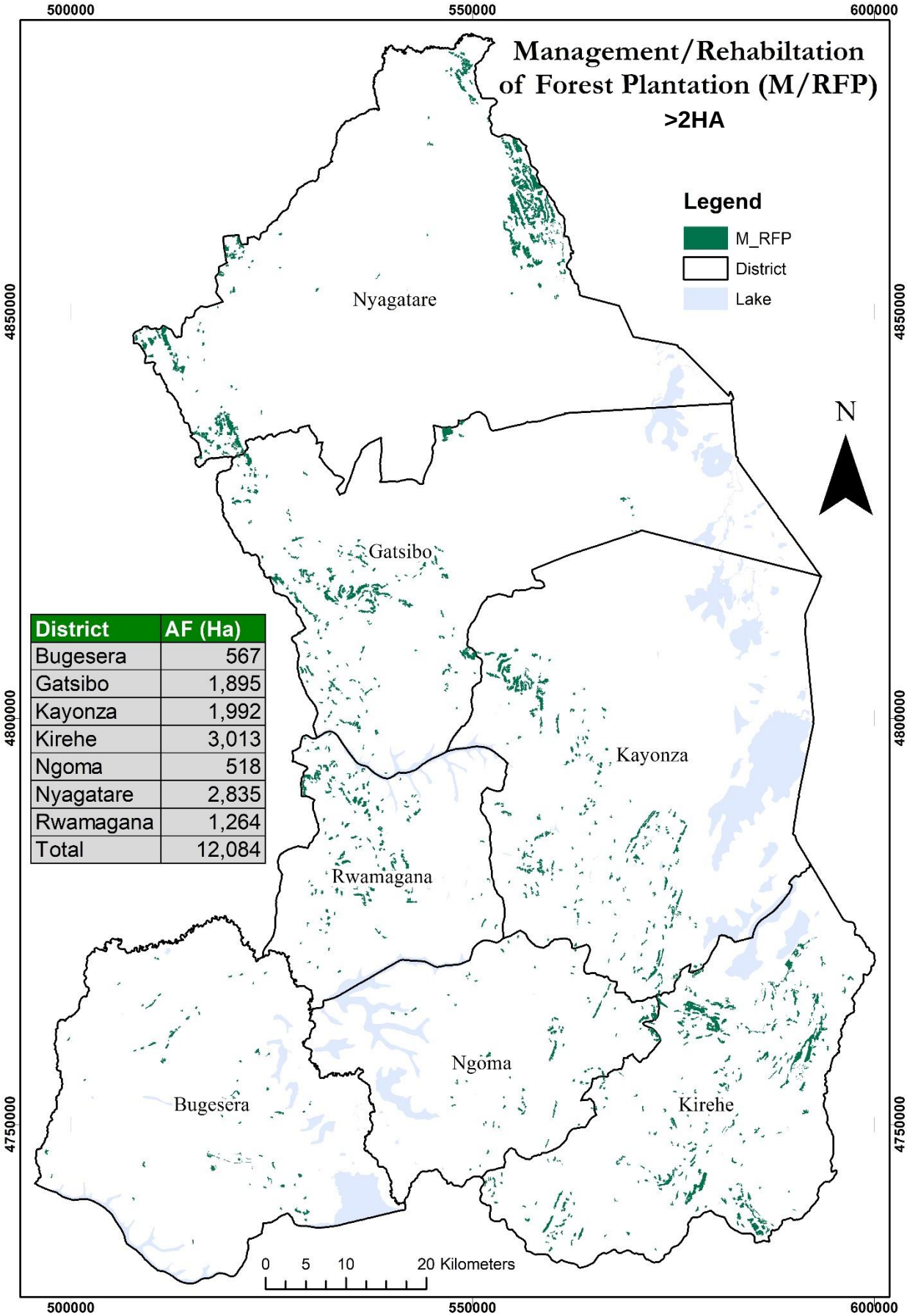
4.3. Afforestation, Reforestation and Management forest plantations

Afforestation will be carried out in the government and private lands with forest vocation according to the land use master plan in each district and the process will focus on forest products like timber, poles, charcoal, logs, etc.

The density will depend on the production purpose, tree species and type of lands. The structure of the forests will also take into consideration both the ecological focuses: (restoring and maintaining the ecological functions such as water and soil conservation) and the economic focuses: timber management, and other saleable woody products.

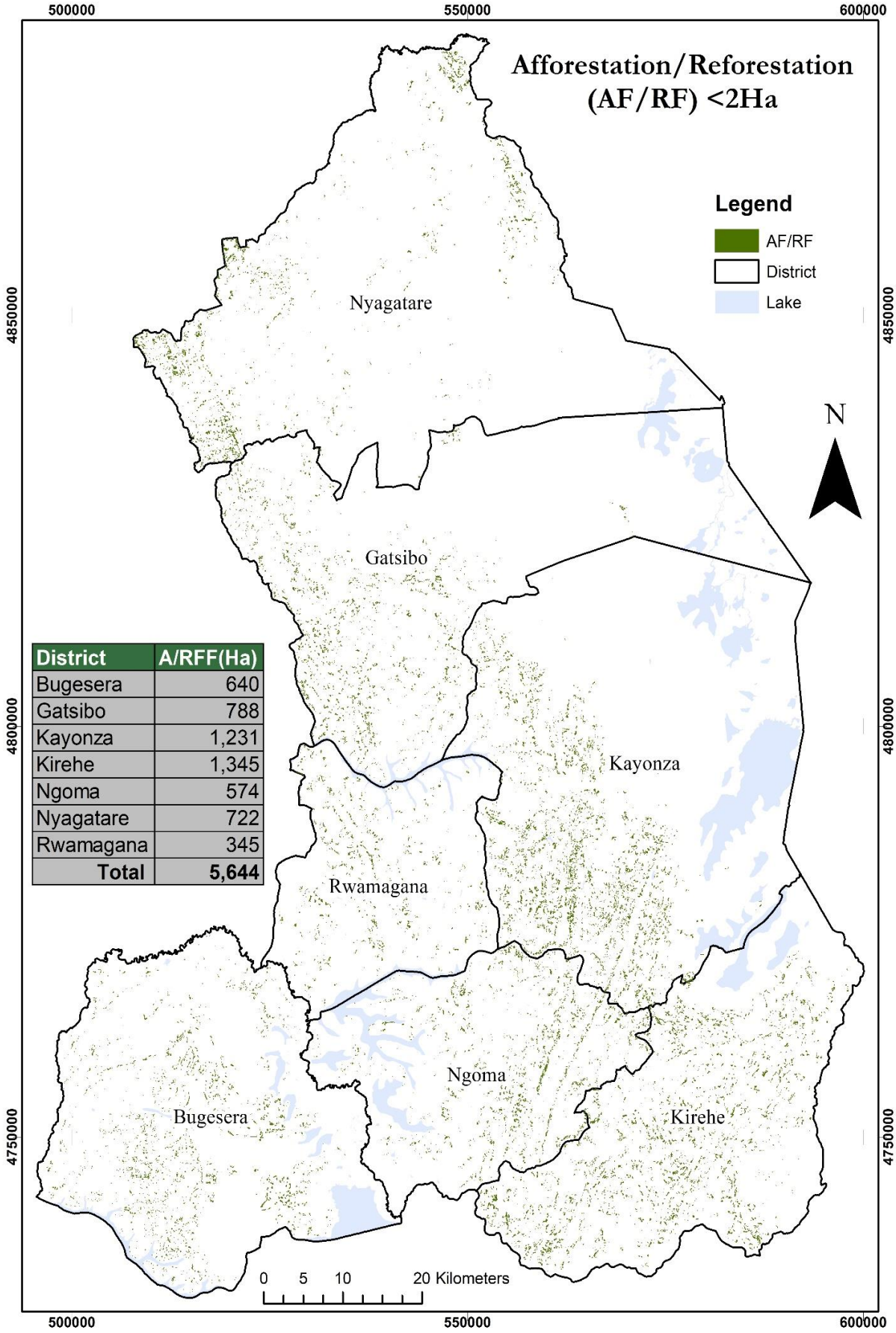
The recommended afforestation should be within the context of Sustainable Forest Management (SFM) which extends beyond the simple planting of trees to encapsulate the planting of the right trees in the right places. Given the nature of afforestation as a major change in land use, the activity impacts greatly on the site and its surroundings. It also has wider implications in relation to, for example, the protection of river catchments, landscape management and the provision of an adequate regional nature based infrastructure.

Sustainable forest management (SFM) entails the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and that does not cause damage to other ecosystems. SFM is an international initiative and is adapted to different areas of the globe according to the regional context. Despite this diversity in implementation, core criteria remain common throughout, and these relate to the forest resource, forest health and vitality, productive capacity, biodiversity, soil and water, and socio-economic issues. Although applicable to all stages of the forest cycle, these criteria are perhaps of greatest importance at the afforestation stage involving the development of new forests on open land. Proper practices at this stage lay a solid foundation for the full implementation of SFM throughout the forest's lifetime and beyond. The designs are similar to those used in rehabilitation.



District	AF (Ha)
Bugesera	567
Gatsibo	1,895
Kayonza	1,992
Kirehe	3,013
Ngoma	518
Nyagatare	2,835
Rwamagana	1,264
Total	12,084

Figure 11. Map showing opportunity areas for afforestation forest plantations



District	A/RFF(Ha)
Bugesera	640
Gatsibo	788
Kayonza	1,231
Kirehe	1,345
Ngoma	574
Nyagatare	722
Rwamagana	345
Total	**5,644**

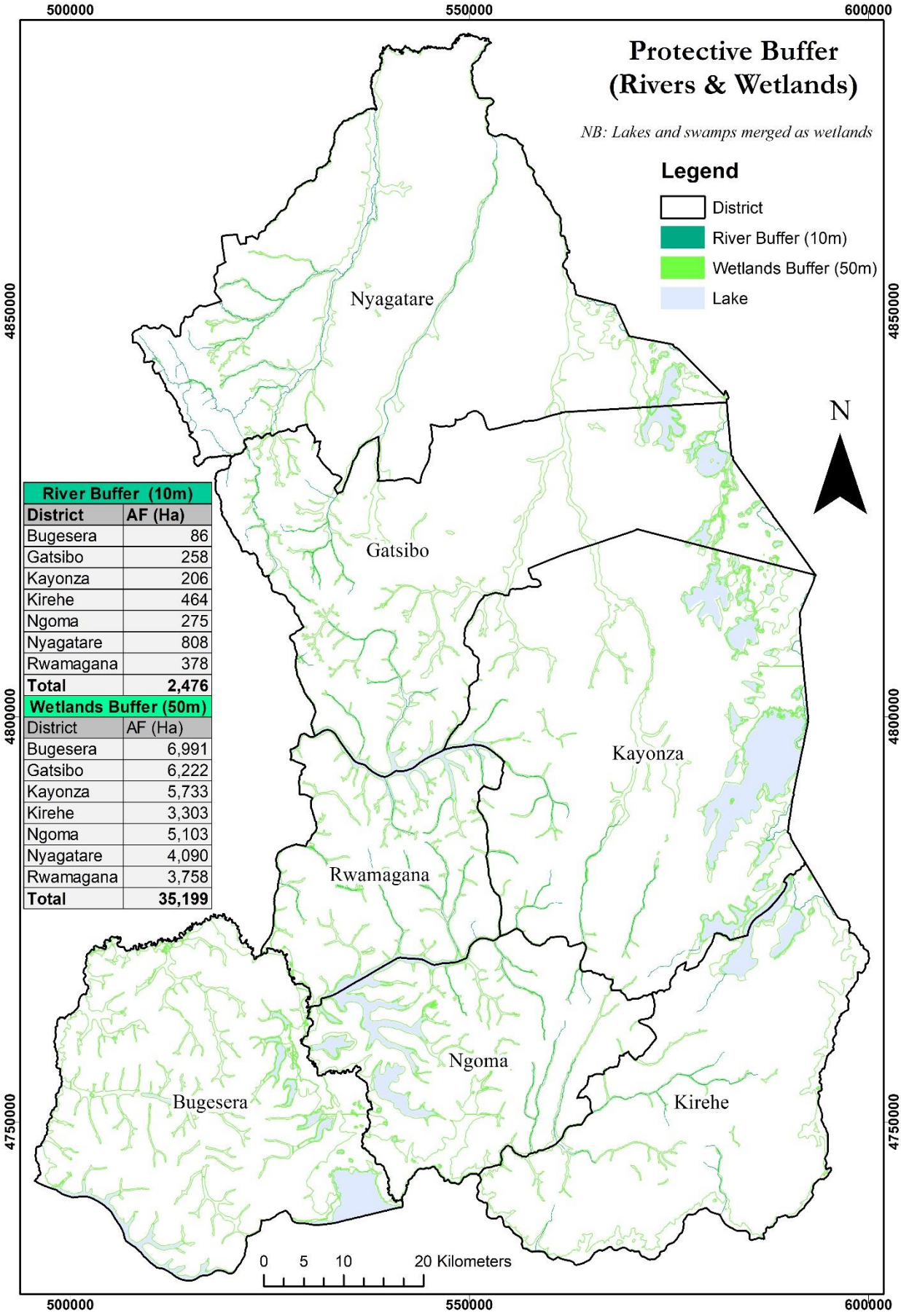
Figure 12. Map showing opportunity areas for afforestation and reforestation of woodland

4.4. Protective forests around wetlands, water bodies and riversides forests

Most of these forests are the forest interventions aiming at preventing erosion on the many steeply-sloped ridges and hillsides and to protect rivers and wetlands from the harmful effects of erosion by creating buffer zones of natural forest around these important water bodies and swamps. The protective forest interventions were divided into five categories:

1) protective forests on ridge tops with very steep slopes;
2) planting native tree species to create 20-m buffers of non-forested river courses;
3) planting native species as buffers within 50-m of wetlands and swamps.

The following map (Figure 13) shows opportunity for establishing riparian forests around rivers, water bodies, and wetlands in eastern province of Rwanda. The total areas covered this restoration action is about 37,675 hectares distributed in seven districts.

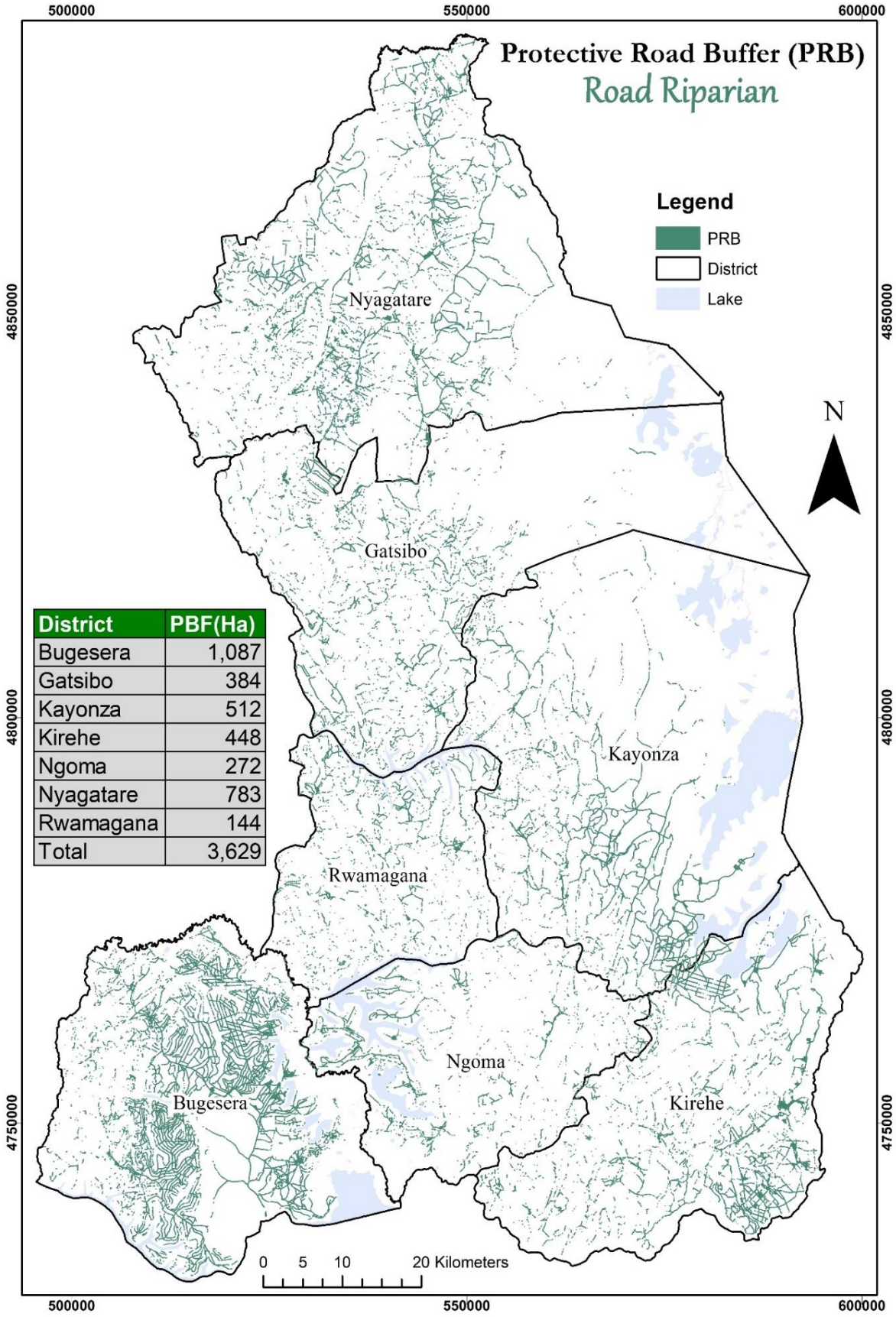


River Buffer (10m)	
District	AF (Ha)
Bugesera	86
Gatsibo	258
Kayonza	206
Kirehe	464
Ngoma	275
Nyagatare	808
Rwamagana	378
Total	**2,476**

Wetlands Buffer (50m)	
District	AF (Ha)
Bugesera	6,991
Gatsibo	6,222
Kayonza	5,733
Kirehe	3,303
Ngoma	5,103
Nyagatare	4,090
Rwamagana	3,758
Total	**35,199**

Figure 13. Map showing opportunity areas for the creation of river, waterbody and wetland buffers

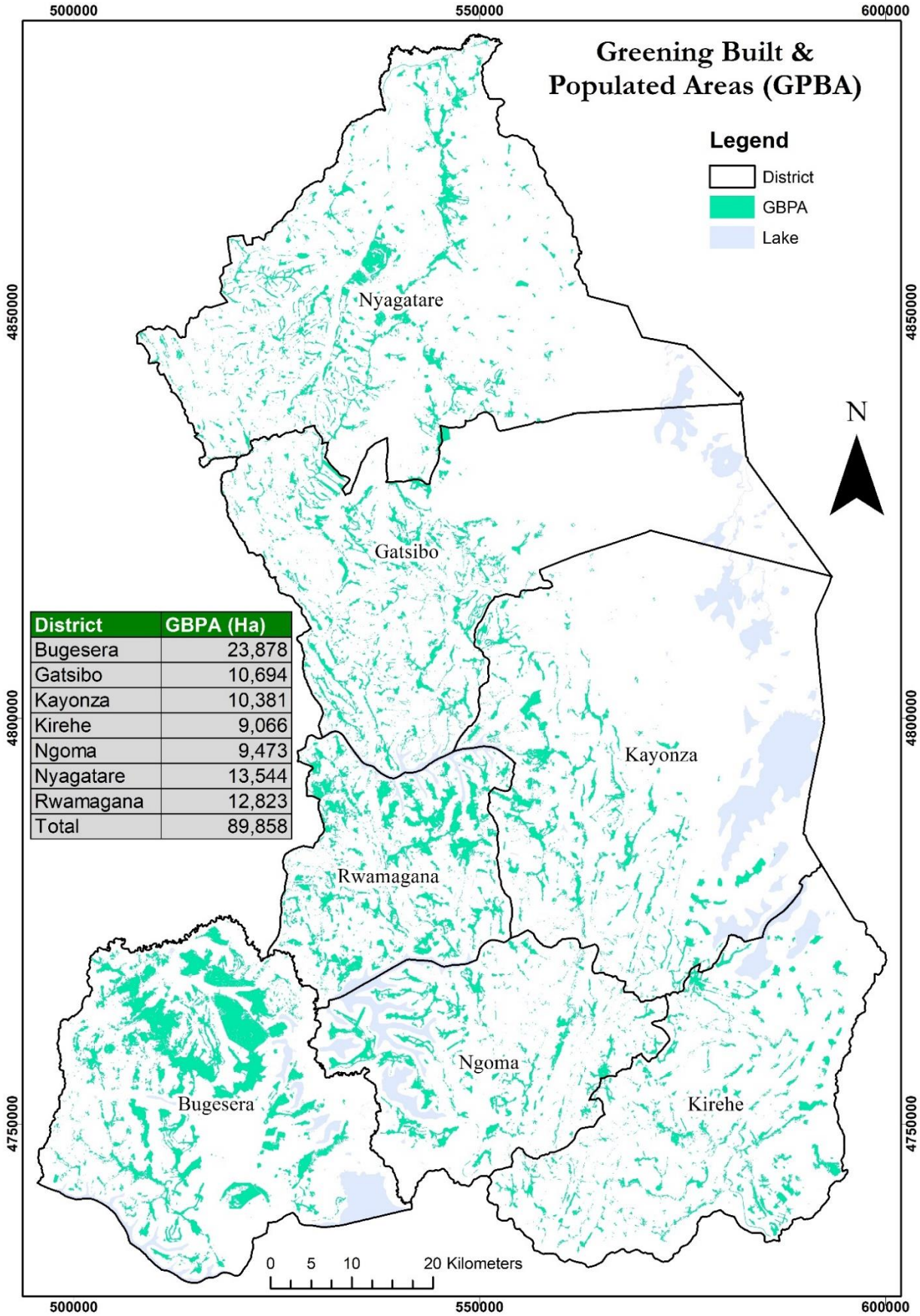
4.5. Roadside forests



District	PBF(Ha)
Bugesera	1,087
Gatsibo	384
Kayonza	512
Kirehe	448
Ngoma	272
Nyagatare	783
Rwamagana	144
Total	3,629

Figure 14. Map showing areas suitable for road riparian buffer

4.6. Urban greening



District	GBPA (Ha)
Bugesera	23,878
Gatsibo	10,694
Kayonza	10,381
Kirehe	9,066
Ngoma	9,473
Nyagatare	13,544
Rwamagana	12,823
Total	89,858

