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Reducing or creating poverty? Analyzing livelihood impacts of forest carbon projects with evidence from India

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ABSTRACT

Forest carbon projects, in addition to climate mitigation and conservation benefits, are expected to improve local livelihoods and contribute to poverty alleviation across developing countries. Despite substantial investments over last decade, there is limited empirical evidence on the livelihood impacts of these projects especially across different socioeconomic categories.

This paper aims to contribute to this knowledge gap through an analysis of the livelihood impacts across small, medium and large categories of participating farmers in a forest carbon project from the state of Haryana in India. Data from 107 households have been analysed to study the impacts in terms of foregone crop, fodder and fuel wood benefits. The analysis suggests that the project has adversely affected the livelihoods of all three categories of farmers. However, small and marginal farmers are the most distressed due to their low incomes, asset base and risk-bearing capacities.

It raises critical project design issues such as binding land use, delayed accrual of benefits, static opportunity costs and displacement of existing economic activities, which have serious livelihood and equity implications. Unless these issues are addressed and strong safety nets are provided, forest carbon projects might create more poverty than wellbeing for marginal communities.

1. Introduction

Forest based climate mitigation measures have proliferated in last decade based on the premise of multiple benefits of climate mitigation, biodiversity conservation and livelihood improvement (Kongsager et al., 2016; Ojea et al., 2016; Angelsen and McNeill, 2012; Miles and Kapos, 2008; Stern, 2007). Various studies argue that deforestation and forest degradation release between 12–17 % of global greenhouse gas (GHG) emissions, which provides a 'big, cheap and quick' opportunity for climate mitigation (Pendrill et al., 2019; Angelsen and McNeill, 2012; Eliasch, 2008; IPCC, 2014). Sathaye et al. (2005) estimate that 51–78 % of the total mitigation benefits can be attained by reducing deforestation and degradation by the year 2100. These arguments have led to the development of forest carbon projects, which can contribute to climate mitigation in two ways- first, through increased capture of the carbon dioxide, one of the major greenhouse gases responsible for climate change and second, through conserving the carbon stock in the forests (Duchelle et al., 2018; IPCC, 2014; Corbera and Kosoy, 2009).

There are 1500 forest carbon projects registered across globe with billions of dollars' worth investments from international organisations, national and sub national governments and climate investors (Hamrick and Gallant, 2017). Multilateral initiatives like United Nations' REDD (UN-REDD) and World Bank 's Forest Carbon Partnership Facility (FCPF) and Forest investment programme (FIP) are financing developing countries to prepare and implement REDD + strategies (Nakhooda et al., 2014; Schalatek et al., 2012; Streck and Parker, 2012). Besides there are various regional and bilateral initiatives like Norway International Climate and Forest Initiative, Amazon Fund, and Congo Basin Forest Fund, which are financing a number of forest carbon initiatives (Schalatek et al., 2012). The private sector, through carbon markets, has also played an important role in driving forest carbon projects (Hamrick and Gallant, 2017; UNFCCC, 2012).

It has been argued that the resource flow from different sources can improve livelihoods and help in poverty reduction in some of the most underdeveloped landscapes across the globe (Angelsen et al., 2009; Brown et al., 2008; Bumpus and Liverman, 2011). These projects can provide alternative livelihoods and other developmental benefits for local communities (Kanowski et al., 2011; Pokorny et al., 2013). However, there has been rather limited research on livelihood impacts of forest carbon projects in general and across different socioeconomic

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categories in particular. Much of the research undertaken so far (with some notable exceptions), is either speculative or at best anecdotal (Brown et al., 2008; Ebeling and Yasué, 2008; Harvey et al., 2010; Lipper and Cavatassi, 2004; Peskett et al., 2012; Phelps et al., 2010a, 2010b; Stickler et al., 2009). Only some studies present the empirical evidence on the impacts (see Asquith et al., 2002; Boyd et al., 2007; Brown et al., 2011; Sango Mahanty et al., 2012; Mutabazi et al., 2014; Nelson and de Jong, 2003; Reynolds, 2012). However, these studies lack a comprehenisve differential asseessment across socio economic categories, which becomes important as poor and marginal people are most sensitive to any such changes.

