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Analysing foregone costs of communities and carbon benefits in small scale community based forestry practice in Nepal

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1. Introduction

The critical role of forests in climate change mitigation is accepted globally (Maraseni et al., 2005; UNFCCC, 2007; Maraseni et al., 2008; Alongi, 2011; Maraseni et al., 2016). Of several climate change mitigation options, reducing emissions from deforestation and forest degradation, conservation, sustainable management of the forests and enhancement of forest carbon (REDD+), linked to a payment mechanism, is considered an important and cost effective strategy (Stern, 2007). REDD+ is regarded as a relatively cost effective, easy and quick way to mitigate climate change (Clements, 2010; Angelsen et al., 2012; Gardner et al., 2012) and is being piloted in developing countries after its inception in COP 14 in Poznan 2008 (Cerbu et al., 2011; Pandey, 2014). Many developing countries are implementing pilot projects and activities in readiness for the REDD+ mechanism under various funding schemes such as the World Bank's Forest Carbon Partnership Facility, UN-REDD and other bilateral aid schemes (Davis et al., 2009; Minang and Murphy, 2010; Cerbu et al., 2011; UN-REDD, 2012; Maraseni and Pandey, 2014). However, REDD+ is still in its infancy in terms of its processes and financing mechanisms.

Through the REDD+ results based payment mechanism, enhancement of carbon quantities in forest land use practices need to be reportable and verifiable (Gibbs et al., 2007; Fry, 2011). The verified additional carbon stocks generated from REDD+ activities are then brought into the market mechanism (Lederer, 2011; Skutsch et al., 2011). Within the REDD+ process, payment must be distributed according to performance without promoting perverse incentives (Angelsen et al., 2012). Carbon stock changes in forests are monitored and quantified under REDD+ (IPCC, 2006), but questions arise as to whether the current REDD+ payment mechanism identifies all possible costs and whether improvements can be made to ensure greater fairness. Globally, there are a range of forest management systems including government forests, private forests and community based forestry systems. For various obvious reasons, forest carbon stock changes will differ between forest types (Battles et al., 2001). Forest managers can also incur additional costs due to either sacrificed benefits or additional efforts in forest management required to reduce deforestation and forest degradation, conserve existing carbon stock and increase carbon stock in the forests. These costs and carbon benefits need to be considered in designing an effective and equitable REDD+ mechanism.

The community based forest (CF) management system is an example of a successful forest management model for conserving forests, raising awareness and decentralising forest governance practices, globally and particularly in Nepal (Pagdee et al., 2006; Adhikari et al., 2004). Under community forest arrangements, local community user groups are vested with collective responsibility for the management of a certain patch of forest (Agrawal and Ostrom, 2001; Nurse and Malla, 2006). The CF model has been in practice for more than 30 years in many Asian countries (Gilmour, 2003; Nurse and Malla, 2006), over which time they have been contributing to carbon sequestration (Maraseni et al., 2005; Pandey et al., 2014). The REDD+ global climate change mitigation initiative is a financial mechanism to further incentivise and reward developing countries for gains in carbon storage; hence, many of these countries, including Nepal, are now carrying out pilot activities

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to trial REDD+ in CFs (Cerbu et al., 2011; MFSC, 2011).

In Nepal, after three decades of CFs, a total of 1813, 478 ha of forest is managed by 19,361community forest user groups (CFUGs) involving more than 35% of the total population of the country (DoF, 2017). After the inception of the REDD+ mechanism in global policy frameworks, Nepal has been actively involved in REDD+ development and has received international assistance to prepare itself for the implementation of REDD+, including preparation of a Readiness Preparation Proposal (R-PP) for piloting REDD+ activities in community forests (REDDIC, 2015). However, it is still unclear whether the REDD+ mechanism will generate additional incentives for carbon enhancement by CFUGs. This study investigates the costs and carbon benefits to CFUGs involved in REDD+ activities in Nepal. The learnings from this study will help in the formulation of an appropriate REDD+ policy for CFs and in the design and implementation of successful CF REDD+ projects.

2. Methodology

2.1. Description of the study area

The study was carried out in 105 CFs representing diverse physiographical and social contexts in Nepal. These forests occur at different altitudes from 200 to 3200 m above sea level (masl) (Fig. 1). The CFs were divided into four categories based on major dominant vegetation types: 1)*Shorea robusta* mixed broadleaf forests (including *Lagerstroemia parviflora, Mallatus phillipinensi* and *Terminalia tomentosa*) of predominantly large, deciduous, light-demanding and moderate growth trees; 2)*Schima-Castanopsis* forests which consist of moderately shade-tolerant trees with moderate growth habits occurring in the lower to mid-hills areas (Boojh and Ramakrishnan, 1983; Jackson, 1994); 3) pine forests, which occur in the mid-hills to higher altitudes areas and which are light demanding and mostly fast growing; and 4)*Rhododendron–Quercus* forests, from the mid-hills to higher altitudes areas and which are typically slow growing (Jackson, 1994; GoN, 2002; CFD/GoN, 2012). Altogether 10,266 ha of forest patches were included in this study, as well as 93,791 people from 15,380 households who were active in community forest management in this area. These people were from diverse castes (a form of hereditary social stratification characterised by different occupations and beliefs) including Dalit (untouchable caste group), Indigenous people (caste groups traditionally having a separate culture, language and customs) and poor women (Gellner, 2007; Subedi et al., 2010).

