info brief

Forests, water and land health are the natural capital of African montane forest ecosystems

Mariana C. Rufino[1], Anne-Marie Ran[2], Jaqueline Stenfert-Kroese[1], Douglas B. Ombogoh[2], Suzanne R. Jacobs[3], Bjorn Weeser[3], Naomi K. Njue[2,3,4], Ojoatre Sadadi[1], Paolo O. Cerruti[2], Esther Mwangi[2], Christopher Martius[2], John N. Quinton[1] and Lutz Breuer[3]

Key messages

- This brief explains the impacts of conversion of indigenous forest to small- and large-scale agriculture on water, carbon and nutrient cycles, and the implications for forest, water and land health.
- Our long-term research in the Mau forest of Kenya quantified the negative effect of forest encroachment and poor agricultural practices on the natural capital of the communities living on the edges of the forest and the livelihoods of those downstream in the river basin, threatened by soil loss and nutrient pollution of water resources.
- We propose practical solutions that tackle the root cause of the problem and increase community resilience aligned with the implementation of existing national and sub-national policies designed to protect natural resources.
- Solutions include the promotion of regenerative, holistic agricultural practices that preserve natural capital. In addition, enhanced governance of natural resources at the local level through joint activities between forest and water associations will contribute to the effectiveness of initiatives to improve simultaneously forest, water and land health.

Introduction

Tropical forests regulate water and nutrient cycles through their diverse and abundant biomass. The protective surface cover and dense rooting systems of forests promote biological activity and rainfall infiltration, and protect the soil from erosion.

Montane forest ecosystems in the highlands of Kenya such as the Mau Forest Complex, are hotspots of forest degradation and conversion to agriculture. Scarcity of arable land due to increasing human population leads to encroachment into these forest ecosystems. Large parts of the forests are degraded due to unsustainable extraction of firewood, production of charcoal, fire, and forest livestock grazing (Brandt et al. 2018).

The Mau Forest Complex is the largest remaining closed-canopy forest of East Africa, covering about half a million hectares. As such, it is an important water catchment. Its water resources support the livelihoods of approximately 5 million people, as well as livestock, wildlife and the economy.

Unsustainable agricultural practices are at the core of land degradation and loss of natural capital, increasing risks to community resilience, which depends on forest, water and land health (Figure 1).

Forest, Water and Land health

Multiple interdisciplinary studies conducted since 2013 under the CIFOR's 'Water Towers of East Africa' project have provided clear empirical evidence of the effect of forest conversion to small- and large-scale agriculture (commercial tea and timber plantations) in Mau's Forest Complex. Conversion impacts water and nutrient cycles, reduce carbon storage, increase soil erosion and affect forest and water governance. The key findings are:

Key finding 1

Forests play a key role storing carbon in montane ecosystems. Measurements within the Mau forest (Ojaotre 2022) have shown a significant impact of forest clearance reducing carbon storage in aboveground tree biomass, and a smaller effect on carbon storage in forest soils. Carbon in aboveground biomass and species diversity tend to recover after two to three decades, reaching the levels of the old growth secondary forest, although there are no sites to compare against primary intact forest. This finding shows the value of forest carbon storage and the need to support forest health recovery to contribute to climate change mitigation and biodiversity.