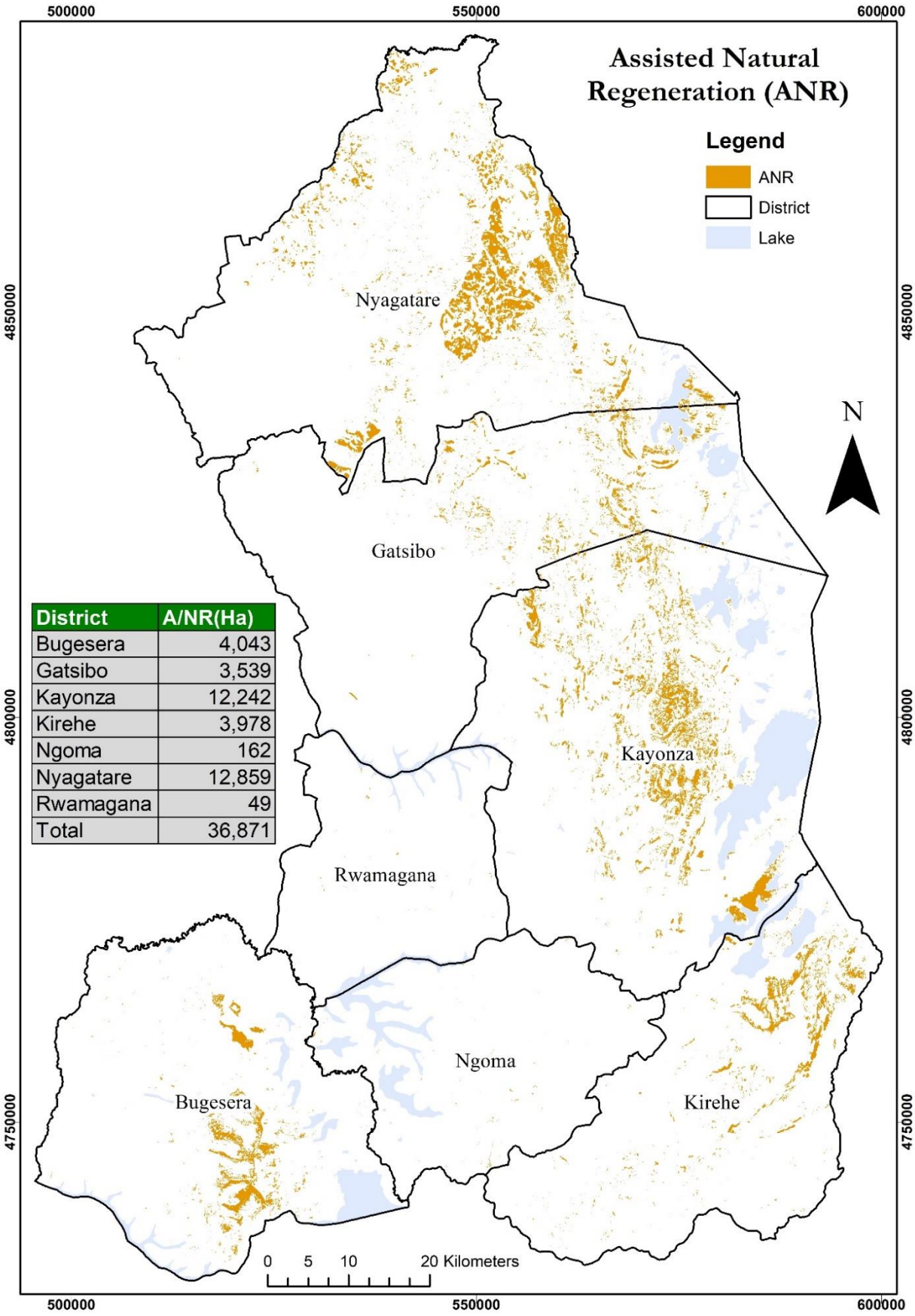
Figure 15. Map showing areas suitable for greening built and populated areas

4.7. Assisted Natural Regeneration (ANR) in Akagera National Park, relic forests, and Gako Natural Forest Reserve.

Natural regeneration interventions are designed to capitalise on Eastern Province degraded natural forests of intact natural forest to both expand and restore the ecosystems that are particularly important for their wildlife and livestock. Improving and expanding the natural forests would improve habitat for wildlife, which can attract greater tourism revenues. Two types of natural forest interventions were assessed: 1) enrichment planting within Akagera National Park; and 2) restoring degraded relic natural forest scattered across Easten Province, and Gako natural reserve.

Assisted Natural regeneration (ANR) is a biological process that can be assisted and managed to increase forest cover and achieve the recovery of the native ecosystem or some of its functions. To understand ANR, it is important to note what happens in degraded and denuded lands that are not burned or otherwise disturbed. After 10 to 20 years, trees and many other plants, growing from seeds spread by birds, animals, wind and other means, will cover these lands. The word ‘assisted’ in ANR simply means helping the naturally growing young trees to grow faster. During ANR, local biodiversity is enriched by: (1) Natural establishment of trees and shrubs from seeds, root sprouts, stumps or coppices; (2) Regeneration of local genetic resources adapted to local soil and climate conditions; and (3) Associated pollinators, herbivores and seed-dispersal agents of colonising trees. ANR accelerates the natural successional process by protecting against disturbances (from fire, stray domestic animals and humans) and by reducing competition from grasses, bushes and plants that hinders the growth of naturally regenerated trees.

The spatial definition of assisted natural regeneration are all the degraded protected areas which according to the analysis is about 36,871 ha.



District	A/NR(Ha)
Bugesera	4,043
Gatsibo	3,539
Kayonza	12,242
Kirehe	3,978
Ngoma	162
Nyagatare	12,859
Rwamagana	49
Total	36,871

Figure 16. Map showing areas suitable for Assisted Natural Regeneration (degraded Akagera National Park, Gako natural forest reserve and relic natural forests)

There are certain ecological, socio-economic and regulatory conditions that favour forest restoration through ANR:

1) Adequate density of naturally regenerated tree seedlings. The minimum number of naturally regenerated seedlings required will vary based on their distribution, species composition, growth rates, soil fertility, rainfall and so forth.
2) Availability of seed inputs. There should be remnant forest patches nearby that can serve as seed sources; seed dispersers are required to carry these seeds to the restoration site. Soils should not be heavily disturbed. There should be a viable seed bank in the soil.
3) Controlling disturbances. It is essential to prevent or at least minimise human induced disturbances, including fires, grazing and unsustainable harvesting.
4) Social support. Local communities need to be interested, willing and incentivized to participate in forest restoration.
5) Competing land uses. The area should be not suitable for land uses that are economically more attractive.

Fences can be used to exclude livestock/wild lives during the early stages of ANR. Enrichment planting is also a form of ANR technique. Enrichment planting is recommended where: 1) canopy closure does not occur due to low density of natural regenerants; and/or 2) desired tree species are not present amongst the natural regenerants. If the remnant forest is far from the ANR site and seed-dispersing animals are not present in sufficient numbers, enrichment planting may be needed to bring back the full complement of late successional forest tree species.

ANR can also apply direct seeding. Direct seeding involves: 1) collecting seeds from native trees in nearby remnant forest and if necessary storing them until sowing; 2) sowing them in the ANR site at the optimal time of year for seed germination; and 3) manipulating field conditions to maximise germination. The method is inexpensive because there are no tree nursery costs. Transporting seeds to the restoration site is obviously easier and cheaper than trucking in containerized tree seedlings, so the method is particularly suitable for less accessible sites.

4.8. Suitable species for restoration of Eastern Province degraded and deforested land

During stakeholder workshops and community consultations, various tree/shrub/grass species were suggested for restoration based on community preference and local knowledge, their multiple uses, and where they should be used. The costs (price) of the products and ecosystem services provided by these selected species (energy wood, service wood, soil fertility, fodder, medicinal and cultural use, feeding, carbon sequestration etc.) were also sought. For example, Table 8 shows the tree species to be considered in the restoration and where they should be planted in land uses as per the District land use master plan (DLUPs).

Table 8. Recommended tree species for the restoration of Eastern Province in different land uses (refer to annex 2 for more detailed species 'list)

DLUPs General LU	Landscapes	Tree, shrub, and fruit species	Districts
Agriculture (A1-Agriculture zone)	Farm lands	Grevillea robusta, Cedrela serrata, Acrocarpus flaxinifolius, Sesbania sesban, Senna spectabilis, Markhamia lutea, Ficus sycomorus, Maesopsis eminni, Terminalia superba, Calliandra calothyrsus, Ficus sycomorus, Avocado, mango, Papaya, Guava, Jack fruits, Citrus and Orange	All eastern Province districts
Forest	Degraded forests and woodlots	Eucalyptus microcorys, Acacia sieberiana, Acacia polycantha, Callitris robusta, Pinus, kesiya	Bugesera, Kayonza, Ngoma, Kirehe
		Eucalyptus grandis, E.terticornis, , Acacia sieberiana, Acacia polyacantha,	Nyagatare, Gatsibo
Forest	Afforestation on the bare/stony lands	Eucalyptus microcorys, Pinus caribea,	Bugesera, Kayonza
		Eucalyptus grandis, E. terticornis,	
		Callitris sp, Pinus kesiya, Acacia siberiana, Acacia polyacantha	Kirehe
Agriculture (A2-Livestock zone)	Pasturelands	Acacia polycantha, Acacia siberiana, Erythrina abyssinica, Ficus thonningii, Prunus africana, Terminalia	All districts
Forests (use Akagera National Park) + Relic forests	Natural forests	Zanthoxylum chalybeum, Croton megalocarpus, Lannea schimperi, Euclea racemose etc	Nyagatare, Gatsibo, Kayonza Akagera National park, Relic forests
Settlement sites (from the same dataset)	Urban areas/ roadsides	*Senna siamea, Senna spectabilis, Terminalia mentalis, Araucaria species, Croton megalocarpus*,	All districts
Riparian zones	Rivers, springs, and wetlands	*Acacia kirkii, Bamboo sp. and Ficus sycomorus*	All districts

4.9. Ecosystem services analysis

Some ecosystem values and services equally important for the ecological and socio-cultural heritage within the landscape are not included in the financial analysis (monetary valuation) due to the complexity of the evaluation criteria and insufficient data; however, it matters to highlight them. These ecosystem services are but are not limited to erosion control, Improving water resources, biodiversity conservation, and socio-cultural values such as traditional medicine, religion, and cults.

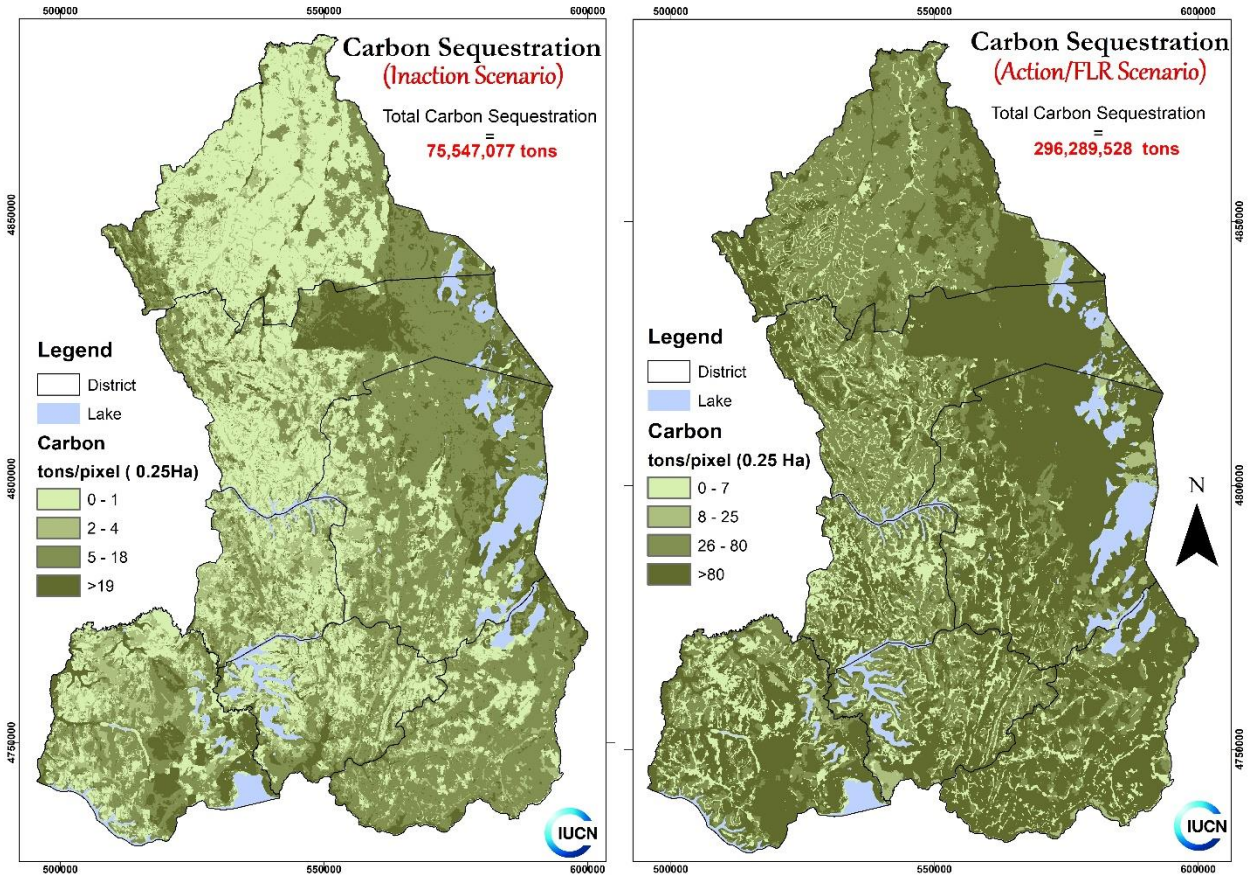


Figure 17. Map showing carbon sequestrated over 20 years of restoration (FLR action versus to inaction)

Carbon sequestration is a one of the highest benefit from restoration. Millions of tons of carbon would be sequestered if the eastern province were restored with the proposed FLR interventions. Table 9 and Figure 17 shows that after 20 years of increased restoration efforts eastern province landscapes can potentially sequester approximately 4 times what is doing currently.

Table 9. Increased carbon stock (below & above) from FLR action for a period of 20 years (220,742,451 tons)

		Carbon Sequestration Scenario	
District	Area(Ha)	Inaction	Action/FLR
Bugesera	129,057	13,422,386	38,362,777
Gatsibo	157,873	17,728,179	52,326,665

Kayonza	193,609	17,346,474	63,102,215
Kirehe	118,486	9,445,414	39,660,982
Ngoma	86,775	5,811,577	24,528,664
Nyagatare	192,256	9,070,945	61,407,661
Rwamagana	68,196	2,722,102	16,900,564
	946,252	**75,547,077**	**296,289,528**

Water yield is also a benefit from restoration. Millions of cubic meters of water would be yielded if the Eastern province were restored with the proposed FLR actions/intervention. After 20 years of increased restoration efforts, Eastern Province landscapes can potentially retain water to approximately 4 times what is retaining currently.

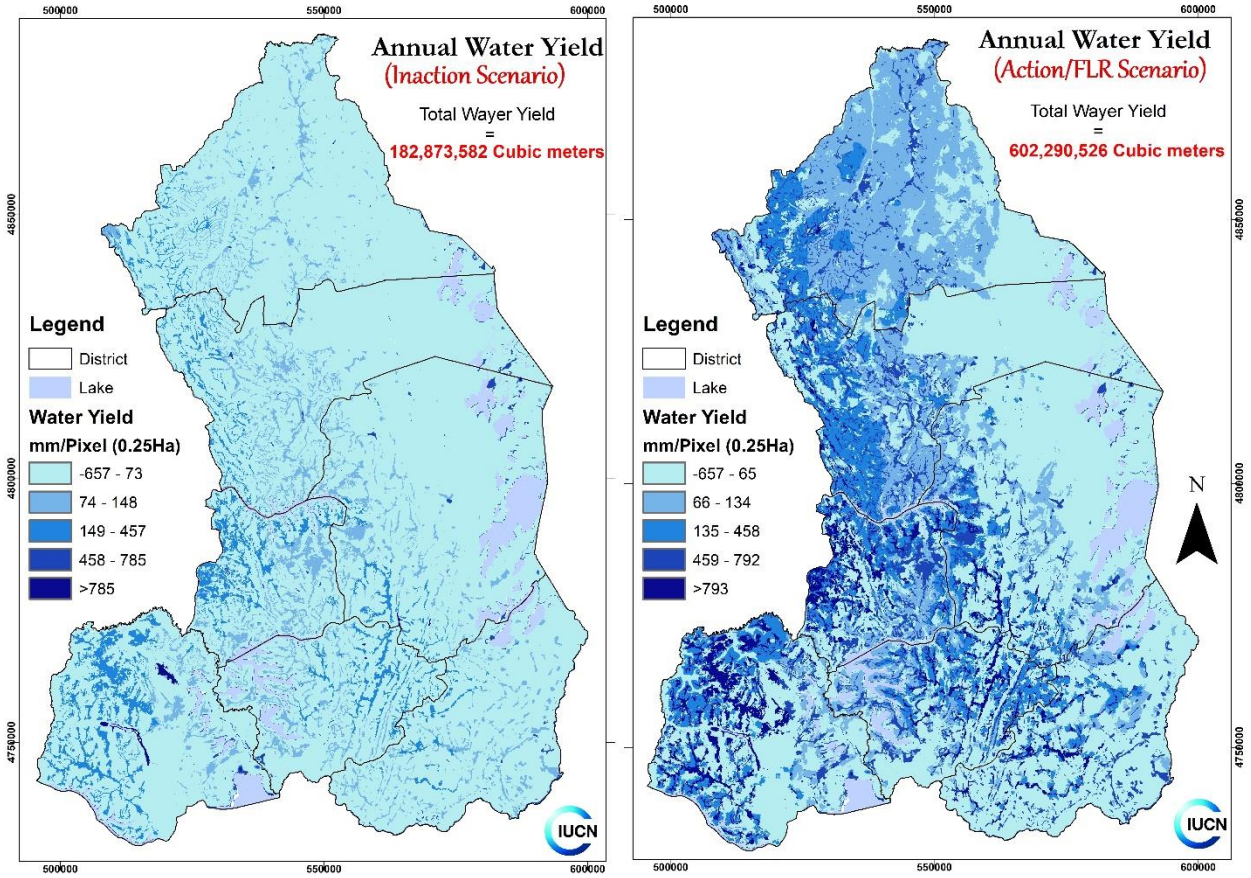


Figure 18. Increased water yield from FLR action (419,416,944 cubic meters)

Table 10. Increased water yield from FLR action for a period of 20 years (419,416,944 m^3)

		Water Yield Scenarios (M^3)	
District	Area(Ha)	Inaction	Action/FLR
Bugesera	129,057	37,236,732	112,005,606
Gatsibo	157,873	26,243,666	92,882,988
Kayonza	193,609	31,519,393	80,270,744
Kirehe	118,486	19,975,109	58,316,356
Ngoma	86,775	21,278,737	70,544,827
Nyagatare	192,256	25,895,279	105,632,706

Rwamagana	68,196	20,724,666	82,637,299
Total	**946,252**	**182,873,582**	**602,290,526**

Concerning Soil erosion control with restoration, about 478,032 tonnes are reduced/controlled through FLR actions. FLR impact on soil erosion control hasn't been quite significant. Perhaps this has to do with SLM (P-factor) rather than FLR (C-factor). Nonetheless controlling more than 450 thousand tonnes is something not negligible. A combined approach where terracing, contour banks and establishment of anti-erosion hedge rows would additionally yield more sediments retentions from runoffs.

Table 11. Reduced Soil erosion: FLR action versus to inaction (478,032 tonnes of soil)

		Soil Loss Scenarios (tonnes)	
District	Area(Ha)	Inaction	Action/FLR
Bugesera	129,057	235,304	176,912
Gatsibo	157,873	461,203	388,072
Kayonza	193,609	445,803	377,580
Kirehe	118,486	312,440	265,508
Ngoma	86,775	252,797	210,055
Nyagatare	192,256	660,130	517,167
Rwamagana	68,196	243,624	197,975
	946,252	**2,611,301**	**2,133,269**

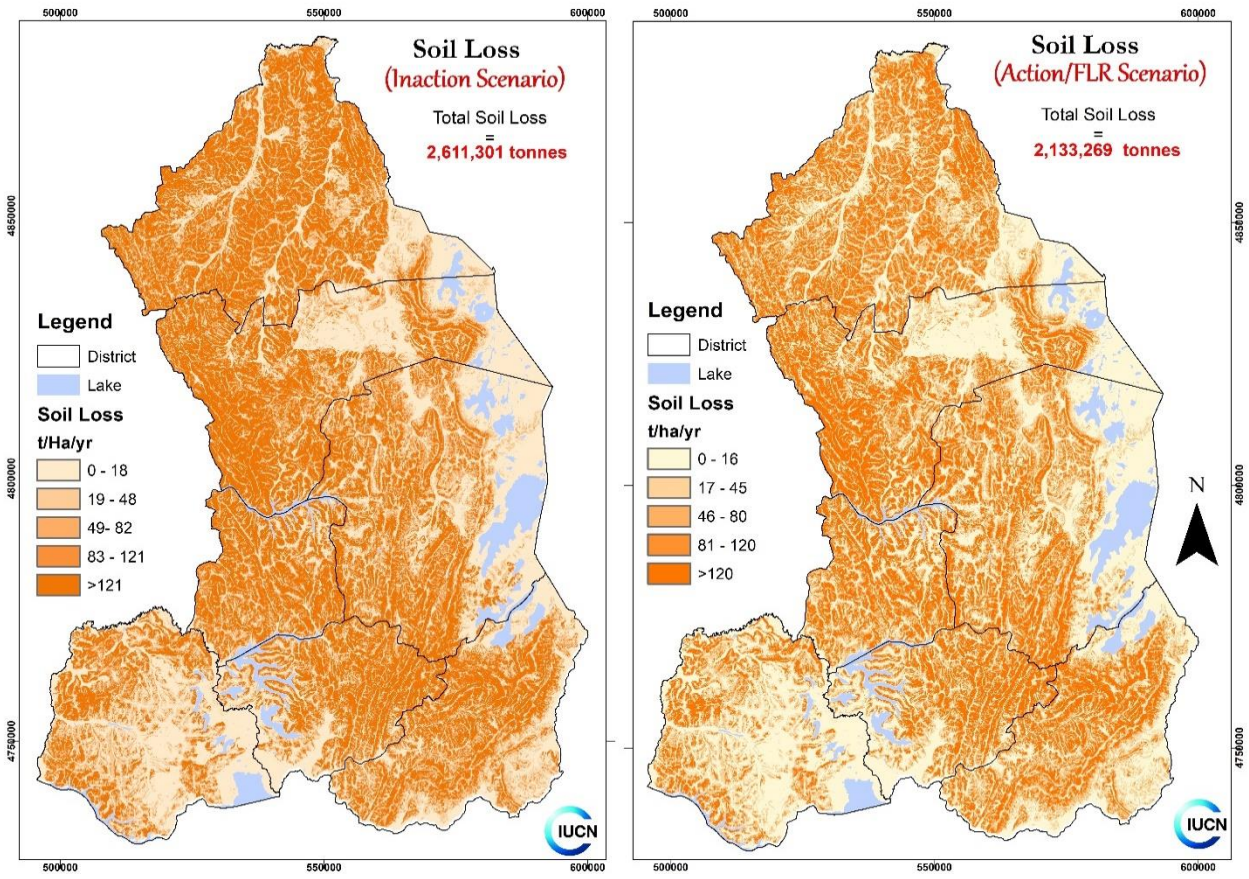


Figure 19. Reduced Soil erosion: FLR action versus to inaction

5. Socio-economic analysis

5.1. Financial and Economic analysis

Profitability of a restoration intervention depends on several reasons including the initial establishment costs and related activities, rotation period and discount rate used.

