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Economics of carbon sequestration in community forests: Evidence from REDD+ piloting in Nepal

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ABSTRACT

Reducing Emissions from Deforestation and Forest Degradation (REDD+) has been piloted in developing countries as a climate change mitigation strategy, providing financial incentives for carbon sequestration in forests. This paper examines the economic feasibility of REDD+ in community forests within two watersheds in central Nepal, Ludikhola and Kayarkhola, using data on forest product demand, carbon sequestration, carbon price and REDD+ related costs. The benefits of REDD+ are about $7994, $152, and $64 per community forest, per hectare of forest area, and per household in Ludikhola watershed compared to $4815, $29, and $56 in Kayarkhola watershed, respectively, under the business-as-usual scenario. Compared to the EU ETS carbon price ($10.3/$tCO_2$e), the average break-even carbon price in community forests is much higher in Kayarkhola watershed ($41.8/$tCO_2$e) and much lower in Ludikhola watershed ($2.4/$tCO_2$e) when empirical estimates of annual expenditure in community forests are included in the analysis. The incorporation of annual expenditure estimates and opportunity cost of sequestered carbon (in the form of firewood prices in local markets) in the analysis suggests that community forests are economically infeasible for REDD+ at the prevailing carbon prices. The implication of our findings is that economic feasibility of REDD+ in community forests depends on the local contexts, carbon prices and the opportunity costs, which should be carefully considered in designing REDD+ projects.

Introduction

Climate change is a significant global problem which has negatively impacted ecological processes, biodiversity, food production, economic growth, social order, and human health and wellbeing (IPCC, 2014a). The forestry sector is both the source and sink of carbon emissions. It emits about 12% (6–17%) of anthropogenic CO_2 annually through deforestation and forest degradation (Van der Werf et al., 2009). Based on 1991–2015 data, Food and Agricultural Organisation estimates that forests emit about 4.04 Gt of CO_2 from deforestation of which 0.8 Gt is from forest degradation, while sequester about 2.52 Gt of carbon annually (Federici et al., 2015). The IPCC fifth assessment report estimates that forestry and other land use emitted 5.39 Gt of CO_2e (11% of 49 Gt) in 2010 up from 4.59 Gt of CO_2e (17% of 27 Gt) in 1970 (IPCC, 2014b). Most of these emissions from the forestry sector occur in developing countries. Thus, to reduce carbon emissions in

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developing countries, 'Reducing Emissions from Deforestation and Forest Degradation' along with forest conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+) has been adopted as a mitigation strategy by the United Nations Framework Convention on Climate Change (UNFCCC).

REDD+ is specifically targeted at the forestry sector in developing countries to reduce forest biomass loss and sequester carbon (Beyene et al., 2016). Households in developing countries often rely heavily on forests for a variety of ecosystem services, particularly for the supply of timber and firewood. In these countries forests support the livelihoods of about 1.6 billion people (Zenghelis and Stern, 2009) and provide energy for over 2.5 billion people (IEA, 2006). Therefore, the design and implementation of the REDD+ projects in high forest-dependent contexts are likely to compromise the essential services derived by local communities from the forests. Because REDD+ seeks to directly offset extractive activities, such as firewood or timber harvest, by providing revenue for carbon sequestration and storage in forests (Fletcher et al., 2016).

Literature on potential impacts of REDD+ provides mixed evidence. Most studies argue that REDD+ is a cost effective way to reduce carbon emissions to mitigate climate change in the short term (Angelsen et al., 2012; Editorial, 2009; Richards and Stokes, 2004; Stern, 2007). On the other hand, some studies raise concerns that REDD+ may interrupt a promising trend of decentralised forest management in developing countries (Phelps et al., 2010), crowd out conservation motivations, reproduce social inequities and exclusions (Corbera, 2012), and generate inequitable and inefficient income to communities (Skutsch et al., 2013). The flow of income from REDD+ to forest-dependent communities is risky and may be financially unsustainable in the longer term given the funding challenges faced by REDD+ projects (Beyene et al., 2016; Sunderlin et al., 2015).

It has been argued that the costs and benefits of REDD+ are uncertain, and depend on the forest transition stage, specific policy options, and the implementation contexts (Lubowski and Rose, 2013; Rakatama et al., 2016). The forest transition stage influences the carbon sequestration potential of forests (Angelsen and Rudel, 2013). Specific policy support at the implementation phase may be needed to benefit local users. For example, Martin (2008) argues for a support mechanism (e.g., training for underemployed rural and indigenous populations) to forest users and subsistence farmers to promote carbon-rich, community-friendly sustainable forest management. Likewise, Mertz (2009) argues for ensuring households' access to forest products, particularly for the poor households, to support their livelihoods while implementing REDD+. The costs and benefits of REDD+ could be affected by the economic, social, political and institutional contexts in which it is implemented, suggesting a flexible and adaptive implementation approach (Ghazoul et al., 2010). However, the literature on the economics of REDD+ is still in its infancy when considering the diverse contexts of REDD+ implementation. More context specific studies based on comprehensive analysis of costs and benefits are required to inform future REDD+ project design (Rakatama et al., 2016). Context specific studies where REDD+ objectives could be in conflict with existing forest management practices are the most informative for policy and project design. Nepal's community forestry is one such example, where the objective of community forestry – to supply forest products, i.e., firewood, fodder, timber, to local communities (*local needs*) – is partly in conflict with REDD+ objectives to manage these forests for carbon sequestration and storage (*global needs*). It has also been argued that there are some equity issues with REDD+ at the local level, favouring carbon sequestration while potentially jeopardising local peoples' livelihoods (IUCN, 2010; Veronesi et al., 2015). Thus, studies on economics of REDD+ from different implementation contexts is necessary to learn from experiences and to provide insights for REDD+ project design and implementation.

This study contributes to the REDD+ literature by conducting an economic analysis of REDD+ with a focus on implementation contexts using forest product demand and carbon sequestration data from two REDD+ piloting sites in Nepal. More specifically, the paper: (a) examines the forest product demand of households and the carbon storage potential of community forests, and (b) assesses the economic feasibility