1   Lancaster University
2   Center for International Forestry Research (CIFOR)
3   Justus Liebig University Giessen
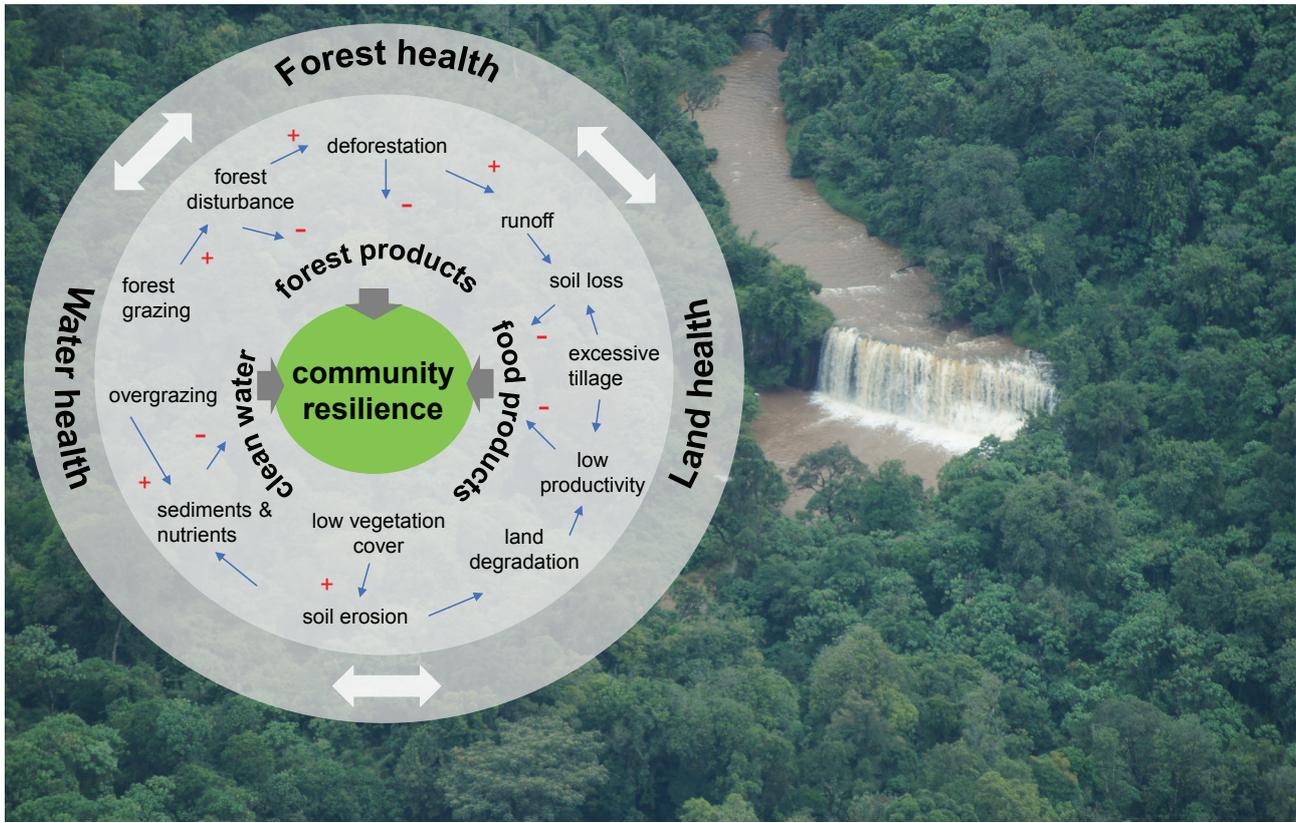4   University of Kabianga

Figure 1. Forest, water and land health underpin the delivery of key ecosystem services such as clean water, forest products and food products that support communities living in forested montane ecosystems. Livestock forest grazing causes forest disturbance and overgrazing increases sediment and nutrient losses to water bodies affecting clean water supply. Forest disturbance due to grazing, fire, fuelwood and charcoal extraction and deforestation increase runoff after storms leading to soil loss, which together with excessive tillage of cropland affect food production leading to low agricultural productivity. On farmland, low vegetation cover due to continuous cultivation increases erosion contributing to land degradation. These processes combined reduce community resilience.

Key finding 2

Groundwater is an important source of water for streams in natural forest, tea and timber plantations, and smallholder agricultural catchments. The deep and well-drained soils of natural forests absorb, store and slowly release rainwater via groundwater (Jacobs et al. 2018a). Agricultural land is more prone to surface runoff due to its more compacted soils (Owuor et al. 2018).

Key finding 3

Catchments dominated by agricultural land export up to four times more nitrate than forested catchments (Jacobs et al. 2018b). Agricultural land loses a significant amount of nutrients to waterways through leaching to the groundwater and runoff. Surface runoff containing nutrients bound to sediment is another pathway that contributes to the loss of nutrients from agricultural land.

Key finding 4

Conversion of natural forest to agricultural land increases soil erosion rates and sediment transport. Agricultural catchments generate up to six times more sediment compared to a forested catchment and up to four times more than a commercial tea plantation catchment (Stenfert Kroese et al. 2020a). The largest quantity of sediment is generated at the beginning of the rainy season when the soil has been prepared for planting of crops and is unprotected.

