Agriculture and Ecosystem-based Adaptation Policy Brief

1. Introduction

Climate change is already at our doors. The rise in temperature over the past few decades in East Africa, including Rwanda, is undeniably accepted by many climate researchers. Warming temperatures are projected to cause more frequent and more intense extreme weather events, such as heavy rain storms, flooding, especially in highlands regions and droughts in dry ecosystems. Annual rainfall throughout East Africa has largely decreased since 1960, while variability has increased. Rwanda has experienced a significant increase in average annual temperatures of about 0.7-0.9°C since 1950, with a warming pattern over the past 40 years at the average of 0.35°C per decade (Ngarukiyimana et al., 2021). Over 95% of agriculture in the region is rain-fed (FAO, 2022), which explains the high vulnerability of smallholder farmers to the impacts of climate change. Agriculture is one the most important economic activities in Rwanda, contributing more than 33% of GDP, with 70% of the population engaged in the sector, and around 72% of the working population employed in agriculture 70% of the population engaged in the sector, and around 72% of the working population employed in agriculture (FAO, 2022). Much of the Rwandan population is still rural and agriculture sustains much of the population. Under this sector, smallholder farmers are the most hit by the impacts of climate change. Some crops cannot adapt to the variability of the climate while smallholder farmers lack the capacity to cope with the changing climate. The government of Rwanda has deployed significant efforts to ensure food security through a crop intensification programme, agroforestry and other associated agricultural management practices, including terracing, diches, grass strip planting. However, there is still a long way to go in terms of addressing food insecurity while building agrosystems and communities' resilience to climate change. This policy briefs highlights some of the gaps pertaining past and current government efforts for mitigation and adaptation to climate change and leverages the potential for Ecosystem-based Adaptation approach for building resilience of agrosystems and communities to climate change.