5.1.1. Financial analysis for Business as usual

To be able to evaluate the profitability of a FLR action, whether this action is more profitable than what would have been generated by continuing with the previous agricultural land use, and the estimated costs and benefits related to the previous system provides a superb tool for comparing complex production systems. The following analysis provides net benefit estimates for a traditional agricultural production system of beans and maize which will be compared to an improved scenario of restoring degraded lands. The tradition agriculture will be compared to improved agroforestry systems in |eastern province. Results presented below show the financial model for traditional agriculture without considering the cost of soil loss, impact of sediments and a decrease of agriculture production that may result from land/soil degradation. The following graph present the annual net benefit of traditional agriculture (BAU)

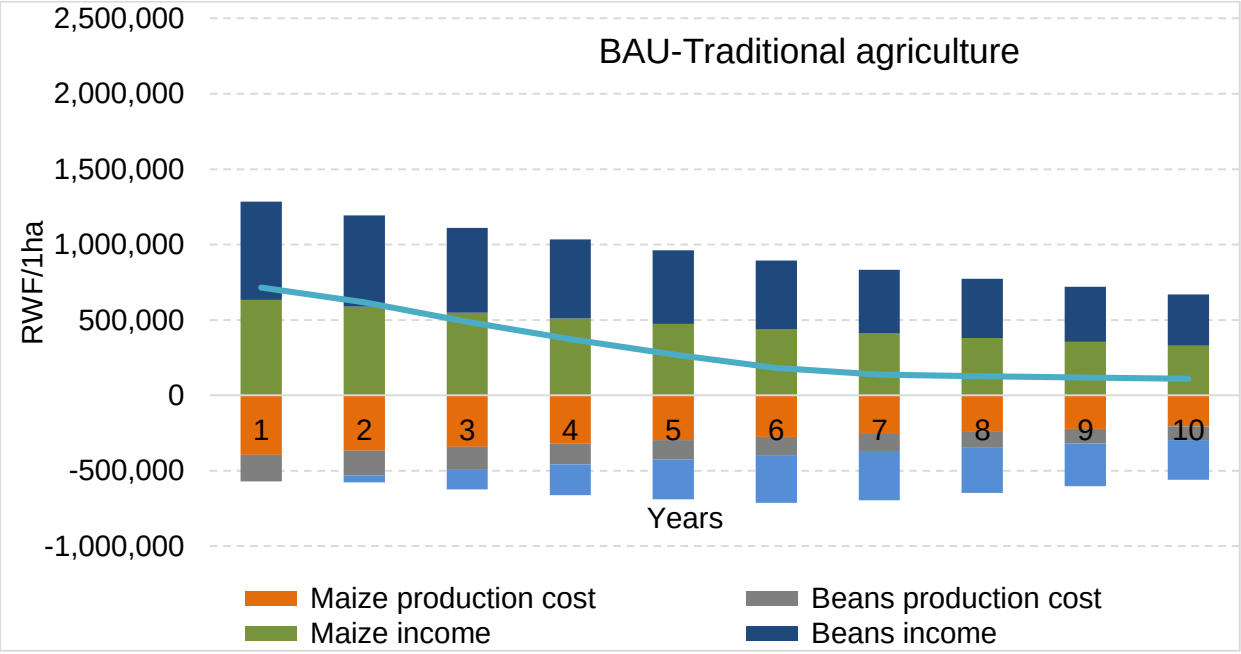


Figure 20. Annual net benefit from traditional agriculture

The below table illustrates the financial indicators of continuing with a traditional agriculture (BAU).

Intervention	NPV3%	NPV7.5%	NPV13%	NPV25%	B/R 7.5%	ROI
Traditional Agriculture	3,693,862	3,138,808	2,634,443	1,926,733	1.49	0.5

5.1.2. Cost-benefit analysis for FLR intervention packages

All proposed interventions are profitable; the anticipated benefits outweigh the cost of implementation. The section presents the difference between financial and economic analysis for each proposed intervention. The economic analysis considered carbon and avoided soil loss as indirect or public benefits.

5.1.2.1. CBA for Agroforestry System

The costs and benefits of the agroforestry system with fruit orchards are represented in the two figures below. The analysis considered an agroforestry system on a one-ha unit area. The agroforestry system is made of fruit orchards. As shown by the figure 29, the benefits of this agroforestry system outweigh the cost of establishment, and of production and management for both analyses.

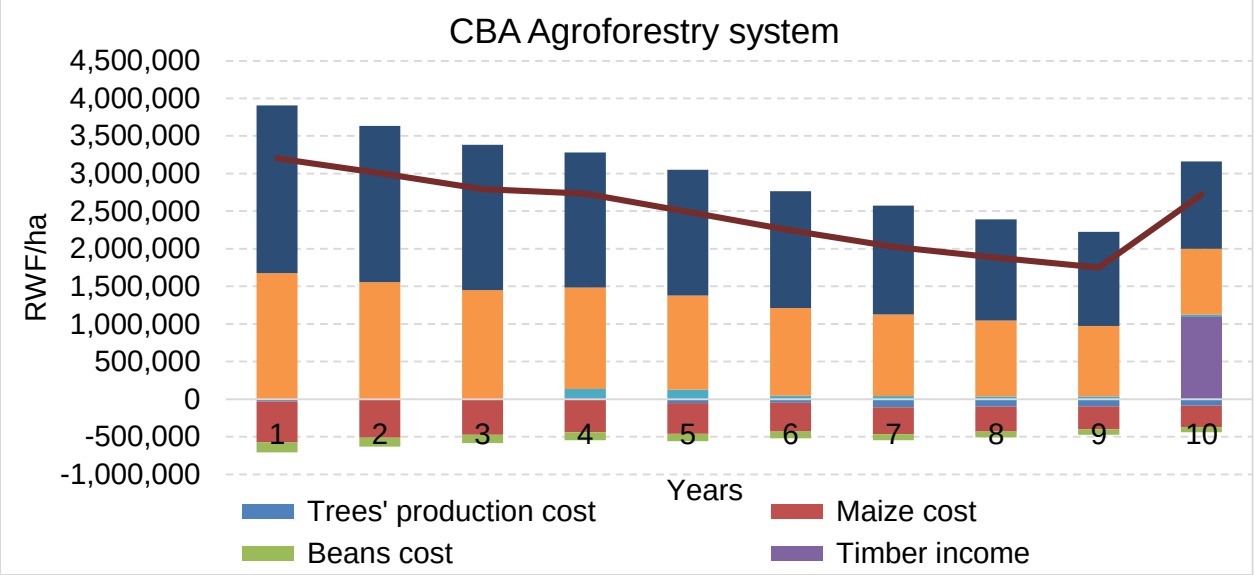


Figure 21. Annual net benefits from Agroforestry systems

5.1.2.2. CBA for Agroforestry with fodder shrubs

This is an Agroforestry system made by tree, maize, beans and fodder shrubs for animal feeding. The fodder shrubs start generating income from the second year until the end of period of 10 years.

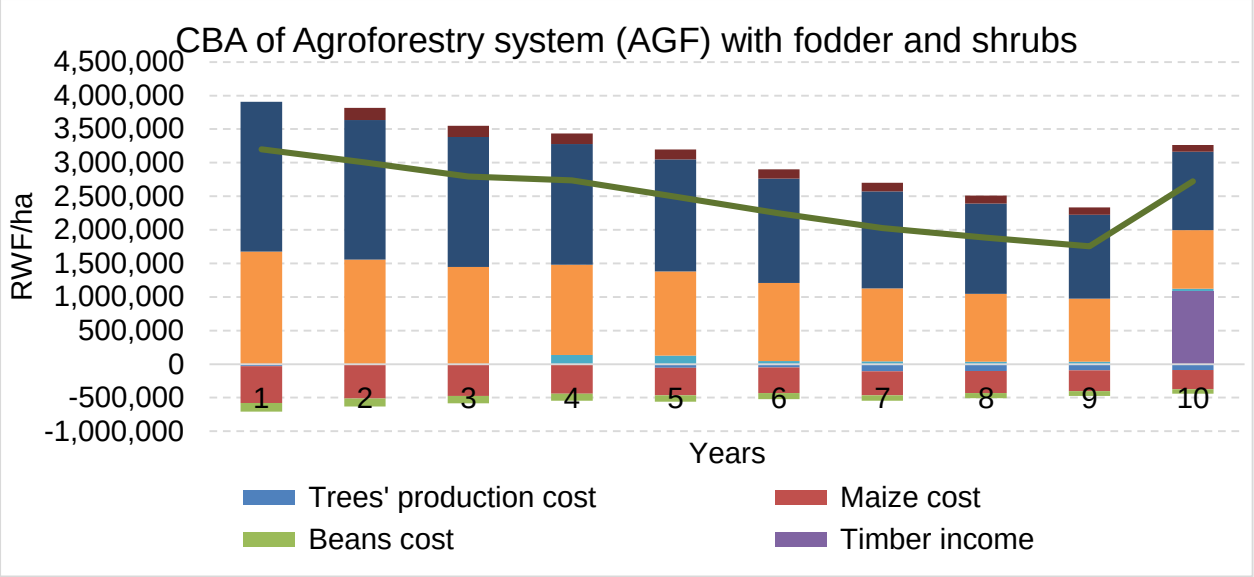


Figure 22. Annual net benefits from agroforestry with fodder and shrubs

5.1.2.3. CBA of Silvopastoral system

The cost benefit analysis of Silvopasture system was conducted. The analysis considered the system on 1ha unit area for a period of 10 years as other agroforestry, which is considered as a rotational cycle for this case. After this period, fodder shrubs are no longer productive and can be replaced by other shrubs but the trees can extend up to 30-40 years depending on type of trees. Even though the trees will not be harvested after 10 years, the model considered the value of planted trees at 10 years. Due to data availability, the financial model for Silvopasture system did not consider the benefits from increased milk from animals. The model only considered the value of fodder shrubs in case they are cut and sold to the market.

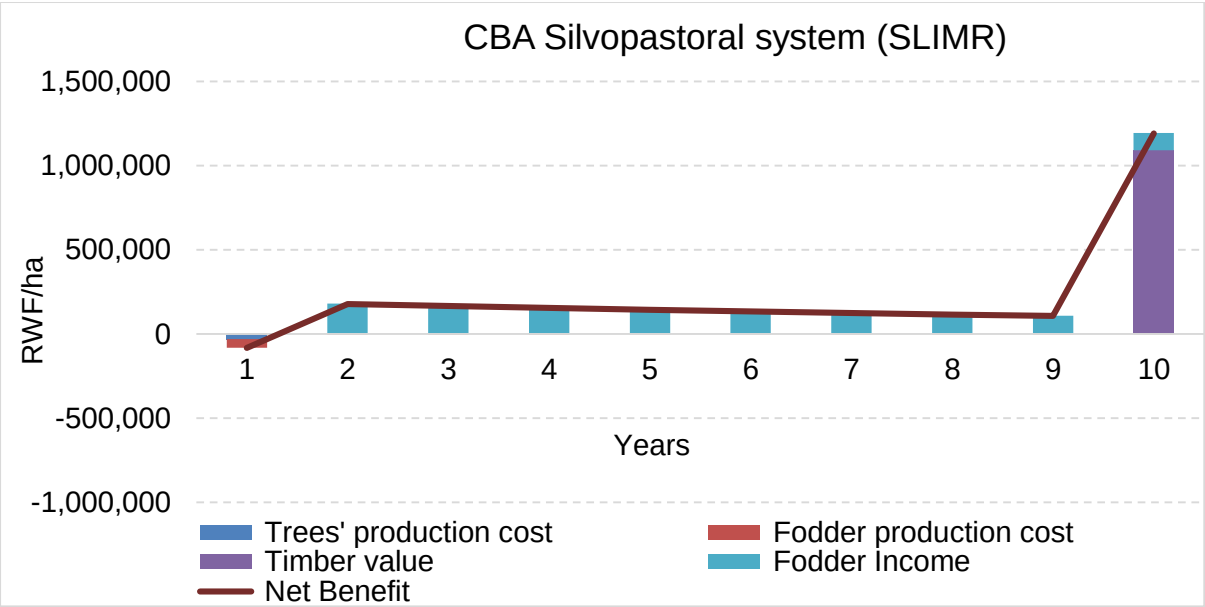


Figure 23. Annual net benefits from Silvopastoral system

5.1.2.4. CBA of Protective forests

Protective forests, riverside and roadside reserve protection were illustrated and described in the package section of this report. The riverside plantation is mixed with fodder for animals. Both interventions assume that trees may need to be replaced after a period and be used for firewood services to avoid accidents that may be caused by old unproductive trees.

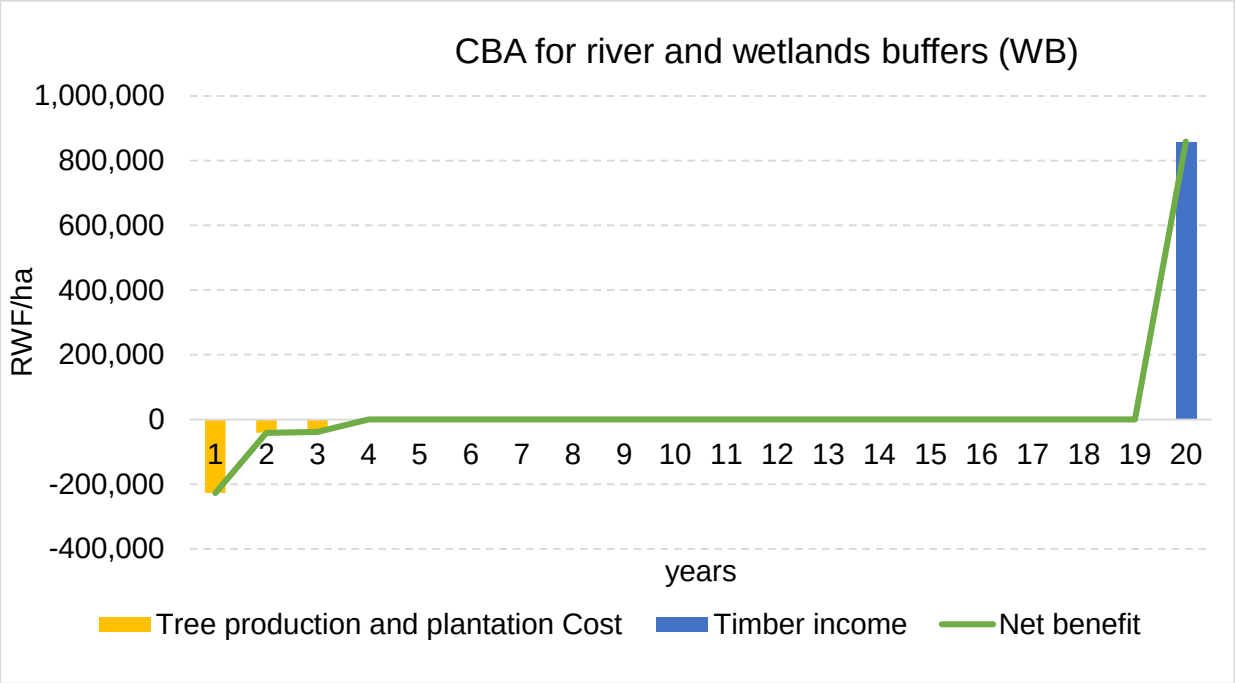


Figure 24. Annual net benefits from river and wetland buffers

The Figure 24 and Figure 25 illustrate present protective forests, roadside plantations and riparian forests respectively through the estimation of costs and benefits of tree plantations along roads and riparian areas. The cash flow models were developed for an area of 1 ha with a rotation period of 20 years. This period reflects the planted trees species, (eg. *Grevillea robusta*) be replaced after 20 years for timber or other services. Normally, protective forests are not harvested but over mature trees on roads/rivers which are no longer productive and can cause other accidents. Trees can also be replaced due to public benefits like their capacity to sequester carbon, biodiversity benefits etc. Riparian forests include both riverside and lakeside plantations.

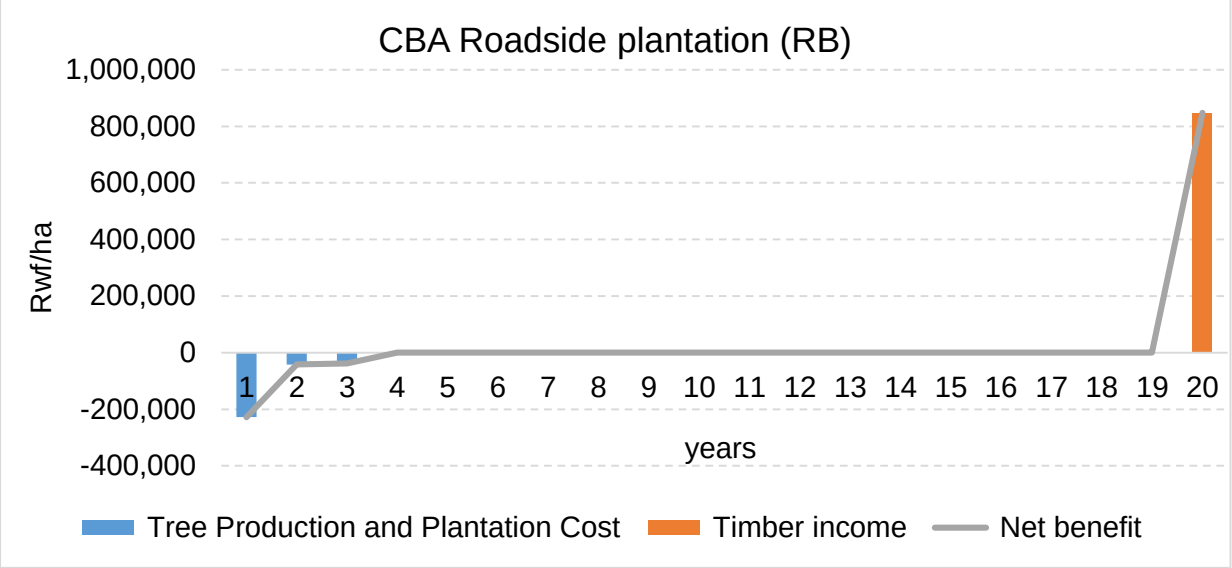


Figure 25. Annual net benefits from roadside plantation

5.1.2.5. CBA for Eucalyptus Forest plantation (woodlot) and Rehabilitation

This FLR action also evaluates the establishment of woodlots with Eucalyptus trees on degraded lands (figure 6). Though the main purpose of this FLR action is the production of energy (fuelwood) and other wood products (timber for construction, stakes, electric poles, etc.), this system also produces timber at the end of the rotation period, depending on silviculture practices adopted by the forest owner. The woodlot is harvested in years 8, 15 and 22 to provide energy, wood products and timber at year 29 which is considered as physiological maturity. After this period, trees are no longer productive and can be uprooted for a new forest plantation. The results show a positive annual net income when products are sold and no income or costs in the years without any harvest taking place. The figure 7 illustrate the Eucalyptus Forest rehabilitation which involves additional costs of stamps removal and bush clearing as expensive operations.

