RESPONSE

To the study

Aggregate Effects on Ecosystem Services from Certification of Tea Farming in the Upper Tana River Basin, Kenya

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BACKGROUND

The role of certification in achieving sustainability outcomes is not limited to the farm-level. On-farm practices are directly linked to landscape-level impacts, especially as adoption of certification expands across regions. However, it can be difficult to measure and map the aggregate impacts of certification since adoption is often heterogeneous and landscapes are complex. This study, led by Louise Willemen of the University of Twente and Neville Crossman of the University of Adelaide, provides an interesting example of how the cumulative impacts of certification can be quantified at the landscape scale.

The research team, which included the Rainforest Alliance's Deanna Newsom, David Hughell, and Jeff Milder, used ecosystem service modeling techniques to investigate the landscape level effects of tea certification in the Upper Tana River basin in Kenya. In this region, around 95% of tea growers (250,000 smallholders) have been Rainforest Alliance Certified since 2011. The ecosystem services provided by the Tana River play an important social and economic role: the river provides almost all of Nairobi's domestic water, and hydropower produced along the river powers 50% of the country. Agricultural practices in the watershed are directly linked to these key ecosystem services. For example, sedimentation from erosion (i.e., soil entering the waterway) can inhibit the functioning of downstream water treatment infrastructure, and nutrient run-off from fertilization can affect water quality. Therefore, this setting provides a valuable opportunity to investigate the landscape-level impact of more sustainable land management practices, such as those promoted in the Rainforest Alliance standard.

Evaluation questions

- *How do the land management practices used on Rainforest Alliance Certified tea farms in the Upper Tana watershed in Kenya affect water quality, specifically sedimentation and nutrient load?*

- *What is the usefulness and limitation of ecosystem service models in investigating landscape-level impacts of certification?*

Methodology

This study used ecosystem service models to estimate the impact of Rainforest Alliance Certified tea smallholders on water quality in the Tana River watershed. The ecosystem service approach is based on the notion that enhancing on-farm ecosystem services through practices such as those prescribed in the Rainforest Alliance standard will, in aggregate, bolster landscape-level services as well.

The research team applied two ecosystem service models, InVEST and the Soil and Water Assessment Tool (SWAT), to estimate sedimentation and nutrient run-off into the Tana River before and after certification. Model inputs for pre- and post-certification scenarios were developed through farmer interviews and field visits to a subset of 15 farms, and data provided by the Kenya Tea Development Agency (KTDA). For the post-certification scenario, model inputs were adjusted to reflect Principles 2 and 9 of the 2010 SAN Standard; the land management practices in these two principles include erosion control, optimization of fertilizer use, and maintenance of buffer zones between production areas and natural areas such as streams.[1]

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[1] Principles 2 and 9 in the 2010 SAN Standard address Ecosystem Conservation and Soil Management and Conservation, respectively. These approaches are reflected in Principles 2 and 3 of the 2017 SAN Standard (Biodiversity Conservation and Natural Resource Conservation, respectively).

Finally, the research team conducted sensitivity analysis to examine the robustness and reliability of the two models. To do this, they compared baseline outputs between the two models and ran the models again with higher resolution land cover data, which was available for about half of the area under study.

EVALUATION FINDINGS

How do the land management practices used on Rainforest Alliance Certified tea farms in the Upper Tana watershed in Kenya affect water quality, specifically sedimentation and nutrient load?

- **Sedimentation was lower in the post-certification scenario** – Erosion control measures implemented on Rainforest Alliance Certified farms were estimated to substantially decrease the amount of sediment entering the watershed. The model estimated that sedimentation decreased by an average of 3.3 ton/ha/year, or 184,000 tons/year in total, a decrease of about 40% from the pre-certification scenario. Reduced sedimentation has clear and tangible benefits to regions that rely on this watershed. In particular, reduced sedimentation improves the functioning and efficiency of hydropower and other water treatment infrastructure downriver.

- **Nutrient loading was higher in the post-certification scenario** – Exports of both nitrogen and phosphorus were higher post-certification compared to the pre-certification scenario. Nitrogen loading increased by 0.53 kg/ha/year or 30 ton/year total, and phosphorus loading increased by 0.1 kg/ha/year or 6 ton/year total. Rainforest Alliance certification aims to optimize fertilizer application to maintain soil fertility while avoiding the excess nutrient runoff that can impact water quality. Farm visits and interviews revealed that farmers purchased and applied more fertilizer after becoming certified.

What is the usefulness and limitation of ecosystem service models in investigating landscape-level impacts of certification?

- **Ecosystem service models were helpful for learning about landscape-level impacts** – This study found that the modeling approach helped illustrate how the impacts of farm-level activities scale across landscapes. Model results were consistent in the direction of their results, suggesting that, at a broad level, these models accurately depicted the impacts of land management practices on water quality in the Tana River.

- **Ecosystem service models were limited in their precision** – The authors found that the models were highly sensitive to input data and the resolution of land cover data. This finding indicates that these models are limited in their ability to precisely quantify the impacts of sustainable land management practices in the absence of complete and accurate input data (see Limitations, below).

Limitations

The authors acknowledge two main limitations that stemmed from lack of data and the reliability of the ecosystem services models:

1. **Buffer zones were assumed to be the same pre- and post-certification** – Based on interviews with a subset of farmers (11 farms), the researchers assumed that buffer zones were comparable in pre- and post-certification scenarios. However, given the emphasis placed on maintaining and improving buffer zones in the Rainforest

Alliance standard, it is likely that the quality and prevalence of buffer zones increased overall following certification. As a result, the role of buffer zones in mitigating sedimentation and controlling fertilizer runoff is not accounted for in these models.