This paper attempts to contribute to this knowledge gap by analyzing the livelihood impacts across different socioeconomic categories through the case of the forest carbon project in the state of Haryana in India. It explores the impacts across small, medium and large farmers, categorized based on their landholdings. This study assesses livelihood impacts in terms of foregone benefits like crops, fodder and fuel wood from the project lands. The participants have not received carbon revenues or any other benefits from the project. However, project documents reflect a number of benefits over the 20-year project period. Hence, Net Present Value (NPV) has been calculated to account for all costs and benefits over the project period.

This paper is divided in to seven sections. After the introduction, the second section discusses the project and socioeconomic context of the region. The third section details the methods employed in undertaking this research. The fourth section presents the livelihood profile of the participants. It presents the occupation, land holdings and incomes of the project participants. The next section explores the livelihood impacts of the project in form of foregone benefits across three categories of participants. The sixth section discusses the results in view of the literature and the next section concludes the paper.

2. About the project

The forest carbon project titled as the 'small scale cooperative afforestation CDM pilot project activity on private lands affected by shifting sand dunes in Sirsa, Haryana' is being implemented in the 8 villages of district Sirsa in the northern state of Haryana in India. Though the project formally started in July 2008 but land preparation and nursery activities started in 2007. The project is being implemented with the objectives to earn carbon credits, help in mitigation of global warming, and improve the local soil quality and to increase income and alleviate poverty of local communities (HFD, 2008:2). It is being implemented on the 369.87 ha of private agriculture lands of 227 farmers from the villages of Neemla, Dhani Sheranwali, Bhuratwala, Poharkan, Umedpura, Mallekan, Madhosinghana and GudiaKhera in Sirsa district.

It is part of a large community forestry project co-financed by the European Union (EU) and Haryana Forest Department (HFD). The significance and scale of the community forestry project can be judged by the fact that a separate community forestry division with dedicated staff has been created to implement the project across the state. The community forestry division of Haryana Forest Department is responsible for the implementation and management of the forest carbon project (HFD, 2008). At local level, a community institution known as '*Haryana CDM Variksh Kisan Samiti, Ellenanbad*' (referred as 'the Society'); a cooperative has been constituted for the project.

The project area is on the northern tip of the great Indian *Thar* desert and hence is prone to sand storms and droughts. The rainfall is scarce and erratic ranging between 100 – 200 mm annually. When the project started, much of the area in the project villages was out of the service area of *Bhakra* canals, fed by Himalayan rivers to the north, which are the major source of irrigation in the neighboring areas (HFD, 2008). The major expansion of the canal network in the area happened in between 2006–2012 (Interview 6). Many of the participants have small land holdings with low productivity due to shifting sand dunes and scarce irrigation in the area (HFD, 2008). The main sources of their livelihood are agriculture and animal husbandry. The farmers cultivate two crops in a year in the irrigated lands. They cultivate cotton, cluster bean or *guar* (a crop used for fodder), paddy, maize and pearl millet during *kharif*[1] season and wheat, gram, barley and mustard during *rabi*[2] season (HFD, 2008). On the marginal and unirrigated lands, they cultivate a single crop in a year.

The project has planted mainly seven species of tree: Ailanthus excelsa, Acacia tortilis, Eucalyptus hybrid, Acacia nilotica, Dalbergia sissoo, Zizyphus mauritiana and Prosopis cineraria on the private lands of the participating farmers (HFD, 2008). All the costs of the plantations and maintenance for three years have been borne by the Haryana Forest Department. The project design document suggests that the species have been selected after consultation with farmers and taking into account carbon sequestration rates, biodiversity enhancement, soil and climate conditions, and the value of associated forest products (HFD, 2008). The farmers had to commit a minimum of 0.05 ha of area for plantation and maintain it for a minimum of 20 years to participate in the project and become the members of the society (HFD, undated, 2020). The land committed under the project could be 'sold, gifted or transferred' but the successor is bound by the conditions of the project (HFD, undated, 2020: 2). Hence, it is a big commitment on part of the participants to keep their land with the project for 20 years. The project is expected to generate benefits in terms of timber, fruits, fuel wood and carbon. The participants are expected to get timber benefits at different intervals based on the rotation of different species. Fifth year onwards, they were expected to start getting benefits of fruits and carbon, which have not come through.