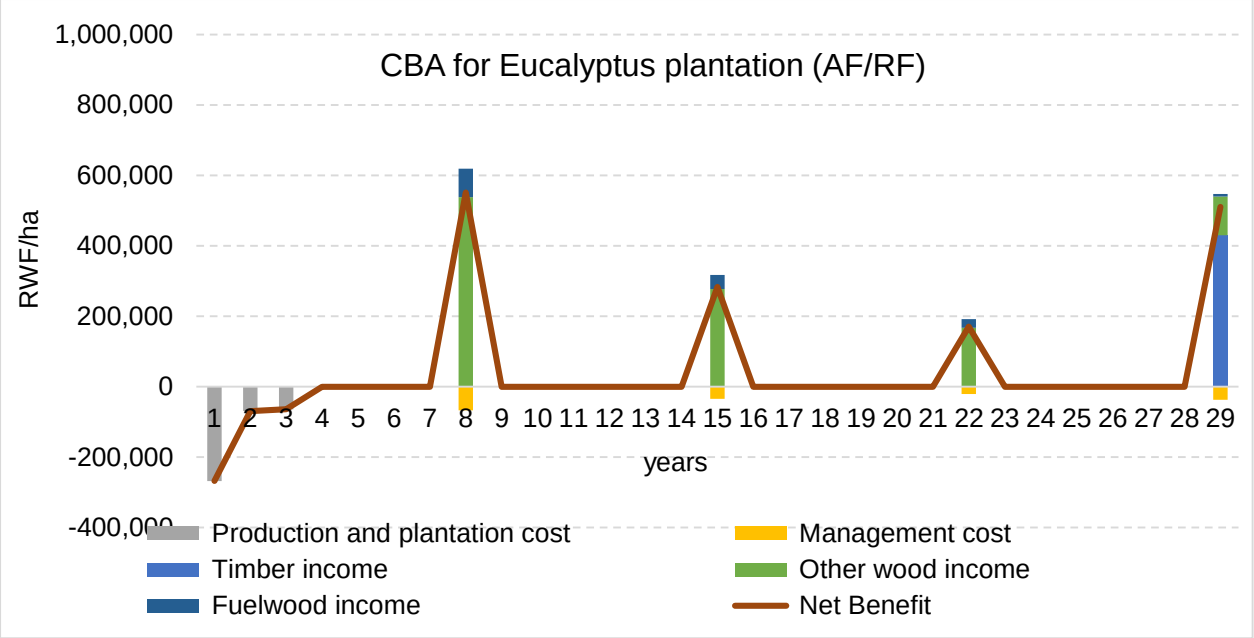


Figure 26. Annual net benefits from the establishment of new Eucalyptus woodlots

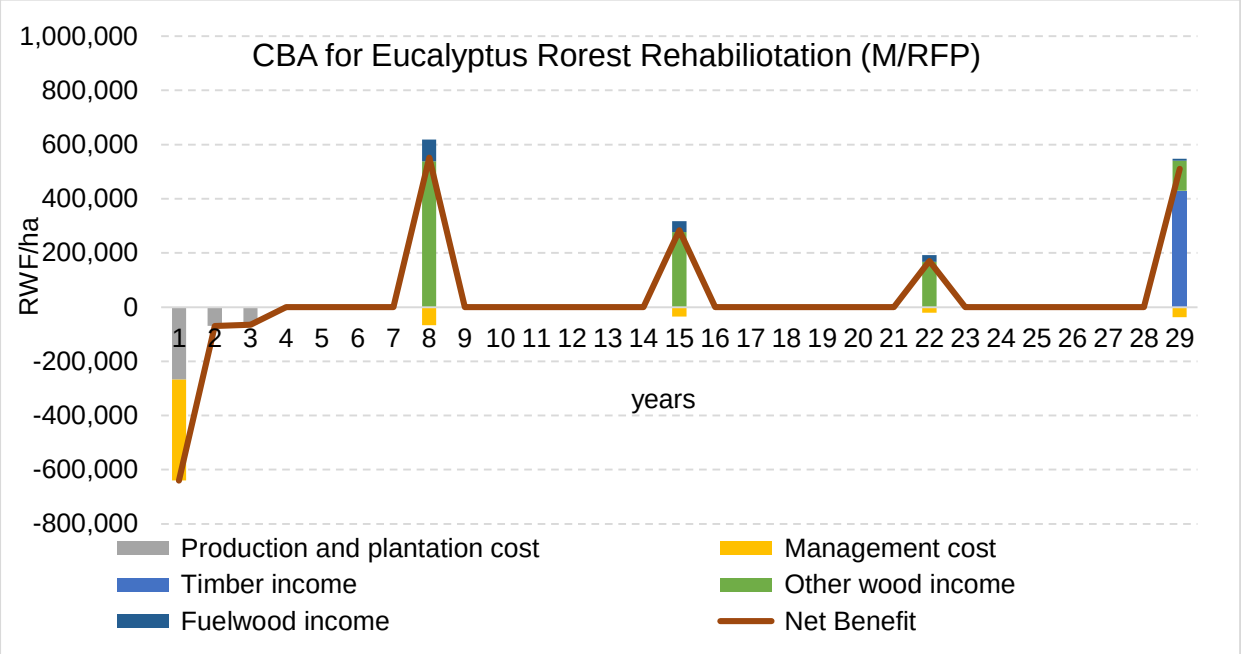


Figure 27. Annual net benefits from the rehabilitation of Eucalyptus woodlots

5.1.2.6. CBA for Woodlot made by indigenous trees

As the biodiversity evolves and for other ecological benefits, it is also important to think on the historical background of including indigenous species that can provide equal benefits to avoid high dominance of Eucalyptus plantation. The dominance of mono-species has shown risks from diseases and termites which may be disastrous.

The below figure illustrate the CBA results from establishment of *Maesopsis Eminii* woodlot for a

period of 30 years.

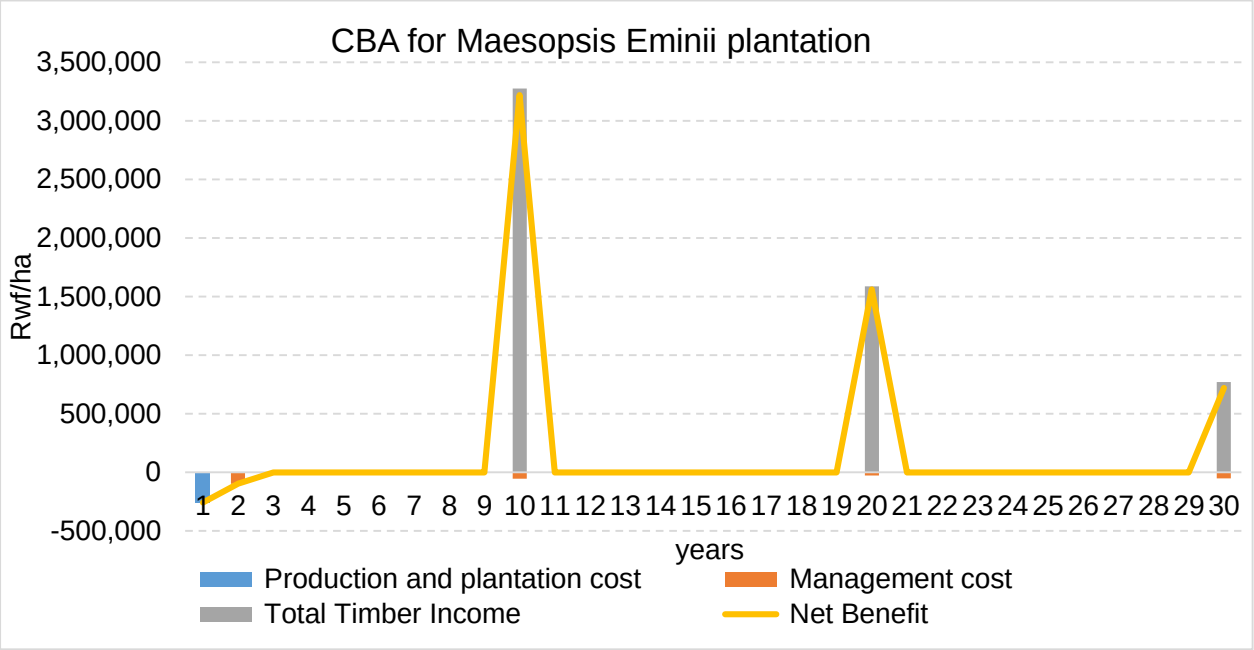


Figure 28. Annual net benefits from the rehabilitation of Eucalyptus woodlots

The financial indicators include the Net Present Value, Benefit Cost ration and Return on Investment. higher NPV compared to the agroforestry system with only maize and beans, due to additional income from fodder. The agroforestry systems both have a higher NPV than what would have been generated with the previous agricultural practice (Table 12). The BCR is positive for all three options but agroforestry with maize, beans and fodder has the highest BCR, and presents the highest ROI. Continuation of traditional agriculture of maize and beans has the lowest ROI and BCR. The financial indicators (NPV, BCR and ROI) of the traditional system are relatively lower compared to related agroforestry systems, indicating the contribution of FLR actions.

Table 12: Summary of Financial indicators per interventions

Restoration packages/Interventions	NPV7.5%	B/C	ROI
Agroforestry system with maize and beans	24,855,802.55	5.5	4.5
Agroforestry system with maize, beans and fodder shrubs	26,027,333.20	5.6	4.6
Silvopastoral system	2,233,449.55	22.4	21.4
Roadside forest plantation	539,406.28	2.7	1.7
Riparian forest plantation	552,084.77	2.8	1.8
Eucalyptus woodlot (afforestation)	1,114,922.08	2.9	1.99
Woodlot Rehabilitation (reforestation)	742,829.06	1.7	0.8
Woodlot with indigenous trees (*Maesopsis Eminii*)	5,149,120.26	11.59	11.8

5.1.2.7. Sensitivity analysis

The sensitivity analysis is used to assess how the change in inputs and the discount (margin tax rate) will affect such output as the net present value (NPV) of the restoration interventions. It appears that the NPV decreases as the discount rate increases. To test the robustness of financial analysis, the sensitivity analysis used the official discount rate of Rwanda central bank of 7.5%. The analysis considered the change in discount rate, which might be linked to the inflation throughout the rotation period of several proposed interventions. The below table shows the results for financial analysis with different discount rates.

Table 13. Sensitivity analysis for both economic and financial analysis

Restoration packages	Financial analysis			
	NPV3%	NPV7.5%	NPV13%	NPV25%
Agroforestry system with maize and beans	31,157,597	24,855,802	19,479,758	12,650,801
Agroforestry system with maize, beans and fodder shrubs	32,662,097	26,027,333	20,366,620	13,177,217
Silvopastoral system	3,147,643	2,233,449	1,521,367	742,408
Roadside forest plantation	1,666,197	539,406	24,745	**(209,791)**
Riparian forest plantation	1,887,667	552,085	59,458	**(205,179)**
Eucalyptus woodlot (afforestation)	3,089,055	1,114,922	308,296	**(115,367)**
Woodlot Rehabilitation (reforestation)	2,700,706	742,829	**(45,686)**	**(435,367)**
Woodlot with indigenous trees (Maesopsis Eminii)	10,836,897	5,149,120	2,360,137	503,883

5.1.3. EP-FLR implementation costs

The below table presents the total cost for each of the proposed interventions without considering management costs that will be accrued through the restoration period of interventions. The unit cost for establishing each of the FLR intervention is based on community approach and it includes all activities required to establish a standard restoration action in order to accrue multiple benefits.

Table 14. Implementation cost of FLR interventions

Restoration interventions	Acronyms	Area (Ha)	Unit cost (RWF/Ha)	Total Cost (RWF)
Agroforestry (with fodder)	AGF	227,764	264,000	60,129,696,000
Greening built-up areas	GBPA	89,858	293,000	26,328,394,000
Assisted Natural Regeneration	ANR	36,871	411,000	15,153,981,000
Wetlands Buffers (lakes and swamps)	WB	35,199	293,000	10,313,307,000

Silvopasture and Improved management of ranches	SLIMR	29,044	120,500	3,499,802,000
Management & reforestation	M/RFP	12,084	768,000	9,280,512,000
Afforestation & reforestation of woodlots	AF/RF	5,644	411,000	2,319,684,000
Protective Road buffer	PRB	3,629	293,000	1,063,297,000
River buffer	RB	2,476	293,000	725,468,000
TOTAL		**442,569**		**128,814,141,000**

5.2. Financing mechanisms

The economic, ecological, and environmental values of forest landscape restoration are increasingly being recognized, and many countries have understood the need to better manage their resources. Forest landscape restoration is a long-term process and will require a sustained source of funding. Even if there is an overreliance on grants, either from short-term or long-term projects, grants are not the only source of funding. Traditional financing sources of FLR/restoration in developing countries have been domestic public and private, foreign public and private, and international organizations, including NGOs. The global financing trends in general are changing, and a wave of economic liberalization is providing incentives for increased private sector participation (Schuyt, K., 2005).

The key to financing opportunities from both private and public funding sources for landscape restoration lies in recognizing its full economic and financial value. This necessitates estimating and recognizing the economic values of restoration and therefore recognizing the benefits provided by restoring landscapes. The restoration or loss of these landscape benefits can then be more realistically weighted against other possible uses of land. In a landscape context, it then becomes possible to better select areas within the landscape for different uses, allowing a potentially more complete range of values and benefits to be offered. This requires a proper pricing of forest goods and services and setting up a mechanism where money is transferred to pay these prices. One way of FLR finance is through Payment for Ecosystem Services (PES), which consists of selling environmental services from Forest Landscape Restoration such as carbon sequestered, watershed protection, and other biodiversity services. The PES mechanisms ensure that those who use these services pay those who supply these services. New opportunities for financing large-scale restoration are rising from the private sector in addition to public funding sources.

The section below discusses different sources of funding at the national and sub-national levels:

5.2.1. Multilateral and bilateral donors

Despite the declining overseas development assistance, efforts must be directed at maintaining current funds from multi and bilateral aid. The environment has been mainstreamed in all development activities under the new sector approach embraced by many donors' agencies. Successful proposals for forest landscape restoration from multilateral and bilateral donors need to explain how forest landscape restoration activities will address poverty alleviation while mitigating climate change. Furthermore, it is also important to use overseer development agencies

to leverage private funding for restoration. The World Bank's sustainable Forest Market Transformation Initiative (SFMTI) and United State Agency for International Development (USAID) Biodiversity Conservation Network are perfect examples of initiatives for this category and can be expanded to attract more funding

5.2.2. Domestic public financing sources

This financing mechanism consists of using the government budget (national and district) for landscape restoration activities. The general strategy to increase public sources for large-scale restoration must involve activities such as improving expenditure policies on forestry, reforming macroeconomic policies and putting in place new incentives, subsidies, and technical and institutional changes to support restoration that provide a wide range of benefits. In the wake of drought in the Eastern Province, AREECA programme can leverage the various studies to produce s strategic policy brief targeting the district or province and national government on the increased funding for sustainable rangeland restoration.

5.2.3. Private for-profit sources

This financing mechanism includes the mobilization of private, institutions, farmers, and households to invest in forest landscape restoration. The household investment will have an effect only if the project offers short-term benefits with an acceptable level of risk. Another example of private investment includes NGO that has forest business related like timber investment companies. Equity bank, one of the key project stakeholders and representing the larger business community, offers a perfect opportunity to expand restoration financing through not only its social-corporate responsibility plans (contributing to the 15 billion trees initiative[12]) but also creating local FLR investment plans targeting individual farmers and farmer groups. Other micro-financing institutions include the Agricultural Finance Corporation and Kenya Women Micro-financing.

5.2.4. Private non-profit organization

Private non-profit includes financing channelled through local communities, international foundations and NGO for forest landscape restoration activities. International NGOs have become important for providing new financing mechanisms, of which environment trust funds of foundations are particularly interesting for providing financing to natural resources.

5.2.5. Adoption of Payment for Ecosystem services

A good example of payment for environmental goods is the certification body, which develops a market for suitably produced products that come with a certificate. Another example is the PES mechanism where downstream beneficiaries pay for the sustainable management of forests upstream. This mechanism provides opportunities for innovative funding for forest landscape restoration. While both of them are applicable in the Eastern Province, strong policy and institutional, frameworks are critical in the development and operationalization. An example of a company that can potentially work with the Eastern Province districts to roll out a typical PES would be Simba cement. Given the complexity and politics involved in such a process, developing

[12] https://www.president.go.ke/wp-content/uploads/DOC-20221105-WA0163..pdf

this mechanism requires a partnership with the national government where most of the natural resources management policies are developed.

5.2.6. Available sources of finance in Eastern Province

There are fairly good number of partners and restoration efforts taking place already in Eastern Province, however, since there is an ambitious target to restore hundred percent the areas identified that need restoration, more project need to be developed for that purpose.

Table 15. Projects and partners currently contributing to FLR implementation in Eastern Province

FLR projects	Partners	Budget	Source of funds	Period	Beneficiary districts
TREPA	IUCN, RFA, WORLD VISION, CORDAID, ENABEL	30M$	GCF	2022-2027	Bugesera, Gatsibo, Kayonza, Kirehe, Ngoma, Nyagatare, Rwamagana
COMBIO	IUCN, RFA, ENABEL	7.8M$	SIDA	2022-2027	Bugesera, Gatsibo, Kayonza, Kirehe, Ngoma, Nyagatare, Rwamagana
KWIIP	RAB	86M$	IFAD	2021-2026	Kayonza
CDAT	RAB	300M$	World Bank		Bugesera, Gatsibo, Kayonza, Kirehe, Nyagatare
AREECA	IUCN, RFA	1.2M €	GIZ	2022-2024	Kirehe, Nyagatare
NAP	REMA	6M$	GEF	2020-2025	Nyagatare, Kirehe
SMART	DUHAMICADRI		WFP	2020-2022	Kayonza
Tree Planting Campaign	ONE Acre Fund		One Acre FUND	2018-2030	Bugesera, Gatsibo, Kayonza, Kirehe, Ngoma, Nyagatare, Rwamagana
Promoting AF/FLR for climate change adaptation for Poor and vulnerable HHs	Movement Pour Christ au Rwanda (MPCR)	74,000$	AFF (African Forest Forum)	2023-2025	Gatsibo
Forest Rehabilitation	Gatsibo	58M Rwf	Government of Rwanda		Gatsibo
Muvumba Resilience Community-Led Adaptation Initiative	Rwanda Water Resources Board and Nyagatare	4.5B Rwf			Nyagatare

FLR projects	Partners	Budget	Source of funds	Period	Beneficiary districts
Renewable energy and energy efficiency	TVET School of Eastern Province	3.2B Rwf			EP/TVET School greenhouse gas emissions and improve water access

6. FLR Implementation Strategy (2024 – 2029)

Landscape restoration refers to processes undertaken to assist in the recovery of deforested, degraded and/ or damaged ecosystems. These processes eventually lead to the restoration of the ecological functionality of the affected landscapes while delivering several environmental and socio-economic benefits including improved human well-being, enhanced livelihoods, watershed protection, biodiversity conservation, amongst others.

The Eastern Province Forest Landscape Restoration (EP-FLR) Strategy therefore aim to achieve a sustainable land management, and supply of planted forest goods and services to deliver a range of economic, social, and environmental benefits to Eastern Province in particular and to Rwanda at large. The EP-FLR strategy will cover about 442,571 hectares of land with various restoration actions, distributed in seven districts (Table 14). The identified restoration interventions include mainly but is not limited to:

- Integrating tree planting within agricultural landscapes into agroforestry systems (AGF) covering about 227,764 hectares, and enriching pasture land and ranches with tree fodders (SLIMR) on 29,044 ha.
- The afforestation, reforestation and management of existing forest plantations (AF/RF, M/RFP) of 17,728 hectares identified to increase the wood supply in timber and biomass energy in the Eastern Province.
- Assisting natural regeneration (ANR) and conducting enrichment planting on 36,871 hectares of poorly-stocked and degraded forest reserve is also crucial to many relic natural forests and Akagera National park.
- Greening populated areas and planting roadside reserves were also identified as key to build resilience to newly developed Eastern cities and towns.
- The total cost of implementation of this FLR strategy amounts up to **128,814,141,000 Rwandan francs**

Table 16. Table showing restoration interventions and area proportion in Eastern Province districts

District	*Bugesera*	*Gatsibo*	*Kayonza*	*Kirehe*	*Ngoma*	*Nyagatare*	*Rwamagana*	*Total*
AGF (Ha)	33,948	28,079	39,231	31,116	18,145	59,195	18,050	**227,764**
GBPA (Ha)	23,878	10,694	10,381	9,066	9,473	13,544	12,823	**89,858**
ANR (Ha)	4,043	3,539	12,242	3,978	162	12,859	49	**36,871**
WB (Ha)	6,991	6,222	5,733	3,303	5,103	4,090	3,758	**35,199**
SP/IMR (Ha)	193	788	6,370	2,584	28	18,971	111	**29,044**
M/RFP (Ha)	567	1,895	1,992	3,013	518	2,835	1,264	**12,084**
AF/RF(Ha)	640	788	1,231	1,345	574	722	345	**5,644**
PRB(Ha)	1,087	384	512	448	272	783	144	**3,629**
RB (Ha)	86	258	206	464	275	808	378	**2,476**
Total	71,432	52,646	77,897	55,317	34,550	113,807	36,920	**442,571**

AGF Agroforestry (with fodder), ***GBPA*** Greening built-up areas ***ANR*** Assisted Natural Regeneration

WB Wetlands Buffers (lakes and swamps) ***SP/IMR*** Silvopasture and Improved management of ranches ***M/RFP*** Management & rehabilitation of forest plantations ***AF/RF*** Afforestation & reforestation of woodlots (<2Ha) ***PRB*** Protective Road buffer ***RB*** River buffer

Implementing this EP-FLR strategy, jobs are expected to be created for in rural communities especially for youth and women through creation of tree nurseries, forest and tree planting and maintenance, investment creation through forest management and value addition, research and extension through forest farming schools, capacity building for sustainable forest management, timber utilization, and marketing etc. EP-FLR will also enable improving forestry governance in the regulation and management of forest plantations by adhering to best practice principles which are associated with FLR benefits.

6.1. The context of FLR strategy

EP-FLR aligns with Rwanda Forestry Policy (RFP) and Forestry Sector Strategic Plan (FSSP). The Forest Sector Strategic Plan (FSSP) is a national planning instrument relating to the period 2018-2024. It was adopted to achieve the medium to long-term policy actions presented in the 2018 National Forest Policy (NFP) for the development and management of forest sector. The Plan's objectives therefore intend to implement the Policy Statements of the NFP. The following are the FSSP's objectives: 1) the capacity of forest institution and actors will be enhanced to match the requirements for Sustainable Forest Management (SFM); 2) to ensure Sustainable Forest Management through the establishment and implementation of integrated forest management plans at all levels; 3) the private sector will be encouraged to increase their investment in forestry sector; 4) appropriate regulatory instruments will be developed and implemented to ensure sustainable and efficient biomass supply; 5) biodiversity and ecosystems services and values will be enhanced in accordance with national and international agenda; 6) active participation of stakeholders in Sustainable Forest Management to ensure ownership and proper benefit sharing; 7) the adoption of Agroforestry and Trees Outside Forest (TOFo) techniques will be enhanced to contribute to overall forest resources and agriculture productivity.

To ensure sustainable forest management, the plan lays down measures and foresees interventions applicable to management of both private and public forests. Integrated forest management plans shall be established and implemented at all levels. With respect to forest ecosystem conservation, the objective is that biodiversity and ecosystems services and values will be enhanced in accordance with national and international agenda. The following outcomes are expected: (i) forest ecosystems are sustainably managed; (ii) natural forest ecosystems and native tree species are identified, mapped and gazetted as protected; (iii) management plans are formulated and implemented for each protected area; (iv) threatened native forest tree species are identified and protected; (v) Payment for Ecosystem Services (PES) is in place. With specific regard to agroforestry, the adoption of Agroforestry techniques will be enhanced to contribute to agriculture productivity.

The following are policy focus and statements from which FLR is aspired. Table 17 shows policy aspirations from which FLR strategy shall contribute.

Table 17. Rwanda forestry focus and Policy Statements from which FLR strategy for Eastern Province of Rwanda is aspired

Policy focus from which FLR aspires	Policy statements
Policy Statement 2: Sustainable Forest Management	Ensure SFM through the establishment and implementation of integrated forest management plans at all levels.
Policy Statement 3: Private Sector participation	Private sector will be encouraged to increase their investment in forestry sector.
Policy Statement 4: Woody Biomass Energy	Appropriate regulatory instruments will be developed and implemented to ensure sustainable and efficient biomass supply
Policy Statement 5: Forest Ecosystem Conservation	Biodiversity and ecosystems services and values will be enhanced in accordance with national and international agenda.
Policy Statement 6: Participatory Forest Management	Active participation of stakeholders in Sustainable Forest Management to ensure ownership and proper benefit sharing.
Policy Statement 7: Agroforestry and Trees Outside Forest (TOFo) Development	The adoption of Agroforestry and Trees Outside Forest (TOFo) techniques will be enhanced to contribute to overall forest resources and agriculture productivity.