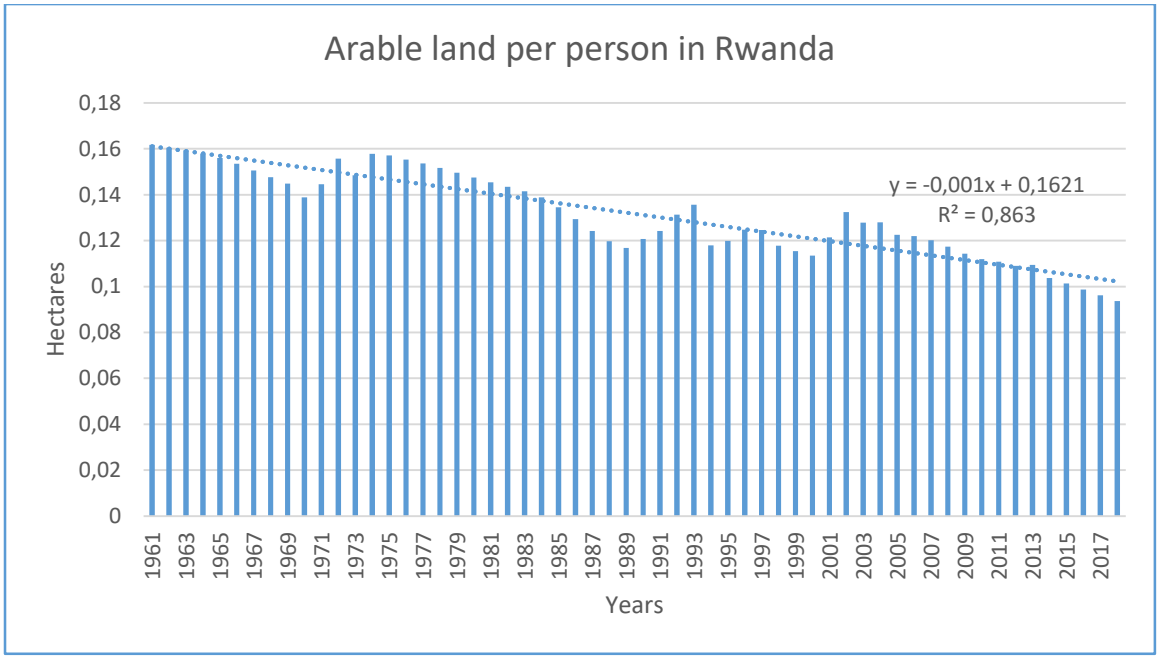
2. Overarching issue

Agriculture in Rwanda is already facing the impacts of climate change which translated into soil fertility loss. Recently, the rate of occurrence of either floods, landslides and erosion has been on the increase particularly in the northern and western highlands of Rwanda (Asumadu-Sarkodie, 2017) where nutrient-rich top soil is washed away in big amount annually. The estimated mean annual soil losses were 48.6 t ha−1 y −1 and 39.2 t ha−1 y −1 in 2000 and 2015, respectively, resulting in total nationwide losses of approximately 110 and 89 million tons most of which consists of nutrient-rich top soil from agrosystems (Nambajimana et al., 2020). According to a study conducted on 'the Economics of Climate Change in Rwanda' by the Stockholm Environment Institute, periodic floods events such as those which occurred in 1997, 2006, 2007, 2008 and 2009 resulted in landslides, loss and damage of agricultural crops,

soil erosion and environmental degradation. The 2007 flood the direct measurable economic costs of the 2007 flood event alone were $4 to $22 million (equivalent to around 0.1 – 0.6% of GDP) for two districts alone. The same study indicates that many climate models indicate an intensification of heavy rainfall in the wet seasons, which is particularly important in relation to a greater flood risk. Floods are embedded in a general erosion issue; In Rwanda there is a high soil erosion risk for land, because smallholder farmers cultivate steep slopes to bring land under cultivation that is not suited to this purpose. Previous studies have estimated that soil erosion results in a loss of 1.4 million tons of soil per year, equivalent to an economic loss due equivalent to US $ 34,320,000, or almost 2% of GDP.

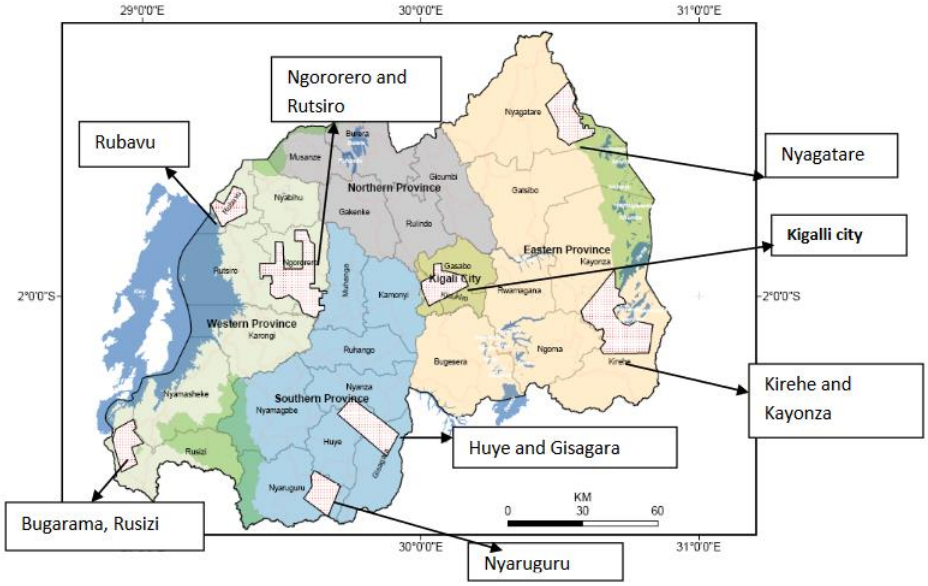
Besides rain intensity related issues, drought is another issue facing Rwanda. A recent assessment study on the level of drought vulnerability across Africa revealed that Rwanda is at a high risk of drought (Ahmadalipour and Moradkhani, 2018) particularly in the eastern lowland of the country (Ndayisaba et al., 2016; Hakizimana, 2018; Rugimbana, 2019). In eastern lowlands, soil fertility loss is impacted by increasing soil water imbalance due to increased evapotranspiration during the dry season of June-August, which affects the physiology of some plant species such as an increase in cyanogenic glucosides in cassava plants for example and the incidence of pests such as termites that attack plants roots in search of water.