3. Methods

A 'mixed method' approach was used, where both quantitative and qualitative data were collected and analysed (Creswell and Clark, 2007). It helped in overcoming the weakness of each method through triangulation, provided a more holistic view and enhanced the reliability of the research (Bryman, 2004). A household survey was conducted to collect quantitative data on social background, livelihood sources and impact on the project participants. There were some open-ended questions in survey formats, which provided qualitative information. Key stakeholder interviews and focus group discussions (FGD) were conducted to collect qualitative data to understand issues and impacts on various socioeconomic categories of participants. Data were collected in two phases. Much of the data were collected from August 2011 to March 2012 in first phase. In second phase, data on the progress and impacts of the project were collected through secondary sources and key informant interviews from April 2016 to March 2017.

A stratified random and proportionate approach was used to sample households (Bryman, 2004). Out of a sample of 227 households, it was planned to survey 100 households. All the lists with socioeconomic details of villagers and the project participants were obtained from Haryana Forest Department (HFD). First, five out of the eight project villages were randomly selected. As the number of project participants varied in each village, 70 % of the participating households were targeted in each village to achieve the overall target and maintain the representativeness of different villages (Table 1). In total, 107 households were surveyed.

The major challenge during the survey was to collect data on income and foregone benefits[3] . In the case of income, data were taken for

[1] *Kharif* crops are harvested in winter in India. These includes crops such as paddy and maize

[2] *Rabi* crops are harvested during summer in India. These include crops such as wheat and mustard

[3] Data on income and expenditure were collected and analysed in Indian Rupees (INR). It has been converted to USD with exchange value of 1 USD equals 50 INR

Table 1
Household survey sample design in Haryana.
Source: Project Design Document and authors' survey design

S.No.	Village	Participating households	Sample size	% sample size
1	Neemla	43	30	69.77
2	Dhani Sheranwali	30	19	63.33
3	Poharkan	19	15	78.95
4	Bhuratwala	20	13	65.00
5	Umedpura	38	30	78.95
	Total	**150**	**107**	**71.33**

the preceding year. The crop income was calculated based on crop seasons of *Rabi* and *Kharif*. All other incomes i.e. income from livestock, wages and business were collected on a monthly basis. All the income data were finally added up to arrive at the annual income.

Farmers had forgone benefits in terms of crop, fodder and fuel wood. The average quantities of fuel wood or fodder produced per quintal of crop were calculated in participant meetings, which provided reference data for household survey. For example, on average one quintal of wheat produces an equal amount of fodder, whereas cotton crop produces almost double the amount of fuel wood to the raw produce of cotton. The better off farmers mostly used kerosene and LPG, hence the most of the farmers from middle and large categories did not report any forgone fuel wood benefits.

Qualitative data were collected through key informant interviews and focus group discussions. 25 key stakeholders were interviewed across different stakeholder categories including project proponents, carbon market agents, government departments and local institutions. We conducted 12 FGDs across five villages, where we discussed specific issues related to different socioeconomic classes and gender categories. We collected rich qualitative data, which was used to frame and analyse important issues.

Quantitative data were analysed with help of SPSS 19 version. Qualitative data were divided in to various themes such as participation, institutions, ecological impacts and livelihood impacts. Important information and quotes were used for the analysis.

In the case of Haryana, the project participants, were classified in to small (< 4 ha), medium ($4-10$ ha) and large (> 10 ha) categories based on their land holdings. This classification is based on the Government of India's categorization of farmers into five categories of marginal (< 1 ha), small ($1-2$ ha), semi medium ($2-4$ ha), medium ($4-10$ ha) and large (> 10 ha) (DOAC 2012). However, due to low productivity of the land in the project area and for the sake of convenience, the categories of marginal, small and semi medium have been merged into the category of small farmers, who are economically marginal.