Table 18. FLR aligned with the outcomes of the Forestry Sector Strategic Plan (FSSP)

FSSP Outcomes	FSSP Outcomes aligned with FLR	Policy Statements and Focus
FSSP Outcome 2.1	Forest management planning and its implementation are enhanced to ensure Sustainable Forest Management	PS2,3,4,6
FSSP Outcome 5.1	Forest ecosystems are sustainably managed	PS5,6
FSSP Outcome 7.1	Agroforestry adopted by farmers and tree outside forests (TOFO) best practices are adopted in urban areas	PS7
PSTA 5 Outcome 1.1	Climate Smart Crop Production and Productivity (Output 1.1.4 Climate smart agriculture and improved land management for sustainable production	PS7

6.2. Alignment with other related strategies and commitments

Forest Landscape restoration has a unique aspect of integrating forest land use with other rural and urban land uses and it must operate at a range of different scales. The public forest estate is diverse – ranging from large, productive, managed woodlands to small, natural, semi-natural woodlands with high biodiversity value. Private forests are from small scale woodlots to scattered trees in agricultural land (agroforestry).

This strategy will contribute to a distinct range of priority areas defined in forestry and environment strategies. It will help to address current and emerging challenges on cross-border issues such as biodiversity, plant health and climate change.

The Eastern Province FLR strategy will reflect wider issues outlined in the forestry policy, in the National Strategy for Transformation (NST2), in the Sustainable Development Goals 2030 (SDGs), as well as in the Green Growth Strategy for Climate Change and Low Carbon Development 2050 (revised GGCRS).

1. The NST2 stress that all undertakings should abide to the protection of environment and sustainable use of Rwanda's natural resources.

2. GGCRS formulates an action programme for sustainable forestry, agroforestry and biomass energy. Forestry related sub-programmes (12) cover:

a) enhancing silviculture practices
b) improving forest management for degraded forest resources
c) Agroforestry.
d) Improving the use of biomass energy through improved cook stoves.

GGCRS calls for effective protection and sustainable management of protected areas. This will be possible by maximizing the community involvement and benefit sharing as well as establishing participatory Payments for Ecosystem Services (PES) schemes.

3. The United Nations development agenda entitled "Transforming our world: the 2030 Agenda for Sustainable Development" known as SDGs was entrusted to Rwanda the Africa host of the Sustainable Development Goals Centre – which is expected to drive innovation and research towards achievement of the SDGs in Africa. The SDGs which are linked to the sector are ultimately fully reflected in the Rwanda Forest Sector Strategic Plan 2017-2024 that derives from the r National Forestry Policy. There two major SDGs directly related to forestry: Goal 13 which calls for actions to combat climate change and its impacts and Goal 15 which deals with: 1) protection and restoration of terrestrial ecosystems 2) promotion of sustainable management of forests, 3) combating desertification, 4) halting and reversing land degradation and biodiversity loss.

4. Rwanda's comprehensive National REDD+ Preparation Proposal (RPP) calls for systematic studies to assess the background, level and impact of drivers of deforestation and forest degradation.

5. The National Tree Reproductive Materials Strategy (2017-2026) the production of high quality tree reproductive material for sustainable forestry. Particularly, TRM strategy calls for selection of tree seeds suitable for Agroecological zones of Rwanda. TRM strategy also encourages the conservation of tree biodiversity. The focus shall be on *ex-situ* and *in-situ* conservation[13] to be able to conserve high value exotic and indigenous tree genetic resources for the supply of high quality reproductive materials for use in forestry and agroforestry programmes in the future.

[13] Ex-situ conservation means the conservation of biological diversity outside its natural habitat. In the case of tree genetic resources, this may be in seed genebanks, in vitro genebanks or as live genebanks.

6. The new strategic plan for agricultural transformation in Rwanda (PSTA-5), an instrument implementing the National Agriculture Policy 2018, has a particular focus on agroforestry as a means for sustainable agricultural land conservation. PSTA-5 encourages the investments in hill slopes soil and water conservation and agroforestry (tree belts, contour belts) and non-tree measures (grass trips, contour bunds, planting of fodder grasses on bunds/ridges, use of permanent, perennial vegetation on contours), integration of trees on farm plots, tree belts, protective forests etc.). The choice of trees to be used in Eastern Province have been tested (refer to the list in annex 2).

7. The Bonn Challenge (2011) is a global aspiration to restore 150 million hectares of the world's deforested and degraded lands by 2020. In 2011, Rwanda made its pledge to the Bonn Challenge to restore 2 million hectares of degraded forests and agricultural land. This represents proportionally the highest national commitment to the challenge. To implement this commitment in Eastern Province, sub-national ROAM assessment was done to inform this strategy.

6.3. Formulation process of EP-FLR strategy

The EP-FLR formulation process has been designed towards having a consultative and evidence-based strategy. Implementation of EP-FLR will require a multitude of stakeholders, and therefore, significant efforts have been made to make the strategy formulation inclusive and participatory while responding to the national policy directive and international FLR directives including AFR 100 initiative.

The process is aligned to the planning guidelines, which requires a consultative process at local and central levels. To ensure alignment and coherence, the strategy was formulated in alignment with Rwanda's Vision2050, National Forestry Policy and Forestry Sector Strategic Plan. It also aligned with National Strategic for Transformation (NST2), Green growth and Climate Resilience Strategy (Revised GGCRS 2022 -2050, Strategic Plan for Transformation of Agriculture (PSTA 5), and Rwanda's commitment to Climate action through updated Nationally Determined Contribution (NDC, 2022). EP-FLR strategy also took into consideration international commitments, such as the Bonne Challenge 2011 and AFR 100, the Sustainable Development Goals (SDGs).

The drafting team conducted a systematic review of relevant literature, national documents and secondary data sources, including the National ROAM-Rwanda (2014), prior strategic documents (FSSP, GGCRS, NST1, NDC …), Policies, Laws and Regulations, and reports. Additionally, publicly available datasets on district land use plans (DLUPs), forest cover dataset, erosion control data, road network, data of ecosystems (river, wetlands and water bodies) were collected from different government offices and analysed to come up with restoration opportunities areas for food security, reduced erosion, enhanced biodiversity conservation, water yield and carbon sequestration. This allowed for a holistic understanding of the historical and current context, challenges, and the progress made in the restoration of Eastern Province degraded landscapes in order to determine gaps in restoration and identify restoration actions and package appropriate for each of the dominant land uses at district level.

There have been primary data collection and consultations across the Eastern Province (EP) and with representatives from seven EP districts. Focus group discussions with Key FLR actors including farmers and value chain actors have been held in every district of Eastern Province. Civil society, the private sector, and development partners have been consulted through

the district JADF.

6.4. FLR outcome 1. Sustainable forest management

Despite that Eastern Province present relatively large forest land compared to other province, the province suffers from a very low productivity: More than 80 percent of forest plantations are degraded and others are at the end of its production cycle. Due to short rotations stumps are exhausted and in the last three decades, the annual wood increment dropped up to 8m3 per hectare.

Figure 29. Example of a well-managed eucalyptus forests (yield up to 300m3 per hectares)

6.4.1. Output 1.1. Afforestation and Reforestation

The EPFLRS prescribes a target for the establishment of 17,728 ha of forest plantations. comprising public and private forests including the rehabilitation of poorly managed eucalyptus and pine plantations across eastern districts.

Figure 30. A well rehabilitated eucalyptus forest in Gicumbi District, Gisuna cell, Byumba sector by Green Gicumbi project

6.5. FLR outcome 2. Sustainable forest ecosystems

6.5.1. Output 2.1. Wetlands, water bodies and river protected by buffers

An effective and environmentally friendly method of river bank erosion protection is to ensure that the banks have healthy vegetation. A healthy riparian zone will have a mixture of herbaceous plants, shrubs and trees extending back from the bank for at least 10 metres, preferably more. The roots of plants can help the banks maintain their structure and provide a barrier against erosion. The plants not only protect the soil against river water but also prevent erosion from rainfall as well. The tree species proposed here are *Acacia kirkii.* The fodder grass can include *Pennisetum purpureum*, *Pennisetum clandestinum*, *Medicago sativa*, *Chloris gayana*, *Eragrotis superba* and *Brachiaria ruziziensis*.

Figure 31. Example of a model for protection of riverbanks to preserve water quantity and quality Acacia kirkii

There are multiple benefits from establishing buffer zones around rivers, water bodies and wetlands

- buffers improve water quality by creating a physical barrier of rough vegetation that slows the flow of overland runoff and increases infiltration into the soil, helping to trap and retain pollutants before they reach the watercourse.
- increased infiltration of water through the diverse root systems within the buffer

zone reduces the amount and rate at which heavy rain reaches the river.

- the increased roughness of river-banks with wooded or shrubby buffer strips helps to slow the flow of flood waters, reducing erosion rates and flood peaks.
- buffer zones allow a natural connection between a river and its floodplain, allowing flood water to spill out of the channel and reduce the intensity of flooding downstream.
- buffers provide habitat connectivity: 'wildlife corridors' for wild animals to move around the countryside.
- tree roots strengthen stream banks.
- the tree canopies provide shade to keep the river cool during hot summers.
- trees act as a barrier to prevent wind-blown agricultural pesticide and herbicide sprays from reaching the river.
- leaf litter input to the river from bankside trees and shrubs is an important food source for invertebrates.
- adequate buffer zones allow the river space to move — to erode, deposit, meander in a natural way.

6.5.2. Output 2.2. Urban greening and roadside protection

When looking across Rwandan cities and towns, trees are distributed unevenly (if not existing), negatively impacting health and environmental outcomes in neighbourhoods. As a result of historic under-investment and discriminatory housing policies such as redlining, low-income communities are more likely to live in environments with lower tree canopy and experience other types of unhealthy conditions, such as higher air pollution. As city administrations look to address this gap, it is important to also ensure that resources such as workforce development and funding are invested to ensure the long-term health of existing trees and plant more. Cities can support the establishment of permanent nurseries, and tree planting can be done through community-led efforts community works (known as UMUGANDA, and VUP).

Urban greening plays a vital role in human health by providing the following multiple social, economic and environmental benefits. The Figure 32 shows such benefits to human health[14]. From climate resiliency to community well-being, trees provide a variety of benefits. Trees reduce the amount of rainwater that becomes polluted stormwater - Urban forest systems slow stormwater flow and filter out pollutants, reducing the burden on water treatment facilities. Trees capture water on their leaves and support infiltration, increasing the amount of rain soaking into the ground. Trees filter pollutants out of stormwater, preventing them from reaching waterways. Soil can infiltrate 50% more water under the canopy than outside of the tree canopy.

Studies have shown that properly selected and planted trees can reduce outside surface temperatures as much as 20 to 40 percent, reducing the number of heat-related illnesses and death. Trees properly placed around buildings can reduce air conditioning needs by 30 percent and can save 20–50 percent in energy used for heating – reducing carbon at the same time. Trees reduce carbon pollution. Trees absorb and store carbon dioxide, one of the main contributors to greenhouse gases. Planting trees in cities and populated areas is one tool in the effort to address

[14] Adapted from USDA Forest Service

climate change and mitigation of its effect.

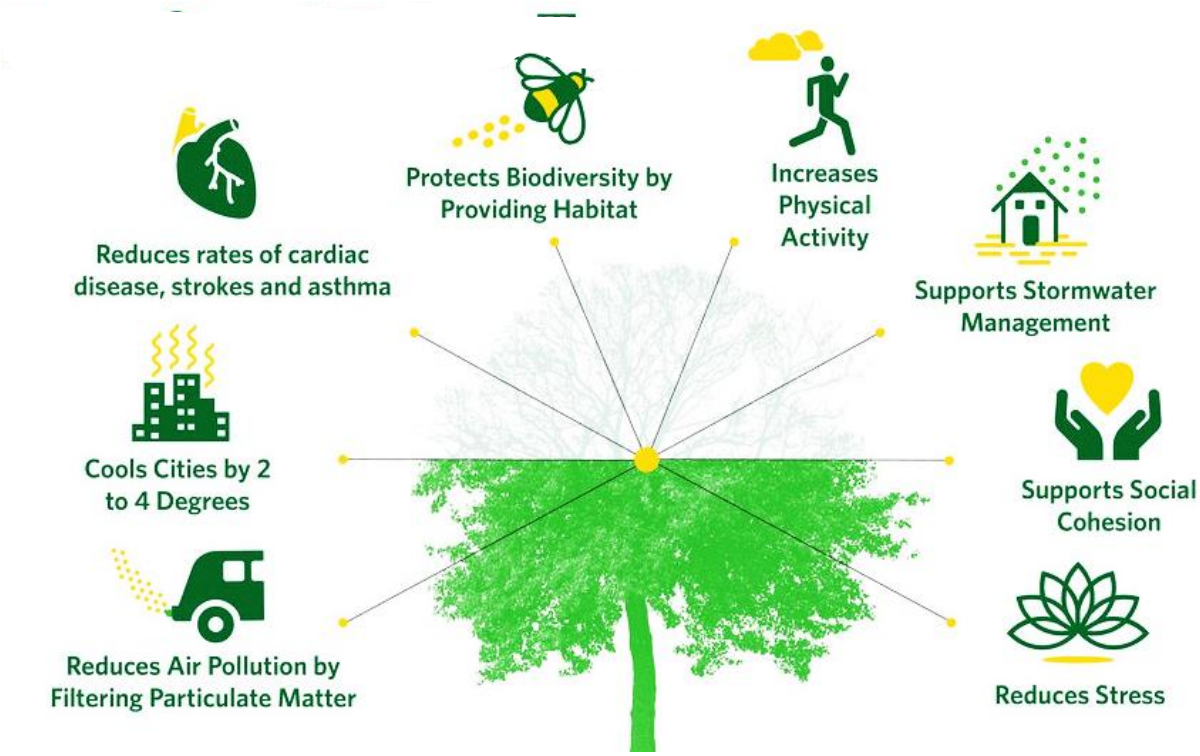


Figure 32. Multiple benefit of urban trees

The roadside forests also contribute to forestry resources and their benefits are as much as the benefits of urban trees, but the roadsides forests add the protection of roads against road accidents. These trees not only protect the road and provide shed for pedestrians, they are also ornamental with decorative yellow, and red flowers. Trees with different flower colours are mixed to increase the beautification of the roads.

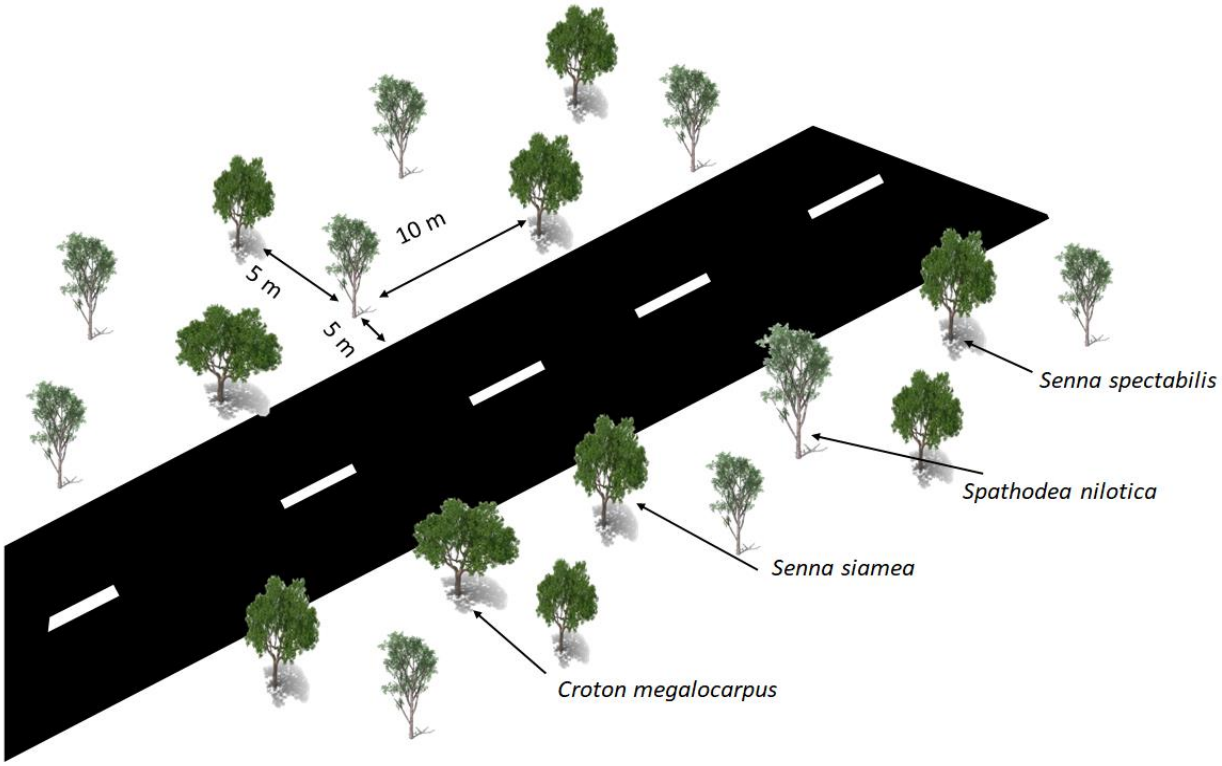


Figure 33. Roadside tree buffer model proposed for roads in Eastern Province

6.6. FLR outcome 3. Sustainable land management

6.6.1. Well established Agroforestry systems

Agroforestry is an economically and ecologically sound practice that incorporates cultivation, conservation and tree planting alongside crops or livestock farming. It is an efficient method of land utilisation by integrating unique relationships within a given ecosystem that embraces the benefits provided by trees into agriculturally productive landscapes, which can be adapted by both small as well as large-sized land-holders. The intentional combination of agriculture with forestry increases biodiversity and reduces erosion. Agroforestry also emphasises on the utilisation of various indigenous shrubs and trees to multiply output while protecting the resource base.

Figure 34. A Well-established agroforestry system along the slopes

Agro-silvopastoral systems combine domestic livestock with crops, multifunctional hedgerows, woodlots, or fodder trees. Within these broad categories, numerous varieties exist in their functional characteristics (i.e., tree and shrub components), productive functions (i.e., crops, food, fodder and fiber), and protective functions (e.g., soil conservation, windbreaks). Practices include planting high densities of trees and shrubs in pastures, cut-and-carry systems whereby livestock are fed with the foliage of specifically planted trees and shrubs in areas previously used for other agricultural practices, and using fast-growing trees and shrubs for fencing and wind screens.

6.6.2. Key benefits of agroforestry

Agroforestry is a highly advantageous land management model that goes in line with sustainable and developmental goals of every nation aiming for holistic development. Under this model, all community members generate income from crops while keeping forests alive and healthy, which is a win-win for both the farmers and the organisations implementing environmentally sustainable projects. Agroforestry, therefore, offers benefits to its stakeholders on various fronts such as- environmental, economic, and social. The aim of sustainable development is imbibed in the goals of agroforestry as it thrives to strike a balance among the socio-economic and environmental needs allowing the present and future generations to live in prosperity.

Environmental benefits: Agroforestry works towards the protection and conservation of land through effective protection of soil, control of soil erosion, salinity, and higher quality control of water tables. Agroforestry also controls water and soil runoff, thereby holding on to organic matter and essential nutrients present in the soil due to the deep-rooted trees on the site. As a solution to climate change, carbon sequestration is employed by combining livestock maintenance and overlying net fixing wooden layer, which significantly reduces the greenhouse effect. It also aids in reducing global warming.

Agroforestry improves the soil structure by constantly adding organic matter through decomposed

litter, increasing the nutrients present in the soil. Another benefit of agroforestry is the improvement of microclimate as a step to mitigate environmental change, such as reducing the temperature at the soil surface and evaporation of moisture present in the soil, through a combination of shading and mulching. Most importantly, agroforestry can reclaim degraded or eroded land and regain its lost soil fertility through conserving and replenishing the resources available. It also contributes to the restoration of natural capital.

Economic benefits: Farmers are benefited by the extra income generated by selling the tree products. Trees provide the farmers with fertilizers, timber, livestock fodder, fruits and more, which the farmer would otherwise have to buy, consequently reducing the farmers' overhead expenses. Farmers are also entitled to earning income throughout the year, depending on the crop variety and rotation. Trees used in agroforestry are of good value to the farmers, as they do not demand high maintenance, yet they can be a source of income. They also help overcome malnutrition risk by producing fruits and nuts. There are relatively fewer chances of failure of the entire crop as when compared to the traditional farming methods of single cropping. This, in a way, guarantees the farmers of some monetary returns for every crop cycle.

Social benefits: Due to the stability in employment and higher income generation, the standard of living of the farmers in rural areas is advanced. Health conditions are refined as they consume crops that are not exposed to harmful pesticides. Their quality of life, in turn, is improved simultaneously with the improvement of crop quality. Agroforestry provides the farmers with regular income eliminating their need to migrate to urban areas in search of employment, thus ensuring stabilisation and improvement of communities. The agroforestry also enables the farmers to cultivate medicinal and veterinary plants to support modern and veterinary medicine.

6.6.3. Silvopasture and improved management of ranches

Silvopastoral systems are those that combine tree growing with the production of livestock. These systems typically include pasture systems containing trees that are widely spaced or planted in clusters throughout the pasture.

Figure 35 Silvopastoral systems created by training farmers how to maintain native trees in ranches in Kibondo site, Kabarore Sector, Gatsibo district. The system improved the productivity of ranches compared with ranches without trees.

Silvopastoral systems can be managed intensively or extensively: (i) Intensive silvopastoral systems feature high-density cultivation of fodder shrubs (4000–40,000 plants per hectare) with improved tropical grasses, and tree species at densities of 100–600 trees per hectare; these

systems are managed under rotational grazing with high stocking rates and brief grazing periods interspersed with long recovery periods.

(ii) Semi-intensive silvopastoral systems rely on three-levels vegetation—pasture, shrubs with edible leaves, and trees that may also have edible leaves—to produce more edible plant material and more animal products than pasture-only systems, with opportunities for cutting and feeding tree and shrub leaves to animals during dry periods.

