A Probabilistic Framework for the Cost-Benefit Evaluation of Restoration Outcomes for a Dry Afromontane Forest in Northern Ethiopia

Yvonne Tamba[1], Cory Whitney[2], Eike Luedeling[2], Keith Shepherd[1], Ermias Aynekulu[1], Aklilu Negussie[3], Negusse Yigzaw[3], Joshua Wafula[1], Yemane Gebru[3], Caroline Muchiri[1]

[1] *World Agroforestry (ICRAF), Land Health Decisions, Kenya*
[2] *University of Bonn, Inst. Crop Sci. and Res. Conserv. (INRES), Germany*
[3] *WeForest, Ethiopia*

Abstract

Forest and Landscape Restoration (FLR) is carried out with the objective of regaining ecological functions and enhancing human well-being through intervention in degrading ecosystems. However, uncertainties and risks related to FLR make it difficult to predict long-term outcomes and inform management plans. We applied a Stochastic Impact Evaluation framework (SIE) to simulate returns on investment in the case of FLR interventions in a degraded dry Afromontane forest while accounting for uncertainties. We ran 10,000 iterations of a Monte Carlo simulation that projected FLR outcomes over a period of 25 years. Our simulations show that investments in assisted natural regeneration, enrichment planting, exclosure establishment and soil-water conservation structures all have a greater than 77 % chance of positive returns. Sensitivity analysis of these outcomes indicated that the greatest threat to positive cashflows is the time required to achieve the targeted ecological outcomes. Value of Information (VOI) analysis indicated that the biggest priority for further measurement in this case is the maturity age of exclosures at which maximum biomass accumulation is achieved. The SIE framework enabled us to clearly define the objectives of FLR activities and quantify the expected impacts on land use and land cover trends. With the framework, we translated outcomes into economic impacts for easy integration into decision-making processes. For FLR implementers, initial costs incurred to establish livelihood interventions, mobilise communities, strengthen social governance structures, and provide capacity building can result in net losses in the first few years. Implementers will therefore need significant financial support to see their interventions through to the medium and long term.

Keywords: Decision analysis, forest and landscape restoration, Monte Carlo risk analysis, uncertainty, value of information

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Contact Address: Yvonne Tamba, World Agroforestry (ICRAF), Land Health Decisions, 30677 U.n. Avenue, 00100 Nairobi, Kenya, e-mail: Y.Tamba@cgiar.org