Table 2 provides the classification criteria and distribution of various categories of farmers in the project. The small, medium and large category farmers constitute 36 %, 51 % and 13 % of the project participants.

Income data were segregated in farm and non-farm incomes. The data on the farm incomes comprised of the area sown, crops cultivated and the yield for each crop during two seasons i.e. *Rabi* and *Kharif*. It also included the information on the number of different livestock owned by the households and their products. All the produce from farm and livestock sources was monetized based on the prevalent market prices. These prices were estimated and triangulated in different participant meetings. The prices for the by-products in the form of fodder and fuel wood from different crops were estimated and added to the crop incomes. Similarly expenses on irrigation, labor, fertilizers, pesticides and other inputs were calculated for different crops and deducted from the gross crop income to calculate net crop income.

Table 2
Participation of various categories of farmers in the project.
Source: Household Survey

S.No	Category of farmer	Land (ha)	Number	% of sample
1	Small	0-4	39	36
2	Medium	4-10	54	51
3	Large	> 10	14	13
	Total		107	100

Buffalo and cow milk prices were taken at USD 0.7/litre and USD 0.5/litre respectively. The price of dung was taken based on the prevailing market prices of USD 0.012/Kg. Also, the cattle expenses related to feed and health for different livestock were estimated and finally net income from livestock was calculated.

The non-farm incomes included incomes from the sources like wage labor, petty businesses and other jobs. The wage rates varied between USD 2.4 to USD 10 per day for 8 hours of work depending on the skills and type of job. The variations for individual households were taken into account while calculating the nonfarm incomes. All the non-farm incomes were recorded monthly and were finally added up to calculate annual incomes.

To understand the economic viability of project, the NPV was calculated using the equation 1 (Perman et al., 2003). It was calculated by using a discount rate of 6% over the project period of 20 years from 2008 to 2027 with a sensitivity analysis at 4% and 8% discount rates. The discount rate of 6% was used by the proponents for economic projections in project concept note (see HFD, undated, 2020). The annual foregone benefits (of crops and associated fodder and fuel) were taken as the annual opportunity cost of putting land into the project. For the sake of comparison, it was assumed that the opportunity cost of the land remained same over the project period. The projected benefits of carbon and timber were taken from the project concept note. These were calculated for the average land planted under the project by the small, medium and large farmers respectively. The fruit benefits estimated in the project economic assessment were not included in the calculation of NPV because, with one exception, no one else harvested fruit. Moreover, the exception did not attribute his fruit to the project. Rather he had invested his own money and labor to graft an improved fruiting variety of *Ber (Zizyphus mauritiana)* on the local *Ber* species planted under the project.

$$NPV\,(i, N) = \sum_{t=0}^{N} \frac{R}{(1+i)^t}$$

Equation 1: Net Present Value of the project

Where i is the discount rate (6% in this case), N = total period (20 yrs), Rt = cash flow at t time

4. Livelihood profile

Agriculture has been reported as the main occupation by 92 % of the project participants, whereas 7% are employed in government or private jobs. Only 1% of the participants have business as their main occupation. All the project participants who do not have agriculture as their main occupation are still involved with it through one of the family members. Many of the small category farmers are engaged in wage labor in government sponsored development schemes or in the construction activities or petty businesses in the nearby towns of Ellenabad and Sirsa. The daily wage rate for the unskilled labor has gone up from USD 1.6 to USD 2.4 in last six years. This is because of Mahatama Gandhi Rural Employment Guarantee Scheme (MNREGS)[4] and other developmental activities like road and building construction being

[4] MNREGS Act was passed in 2005 by the Government of India, which was subsequently implemented in all the states. It ensures 100 days of employment per year to a rural household at a fixed wage rate (MOLJ 2005)

Table 3
Land holding and plantation area across various categories of farmers.
Source: Household Survey

S.No	Category	Avg. Land holding (ha)		Planted area (ha)		% area planted
		Mean (ha)	Std. dev	Mean (ha)	Std dev	
1	Small	2.15	0.93	0.83	0.56	38.60
2	Medium	6.2	1.38	1.55	1.21	25.00
3	Large	17.61	6.34	3.72	3.03	21.12

undertaken in the area.