In Eastern Province, Silvopasture can be successfully established and managed by planting trees and forages at the same time, by planting trees into existing pastures, or by thinning existing tree stands and planting forages

Possible modalities to successfully create and manage pastures in eastern province:

1) Introducing trees into existing ranches;
2) thinning the existing woodland to allow the undergrowth to flourish (Nyagatare in Rwimiyaga and Karangazi sectors).
3) Introducing livestock forage into a woodlot or tree plantation or planting trees and forages at the same time (use forest space to produce livestock forage)

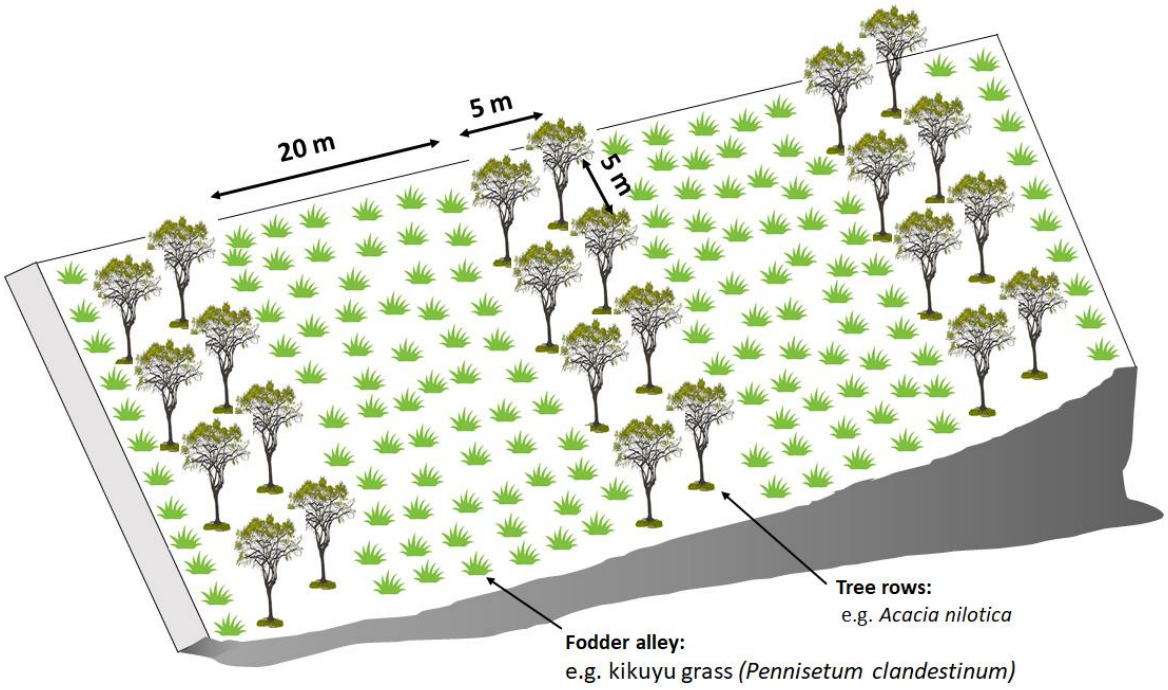


Figure 36. Example of a silvopastoral system model

All systems offer a wide range of benefits for biodiversity, animal welfare and income diversification. In addition, if there is sufficient complementarity between the requirements of trees and grasses for light, water and nutrients the total production of grass and timber together may be greater than for grass and trees grown in equivalent areas of monoculture (a value known at the land equivalent ratio). The use of trees as protection from both sun and wind/rain provides a significant animal welfare benefit and can reduce new-born mortality rates. Research has shown that providing shade for livestock and protecting them from wind can increase livestock production and performance. This is a result of reducing the stressful environments in which livestock are raised. Additional benefits can also be harnessed by allowing the livestock to browse on the trees

or bushes, providing nutrients that would otherwise have to be provided through supplementary feed.

A range of fencing and protection types are used depending on the exact systems and costs. Individual fencing and guards may be suitable protection for rows of new trees.

Figure 37. protecting trees from animals in the pasture (© AREECA, 2024)

6.7. FLR flagship projects

This section propose some projects once tried could boost the restoration of degraded landscapes in Eastern province. The project models are built based on experiences and lessons learnt elsewhere in AFR100 countries, and are worthy to pilot.

6.7.1. Modified Taungya System Project (MTSP)

The MTS involves the establishment of forest plantations in degraded public forest reserves by The Rwanda Forestry Authority (RFA) in partnership with farmers from forest fringe communities. A distinctive feature of MTS is the defined roles and benefit sharing agreements between the Government, and farmers. The farmers provide labour for site preparation, planting and plantation maintenance activities, while RFA and the District forest Office (DFO) supervises and provides the required logistics including tree seedlings. The farmers are permitted to cultivate their food crops alongside the planted trees on the same piece of land for a period of three (3) years. The MTS farmers, in addition to the food crops, may get a 40% share in the Standing Tree Value (STV) of the planted trees (when harvested) while the Government has a 60% share. This model will not only contribute to sustainable management of public forest at low cost, but will also contribute to food security, and income generation to farmers. Moreover, this system will create jobs to most vulnerable groups, women who, their livelihood depend on agriculture while they are least to possessor of land.

6.7.2. Youth in Afforestation/Reforestation Project (YARP)

The Youth in Afforestation/Reforestation Project (YARP) will be a government-funded landscape restoration intervention through the National Green Fund (FONERWA) that involves the engagement of predominantly young people as beneficiaries to undertake tree planting in built-up and populated areas. Youth can also be used to plant and safeguard roadside forests and riparian forests along rivers, lakes, dams and wetlands. The activities undertaken by the YARP beneficiaries can include but not limited to: raising of tree seedlings in nurseries, planting, enrichment planting in natural ecosystems through ANR, and maintenance of existing plantations.

6.7.3. Youth in Forest Management Enterprise Project (YFMEP)

The Youth in Forest Management Enterprise Project (YFMEP) can also be an initiative of the Government for forest management and can be funded by the Development Bank of Rwanda (BRD) to create a pull of future forestry entrepreneurs. Today, most of forest concessions are owned by external forest companies or sometimes with local shareholders but with marginal shareholdings (up to 20%). As a country with vision to boost local economies, in forestry there is a need to start training young foresters to venture into public forest management with the government. This initiative offers young entrepreneurs an opportunity to undertake commercial forest plantation development and become owners of the established stands on public land. The GoR through the BRD (or FONERWA) could provide monthly allowance and logistical support to the young entrepreneurs until the stands are mature and start pay back the funds with agreed affordable interest.

6.8. FLR Logframe and performance indicators

Table 19. FLR Logframe: the FLR interventions are aligned under Forest Sector Strategic Plan outcomes, and PSTA5 and Forestry Policy statements.

FSSP outcomes	**Restoration Interventions (FLR Outputs)**	**FLR targets (Ha)**	**Annual targets (Ha) per district. BU**: Bugesera, **GA**: Gatsibo, **KA**: Kayonza, **KI**: Kirehe, **NG**: Ngoma, **NY**: Nyagatare, **RW**: Rwamagana				
			2024/2025 (Ha)	**2025/2026 (Ha)**	**2026/2027 (Ha)**	**2027/2028 (Ha)**	**2028/2029 (Ha)**
Outcome 2.1 Forest management planning and its implementation are enhanced to ensure Sustainable Forest Management (PS2,3,4,6)	Afforestation & reforestation of woodlots (<2Ha) (AF/RF)	5,644	**TOT: 1,776 Ha** BU=40 GA=250 KA=616 KI=460 NG=200 NY=145 RW= 65	**TOT: 1,849 Ha** BU=200 GA=250 KA=500 KI=520 NG=180 NY=145 RW=54	**TOT: 1,266 Ha** BU=200 GA=150 KA=150 KI=480 NG=70 NY=144 RW=72	**TOT: 1,242 Ha** BU=100 GA=138 KA=150 KI= 550 NG=80 NY=144 RW=80	**TOT: 982 Ha** BU=100 GA=0 KA=150 KI=470 NG=44 NY=144 RW=74
	Management & rehabilitation of forest plantations (>2ha) (M/RFP)	12,084	**TOT: 1,937 Ha** BU=150 GA=150 KA=275 KI= 270 NG=250 NY=567 RW=275	**TOT: 2,216 Ha** BU=100 GA=450 KA=317 KI= 351 NG=184 NY=567 RW=247	**TOT: 2,165 Ha** BU=100 GA=500 KA=400 KI= 311 NG=40 NY=567 RW=247	**TOT: 2,134 Ha** BU=100 GA=400 KA=500 KI= 280 NG=40 NY=567 RW=247	**TOT: 2,067 Ha** BU=117 GA=395 KA=500 KI=240 NG=0 NY=567 RW=248
Outcome 5.1 Forest ecosystems are sustainably managed (PS5,6)	Assisted Natural Regeneration (ANR)/Farmer - Managed NR	36,871	**TOT: 3,966 Ha** BU=43 GA=500 KA=400 KI=1500 NG=12 NY=1500 RW=11	**TOT: 8,667.5 Ha** BU=500 GA=800 KA=2800 KI=1500 NG=57.5NY=3000 RW=10	**TOT: 10,035 Ha** BU=1500 A=1000 KA=2800 KI= 1720 NG=0 NY=3000 RW=15	**TOT: 10,114 Ha** BU=1500 A=1000 KA=2800 KI= 1760 NG=47 NY=3000 RW=7	**TOT: 8,042 Ha** BU=500 GA=239 KA=3442 KI=1450 NG=46 NY=2359 RW=6
	Wetlands Buffers (lakes and swamps) (WB)	35,199	**TOT: 4,423 Ha** BU=50 GA=250 KA=933 KI=580 NG=1300 NY=590 RW=720	**TOT: 6,657 Ha** BU=1000 GA=672 KA=1200 KI=980 NG=1000 NY=875 RW=680	**TOT: 7,875 Ha** BU=2000 GA=750 KA=1200 KI= 1120 NG=1000 NY=875 RW=930	**TOT: 9,345 Ha** BU=2500 GA=1800 KA=1200 KI=1250 NG=900 NY=875 RW=820	**TOT: 9,427 Ha** BU=2441 GA=2000 KA=1200 KI=1400 NG=903 NY=875 RW=608
	River buffer (RB)	2,476	**TOT: 363 Ha** BU=5 GA=0 KA=0 KI= 100 NG=40 NY=162 RW=56	**TOT: 554 Ha** BU=30 GA=60 KA=50 KI=120 NG=60 NY=162 RW=62	**TOT: 569 Ha** BU=30 GA=70 KA=50 KI=120 NG=65 NY=162 RW=72	**TOT: 580 Ha** BU=21 GA=70 KA=50 KI=123 NG=70 NY=162 RW=84	**TOT: 538 Ha** BU=0 GA=58 KA=56 KI=120 NG=40 NY=160 RW=104
Outcome 7.1 Agroforestry adopted by farmers and tree	Agroforestry (with fodder) (AGF)	227,764	**TOT: 44,570 Ha** BU=6000 GA=5100 KA=5231 KI=4200	**TOT: 47,100 Ha** BU=6900 GA=6200	**TOT: 44,076 Ha** BU=6900 GA=7500	**TOT: 39,800 Ha** BU=6900 GA=5000	**TOT: 40,205 Ha** BU=7187 GA=4279

FSSP outcomes	**Restoration Interventions (FLR Outputs)**	**FLR targets (Ha)**	**Annual targets (Ha) per district. BU**: Bugesera, **GA**: Gatsibo, **KA**: Kayonza, **KI**: Kirehe, **NG**: Ngoma, **NY**: Nyagatare, **RW**: Rwamagana				
			2024/2025 (Ha)	**2025/2026 (Ha)**	**2026/2027 (Ha)**	**2027/2028 (Ha)**	**2028/2029 (Ha)**
outside forests (TOFO) best practices are adopted in urban areas (PS7) **PSTA 5 Outcome** 1.1. Climate Smart Crop Production and Productivity (Agroforestry intervention)			NG=10639 NY=11000 RW=2400	KA=8500 KI=5200 NG=5400 NY=11000 RW=3900	KA=8500 KI=4500 NG=2106 NY=11000 RW=3570	KA=8500 KI= 4300 NG=0 NY=11000 RW=4100	KA=8500 KI=4320 NG=0 NY=11839 RW=4080
	Silvopasture and Improved management of ranches (SP/IMR)	29,044	**TOT: 5,915 Ha** BU=10 A=200 KA=2000 KI=690 NG=5 NY=3000 RW=20	**TOT: 7,781 Ha** BU=50 GA=180 KA=1370 KI=2650 NG=7 NY=3500 RW=24	**TOT: 7,170 Ha** BU=50 GA=150 KA=1000 KI=2340 NG=7 NY=4500 RW=23	**TOT: 7,070 Ha** BU=50 GA=150 KA=1000 KI=2340 NG=7 NY=3500 RW=23	**TOT: 6,937 Ha** BU=33 GA=108 KA=1000 KI= 2300 NG=4 NY=3471 RW=21
	Greening built-up and populated areas (GBPA)	89,858	**TOT: 13,426 Ha** BU=2778 GA=1500 KA=1381 KI= 551 NG=2150 NY=1500 RW=3566	**TOT: 17,496 Ha** BU=5775 GA=1800 KA=2000 KI=671 NG=2000 NY=3250 RW=2000	**TOT: 17,836 Ha** BU=5775 GA=2500 KA=2000 KI=561 NG=1900 NY=3250 RW=1850	**TOT: 18,606 Ha** BU=5775 GA=2500 KA=2000 KI=661 NG=1800 NY=3250 RW=2620	**TOT: 16,553 Ha** BU=3775 GA=2394 KA=3000 KI=680 NG=1623 NY=2294 RW=2787
	Protective Road buffer (PRB)	3,629	**TOT: 696 Ha** BU=100 GA=39 KA=32 KI=300 NG=40 NY=156 RW=29	**TOT: 1,033 Ha** BU= 245 GA=80 KA=120 KI= 341 NG=70 NY=157 RW=20	**TOT: 1,039 Ha** BU= 245 GA=80 KA=120 KI=345 NG=62 NY=157 RW=30	**TOT: 1,050 Ha** BU= 245 GA=80 KA=120 KI=346 NG=50 NY=157 RW=52	**TOT: 942 Ha** BU=250 GA=105 KA=120 KI= 248 NG=50 NY=156 RW=13
TOTAL (Hectares)		**442,571**	**77,072 Ha**	**93,353.5 Ha**	**92,031 Ha**	**89,941 Ha**	**85,693 Ha**

Table 20. FLR performance indicators

FSSP Outcomes	FLR Outcomes	FLR interventions	FLR Indicators (KPIs) aligned with FSSP KPIs
FSSP Outcome 2.1	Outcome 1. Sustainable forests management	AF	Number of hectares of forest and woodlots newly established
		RF	Number of hectares of forest rehabilitated
		M/RFP	Number of hectares under Simplified Forest Management plans (SFMPs) for private forests (>2ha) and woodlots (<2ha)
		M/RFP	Number of hectares under co-management agreements for public forests
FSSP Outcome 5.1	Outcome 2. Sustainable forest ecosystems management	WB	Number of hectares of wetlands buffers (swamps and lakes)
		RB	Number of hectares of river buffers
		ANR	Number of hectares of natural ecosystems rehabilitate through ANR/FMNR and Enrichment planting
FSSP Outcome 7.1 & PSTA 5 Outcome 1.1	Sustainable Land Management	AGF	Number of hectares of well-established agroforestry
		SP/IMR	Number of hectares of well-established silvo-pasture /farmer-managed regenerative ranches
	Greening urban areas – sustainable management of urban forests	GBPA	Number of hectares of well-greened urban zones/settlement sites
		PRB	Number of hectares of roadside forests
		PRB	Length road in kilometre of tree planted

6.9. Restoration impact

Forest landscape restoration will have the following impacts at local and national level:

- ***Increase in forest cover and carbon sequestration to combat climate change.*** Climate change is a real threat in Rwanda. FLR has lot of potential in combating climate change in order to enhance human well-being and the health of the planet[15].
- ***Improvement in biological diversity.*** Four levels of biodiversity are important to the FLR: species biodiversity; genetic biodiversity; ecosystem biodiversity and global biodiversity.

[15] Ousseynou Ndoye and Meseret Shiferaw (2023). The AFR100 initiative: Nature-based solutions to address the climate crisis in Africa. Information note October 2023. AUDA-NEPAD/AFR100 Secretariat

Biodiversity is very important because of what it provides to human, and for the value it has for its own right[16]. Human populations obtain the following services from biodiversity: food, fuel, shade and shelter, medicine. Other important services biodiversity provides in the ecosystems are pollination, seed dispersal, climate regulation, water purification, nutrient cycling and control of agricultural pests[16]. However, the main threat to biodiversity are habitat loss and fragmentation, over exploitation of resources or unsustainable resource use, invasive species, pollution and climate change[16].

- ***Improvement in soil fertility*:** Soil fertility has a positive effect on carbon sequestration. Promoting agroforestry activities by integrating nitrogen-fixing legumes into existing farming systems is a good approach to promote in AFR100 countries. Legumes such as Acacia (*Acacia sp*), Caliandra (*Caliandra colothyrsus*), Leucaena (*Leucaena leucocephala*), Cadd (*Acacia albida*), and Neem (*Azadirachta indica*)[17] improve soil fertility. In Rwanda, soil erosion is among the major challenges caused by forest and land degradation that result in loss of soil fertility and productive lands. FLR will significantly improve soil fertility and enhance land productivity for rural communities, hence increase income and improve food security and nutrition.
- ***Enhanced ecosystems and ecological functions of the forests*:** Ecosystem function is the capacity of natural processes and components to provide goods and services that satisfy human needs, either directly or indirecti. The benefits provided by forest ecosystems include but is not limited to: goods such as timber, food, fuel and bio-products. ecological functions such as carbon storage, nutrient cycling, water and air purification, and maintenance of wildlife habitat.
- ***Improvement in air and water quality*:** Improved air and water quality is very important for the health of the populations. Forest landscape restoration improves air and water quality to enhance the well-being of rural and urban populations.
- ***Increase in employment opportunities for rural communities by providing green jobs to women, and youth:*** Forest landscape restoration will allow rural communities to get green jobs with restoration activities through the different value chains that will be developed. In many AFR100 countries, women and youth constitute the majority of the population. Therefore, the AFR100 initiative is a good source of green employment for them.
- ***Increase in rural incomes*:** The revenues generated by selling AFR100 products, i.e., products coming from the restoration of degraded forests and lands need to be estimated. Investments made from restoration revenues need also to be documented. For example, restoration revenues can be used to pay children's school fees and their school materials; restoration revenues can be used to purchase food to improve household food security and nutrition.
- ***Improvement in food security and nutrition*:** According to FAO, "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Furthermore, according to FAO, food security has four pillars: availability, accessibility, utilization and stability. Access to food is very important. However, it is

[16] https://www.amnh.org/research/center-for-biodiversity-conservation/what-is-biodiversity
[17] https://www.tandfonline.com/doi/pdf/10.1080/01811789.1988.10826901.

unfortunate to realize that despite an increase in food production in Rwanda, about 20.4% of the household still face food insecure and stunting rate was at 32.4% (CFSVA, 2021). One important issue to consider is the purchasing power needed in order to be able to purchase food or to get access to land to grow its own food. Therefore, there is a need to address poverty and social inequalities in order to improve food security in Rwanda.

- ***Reduction in gender inequality and exclusivity*.** Although Rwanda has reached a satisfactory result in terms of gender equity, however women still face challenge to sustain their family's needs especially those women-headed families. FLR will empower women and give them more power in the households. Furthermore, disadvantaged groups should also be involved in the restoration activities which will provide them with income and be able to purchase foods and other household needs. By establishing their own forests and trees, it will give them incomes by selling FLR products (timber, fruits, honey, mushrooms, gums and resins etc.).

6.10. Cross-cutting priorities

Rwanda has a strong culture of ensuring stakeholders' participation in forest sector planning. Foremost, this includes broad application of measures to ensure gender mainstreaming and benefit sharing. FSSP acknowledges this and other community access to forest development and benefits by supporting measures to invigorate and integrate Participatory Forest Management and gender mainstreaming into all levels of formal forest management planning, implementation and monitoring. PFM general principle is to ensure participation of local community in forest management and benefit sharing. The modalities and rules will differ accordingly to type of forest and type of ownership. Small natural forests will be transferred into participatory management with private operators mainly community cooperatives. Non-Timber Forest Product like honey collection, mushroom collection, seed collection, medicinal plant collection etc. will be applied to inspire the participation of local community in the management of those forest. Communities will generate income from the NTFP collection, while the government will save resources allocated to the management and maintenance of those remnant natural forest Gender and youth mainstreaming issues Initial guidelines to ensure integration of gender and youth aspect into DFMP design and implementation have been developed. Key issues are:

- Ensuring the adequate representativeness of women in every operational planning;
- Ensuring the adequate participation of youth in the management of forests especially in establishment of tree nurseries and planting
- Ensuring awareness of all stakeholders on gender issues and how it can be avoided;
- Ensuring that newly established mechanism of benefit sharing will be gender sensitive.

The strategy has several cross-cutting priorities. These are priorities which due to their importance and complex nature need to be considered across all strategic components both in planning and implementation. In EPFLR the following are considered cross-cutting:

1. **Farmer inclusion:** Farmers are key stakeholders in the forestry systems and their participation is crucial for successful implementation of the EPMR strategy. It is critical to involve farmers in the decision-making process and ensure that interventions are closely aligned with their needs, experiences, and insights. This will happen for example though introducing Village Forest Land Use Action Plans. Also, inclusion of farmers in the agroforestry systems (crops – fruit – trees systems) by linking them to markets and

services is also a cross-cutting priority, as this will underpin the transformation of the forestry sector in the decades to come.

2. **Climate Change Adaptation and Regenerative Agriculture:** The accelerating impact of climate change is affecting the entire food system. Climate adaptation though agroforestry systems is therefore to be considered across all strategic interventions.
3. **Improved nutrition through promoting fruit trees in riparian areas:** Nutrition is critical for building human capital and it is therefore critical for the long-term potential of the economy. Yet, the stunting rate remains high at 32.4%. Addressing this will require an innovative approach and concerted efforts to plant fruit trees where possible. Considering planting fruit trees in cities and populated areas will boost the availability of fruit products and contribute to PSTA 5 nutrition crosscutting objective.
4. **Youth employment:** Youth are a valuable resource, carrying potential for innovation and dynamism. Harnessing this potential requires intentional effort toward creating job opportunities and capacity building in the EPFLR agenda. Youth can find employment in FLR that match their skills, energy, and interests. The creation of YARP and YFMEP is crucial for integrating the youth in forest operations. This will ensure their integration into the forestry workforce.
5. **Gender mainstreaming:** Equity and equality between genders is a driver for social transformation and optimal use of human resources. Yet, women have lower incomes than men, are less likely to be forest entrepreneur than men. Therefore, special consideration to gender inclusion must be given across the interventions in the EPFLR strategy. Equal access and control over forestry resources (timber and non-timber forest products) and income generated from forestry operations is a driver for social transformation.
6. **Leveraging the private sector:** Recognizing the critical role of the private sector in the management of state forests in increasing forest investment and value addition is very important. This priority seeks to foster a conducive environment for private sector participation and collaboration in the forest industry.
7. **Capacity building:** The holistic nature of FLR requires collaborative and well-informed actors. Interventions across the EPFR strategy will target capacity building of farmers, value chain actors, and systemic enablers (policymakers, public servants) during implementation to achieve sustainable results.