Rwanda is a human-dominated landscape where agriculture rely heavily on rain-fed agriculture and where most of the population rely on the sector for livelihoods and wellbeing. Due to limited land availability in Rwanda where the landholdings per household are continuously dwindling as shown in the graph below, climate change is exacerbating the scarcity of land availability, thereby forcing smallholder farmers to encroach on natural landscapes, conversion of natural wetlands, streams and lakes buffers to agriculture and intensive use of chemical fertilizers and pesticides in an attempt to maintain or increase crop production.



Source: https://data.worldbank.org/indicator/AG.LND.AGRI.ZS?locations=RW

A decrease in available arable land per capita can be attributed to the population growth, especially in regions where landsize per household is small. According to current trend, landholdings per capita will be reduced by half (0.08 ha/capita) by year 2030. A high pressure on arable land, coupled with unsustainable land management practices has led to a high degradation of agrosystems. The map below highlights the hotspots that deserve particular attention for restoration.



Map land degradation hotspots in Rwanda. Source: Bizimana (2018)

Agriculture and EbA Policy Brief

3. Why is it important to address this problem?

It is crucial to address the problem of vulnerability of agrosystems to the impacts of climate change essentially because these systems have been fragilized through unsustainable agricultural practices. Topsoil, which lies closest to the surface of the land, contains essential nutrients for crops. It is this layer of soil that is endangered by the compounded effects of climate change and unsustainable land management practices. In addition, it is worth emphasizing the fact that most of people engaged in agriculture sector are smallholder farmers, who in addition to limited technical capacity are facing poverty that hinders their capacity to adapt to adverse impacts of climate change. Agricultural production depends on well-functioning ecosystems and the services they provide such as the provision of healthy and fertile soils, water, pollination, climate regulation, natural pest management, as well as extreme event buffering. Nearly 70 per cent of the estimated 1.1 billion people living in poverty in rural areas depend directly on the productivity of ecosystems for their livelihoods. A recent study on the impact of climate change on crop production in Rwanda reveals that maize, bush bean and Irish potato are susceptible to decline under future climate. Yet, these are the most nationally cultivated crops and the most targeted by the CIP (Austin et al, 2020).

Agricultural ecosystems terms as "agrosystems" are under increasing pressure from changes in the use of land and natural resources, ultimately driven by population growth, poverty and education as well as other political and socio-economic factors as illustrated in a vicious cycle of degradation below. At the same time, climate change impacts, including increased risk of floods, droughts, landslides and soil erosion especially in highlands areas, are degrading agrosystems and their ability to provide services important to people such as food, fuel, fodder for livestock, timber, etc., This, in turn, puts people under increased pressure to resort to unsustainable agrosystem use and management, thus compromising the capacity of for those agrosystems to provide those services.

Assessing climate change impacts on agriculture requires a good understanding of the complexity of the interactions between various climatic and non-climatic drivers and the nature of vulnerability of communities. Therefore, solutions should be designed in an integrated fashion.