As most of the participants are farmers, land is the main asset and source of livelihood for them. The agricultural land is relatively less productive compared to other regions of the state because of the sandy soil and lack of irrigation facilities (HFD, 2008). However, the area under irrigation has increased over last few years because of the increase in the supply area of two major local canals *viz. Bhakra* and *Ghaggar*. Many participants have had tube wells installed on their lands, which have increased the frequency of irrigation over last five to six years. This has crucial implications for economic viability of the project as it turns unproductive land with little opportunity cost into valuable farming land with considerable opportunity cost.

Table 3 presents the land distribution across the farmer categories. The difference in the average landholdings of small, medium and large is quite substantial. The small, medium and large categories of participants have undertaken plantations on an average 0.83, 1.55 and 3.72 ha of land constituting 38.60 %, 25 % and 21.12 % of their total land holdings respectively (Table 3). It suggests that small farmers have contributed larger percentage of their total land for project plantations as compared to medium and large farmers.

Cattle constitute an integral part of the economic, cultural and religious life in the project villages. The cows and buffaloes are the most commonly owned large livestock. Milk and dung are the main products, which are used at household level and extra quantities are sold. The dung is used as fuel and manure. The villagers prefer to use dung as manure for agriculture as it is cheaper, require less water for crops and environmentally friendly as compared to the chemical fertilizers. On an average, a cow and buffalo respectively produce 1.5 and 3 tons of dung annually. Generally, 3 tons of manure is used for a crop in one acre. The bulls and camels are used for draught and tilling (FGD 1).

Like land, incomes are also distributed unequally across three categories with average annual gross incomes being USD 4337, USD 7420 and USD 22453 for small, medium and large categories respectively Table 4).

Fig. 1 presents the sources of income for various categories. It is clear that agriculture constitutes the most predominant source of income in case of medium and large farmers, whereas income from non-farm sources such as salaried jobs, wage labor from construction and other activities and from livestock is also quite substantial in case of small farmers.

5. Livelihood impacts

As discussed earlier, livelihood impacts have been assessed in terms of foregone benefits i.e. the benefits which farmers would have accrued in absence of the project. Since, they have not received any actual benefits so far, these have not been considered in the calculations. The proposed benefits as projected in the project document are considered for calculation on net present value of the project for 20 years (HFD, undated, 2020).

Table 4
Annual gross incomes across different categories of farmers.
Source: Household Survey

S.No	Category	Mean (USD)	Std dev
1	Small	4337	2167
2	Medium	7420	3547
3	Large	22453	12832

Table 5 represents the annual forgone crop benefits. In the absolute terms, large farmers have foregone the maximum crop income. However, the small farmers have forgone the largest percentage (around 18 %) of their annual crop incomes. It is also because they have contributed the larger share of their lands for the project compared to the medium and large farmers (Table 3). Medium scale farmers have foregone the smallest share of their crop incomes, which might be due to the fact that many of them switched to mixed farming i.e. cultivation of crops along with trees relatively at an early stage (FGD 2,5, 7).

It is clear from the Table 6 that though the large farmers have forgone the greatest fodder benefits in absolute quantity (mean = 32.35 qt, Std dev = 22.99) and income (mean = USD 106, Std dev = 55) as well as in percentage share of their annual livestock incomes. Some of the difference can be attributed to the fact that livestock incomes constitute a larger share of small and medium farmers than the large farmers (Fig. 1). Small farmers have foregone the least fodder benefits in absolute and relative terms, but they have felt its impact the most (FGD 1, 3, 8, 11). They narrate their plight thus- '*We have to purchase additional fodder now. It is getting difficult to keep animals. Some of us have even sold the animals as we cannot purchase enough fodder for them' (FGD 3).*

The small farmers have foregone more fuel benefits compared to the medium and large farmers (Table 7). It is because medium and large farmers depend less on crops stems as fuel rather they depend on cooking gas and fuel wood from trees as their main sources (Interview 10). Most of them have not reported any loss of fuel wood for this purpose.

