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Dynamics of carbon and biodiversity under REDD+ regime: A case from Nepal

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ABSTRACT

There are several pilot projects in developing countries for reducing emissions from deforestation and forest degradation, conserving forests, managing forests in a sustainable way and enhancing carbon stock in forests (REDD+). However, outcomes from these projects, which are crucial for making strategies and developing an appropriate incentive mechanism for REDD+ particularly in relation to impacts on biodiversity, are little researched. The overarching goal of this research is to assess carbon stock and species richness in pilot REDD+ projects in community forests. Forest inventories data for three consecutive years are analysed for projects in Nepal. This study found increases in carbon stocks in forests for all altitudes and canopy types. Forests with dense canopy cover have higher increments compared to sparse canopy. Similarly, forests of lower altitudes have higher carbon stock compared to higher altitudes. The increment is higher in the forests located in middle altitudes which had comparatively low carbon stocks. Regarding species richness, more species are recorded in initial years of the project than later. This indicates a possible reduction in species richness with increasing the carbon stock. There is a need for an incentive mechanism for maintaining species richness together with carbon stock and securing conservation and carbon benefits in REDD+ in community forestry.

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1. Introduction

Stabilising the global carbon dioxide (CO_2) level at 450 ppm and limiting temperature increases, relative to the pre-industrial period, to below 2 °C are guiding targets to reduce climate change risks, impacts and damages (Pachauri, 2007; Meinshausen et al., 2009). The Kyoto-Protocol (1997) set targets to cut the emissions levels of many industrialised countries. Under the Protocol, countries can reduce emissions by changing practices or offset the emissions reduction targets through the Clean Development Mechanism (CDM). Since forests are possible sinks for the atmospheric CO_2, the Kyoto Protocol included afforestation and reforestation projects under the CDM. However, the Protocol did not recognise the role of natural forests in carbon sink and it did not address the issue of deforestation and forest degradation especially in developing countries, which contribute about 10–25% to global emissions (Boyd and Schipper, 2002; Fry, 2008). The United Nations Framework Convention on Climate Change (UNFCCC) 13th session of the conference of parties (COP 13) agreed to include reducing emissions through deforestation (RED) in the

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incentive provisions of UNFCCC policy frameworks (UNFCCC, 2007). Subsequently, this mechanism expanded to include both deforestation and forest degradation (REDD) in later COPs, and by 2009 the REDD+ agenda, which included goals related to conservation, sustainable management of the forests and enhancement of forest carbon was included in the COP 15 agreements (UNFCCC, 2009).

REDD+ gradually became accepted as a possible strategy through the UNFCCC to halt land use changes in developing countries and to reduce forestry related emissions (Angelsen, 2009). The Bali Action Plan (2007) had encouraged the implementation of REDD+ demonstration activities (Cerbu et al., 2011). The overarching goal was to encourage forest managers in developing countries to maintain the existing carbon stock or even generate additional forest carbon stock (Kanowski et al., 2011). Given the relatively recent emergence of REDD+, evaluations of the effectiveness and impacts of its subsidiary programmes and projects are limited in scope and temporal range, however early reviews may help to maximise beneficial outcomes. There is also a need to identify, and where possible and relevant, quantify perverse outcomes or trade-offs amongst goals. Providing incentives to sequester more carbon in forests will change management practices, which may in turn adversely affect existing practices of forest users (Caplow et al., 2011). In particular, in trying to maximise carbon stock, forest users may reduce biological diversity by favouring particular tree species (Huettner, 2012). Undermining the conservation of biodiversity under REDD+ is against the Convention on Biological Diversity (CBD, 1992).

Balancing the multiple goals inherent in forests management in developing countries is particularly important given high resource dependency and complex management systems. Community forest (CF) management is an increasingly popular approach to forest management, especially in Asia and Africa (Brown et al., 2002; Nurse and Malla, 2006). More than 7% of global forests are under CF management (FAO, 2011) and local communities have responsibility for sustainable, with governments recognising traditional forest management practices (Gilmour et al., 2004; Kanel, 2004; Nurse and Malla, 2006).