2.2. Data collection and analysis

Change in biomass carbon in the forests and change in costs and benefits of communities in the CFs were estimated for the REDD+ project period (2009–2012) and compared with those of previous years (2006–2009). Carbon stock changes in CFs were estimated using stock difference methods (IPCC, 2006) between the reference year 2010 and the year 2013. Using a stratified random sampling design, 490 permanent plots covering all vegetation types were established and carbon pool measurements carried out. Satellite images (Geoeye, captured November 2009) of the study sites were analysed to identify CF boundaries and canopy cover. Sample plots were located randomly in the CFs using Hawth's analysis tool (Beyer, 2004). At each sampling location, circular composite plots with different radii were established to monitor changes in different biomass carbon pools (Table 1)

The biomass carbon of trees (≥5 cm dbh) was analysed using the equation proposed by Chave et al. (2005), which was found to be most relevant for moist forest types, based on rainfall patterns. This equation uses three variables (wood specific gravity, diameter at breast height and tree height) and is more accurate than a single variable equation (Segura and Kanninen, 2005). We used a Nepal-specific biomass equation for saplings (1–5 cm dbh); biomass (Tamrakar, 2000) and wood specific gravity of trees was obtained from the master plan for the forestry sector in Nepal (MFSC, 1988). We used average wood specific gravity values for closely related species when these data were not available for species in this study (Baker et al., 2004; Ngugi et al., 2011).

The below ground biomass was estimated by root to shoot ratio (0.27 for forests located up to 2000 m altitude and 0.3 for forests above 2000 m altitude) (Jackson et al., 1996; Cairns et al., 1997; Mokany et al., 2006). The biomass per hectare of litter and herbs were estimated from the relationship between: (1) fresh weight of samples in a plot; (2) dry-weight and fresh-weight ratio of samples; and (3) sample plot area (converted area of sample plot to hectare) (Eq. (1)).

*Litter biomass/Herbs biomass (per hectare) = Fresh weight in sample plot (in hectare) * (dry weight/fresh weight)*……………. (1)

All biomass estimates were converted into carbon stock by multiplying by 0.47 as recommended by the IPCC (2006).

Discussions with CFUG members and executive committee of each CFUG were conducted to better understand community costs and benefits (Sheil and Wunder, 2002) associated with the REDD+ projects. Two types of focused group discussions (FGDs) were conducted. Twelve FGDs (i.e. three randomly selected from CFs dominated by each of the four vegetation types), each with 9–15 participants representing all types of community members (including executive committee members, indigenous people, dalit, female and poor) were identified and separate discussions with each executive committee were organised, following the approach taken in other studies (Adhikari et al., 2007; Maskey et al., 2006; Subedi et al., 2010). Based on data, costs associated with changing forest resource use and forest management activities in CFs were analysed. Annual total benefits (forest products use) and total costs of each of the communities were estimated from discussions with each CFUG. These data were collected for the three years before (2006–2009) and during the REDD+ pilot activities (2009–2012). In addition to group discussions, information regarding forest management activities, costs and forest product use benefits were also collected from relevant documents including the constitutions, operation plans and minutes of CFUGs (Table 2). Data regarding cost and benefits were collected in Nepalese Rupees (NRs) from the field and converted to US dollar (US$) using current exchange rates (1 US $ = 101 NRs).

The price of each product and cost for a particular year was estimated using 2012 values obtained from the local people. Litter and grazing benefits were not marketable within the study area. In order to estimate the unit price of litter, we asked people their willingness to purchase and took an average of these values. Similarly, livestock grazing values were estimated from the quantity of fodder consumed by each livestock type (buffalo, cow and goat) during a grazing day and the unit price of fodder.

The monetary value of the costs and benefits for each CFUG in each year were then averaged over each three year period; i.e. before (July 2006–June 2009) and after (July 2009–June 2012) the REDD+ interventions. All sacrificed benefits or costs to communities in this study were converted into a per hectare basis by dividing the total cost by the areas of CF, as in other studies estimating carbon stocks in forests (Fearnside, 1995; Fearnside, 2002; Maraseni and Pandey, 2014; Pandey et al., 2014; Maraseni and Cockfield, 2015). Similarly, carbon changes and average changes in costs and benefits to communities associated with a per unit carbon dioxide emissions increase in CFs were estimated on a per hectare basis ($MgCO_2e\ ha^{-1}$ i.e. megagrams of carbon dioxide emissions per hectare). The monetary value of carbon benefits was estimated by considering a 100 year time horizon to address possible uncertainties in forestry sector emission reduction projects, as used in other studies (Costa and Wilson, 2000; Fearnside, 2002). Although the market price of carbon credits fluctuates (Sovacool, 2011), we have used the average price US$ 2.5/$MgCO_2e$, applied by Asian offset suppliers (Hamrick and Goldstein, 2016) to quantify carbon benefits.