In case of overall foregone benefits, large farmers have forgone more benefits in absolute terms. However, once we compare across the percentage gross incomes, small farmers have forgone larger share of their gross income as compared to the medium farmers (Table 8).

During the household surveys and focus group discussions, it became apparent that the small farmers were most distressed by the changes brought by the project. It is because of loss of larger share of crop and fuel benefits and due to their lower assets and incomes. One of the small farmers represented his plight thus, '*This project has ruined me and my family. We are going hungry. I will take my children to Hisar and will protest in front of the DFO (Divisional Forest officer) office until I get the compensation*' (Survey 2). And he is not the only one; there are similar views from many other small and marginal farmers (Surveys 1, 8, 46). Hence, the forest carbon project has adversely affected all the farmers but its impact has been most adversely felt by small farmers due to their small landholding, low asset base, small incomes and low risk bearing capacities.

The economic viability of a project can be analyzed through calculation of its NPV over the project period. It is particularly important to calculate NPV in this case as there was a stream of benefits predicted over its 20-year cycle. Annual foregone benefits were taken as the opportunity cost for each category. Carbon and timber revenues were considered as projected benefits in the project concept note. Table 9 represents the NPV of the project for different categories of farmers at varied discount rates. As NPV has negative value, so, small, medium and large farmers will lose despite all the projected benefits, if they continue with the project for next 20 years. Hence, it can be argued safely that the project, given the farming that irrigation and new economic opportunities have now made possible, is an economic liability for its participants.

As a result of these adverse consequences, participation in the project has declined. Around 50 % of the project participants (n = 54) still maintain the project land use while the other half (n = 53) have changed it. 35 % of the participants (n = 37) have uprooted the plants

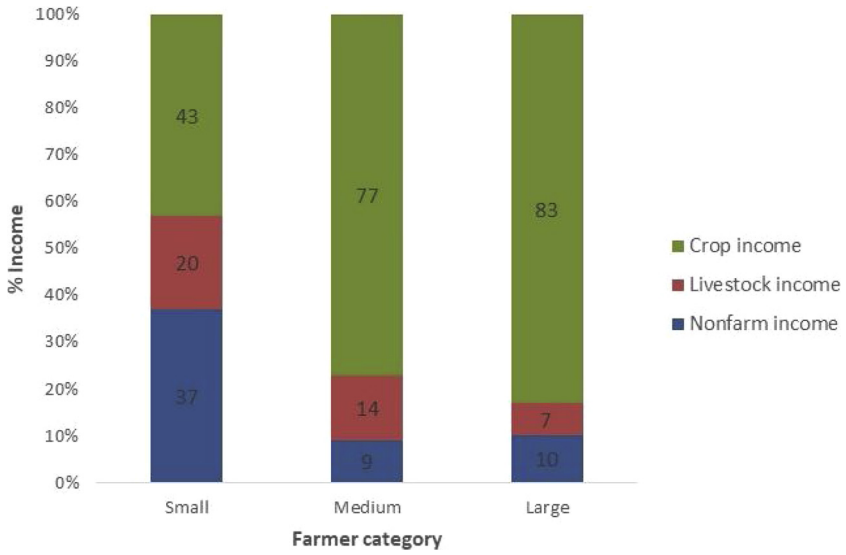

Fig. 1. Profile of income sources across various categories.
Source: Household Survey

Table 5
Annual foregone crop benefits.
Source: Household Survey

S.No	Category	Mean (USD)	Std dev	% of mean annual crop income
1	Small	348	680	18.26
2	Medium	449	517	7.41
3	Large	2671	6528	14.33

Table 7
Annual foregone fuel wood benefits.
Source: Household Survey

S.No	Category	Avg. quantity (qt)	Std dev	Avg. value (USD)	Std dev
1	Small	7.54	19.2	31	78
2	Medium	0.21	1.0	1	3
3	Large	0	0.0	0	0

and withdrawn from the project, while 15 % (n = 16) have changed to mixed land use (Table 10). They have reduced the density of plants and are intercropping agricultural crops with the plantations.