An assessment of whether or not REDD+ projects are contributing to securing the rights of the local communities, sharing benefits equitably and conserving biodiversity in the CFs as recognised by the CBD, is important in developing policy. Concerns about the possible exclusion of local communities and biodiversity loss under the REDD+ mechanism were discussed in the Cancun and formally addressed through the adoption of guidelines and safeguards for policy approaches and incentives (UNFCCC, 2010). This agreement stated that REDD+ activities should ensure multiple functions of forests and that REDD+ actions should incentivize forest managers for these efforts. Given that species richness and carbon enhancement potential are determined by some combination of soil type, climate, altitude, canopy cover and other structural variables, studies of outcomes by forestry types and location will enable both programme and local level design and enhancement strategies to optimise outcomes. This paper aims to identify carbon stock and species richness changes in CFs, participating in REDD+ projects across a range of altitudes and canopy covers differences. The study was carried out in Nepal, which is a pioneer country for CFs (Brown et al., 2002) and REDD+ projects (GoN/MFSC/REDD-Cell, 2011).

2. Methodology

2.1. Description of the study area

This study was carried out in 105 CFs across altitudes ranging from 271 to 3238 m above sea level (m asl) in three study districts namely, Kayerkhola at Chitwan (271–1618 m asl), Ludikhola at Gorkha (418–1401 m) and Charnawati at Dolakha (652–3238 m asl) (Fig. 1). The project sites within those districts include habitats for *Shorea robusta* at lower altitude and *Schima castanopsis* and *Rhododendron* forest at higher altitudes. Associated tree species are *Lagerestroemia parviflora, Mallatus phillipinensi* and *Terminelia tomentosa*, dominant in lower altitude Kayarkhola (Chitwan), while *Schima wallichii* and *Castanopsis indica* are the most common associates in Ludikhola (Gorkha), and *Rhododendron*, *Quercus* species and *Lyonia ovalifolia* in Charnawati (Dolakha). These studied forests cover 10,266 ha of forest patches and provide benefits to 93,791 people of 15,380 households. These areas have diverse castes[1] including Dalit (untouchable group), Ethnic groups (traditionally they have separate culture, language and customs) and Brahmin and Kshetri (considered as upper caste) (Gellner, 2007). Similarly, livelihood options of the people living in these areas differ with altitudinal gradients though most are engaged in agriculture which is interdependent with forest resources (Neupane et al., 2002).

2.2. Data collection

This study analyses annual forest inventory data to estimate biomass changes in CFs in the pilot REDD+ sites in Nepal. A stratified random sampling method is used to collect data. All forest areas were stratified on the basis of canopy cover into two strata using Geographic Information System (GIS). Satellite images of all 105 community forest areas collected by Geoeye in November 2009, were analysed using GIS software IDRAS Imagine to identify forests with dense canopy cover ($\geq$70%) and sparse canopy cover (<70%) and forests in three altitudes: less than 1000 m (hereafter lower altitudes); 1000–2000 m (middle altitudes) and more than 2000 m (higher altitudes). Following these classifications, dense canopy forests covered 7436.0 ha (72% of the total forests) and sparse canopy forests were 2829.5 ha (28% of the total forests). Lower altitudes forests cover 3833.8 ha (37% of total forests), middle altitudes forests are 2436.4 ha (24% of total forests) and higher altitudes forests are 3996.3 ha (39% of total forests).

After classification by altitude and canopy cover, a total of 490 composite plots (Fig. 2), with 95 plots under sparse canopy and 395 under dense canopy were established to enable an annual inventory from 2010 to 2012 of estimated forest biomass changes and species richness. Among the plots, a total of 289 were in lower altitudes, 94 in middle altitudes and

[1] Caste is a form of social stratification characterised by hereditary transmission which may involve different occupations and beliefs (Gellner, 2007).

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