Key finding 5

At the local level, there are separate governance processes for natural resources such as forests and water. Forest and water resource associations work separately even though they conduct similar forest and water conservation and rehabilitation activities on the same landscape, which reduces effectiveness of actions (Ombogoh et al. 2022).

Impact and consequences

Poor agricultural practices and compacted soil decrease the water infiltration rate and increase surface runoff, which causes significant annual losses of nutrient-rich topsoil. It is estimated that soil erosion costs the Kenyan economy USD 390 million per year or 3.8% of gross domestic product (Stenfert Kroese et al. 2020b).

Furthermore, nutrient-rich soil particles enter the waterways, substantially decreasing the biological, chemical and physical quality of the rivers. Decline of water quality and augmented sedimentation impact streams in the upper part of the catchment and the effluent directly pollutes the waters of Lake Victoria. Livelihoods and the economy are impacted by eutrophication, decline of the fish population, increased drinking water treatment costs, increased maintenance of reservoirs and dams, affecting drinking water storage and hydropower generation.

Proposed Solutions

Regenerative farming and agroforestry practices have been shown to conserve soil by improving infiltration rates, and increasing organic carbon and soil nutrients, which directly improve land productivity and avoid erosion. Relatively simple measures include vegetation buffer strips (e.g. using Napier grass), stone rows, terracing, mulching, cover crops, erosion ditches or the retention of crop residues on cropland.

As fertilisers are commonly used in small- and large-scale farming to improve crop productivity, improved fertilizer use adjusting type, quantity, timing and application method can reduce nutrient leaching to groundwater and the subsequent pollution of surface water.

In areas where forests have been converted to agricultural land, appropriate engineering of rural trackways is crucial as it can break the velocity of runoff water on pathways, divert water from the main conduits that lead directly to waterways and disconnect the hillslope agricultural areas from the unpaved tracks.

Protecting forests from illegal abstraction of resources, encroachment and conversion to agricultural land is the most important step to take to avoid a decline of natural resources and community resilience. Wetlands and the riparian zones need to be kept intact as they buffer the surface runoff and serve as a sediment trap.

More than 70% of rural Kenyans are subsistence and commercial farmers (FAO n.d.), therefore, investment and policies targeted at the rural sector will not only help improve land, water, and forest health but also increase significantly community resilience against climate extremes and climate change.

Kenya has relevant acts, strategies and policies in place that support the proposed solutions. For example, the Water Act (Government of Kenya 2016a) emphasizes the rehabilitation of riparian zones and the protection of water resources, while the Environmental Management and Coordination Act (Government of Kenya 2012a) sets out regulation for the conservation of wetlands. The Agriculture Act (Government of Kenya 2012b) provides for the conservation of the soil and its fertility, and clearly mentions the use of good land management practices. The Forestry Act (Government of Kenya 2016b)

is among the most stringent in the world and specifies the conservation and rational utilisation of all forest resources. Moreover, and correctly so, the acts mention the links between the forest and other sectors and requests not to act in isolation.

However, the implementation, compliance and enforcement of these policies is unsatisfactory and progress is slow. Community associations are formed under these respective acts with a focus on conservation of forests and water. However, there is little coordination between these associations, even though they conduct similar conservation and rehabilitation activities, often on the same landscape (Ombogoh et al. 2022).

Recommendations

- Protect forests. Undisturbed and recovering natural forests buffer areas that emit more greenhouse gases and are prone to erosion. Keep wetlands and riparian zones intact.
- Improve farming practices. Keep the soil where it belongs (on farmland) and increase its productivity by implementing soil and water conservation (agroforestry or regenerative agriculture, for instance). Boosting agricultural productivity will protect forest margins against further encroachment.
- Implement policies. Political will and allocation of human and financial resources to support sector institutions in the implementation of their mandate is essential. On the ground, it is important to encourage collaboration between institutions, promote integrated practices and provide solid technical advice to support farmers and communities.
- Govern forest and water resources jointly. Identify entry points for enhanced coordination at the local level. These include local-level planning processes; similar activities, interests and challenges; capacity building on joint management; and rights and responsibilities for forest and water management.

Acknowledgement

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