It is clear from the Fig. 2 that small landholders have withdrawn from the project most (39 %), followed by medium (33 %) and large category (29 %) of farmers. They own less area of land (Avg. 2.15 ha), relatively low incomes (Avg. USD 4337) and have contributed an average of 39 % of their land for the project purpose, which makes it difficult to sustain their livelihoods especially when there have been no gains from the project so far. 13 % of the small farmers have started intercropping agricultural crops along with project plantations. The large farmers own more land Avg. 17.61 ha and have contributed a relatively smaller percentage of their land, have higher incomes Avg. USD 22453 and hence can sustain a longer term commitment in the project. However, around 14 % of large farmers have also started intercropping due to unsure carbon revenues. 33 % of the medium farmers have withdrawn from the project but a relatively greater percentage (17 %) has started intercropping. This will have a strong impact on the viability of the project as according to the UNFCCC approved methodology of the project, there could be only a 10–15% of the change in the land use (Interview 7).

Two of the key stakeholders who have been associated with the project since its inception feel that given the rapidly changing socio-economic context of the region and absence of returns from the project, very few farmers will continue affecting the sustainability of the project (Interviews 5, 6).

Table 8
Total annual foregone benefits across various categories.
Source: Household Survey

S. No	Category	Mean (USD)	Std dev	% of annual gross income
1	Small	401	789	9.25
2	Medium	499	567	6.72
3	Large	2731	6515	12.16

6. Discussion

This paper has analyzed livelihood impacts of forest carbon projects across different socioeconomic categories with the help of a case study from India. The analysis across small, medium and large farmers from Haryana suggests that all the three categories have forgone significant amount of benefits due to plantations and they have not received any of the projected benefits in form of carbon revenues or fruit from *Zizipus* trees. We have also found that the farmers, who continue to participate for the complete period, would bear considerable net economic losses despite some benefits from the forest carbon project. The rapidly changing socioeconomic context of the region has increased the

Table 6
Annual foregone fodder benefits.
Source: Household Survey

S.No	Category	Avg. quantity (qt)	Std dev	Avg. value (USD)	Std dev	% of mean annual livestock income
1	Small	8.18	11.47	34	48	3.83
2	Medium	21.5	32.07	61	60	5.44
3	Large	32.35	22.99	106	55	7.38

Table 9
Net Present Value of the project.
Source: Household Survey

S.No	Category	NPV at 4% discount rate (USD)	NPV at 6% discount rate (USD)	NPV at 8% discount rate (USD)
1	Small	−4277	−3728	−3281
2	Medium	−4583	−4090	−3668
3	Large	−25459	−23045	−20862

Table 10
Status of the project participation.
Source: Household Survey

S.No	Category	Number	Percent
1	Continuing	54	50.5
2	Withdrawn	37	34.5
3	Mixed land use	16	15.0
	Total	107	100.0

opportunity cost of land and labor, exacerbating the economic losses of the participating farmers. The medium and large farmers have incurred more losses in the absolute terms but the small farmers have contributed larger percentage share of their land holding to the forest carbon project and have foregone larger share of their crop incomes and fuel wood benefits. Due to their low incomes, asset base and risk bearing capacities, the small farmers are most distressed from their continued participation. Hence, a relatively larger number of them (39 %) have changed the project land use compared to the medium (33 %) and the large (29 %) farmers. Overall, almost half of the participants have changed the use of their lands. Out of this 35 % have uprooted all the plants and have withdrawn from the project while 15 % have uprooted partial land and have started cultivating agricultural crops there.