7. Enabling Conditions for Restoration

7.1. Key success factors of restoration

The assessment team conducted key informant interviews in the plenary sessions, community consultations, and desk research, to better understand the situation related to the key success factors for forest landscape restoration in Eastern Province. The following table summarises the findings of the Rapid Restoration Diagnostic exercise in the workshop. The goal was to identify the gaps and bottlenecks to be addressed in the course of the implementation of the restoration interventions. It is important to note that not all factors are required in order to be successful. In the results tables below, the column labelled “Ability to Improve” refers to the effort required to improve the situation related to the feature, with “High” being the most probable to change and “Low” being the most difficult to change. The analysis of the successful restoration case studies in several countries suggest that a successful restoration exhibits three common themes:

1. **A clear motivation**. Decision makers, landowners, and/or citizens were inspired or motivated to catalyse processes that led to forest landscape restoration.
2. **Enabling conditions in place**. A number of ecological, market, policy, social, and institutional conditions were in place that created a favourable context for forest landscape restoration
3. **Capacity and resources for sustained implementation**. Capacity and resources were mobilised to implement forest landscape restoration on a sustained basis on the ground.

From the Table 21 and Table 22, restoration strategies were proposed to respond to the existing gaps and problems before or during the restoration process. The proposed strategies marked red should be addressed before the restoration process while strategies marked yellow can be implemented during the restoration process. The other remaining marked green success factors are in place and favour the restoration process.

It is important to note that not all factors are required in order to be successful, a large number of these factors were in place where restoration has occurred in the past. A successful restoration should provide economic, environment and social benefits. The Table 21 presents the overview of FLR success factor as a starting point for development and implementation of restoration projects.

Table 21. Key success factors for restoration to take place in Eastern Province and strategies to address the gap.

Theme	*Feature*	*Key success factor*	*Response*
Motivate	a. Benefits	Restoration generates economic benefits	Yes
		Restoration generates social benefits	Yes
		Restoration generates environmental benefits	Yes
	b. Awareness	Benefits of restoration are publicly communicated	Yes
		Opportunities for restoration are identified	Yes
	c. Crisis events	Crisis events are leveraged	Yes
		Law requiring restoration exists	Yes

Theme	Feature	Key success factor	Response
	d. Legal requirements	Law requiring restoration is broadly understood and enforced	Yes
Enable	e. Ecological conditions	Soil, water, climate, and fire conditions are suitable for restoration	Yes
		Plants and animals that can impede restoration are absent	Yes
		Native seeds, seedlings, or sources populations are readily available	Yes
	f. Market conditions	Competing demands (e.g., food, fuel) for degraded forestlands are declining	No
		Value chains for products from restored areas exists	Partially
	g. Policy conditions	Land and natural resource tenure are secure	Yes
		Policies affecting restoration are aligned and streamlined	Yes
		Restrictions on clearing remaining natural forests exist	Yes
		Forest clearing restrictions are enforced	Partially
	h. Social conditions	Local people are empowered to make decisions about restoration	yes
		Local people are able to benefit from restoration	yes
	i. Institutional conditions	Roles and responsibilities for restoration are clearly defined	Partially
		Effective institutional coordination is in place	yes
Implement	j. Leadership	National and/or local restoration champions exist	Yes
		Sustained political commitment exists	Yes
	k. Knowledge	Restoration "know how" relevant to candidate landscapes exist	Yes
		Restoration "know how" transferred via peers or extension services	Partially
	l. Technical design	Restoration design is technically grounded and climate resilient	Yes
		Restoration limits "leakage"	Yes
	m. Finance and incentives	Positive incentives and funds for restoration outweigh negative incentives	Yes
		Incentives and funds are readily accessible	Partially
	n. Feedback	Effective performance monitoring and evaluation system is in place	Partially
		Early wins are communicated	Partially

GREEN= IN PLACE
YELLOW= PARTLY IN PLACE
RED= NOT IN PLACE

The absence of some of the above success factors can be caused by barriers, which may need to be removed before progress can be made. One of the key benefits of the success factor analysis is that it facilitates a discussion by the project participants over, and learning about the factors that will lead to project success. These factors can be built into the project monitoring and evaluation framework and revisited for example every 6 months or annually on the project. The project team can also be clear about which factors it is attempting to influence, or remove barriers.

Table 22. Some restoration strategy to address the gaps in success factors

Gap in FLR success factors	Description of the gaps	Some strategy to address the gaps
Competing demands for food and biomass energy in the Eastern Province are not declining	Demand for crop, livestock, biomass energy (fuelwood), and/or biofuel production on degraded or forestlands in the EP is not declining (due to productivity improvements elsewhere), thereby "freeing up" land for forest restoration Shifting cultivation shrubland, increasing population putting pressure on forest resources (especially natural savannah and shrub), settlements and infrastructure development	• Pursue technical and financial measures to increase the productivity (yields per hectare) of crops and livestock on existing non-marginal agricultural land. • Pursue technical and financial measures to increase the supply of timber from sustainably managed plantations and of non-biomass renewable energy (LPG, biogas) and improve cook stoves. • Avoid establishing bioenergy targets (KPIs) that could lead to degraded or former forestlands being converted to biomass plantations.
Value chains for products from restored areas partially exists	To the degree that forest restoration in EP generates marketable products and services, value chains are not in place (including NTFP) allowing these products to get from the restored forest to the end consumer. FLR product value chain is not full developed in EP	• Encourage growth of markets (both supply and demand) for timber and non-timber forest products sustainably derived from restored forest landscapes. • Provide low-interest financing for businesses directly involved in the "restoration value chain."
Forest clearing restrictions are not fully enforced	Laws that restrict clearing of remaining natural forests are not adequately enforced Agroforestry trees are harvested and pruned without clear guideline, posing a serious threat to agroforestry yields. Poor implementation of the available enforcement guidelines	• Conduct communication campaign to make relevant actors aware of law. • Establish a forest cover change monitoring system to identify illegal harvesting and clearing shrubs. • Reinforce the use of FMES in forest licensing and issuance of harvesting permits • Take enforcement action (e.g., fines, denial of credit access) against violations of forest law. • Ensure human and financial resources for enforcement are adequate at district level.
Roles and responsibilities for restoration are not clearly defined	Roles and responsibilities for forest restoration in EP are not clearly defined, understood among relevant actors (e.g., government, civil society, private sector), and coupled with authority. EP administration is not fully involved in FLR planning and monitoring. there is still a gap on understanding of the role of EP responsibility to boost /fast track the restoration investments	• Create a national, province, and district Forest Landscape Restoration framework. Action plan that articulates roles and responsibilities among central government, decentralised entities (province and districts), civil society, academic and research, and private sector entities. • EP administration should get involved to support districts in coordination and advocacy for the safeguard of FLR investments, fundraising , and financial institution dialogue to support FLR related SMES

Gap in FLR success factors	Description of the gaps	Some strategy to address the gaps
Restoration "know how" partially (not fully) transferred via peers or extension services	Technical assistance and rural extension ("extension services"), farmer-to-farmer visits, and/or other means of awareness raising and capacity building for restoration are not fully deployed and not adequately resourced, Farmer field schools need to be strengthened FLR best practices have to be communicated using all possible communication tools • Training are needed and can occur via participatory workshops, person-to-person meetings, newsletters, community radios, videos, and other means.	• Facilitate farmer-to-farmer meetings and interaction regarding restoration. • Set key performance indicators (KPIs) related to forest landscape restoration for extension agents. • Increase funding for forest landscape restoration training within extension services. • Include restoration technical assistance as part of agriculture financing packages to farmers especially for agroforestry. • Utilize modern information and communication technologies to better connect extension agents (RFA) and Forest investors, and to provide both with the most up-to-date research and information.
Incentives and funds are not easily accessible and not affordable to all who need to venture in FLR projects	Financial incentives and funds for restoration are not available without excessive hurdles or with high interest rates for FLR investors or communities. There available budget from government and other donors to support restoration initiatives but they are not sufficient. There may be bank product related to FLR but communities are not aware	• Advertise the availability of incentives and funds. • Provide administrative support to small scale farmers and restoration entrepreneurs (SMEs) to apply for incentives and funds. • increase the possibility for the Rwanda Green Fund (FONERWA) to be accessible to FLR entrepreneurs (FLR-SMES). • Reduce amount of paperwork for applying for incentives.
Performance monitoring and evaluation system is not fully effective.	• A system for monitoring progress and evaluating impact of restoration in the candidate landscape exists. The monitoring system (FMES) is available, however not fully operationalized. Need for training the end users. Commissioning FMES at all level of the forest value chain is not yet established • Aspects to monitor could include (but are not limited to) hectares undergoing restoration, tree survival rates, and quantified benefits to people and wildlife.	• Whenever possible, establish a baseline (e.g., photos, satellite imagery, mapping, increment measurement, data on hectares and other measurements from the landscape as it is before FLR action) to enable comparisons over time. • Develop and implement a performance monitoring system (including remote sensing monitoring and ground-level participatory monitoring). Review the FMES to fit also FLR purpose
Early wins are not sufficiently communicated	Early restoration successes are not sufficiently communicated to stakeholders. FLR champions should be facilitated and empowered to transform others. Dissemination and awareness should be enhanced	• Publicly communicate restoration progress, success stories, and lessons learned. Ensure the stories connect with the target audiences. • Visits between farmers is one approach that seems to work for communicating successes.

7.2. Rwanda's policies, laws and strategies supporting the implementation of EP-FLR strategy

The following Rwanda's policies, laws, and strategies are enablers of EP-FLR implementation: Policies, strategies and plans support the implementation and success of FLR activities in Rwanda. These are policies, strategies and plans enacted, adapted, revised, or implemented after Rwanda committed to the Bonn Challenge in 2011. In total 26 policies/strategies/plans were identified to be relevant to FLR implementation. Most of these Policies, strategies and plans supporting FLR in Rwanda are hosted under the Ministry of Environment (MoE), The Ministry of Infrastructure (MININFRA) and the Ministry of Agriculture and Animal resources (MINAGRI). However, the enforcement need a closer follow-up.

Table 23: FLR Supportive Policies, laws, strategies and plans

Policy, Laws and Strategies	Year Passed	Implementing institution	Relevant citations, hyperlinks, or websites where to find the referenced documents
Policy and Laws related to FLR			
1. Law governing national parks and nature reserves (No 001/2023 du 13/01/2023)	2023	Rwanda Development Board	https://www.minijust.gov.rw/index.php?eID=dumpFile&t=f&f=62050&token=be5d366266b3d5bf0913a4cf52a9427bc9fae9ed
2. Law governing Biological Diversity (No 064/2021)	2021	Rwanda Environment Management Authority	https://gazettes.africa/archive/rw/2021/rw-government-gazette-dated-2021-11-11-no-special.pdf
3. Law governing Land (No 27/2021)	2021	Rwanda Land Management and Use Authority	https://gazettes.africa/gazettes/rw-government-gazette-dated-2021-06-10-no-Special
4. National Environment and Climate Change policy	2019	Ministry of Environment	http://www.fonerwa.org/sites/default/files/202106/Rwanda%20National%20Environment%20and%20Climate%20Change%20Policy%202019.pdf
5. Revised National Land Policy	2019	Rwanda Land Management and Use Authority	https://www.environment.gov.rw/fileadmin/user_upload/Moe/Publications/Policies/Revised_National_Land_Policy-Final_Version_2019.pdf
6. Rwanda energy policy	2015	Ministry of infrastructure	https://rura.rw/fileadmin/Documents/Energy/RegulationsGuidelines/Rwanda_Energy_Policy.pdf
7. Law on Mining and quarry operations (No 58/2018)	2018	Rwanda Mining Board	https://www.rmb.gov.rw/fileadmin/user_upload/MINING_QUARRY_OPERATIONS_LAW.pdf
8. Law on Environment (No 048/2018)	2018	Rwanda Environment Management	https://waterportal.rwb.rw/sites/default/files/2018-10/Water%20law%20gazetted%2C2018.

Policy, Laws and Strategies	Year Passed	Implementing institution	Relevant citations, hyperlinks, or websites where to find the referenced documents
		Authority	pdf
9. Law determining the use and management of water Resources (No 049/2018)	2018	Rwanda Water Resources Board	https://waterportal.rwb.rw/publications/laws_policies
10. Forestry Law (No 13/2013	2013	Rwanda Forestry Authority	https://gazettes.africa/archive/rw/2013/rw-government-gazette-dated-2013-09-16-no-37.pdf
11. National Gender Policy	2010	Ministry of Gender and Family Promotion	https://www.migeprof.gov.rw/fileadmin/user_upload/Migeprof/Publications/Guidelines/Revised_National_Gender_Policy-2021.pdf
12. National Human Settlement Policy	2009	Rwanda Housing Authority	https://bpmis.gov.rw/asset_uplds/files/National%20human%20settlement%20policy.pdf
13. National Urban Housing Policy	2008	Rwanda Housing Authority	https://bpmis.gov.rw/asset_uplds/files/National%20Urban%20housing%20Policy.pdf
National strategies related to FLR			
14. Rwanda Vision 2050	2021	Ministry of Finance and Economic Planning	https://www.minecofin.gov.rw/fileadmin/user_upload/Minecofin/Publications/REPORTS/National_Development_Planning_and_Research/Vision_2050/English-Vision_2050_Abridged_version_WEB_Final.pdf
15. National Land Use and Development Master Plan	2021	Rwanda Land Management and Use Authority	https://www.environment.gov.rw/fileadmin/user_upload/Moe/Publications/Policies/National_Land-Use_and_Development_Master_Plan_2020-2050.pdf
16. Updated Nationally Determined Contribution (NDC)	2020	MOE, Rwanda Land Management and Use Authority	https://unfccc.int/sites/default/files/NDC/2022-06/Rwanda_Updated_NDC_May_2020.pdf
17. Revised Green Growth and Climate Resilience strategy (GCRS)	2022	MOE, Rwanda Land Management and Use Authority	https://www.rema.gov.rw/fileadmin/user_upload/Rwanda_Green_Growth___Climate_Resilience_Strategy_06102022.pdf
18. National Strategies for Transformation (NST1, NST2)	2017 2024	Ministry of Finance and Economic Planning	https://www.nirda.gov.rw/uploads/tx_dce/National_Strategy_For_Trsansformation_-NST1-min.pdf https://www.gov.rw/blog-detail/rwanda-announces-2nd-national-transformation-strategy
19. Rwanda National Water Resources	2015	Rwanda Water Resources	https://waterportal.rwb.rw/sites/default/files/2017-

Policy, Laws and Strategies	Year Passed	Implementing institution	Relevant citations, hyperlinks, or websites where to find the referenced documents
Master Plan		Board	09/Rwanda%20National%20Water%20Resources%20Master%20Plan.pdf
20. National Strategy and policy for Water supply and Sanitation Services	2010	Water and Sanitation Corporation	https://www.mininfra.gov.rw/water-and-sanitation
21. Biomass Energy Strategy	2019	Rwanda Energy Group (REG)	https://www.mininfra.gov.rw/digital-transformation-1-1
22. Resources Mobilization Strategy	2019	National Fund for Environment	https://www.environment.gov.rw/index.php?eID=dumpFile&t=f&f=40507&token=ce7e22aac01255049229247f5f07240d4084c324
23. Rwanda Forestry policy	2018	Ministry of Environment	https://www.environment.gov.rw/fileadmin/user_upload/Moe/Publications/Policies/Rwanda_National_Forestry_Policy_2018__1_.pdf
24. Forestry Research Strategy and guidelines for Rwanda	2018	Rwanda Forestry Authority	https://www.iucn.org/sites/dev/files/content/documents/forestry_research_strategy_and_guidelines_for_rwanda_2018-2024.pdf
25. National Agroforestry Strategy (2018-2027)	2018	Rwanda Forestry Authority	https://www.rfa.rw/index.php?eID=dumpFile&t=f&f=36310&token=a85e094d2accdcfee432372544d04d04e1f1a9c8
26. Energy Sector Strategic plan	2018	Ministry of Infrastructure	https://www.reg.rw/fileadmin/user_upload/Final_ESSP.pdf

Additionally, in June 2015, an FLR Cross-Sectoral Taskforce (FLR-CSTF) was established by the FLR implementing institutions to serve as an inter-sectoral working group to foster improved coordination on cross-cutting FLR issues related to agriculture and natural resources. The inter-sectoral working group would serve as a platform for dialogue on issues that are cross-cutting to agriculture and natural resources, with a particular focus on agroforestry. Coordinated by Rwanda Forestry Authority (RFA), IUCN, and FAO, the CSTF was set up with the objectives to support the functioning of the Agriculture, Environment and Natural Resources Sector Working Groups in implementing the National Strategy for Economic Transformation (NST1, 2) priorities. Overall, this CSTF is also to support the domestication of Sustainable Development Goals (SDGs) and their linkage to the high-level dialogue on green growth with specific purpose of promoting forest landscape restoration, sustainable agriculture and livelihood improvement.

7.3. FLR stakeholders' engagement

Stakeholders include any people or organizations that can directly or indirectly affect or be affected by landscape restoration initiatives. Four broad stakeholder classes are identified:

1. Local communities: these includes individual farmers, farmer groups or associations, and Cooperatives
2. Governments: Ministries and parastatal agencies
3. Private sector: Service providers
4. Civil society organizations and Community based organisations.

As shown by Table 15, these groups often have different values and influences, interests and approaches. Interests can also vary within each group. For example, forest, agriculture and water agencies could have conflicting interests with mining and energy agencies. Some civil society organizations focus on community livelihoods, while others work on biodiversity conservation. The process of designing and implementing FLR brings these stakeholders together as equal partners to negotiate mutual interests and collaborative partnerships. The following section summarizes the roles and interests of each stakeholder group, as well as the potential benefits FLR can provide them. Three stakeholder clusters have been identified:

1. **Local communities:** Communities have important knowledge about forest management, wildlife, rangelands management, adapted agriculture practices and water resource protection. This knowledge is valuable for designing, implementing, monitoring and evaluating FLR interventions. For these reasons, local communities can and should play a pivotal role in ensuring the effectiveness and sustainability of any FLR efforts in Eastern Province.

   There are multiple benefits for local communities participating in the implementation of the restoration programme. Such benefits of FLR to local communities include:
   - Increased access to products and services in the landscape contributing to improved livelihoods and social security in the long term;
   - More economic opportunities through restoration-related jobs and activities, and through trade and value-addition of forest products and services;
   - Improved grassroots institutions and multi-stakeholder platforms as a pre-condition or by-product of FLR processes, which contributes to addressing inequality gaps in gender, resource access and benefits, participation and representation.
   - Enhance knowledge and best practices in forest and land management which help them to optimize the use of natural resources

2. **Government:** Government stakeholders include ministries and agencies that manage forests, land, livestock, wildlife, water resources and related livelihood issues in the landscape. Their interests can include other sectors such as agriculture, mining and infrastructure. Some institutions are based within the landscape (in the Province and districts offices), others are based in Kigali (Ministries and National agencies). Government stakeholders develop and implement laws and policies. Depending on their roles, locations and administrative levels, their decisions will affect the landscape to different degrees. However, they often have the strongest impacts on the landscape and on other stakeholders.

   Potential benefits of FLR for government stakeholders include:
   - Increased progress towards National and Eastern Province targets on restoration, biodiversity conservation and poverty reduction
   - Boosted local economic development and livelihoods through improved value chains, taxes and revenues
   - Reduced gender and social inequalities and improved livelihoods among communities
   - Closer engagement with local communities and other stakeholders while developing and implementing related policies and strategies

- Improved stakeholder understanding of, and compliance with, relevant laws and policies enabling landscape restoration
- Increased policy impacts on long-term ecological sustainability and economic stability
- Reduced unemployment through creating job opportunities in the landscape
- Reduced conflict over natural resources, especially land, forests and water
- Increased forest resources for multiple usage (energy, service wood and timber)
- Boosted climate adaptation and mitigation actions (NDC) through increased forests and tree resources in the landscape and consequently more carbon sequestration

3. **Civil society organizations (international, national CSOs and CBOs):** the CSOs and CBOs include non-profit and non-governmental organizations, community-based organizations and research and education institutions. Their interests vary from human rights to animal rights, from environmental sustainability to social-economic development. They play a supporting role, helping communities and the government to achieve restoration goals. Their work ranges from data and research to financing and implementing FLR activities. Their presence is important in landscapes where farmers and community groups lack capabilities (knowledge and skills) and resources to initiate FLR activities.

   Potential benefits of FLR for CSOs and CBOs stakeholders include:
   - Opportunities to introduce their perspectives and to influence local stakeholders through platforms created through FLR processes
   - Improved access to local knowledge and resources

4. **Private sector:** Private sector includes profit organisations limited by shares or enterprises small, medium or large-scale enterprises. They are business oriented stakeholders, mainly interested in FLR value chains. Their presence is so important as they add value to FLR investments and makes them more profitable and contribute to the national economy. Engaging them in the restoration activities is an important opportunity to showcase examples of successful private-sector-led sustainable forest management through PFMUs and forest landscape restoration initiatives in Eastern Province, and to share ideas for scaling up these approaches. Recommendations for moving forward included the continued development of an enabling framework for private-sector investments and new incentives to support public-private partnerships on Eastern Province forests because these forests differ very much from the other parts of Rwanda's forests as they are established in drought risk zones.