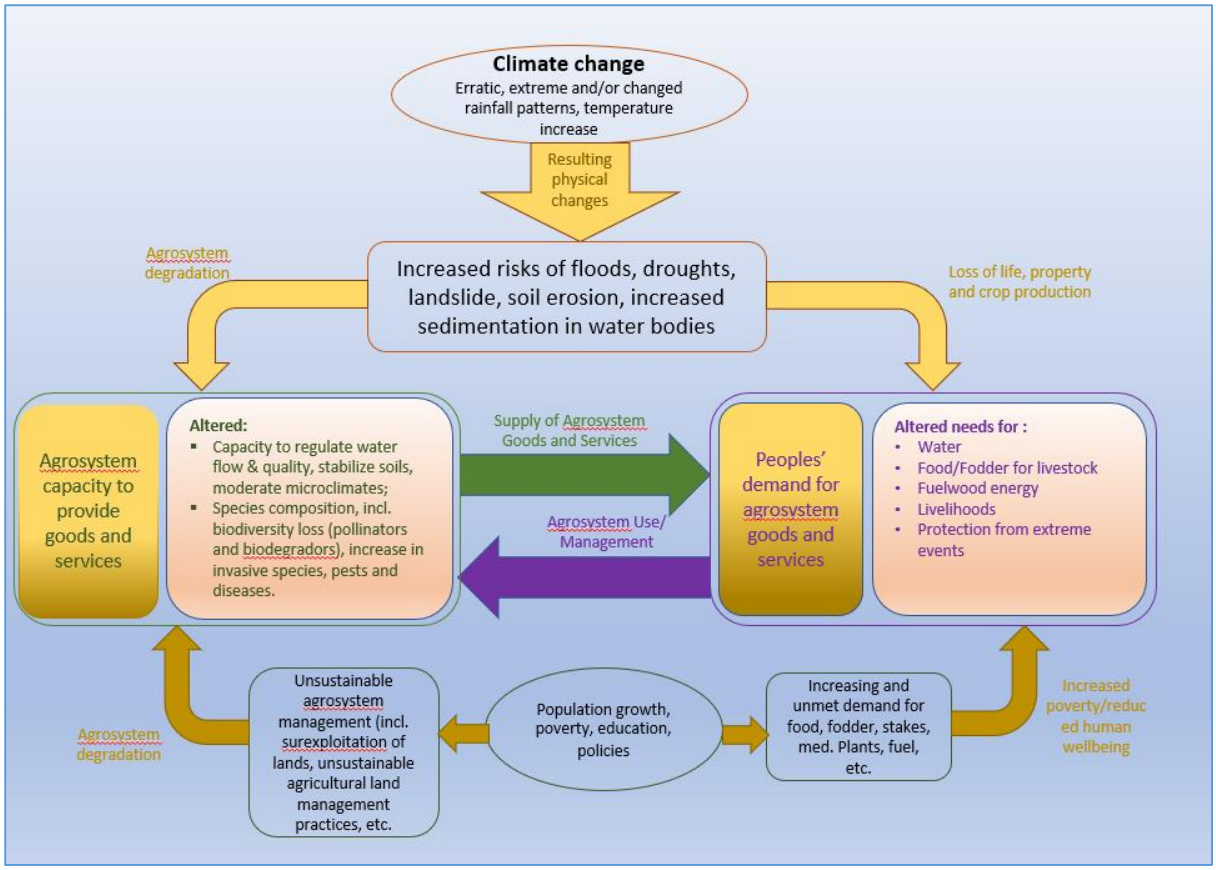


Figure 1. Interactions of climatic and non-climatic degradation processes in terrestrial ecosystems (Adapted from *EbA in different ecosystems: placing measures in context*, by UNEP-WCMC and UNEP, 2019)

Given the complexity of interactions between climatic and non-climatic, including anthropogenic drivers of climate change, it is critical that an approach that capitalizes on a multisector integration and multistakeholder input and which also looks at agrosystem restoration, community-based and driven adaptation for sustainable livelihoods of farmers be considered in the policy making process and development interventions. The Ecosystem-based adaptation in this regard seems appropriate to this end.

4. What are potential benefits of the solutions?

Ecosystem-based Adaptation (EbA) is an approach that focuses on building ecosystem and human community resilience to climate change by restoring, maintaining or improving ecosystem health and reducing social and environmental vulnerabilities. This approach is geared to helping communities to adapt through the goods and services provided by

ecosystems and with the explicit objective of improving the livelihoods and well-being of people affected by climate change.

