The forest-water-people nexus in the Mt. Elgon Water Tower Region, Uganda: impacts of tree cover and population changes on water availability

Files

Kimbowa-CAES-PhD-2025.pdf (10.42 MB)

Date

2025

Authors

Kimbowa, George

Publisher

Makerere University

Abstract

A critical knowledge gap exists in understanding how biophysical changes and socio-institutional dynamics jointly influence water availability and land-use planning, under future development scenarios in data-scarce mountainous regions, particularly in terms of integrating diverse knowledge sources for informed decision-making. Despite numerous natural resource management initiatives and agroforestry programs, forest-water governance in these landscapes remains limited, primarily due to institutional weaknesses rather than local resistance. This study investigates the interactions between human population and tree cover changes and water availability in Uganda's Mt. Elgon Water Tower Region (MEWTR), focusing on the Sipi River and River Manafwa sub-catchments. An integrated, participatory, mixed-methods approach was applied. Structural Equation Modeling (SEM) was used to analyse long-term data (1990–2024) to assess causal links between population change, tree cover change, and hydrological variables. Results show a decline in tree cover from 27.1% in 1990 to 18.9% in 2017. Surprisingly, streamflow in Sipi River Sub-catchment (SRSC) increased during dry months, despite minimal precipitation change—suggesting complex hydrological responses to land-use change transformations. Q-methodology was used to explore diverse stakeholder perceptions of the forest–water–people (FWP) nexus, revealing broad recognition of forests' role in water regulation, while highlighting institutional constraints—poor coordination, limited funding, and weak stakeholder engagement—as key barriers to sustainable agroforestry management. Fuzzy Cognitive Mapping (FCM) and Water Evaluation and Planning (WEAP) scenario modelling explored institutional bottlenecks and future water demand. Findings show that irrigation demand could increase by over 1800% by 2040 under the optimistic development pathways, with unmet demand potentially exceeding 1100 million Cubic Meters per Year (MCM/year) by 2060. Infrastructure interventions, including planned reservoirs can mitigate potential deficits but require coordinated governance and financial feasibility. The study demonstrates that integrating biophysical modelling with participatory methods enhances the understanding of complex socio-ecological interactions and strengthens the design of adaptive, inclusive, and resilient forest-water governance strategies. Comparative analysis of sub-catchments highlights both shared and localized drivers of forest-water dynamics. The findings underscore that effective management of agroforested landscapes in mountain ecosystems like MEWTR requires institutional empowerment, context-specific stakeholder engagement, and the scaling of participatory scenario planning. These measures are crucial for promoting sustainability, reducing future water stress, and improving forest-water governance in rapidly transforming, data-scarce, regions.

Description

A thesis submitted in fulfilment of the requirements for the Degree of Doctor of Philosophy to the Directorate of Research and Graduate Training of Makerere University

Citation

Kimbowa, G. (2025). The forest-water-people nexus in the Mt. Elgon Water Tower Region, Uganda: impacts of tree cover and population changes on water availability; Unpublished PhD Thesis, Makerere University, Kampala

URI

https://makir.mak.ac.ug/handle/10570/15929

Collections

School of Forestry, Environmental and Geographical Sciences (SFEGS) Collections