8. Conclusions and Recommendations

8.1. Summary and Conclusions

The EP-FLR aims to assess the restoration of landscapes needs in Eastern Province and come up with a strategy and an action plan to boost restoration of Eastern Province degraded landscapes. The EP-FLR strategy is aligned with District land use master plans (DLUPs), and District Development Strategies (DDS) to facilitate its implementation. The following are key highlights and findings:

1. Reminding that Rwanda made an ambitious pledge to the Bonn Challenge to restore 2 million hectares of forest and agricultural land, demonstrating a significant commitment to both its people and environment by recognizing the value of the goods and services provided by landscapes and also providing a platform for Rwanda to achieve many of the goals outlined in national strategy for transformation (NST1 & 2) and Vision 2050;
2. Recognising that Forest Landscape Restoration (FLR) is an effective mechanism that facilitate Rwanda to operationalize key global commitments, notably the Sustainable Development Goals, the United Nations Framework Convention on Climate Change, the Convention on Biological Diversity, the Aichi Biodiversity Targets, and the United Nations Convention on Combating Desertification;
3. Forest Landscape Restoration (FLR) offers multiple benefits that align directly with Rwanda's green growth and climate resilience strategy (2022 -2050), boosting economic growth and diversifying resilient livelihoods, creating green jobs, improving agriculture practices, enhancing food security, improving the availability and quality of water resources, increasing the capacity for climate change resilience and adaptation, contributing to climate change mitigation, combating desertification, protecting biodiversity, and reducing the impact of natural disasters;
4. Knowing that the Eastern Province is the most affected region in Rwanda by effects of climate change even though the country bears a minimal responsibility with regards to the causes of the global warming;
5. The results of the FLR assessment effectuated in 2014 for entire country (National ROAM) highlighted that the Eastern Province has the greatest opportunity for agroforestry where approximately 505,000 hectares (56% of the total area of the East province) were suitable for agroforestry (including Silvopasture); 34,030 hectares were opportunity areas to improve the management of eucalyptus woodlots and timber plantations; by that time, restoring natural forest through buffers and enrichment planting of degraded forests inside parks and reserves represented a relatively small (557 hectares), and localized opportunity in terms of scale, but was vitally important for maintaining these ecosystems and the services they provide. Establishing 20-m buffers of native trees species along rivers and streams or 50-m buffers on wetlands and protective forests on ridgetops with very steep slopes, represented a total of 23,337 hectares.
6. Currently (in 2024 – 10 years after), an assessment of restoration opportunities for Eastern Province (EP-FLR) reveals a total of 442,571 hectares suitable for various restoration actions from 562,924 hectares identified in 2014 (a reduction of 21%). These figures shows a tremendous effort made by Rwanda and its partners in restoring Eastern province degraded landscapes through various project and programmes starting 2015 to date. Of 442,571

hectares, 227,764 hectares are opportunity areas for agroforestry while 29,044 hectares are suitable areas for Silvopasture and management of ranches. A total of 89,858 ha are opportunity areas for greening populated areas and creating healthy environment for rural and urban dwellers while 36,871 hectares are suitable for assisted natural regeneration and enrichment planting in relic key biodiversity areas of Eastern Province. A total of 37,675 hectares constitute suitable areas for protecting wetlands, swamps and rivers, while 3,629 hectares are needed to protect roads. Afforestation, reforestation and management of existing forest plantations covers 17,728 hectares where a number of forest plantations will have to be rehabilitated and put under management framework that allows them to growth and increase the productivity.

8.2. Recommendations

This assessment recommends a raft of strategic actions aimed at enhancing the uptake of the EP-FLR report, catalysing restoration:

R1. While FLR hubs continue to play their pivot role of coordinating restoration actions and stakeholder engagement in the districts, **RFA overseeing responsibility need to be improved.** The district presence in all decision making regarding the restoration efforts taking place in respective district is also a key to sustainability of FLR investments done by various partners.

R2. Farmers and landowners continue to struggle with poor farming practices. Trees are planted scattered diminishing their impact in land protection against erosion, and exhausted by pruning for various reasons. This diminish the productivity and the capacity to store carbon as means for timber growth. There is a need to establish a grassroots FLR training initiative aimed at sensitizing and educating farmers and pastoralists on the best practices. This may include peer-to-peer learning within the province or between districts.

R3. Community mobilization at the ranch/conservancy level: The role of communities in the implementation of FLR activities should be strengthened. If support mechanisms throughout the process are to be put in place, communities must play their part. They can easily contribute to the production of a local seed and plant production chain, as well as to watering. Community mobilization is key in ensuring the uptake of the assessment and systematic restoration that respects the landscape approach.

R4. Improving extension service: It is observed that inadequate forest extension is partly to blame when it comes to poor land use management as well as unsustainable farming. The report recommends an increased number of forest extensions as well as an agronomist to not only support the uptake of the assessment but also provide accurate guidance on the implementation of the proposed interventions.

R5. Integrating FLR approach in water resource management: Water is an important resource in Eastern Province and multiuser issue. The report recommends establishment of multiuser platform/umbrella looking at integrating FLR approach in water resource management.

R6. Local restoration task force for enhanced restoration coordination: Noting the lack of proper/structured restoration coordination at the local level (particularly on FLR) this report

recommends the formation of a cross-sectoral taskforce to enhance restoration efforts at the local level like a micro-catchment (or village) based FLR taskforce. Through this community based taskforce, will ensure the FLR communication (both ways) is done regularly and feedbacks reach everyone in the community.

R7. Community-based Approach to Restoration: CAR remains the most powerful restoration strategy at the local level and involvement of youth and women has multiple benefits and respond to the employment and equity challenges in the society. However, need a robust management system and a support in the country procurement systems, this assessment recommends their engagement at all levels of FLR decision-making from the district to the national level to ensure this innovative implementation strategy is supported by existing policy and regulatory framework.

R8. The private sector plays an important role in augmenting the restoration efforts through co-management agreement with Government of Rwanda for public forests. This public – private partnership (PPP) approach is very crucial, however must be strongly monitored and supported by RFA in order to yield intended results. Such PPP should result to forest industry in the area so to create forest field school and a market where smallholder farmers could learn best practices and therefore supply their forest products.

R9. The elaboration of this EP-FLR implementation strategy aims at accelerating restoration of Rwanda's degraded land in Eastern Province in order to hit the national FLR target. On top of existing restoration framework, there must be a number of innovative strategies which can accelerate the restoration of Eastern Province. Some examples have worked elsewhere could also be tried in Rwanda:

- **9.1.** Establish "Green Eastern Province (GEP) day. Recurring day for tree planting in Eastern Province in addition to the usual National tree planting day
- **9.2.** Modified Taungya System (MTS) – integrating food security in forestry (farm forests). This approach works better for public forests to ensure young forests are maintained and safeguarded until closed forest canopy do no longer support farming.
- **9.3.** Youth clubs in championing FLR (YFLR). Youth projects related to forest and tree planting should be supported by National Green Fund (FONERWA). This will reduce both unemployment and exodus of youth in search for jobs in cities and therefore boost the rural economies.

R10. mm

9. References

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10. Annexes

Annex 1. Rapid Restoration Diagnostic Tool

WRI and IUCN published a "Rapid Restoration Diagnostic" that helps identify which success factors already exist and which are currently missing within landscapes being considered for restoration. It is designed to help decision-makers identify factors that must be addressed before investing large amounts of human, financial, or political capital in forest landscape restoration. The preliminary version of this diagnostic was used in Rwanda. Key success factors for forest landscape restoration is shown in Annex 1.

Annex 1. Key success factors for forest landscape restoration

Theme	Feature	Key success factor
Motivate	Benefits	• Restoration provide economic, environmental, social and cultural benefits
	Awareness	• Benefits of restoration are publicly communicated • Opportunities (e.g., where, how much) for restoration are identified
	Crisis event	• Crisis events are leveraged
	Legal requirements	• Law requiring restoration exists and is enforced
Enable	Ecological conditions	• Soil, water, climate, and fire conditions are suitable for restoration • Plants and animals that can impede restoration are absent • Native seeds, seedlings, or source populations are readily available
	Market conditions	• Competing demands for alternative use for degraded lands are declining • Accessible markets for products from restored areas exists
	Policy conditions	• Land and natural resource tenure are secure • Policies affecting restoration are aligned and streamlined • Restrictions on clearing natural forests exits and is enforced
	Social conditions	• Local people are empowered to make decisions about restoration • Local people are able to benefit from restoration
	Institutional conditions	• Responsibility for restoration is clearly defined • Effective institutional coordination is in place
Implement	Leadership	• National and/or local restoration champions exist • Sustained political commitment exists
	Knowledge	• Restoration "know-how" relevant to candidate landscapes exists • Restoration "know-how" transferred via peers or extension services

Theme	Feature	Key success factor
	Technical design Financing and incentives	• Restoration design is technically grounded and climate resilient • "Positive" incentives and funds for restoration outweigh "negative" incentives for status quo • Incentives and funds readily accessible
	Feedback	• Effective performance monitoring and evaluation in place • Early wins are communicated

Source: IUCN and WRI (2014). A guide to the Restoration Opportunities Assessment Methodology (ROAM): Assessing forest landscape restoration opportunities at the national or sub-national level. Working Paper (Road-test edition). Gland, Switzerland: IUCN. 125pp

*Annex 2. Suitable tree species for different FLR interventions of Eastern Province and their multiple benefits[18,19]. Recommended FLR interventions: (**AGF** Agroforestry (with fodder), **GBPA** Greening built-up areas, **ANR** Assisted Natural Regeneration, **WB** Wetlands Buffers (lakes and swamps), **SP/IMR** Silvopasture and Improved management of ranches, **M/RFP** Management & rehabilitation of forest plantations, **AF/RF** Afforestation & reforestation of woodlots (<2Ha), **PRB** Protective Road buffer, and **RB** River buffer*

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Tree species		Origin	Multiple usage & benefits		Where /how to plant it	FLR intervention type
Scientific Name	Kinyarwanda name		Products	Ecological services		
1. Acacia abyssinica,	Umunyinya	Native	Firewood, Charcoal, Timber for construction, Medicine, Fodder, Bee Forage	Ornamental, Soil fertility improvement through nitrogen-fixing	Cropland, rangeland	Agroforestry (AGF)
2. Maesopsis eminni		Native	Timber for construction, Fodder, Firewood, Charcoal, fibre, Medicine	Ornamental, shade,	Open land for forests, tree enrichment in natural reserve, roadside plantation	Reforestation, ANR, PRB
3. Acacia hockii	Umugenge	Native	Firewood, Charcoal, Bee Forage, Fibre	Ornamental	Residential /homestead	Green built & populated area (GBPA)
4. Acacia polyacantha		Exotic	Firewood, Medicine	Protection of water ecosystems, riverbank stability	riverine and groundwater forests	WB, RB, SLIMR
5. Acokanthera schimperi	Umusagwe (Umushewe)	Native	Fruits, Medicine	Ornamental, Shade	Residential /homestead	GBPA
6. Albizia versicolor	Umububa	Native	Firewood, Charcoal, Timber for construction, Farm tools, Medicine	Soil fertility improvement through nitrogen-fixing	Cropland, rangeland boundaries	AGF, & SLIMR
7. Ficus sycomorus		Native	Fodder, firewood & charcoal, Fibre, medicine,	Riverbank stabilization, Ornamental, soil improvement through water holding capacity, Litter improves the nutrient status in the soil	grows in high water table areas. along watercourses such as streams and rivers, and swamps. In cropland, can be intercropped with banana	Water ad river buffers (WB, RB) AGF
8. Pinus caribaea	Pinusi	Exotic	Timber for furniture, Firewood,fibre, medicine, Gum or resin	Erosion control	Open land for forests, degraded forestland through forest establishment	Afforestation/reforestation (AF/RF, M/RFP)
9. Annona cherimola	Umutima w'imfizi	Exotic	Fruits, Medicine, Bee Forage	Ornamental, Shade	Residential /homestead	GBPA
10. Apodytes dimidiata	Umusibya	Native	Firewood, Charcoal, Timber for furniture, Timber for construction, Farm tools, Medicine, Bee Forage	Ornamental	Residential /homestead	GBPA
11. Artocarpus altilis 12. Artocarpus heterophyllus	Igifenesi	Exotic	Fruits, Other Foods, Timber for construction, Medicine, Fodder, Tannins/Dyestuff,	Ornamental, Shade	Residential Homestead boundary/live fence	GBPA

Tree species		Origin	Multiple usage & benefits		Where /how to plant it	FLR intervention type
Scientific Name	Kinyarwanda name		Products	Ecological services		
			Gums/Resins			
13. Azadirachta indica	Neem	Exotic		Ornamental, Shade	Residential /scattered homestead, public spaces (schools, offices and facilities)	GBPA
14. Blighia unijugata	Umuturamugina	Native	Other Foods, Firewood, Charcoal, Timber for furniture, Timber for construction, Farm tools, Medicine, Bee Forage	Ornamental, Shade	Residential /scattered homestead public spaces (schools, offices and facilities	GBPA
15. Cajanus cajan	Umukunde	Exotic	Other Foods, Firewood, Charcoal, Fodder, Bee Forage	Soil erosion control, Soil fertility improvement through nitrogen-fixing, Wind break	Along soil conservation structures or Scattered in cropland,	AGF
16. Calliandra calothyrsus	Kariyandara	Exotic	Firewood, Fodder, Bee Forage	Soil erosion control, Soil fertility improvement through nitrogen-fixing, mulch/leaves, Wind break	Cropland boundary, Scattered in cropland, Along soil conservation structures	AGF & SLIMR
17. Casuarina equisetifolia	Filaho/ Umubuunda	Exotic	Firewood, Charcoal, Timber for construction, Farm tools,	Ornamental, Shade, Soil erosion control, Wind break	Residential /homestead, Homestead boundary/live fence Roadside	GBPA, Roadside buffer (PRB)
18. Cedrela serrata	Sederera	Exotic	Timber for construction, Timber for furniture	Erosion control,	Cropland boundary, Along soil conservation structures, Lake/ river shores	AGF, AF/RF, RB, WB
19. Citrus limon & 20. Citrus sinensis	Indimu & Icunga	Exotic	Fruits, Medicine, Bee Forage	Ornamental, Scattered in homestead	Scattered in cropland, Scattered in homestead,	AGF, GBPA
21. Combretum molle	Umushubi (Umunyonza)	Native	Firewood, Charcoal, Farm tools, Bee Forage	Shade, Soil fertility improvement through mulch/ leaves	Scattered in cropland, Scattered in homestead	AGF, GBPA
22. Cupressus lusitanica & Cupressus sempervirens	Sipure	Exotic	Timber for furniture, Timber for construction, Bean Stakes	Ornamental, Live fence, Shade, Wind break	Residential Scattered in homestead, Homestead boundary/live fence, public spaces (schools, offices and facilities	GBPA, AF/RF. M/RFP
23. Dichrostachys cinerea	Umuyebe (umunkamba)	Native	Firewood, Charcoal, Timber for construction, Medicine, Fodder, Bee Forage	Ornamental, Live fence, Soil fertility improvement through nitrogen-fixing	Residential Scattered in homestead boundary/live fence, cropland boundary	GBPA
24. Erythrina	Umuko	Native	Firewood, Timber for	Ornamental, Live fence, Soil	Residential Scattered in	GBPA, AGF,

Tree species		Origin	Multiple usage & benefits		Where /how to plant it	FLR intervention type
Scientific Name	Kinyarwanda name		Products	Ecological services		
abyssinica			construction, Medicine, Fodder, Bee Forage, Bean Stakes	fertility improvement through mulch/ leaves, Riverbank stabilization	homestead boundary/live fence, public spaces (schools, offices and facilities, cropland boundary,	SLIMR
25. Eucalyptus globulus, maculata, maidenii, saligna	Inturusu	Exotic	Firewood, Charcoal, Timber for construction, Timber for furniture, poles Medicine, Bee Forage, Bean Stakes	Wind break, erosion control on very steep slopes	Forest, Woodlot, roadside forests,	Afforestation/reforestation (AF/RF), PRB, M/RFP
26. Euclea racemosa	Umushikiri	Native	Fruits, Firewood, Farm tools	Ornamental, Live fence	Homestead boundary/live fence, Woodlot	GBPA, ANR
27. Faidherbia albida		Native	Firewood, Charcoal, Timber for construction, Fodder	Shade, Soil erosion control, Soil fertility improvement through nitrogen-fixing, Soil fertility improvement through mulch/ leaves	Along soil conservation structures	AGF, RB, wetland buffers (WB)
28. Ficus ovata, Ficus thonningii	Umurehe, Umuvumu	Native	Firewood, Medicine, Fodder, Live fence	Ornamental, Live fence, Shade, Soil erosion control	Scattered in cropland, Homestead boundary/live fence	GBPA, AGF
29. Gliricidia sepium	Girisidiya	Exotic	Firewood, Charcoal, Timber for construction, Medicine, Fodder, Bee Forage, Bean Stakes	Ornamental, Shade, Soil erosion control, Soil fertility improvement through nitrogen-fixing	Scattered in cropland, Along soil conservation structures	AGF
30. Grevillea robusta	Gereveriya	Exotic	Timber for construction, Firewood, Charcoal, Farm tools, Bean Stakes	Ornamental, Live fence, Shade, Soil fertility improvement through mulch/ leaves, Wind break	Scattered in cropland, Scattered in homestead, Homestead boundary/live fence, Woodlot, Lake/ river shores	AGF, GBPA, WB, RB
31. Jacaranda mimosifolia	Jacaranda	Exotic	Firewood, Timber for construction, Farm tools, Bee Forage	Ornamental, Live fence, Soil fertility improvement through mulch/ leaves	Homestead, Homestead boundary/live fence, roadside	GBPA, PRB
32. Casuarina cunninghamiana	Umubunda	Exotic	Firewood, Timber for construction	Ornamental, Live fence	Road side plantation, Homestead	PRB, GBPA
33. Lannea schimperi	Umumuna	Native	Firewood, Charcoal, Timber for furniture, Farm tools, Medicine	Ornamental, Shade, Soil fertility improvement through mulch/ leaves	Homestead woodland and wooded grassland; savannah	GBPA, ANR
34. Podocarpus sp	Umufu	Native	Firewood, Timber for construction	Ornamental trees for parks and large gardens		GBPA

Tree species		Origin	Multiple usage & benefits		Where /how to plant it	FLR intervention type
Scientific Name	Kinyarwanda name		Products	Ecological services		
35. Leucaena diversifolia, Leucaena leucocephala	Resena	Exotic	Firewood, Timber for construction, Fodder, Gums/Resins	Soil erosion control, Soil fertility improvement through nitrogen-fixing, Soil fertility improvement through mulch/ leaves, Wind break	Cropland boundary, Along soil conservation structures, Lake/ river shores	AGF, WB, RB
36. Macadamia tetraphylla	Makadamiya	Exotic	Other Foods (nuts), Firewood, Bee Forage	Ornamental, Shade, Wind break	Scattered in cropland, Scattered in homestead	AGF, GBPA
37. Mangifera indica	Umwembe	Exotic	Fruits, Firewood, Fodder, Bee Forage,	Ornamental, Shade, Soil erosion control, Wind break	Scattered in cropland, Scattered in homestead, Homestead boundary/live fence	AGF, GBPA
38. Manihot glaziovii	Icyumbati (igicucu)	Exotic	Other Foods (isombe), Medicine, Fodder, Bee Forage	Ornamental, Shade, Soil fertility improvement through mulch/ leaves	Cropland boundary, Scattered in homestead, Homestead boundary/live fence	AGF, GBPA
39. Markhamia lutea	Umusave	Native	Timber for construction, Firewood, Charcoal, Medicine, Bee Forage, Bean Stakes	Ornamental, Shade, Soil fertility improvement through nitrogen-fixing, Soil fertility improvement through mulch/ leaves	Cropland boundary, Homestead boundary/live fence, Along soil conservation structures, roadside reserves	AGF, GBPA, PRB
40. Mitragyna rubrostipulata	Umuzibaziba	Native	Timber for construction, Medicine, Firewood	Water and wetland protection	Along soil conservation structures, Lake/ river shores	WB, RB
41. Moringa oleifera	Moringa	Exotic	Other Foods, Medicine, Fodder, Bee Forage	Shade, Soil erosion control, Wind break	Scattered in homestead, Homestead boundary/live fence	AGF, GBPA
42. Morus alba	Iboberi	Exotic	Fruits, Firewood, Farm tools, Fodder, Bee Forage	Ornamental, Live fence, Shade, Soil erosion control	Along soil conservation structures, Homestead boundary/live fence	AGF, GBPA
43. Persea americana	Avoka	Exotic	Fruits, Firewood, Charcoal, Fodder	Shade, Soil erosion control, Wind break	Scattered in cropland, Scattered in homestead, Homestead boundary/live fence	AGF, GBPA
44. Psidium guajava	Ipera	Exotic	Fruits, Firewood, Farm tools	Shade, Soil stability	Scattered in cropland, Scattered in homestead, Along soil conservation structures	AGF, GBPA
45. Pterygota mildbraedii	Umuguruka	Native	Firewood, Charcoal	Ornamental, Shade	Lake/ river shores, Road boundary/ open land	WB, RB, PRB
46. Rhus longipes	Umusagwe	Native	Fruits, Charcoal, Timber for furniture, Farm tools, Medicine, Fodder, Tannins/Dyestuff	Ornamental, Shade, treatment of asthma and malaria (traditional medicine)	Homestead, cropland boundary	GBPA, AGF

Tree species		Origin	Multiple usage & benefits		Where /how to plant it	FLR intervention type
Scientific Name	Kinyarwanda name		Products	Ecological services		
47. Prunus africana		Exotic	Firewood, Shade,	Ornamental, soil improvement through mulch and green manure	Trees can be grown along contour ridges and terraces.	AGF, GBPA,
48. Senna siamea, Senna spectabilis	Senna	Exotic	Firewood, Charcoal, Timber for furniture, Timber for construction, Medicine, Bee Forage	Ornamental, Shade, Soil erosion control, Wind break	Scattered in homestead, Homestead boundary/live fence	GBPA, PRB
49. Sesbania sesban	Umunyegenyege	Exotic	Firewood, Charcoal, Fodder, Bee Forage, Gums/Resins	Live fence, Shade, Soil fertility improvement through nitrogen-fixing, mulch/ leaves, Wind break	Scattered in cropland, Homestead boundary/live fence, Along soil conservation structures	AGF, GBPA
50. Terminalia mantaly	Teriminariya	Exotic	Firewood	Ornamental, Shade	Scattered in homestead	GBPA
51. Vernonia amygdalina	Umubilizi	Native	Firewood, Medicine, Fodder, Bee Forage	Ornamental, Live fence, Soil fertility improvement through mulch/ leaves	Cropland boundary, Scattered in cropland, Homestead boundary/live fence, Along soil conservation structures	GBPA, AGF
52. Zanthoxylum chalybeum	Intareyirungu	Native	Medicine, Firewood, Timber for furniture, Timber for construction,	Extracts are highly active against Plasmodium falciparum	Homestead boundary, enrichment planting in nature reserve	GBPA, ANR
53. Croton megalocarpus	korotoni	Native	Timber, shade, medicine, Firewood, charcoal, Charcoal, Fodder, Bee Forage,	Ornamental, Soil fertility improvement through mulch/ leaves,	Homestead boundary, enrichment planting in nature reserve, roadside plantation	ANR, PRB, GBPA
54. Araucaria sp.	Arokariya	Exotic	Timber, shade,	Ornamental, Shade and wind break	Roadside plantation, urban park public spaces (schools, offices and facilities)	PRB, GBPA