Nature-based solutions help building resilience of agricultural production systems as well as of the ecosystems on which they depend. Resilience against multiple threats is a key prerequisite for sustainable development, in particular, when it comes to the challenge of being able to feed over 9.5 billion people by 2050. Carbon neutral and climate resilient systems are needed across sectors, especially for agriculture and food systems, to sustain food and nutrition security.

Designing solutions that foster resilience of agrosystems and smallholder farmer to climate change through the improvement of their livelihoods is key to improving the wellbeing of urban as well as rural human communities. Ecosystem-based Adaptation approach (EbA) can, in this regard, play a significant role in the transformation of the agriculture sector towards long-term sustainable production systems that can meet food security for generations to come.

Since 2008, the government of Rwanda has embarked on crop intensification programme (CIP) aimed at boosting agricultural productivity to ensure food security. The programme focused on the use of improved seeds, chemical fertilizers, land consolidation and rice production, in an effort to increase food crop production. Recently, the government has encouraged the use of organic manure with chemical fertilizers. A gradual increase in the use of organic fertilizers, including the increase of the organic biomass in the soil, will reduce the vulnerability to heavy storms. Furthermore, the government is aggressively pursuing measures for soil erosion control. These measures include terracing, increasing soil cover and integrated management approaches such as agroforestry and zero-grazing. There have been increases in the area under radical terracing. However, small scale farmers lack the capacity to respond to the control of soil erosion because the anti-erosion measures are expensive. While these efforts contribute to increasing food production, long-term impacts might be questionable, particularly with regards to the environmental and socio-economic sustainability.

Most interventions have focused on the promotion of sustainable land use and agricultural land management practices through relevant policies, strategies, regulations and legal measures, including

Rwanda's Strategic Plan for Agricultural Transformation 2018-2024, Rwanda Livestock Master Plan 2018-2022, Rwanda National Agricultural Policy 2017 and the National Emergency Plan for Animal and Plant Diseases 2016 (REMA, 2021). The need for promoting smart agriculture has also been encapsulated into Vision 2050, Economic Development and Poverty Reduction Strategy (EDPRS) and the National Strategy for Transformation (NST1) 2017-2024 (REMA, 2021). On the ground, REMA has recently introduced an innovative approach, EbA, in an effort to ensure a crop intensification program that fosters the integrity of agrosystems by focusing on the conservation and sustainable use of ecosystem services provided by green agriculture, including boundary buffers to protect water bodies and other octivities geared towards ensuring that environmental issues and climate change are integrated into Rwanda's development.

These efforts foster longterm soil conservation and sustainable nutrient management that avoids pollution of water bodies with chemical fertilizers such as phosphorus and nitrogen, and that also conserve soil organisms that play a role in biodegradation processes; the efforts also consider above ground biodiversity that include tree diversity through agroforestry which helps control pests and facilitate the conservation of pollinators such as bees and birds. The EbA approach is the right way to ensure food security as it looks at long-term performance of agriculture by incorporating climate change, ecological functioning of agrosystems and socio-economic resilience.

5. Key messages: Application of EbA for Sustainable Agriculture Management

- The EbA accommodates the complex interplay between climatic and non-climatic factors in driving the vulnerability of agrosystems and smallholder farmer community to adverse impacts of climate change; EbA focuses on a participatory cross-sectoral and multistakeholder approach in the design of sustainable socio-economic and environmental adaptation to climate change.
- For agriculture to respond to food security and the integrity of our environment, all economic activities conducted withing agricultural landscapes should consider the conservation of ecosystem services that are key to food production, including conservation of bees and birds that are key to crop pollination as well as invertebrates in the soil that contribute to the biodegradation of organic matter.
- EbA should be given its priority in agricultural policy and planning and should consider farmer communities knowledge and attitudes at the center of the policy making, interventions strategies processes as well as the monitoring and evaluation of outcomes.

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