CASE STUDY **Applied systems approach to modeling forest landscape restoration outcomes in Northern Ethiopia**

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Landscapes restoration intervention planners are often faced with the challenge of prioritizing among different interventions to optimize outcomes. This is because landscape restoration outcomes are often achieved through complex mechanisms, and the success of restoration actions is rarely guaranteed, with many uncertainties preventing precise impact prediction (Luedeling et al. 2019). Success is even harder to predict, when landscape restoration agencies aim to strengthen restoration efforts indirectly, e.g., by supporting livelihoods and economies of local people as an incentive for them to to restore degraded landscapes (Wafula et al. 2018). However decision support tools that allow for the expression of uncertainty and risks could help to overcome these challenges.

This case study is intended to serve as an example for development practitioners in holistically evaluating project costs, benefits and risks using decision support tools. A particular focus is on the methods available to include variables with uncertain and missing information, using a decisionSupport package (Luedeling & Gohring, 2017; Luedeling & Whitney, 2018) to predict outcomes of investing in beekeeping and enrichment planting of trees and management in Desa'a forest in Northern Ethiopia.

Important Details

time (or time period)	2020-2021
country & region	Desa'a forest, Northern Ethiopia
context & agro-eco landscape type	180 ha of semi-arid forest; located in the area where the Tigray and Afar regions overlap
key actors, stakeholders & beneficiaries	Farmers, extension agents, NGO program staff
model and/or tools used	semi-structured interviews with decision-makers; participatory modeling of intervention outcomes

Overview

To preserve and protect Desa'a forest, a non-profit organization with support from the Ethiopian government launched a long-term FLR program that proposes investments in a portfolio of scalable environmental and socio-economic interventions. The specific objectives of the program are to (i) restore the degraded forest's biodiversity and enhance ecological integrity (ii) contribute towards meeting the subsistence needs and hence promote economic development and (iii) build the livelihood resilience of communities living within and around the forest. To achieve these objectives, proposed interventions are to

be implemented within a zoning framework in a pilot area covering 180 ha of the forest (Tamba et al., 2021). In this module we highlight the impact of investing in beekeeping to reduce forest encroachment, where enrichment planting of indigenous trees is being implemented.

Proposed Interventions Modeling: To model proposed interventions, we first define the decision question with decision-makers. For instance, what are the short-term and long-term restoration outcomes, who are the targeted beneficiaries and what type of decision is under consideration (prioritizing vs planning) (Luedeling and Shepherd, 2016). Semi-structured interviews with decision-makers can help to contextualize the decision under consideration. The process also helps to identify subject matter experts to engage in the participatory modeling of intervention outcomes.

To explore in depth the full decision support package applied in this case, please refer to the details of the model as hosted here: https://rpubs.com/jokumu56/801339.

Lessons Learned & Recommendations

Clear definition of interventions and expected outcomes can help develop decision impact pathways in complex systems. This enables project proponents to identify plausible cost, benefit and risk variables. The process provides realistic estimates of the plausible ranges of returns of interventions, considering all outcome dimensions that are relevant in a particular context.

To realistically value ecosystem benefits, landscape restoration actors should base their predictions on expert knowledge of the local context rather than on benchmark estimates carried over from different contexts (Stalhammar & Pedersen, 2017).

The use of distributions when estimating the value of variables rather than best-bet estimates avoids overly hopeful predictions that could misguide planning (Luedeling et al. 2019). Klein's Pre-mortem (Klein, 2007) and the equivalent-bet technique (Freund, & Jones, 2015), have been proven to measurably improve an expert's ability to provide accurate estimates (Hubbard, 2014). However, modeling linkages between forest conservation and improved livelihoods is still a challenge. The process requires making spurious assumptions (e.g assuming that increasing income reduces forest encroachment) that may not reflect the situation on the ground.

Value of Information analysis can provide indications of what needs to be measured to support intervention decisions. While many uncertainties usually exist in all decisions that affect complex systems, only those uncertainties that are of value to the decision maker should be prioritized for further measurement. This can substantially reduce the cost of data collection aimed at informing decisions.

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