2. **Model sensitivity analysis showed inconsistencies** – Sensitivity analysis of the models showed fairly large differences in the absolute magnitude of the results, even though the relative impacts were consistent. In particular, the scenario analyses were highly sensitive to input data and model choice, and the model outputs varied considerably depending on the resolution of the land cover data that was used.

CONCLUSIONS AND RECOMMENDATIONS

The modeling approach presented in this study can be used to estimate landscape-level impacts of land management practices such as those prescribed by the Rainforest Alliance standard. Overall, the research suggests that farm-level practices on smallholder tea farms in Kenya play a role in protecting critical economic and social services in the Tana River watershed, such as clean drinking water and water treatment infrastructure.

In light of the key findings of the study, the authors emphasized the following:

- Decisions on where to prioritize certification can be guided by modeling efforts such as this one. Sustainable land management practices have a larger landscape-level impact if they are targeted. For example, prioritizing soil stabilization measures in erosion-prone areas such as steep slopes can compound the benefits of this approach when aggregated across the landscape.

- Certification programs such as the Rainforest Alliance should seek out and utilize landscape-level findings to highlight the role of sustainable land management practices in protecting ecosystem services.

- Researchers should be careful when applying commonly used SWAT and InVEST modeling techniques to make precise statements about sedimentation and nutrient loading because of difficulties with calibration and data limitations.

- As ecosystem service models gain popularity as decision-making tools, researchers should focus on quantifying, reporting, and visualizing the uncertainty associated with these models.

RAINFOREST ALLIANCE'S RESPONSE

This study provides a very useful example of how land management practices on smallholder farms play a role in protecting critical ecosystem services in the wider landscape. We welcome the empirical results as well as the findings that demonstrate the utility and limitations of applying ecosystem service models in this context. The Rainforest Alliance is actively developing approaches and tools to investigate landscape-level impacts of certification, including LandScale and the Accountability Framework, and therefore the methods and findings from this study are helpful and illuminating.

The researchers emphasize that the value of this study lies partially in its ability to demonstrate the importance of setting priorities for sustainable land management practices on the landscape level, and we agree with this interpretation. The findings provide critical support for policies and incentives that could further protect the ecosystem service functions of the Tana River watershed and highlight the role of market-based incentive programs such as Rainforest Alliance certification. As the authors suggest, the absolute magnitude of the

landscape-level impacts observed in this study may not be reliable owing to model discrepancies as determined through sensitivity analysis. However, the relative impacts are consistent between models.

The finding that sedimentation decreased in the post-certification scenario is in line with what we expect based on the management practices in the Rainforest Alliance standard. For example, the authors noted that farmers were more likely to plant Napier grass (*Pennisetum purpereum*) and build vegetated contour strips post certification, both of which can control erosion. We are pleased to hear that the erosion control guidance in the Rainforest Alliance standard may be contributing to reducing sedimentation at the landscape level.

The finding that nutrient loading increased post-certification is not necessarily an expected result of the more sustainable land management practices required by our standard. Based on data from 10 KTDA processing facilities, the researchers found that fertilizer distributed to farm group members increased from 660 kg/ha/year before certification to 700 kg/ha/year on average after certification.

Through conversations with individual farmers, the authors found that farmers' understanding of fertilization benefits and their purchasing power had increased post-certification. Both of these are desired outcomes of Rainforest Alliance certification and are in line with what we have observed in this region. Specifically, the uptake of Rainforest Alliance certification in the Upper Tana River basin has increased contact between farmers and extension service providers and led to more training through farmer field schools.

While the Rainforest Alliance standard requires farmers to analyze their soil needs to optimize fertilization, training also often includes information on how fertilization can improve yields. Therefore, it is possible that certain farms were previously underapplying fertilizer, and through training, determined that additional amendments were warranted. However, the finding that fertilization increased post-certification emphasizes the importance of ensuring that trainings are clearly focused on optimizing fertilizer use, and not simply increasing the amount of fertilizer used. An analysis of whether yields increased in response to increased fertilization would help clarify this finding. In addition, it would be helpful to know how fertilization rates in the Tana River region compare to rates in other similar tea growing areas.

A final factor that may partially explain the finding that nutrient run-off increased post-certification is that riparian buffers were not accounted for in the models. An important function of riparian buffers is their ability to control nutrient runoff before it enters waterways; the Rainforest Alliance standard requires that farms establish and maintain buffers as a result. If farmers effectively manage riparian buffers while optimizing fertilizer use, we would not expect to see large increases in nutrient loading in waterways even if fertilization rates were higher than in the pre-certification scenario.

In this study, interviews with a selection of farmers (on 11 farms that had streams) suggested that buffers had not changed significantly since becoming certified. However, when considered across all certified farms in the region, it is possible that buffers were more prevalent and more effectively managed post-certification, owing to the detailed criteria in the standard related to this issue. Indeed, some farmer groups in this study noted that the quality of their buffers had increased after becoming certified due to removal of exotic species; this is consistent with anecdotal information from auditors in the region. The authors acknowledge that their assumption of no change in buffer zones was conservative but were limited by a lack of spatial and observational data.

Overall, the findings of this study related to fertilization provide important points of feedback as we continue to develop the new Rainforest Alliance standard, which will be published in 2020. The new standard will place more emphasis on soil management practices including erosion control and analysis of the physical and chemical composition of the soil to help farmers develop tailored fertilization regimes. In particular, these findings underline the importance of intentional and accurate training of farmers and extension service providers with respect to fertilization practices.