The findings of this paper are in line with much of the available literature on this issue. Many of the available studies suggest that the carbon revenues and other benefits are substantially less than the opportunity cost of the projects, due to which livelihoods of especially the poor people have been adversely affected (Asquith et al., 2002; Sassi et al., 2014; Jindal et al., 2012; Mahanty et al., 2012; Nelson and de Jong, 2003; Palmer and Silber, 2012; Chomba et al., 2016; Kansanga and Luginaah, 2019). While presenting the results of the largest survey of forest carbon projects, Sassi et al. (2014) argue that at more than 80 % of study sites, smallholders are at a risk of losing their livelihoods because of restrictions on forest access. Mahanty et al. (2012) argue that payments are generally much lower than the opportunity costs incurred by the participants, hence adversely affecting their livelihoods. Palmer and Silber (2012) also echo the similar concerns and suggest alternate agro forestry models to support livelihoods in forest carbon schemes. In a livelihood impact assessment of N'hambita forest carbon project, Jindal et al. (2012) argue that though poor households are participating in the project but there is very little cash inflow through carbon revenues. Chomba et al. (2016) argue that smallholders are bearing disproportionate costs without much benefits in a forest carbon project in Kenya. Aggarwal (2020) argues that forest carbon projects can adversely affect the rights of local people on community lands adversely impacting their livelihoods. Similarly, Kansanga and Luginaah (2019) argue that smallholders have been have been deprived of their resources livelihoods due to forest carbon projects in Ghana.

Poor people have limited land and other resources, which are critical for their survival. As observed in Haryana project, participants have to wait at least for five years for carbon benefits. This is the minimum duration for third party verification by the UN CDM board designated organization[5] and final issuance of carbon credits. In practice, it might take seven to eight years to realize carbon revenues (Aggarwal, 2014; Kerr et al., 2006; Thomas et al., 2010). In case of Haryana, there was no third party verification even after eight years resulting in no carbon benefits, which further forced people to desert the project. It has left all the participants worse off and marginal farmers are distressed. So, the time period and objectives of forest carbon projects might not match with the livelihood needs of poor people (Blom et al., 2010).

As in case of Haryana, project managers generally enter in a legally

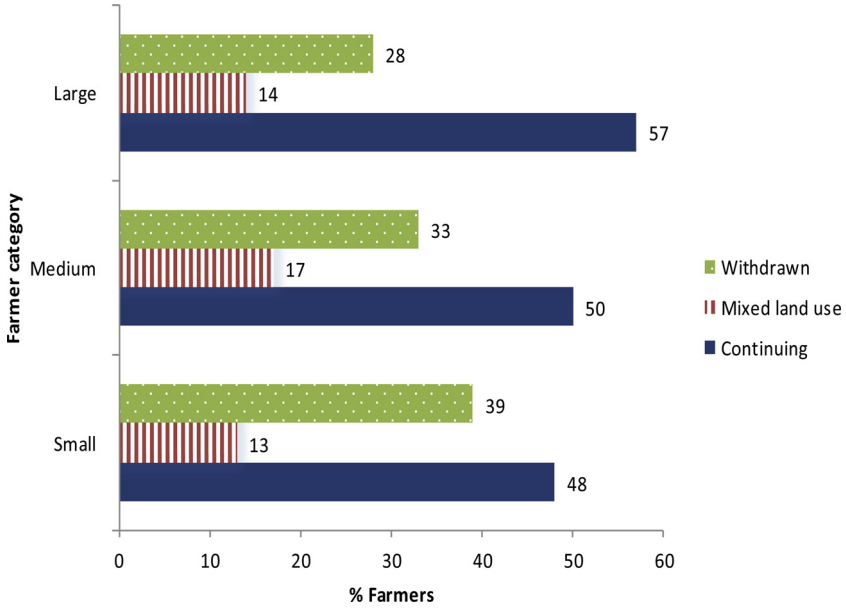

Fig. 2. Status of project participation across various categories (%).
Source: Household Survey

binding agreement with the land owners in case of private land or relevant stakeholders in case of community or public land, which prohibits them from changing the land use for the project duration. Poor people especially are scared to violate the agreement due to legal complexities and its financial implications (Aggarwal, 2019, 2014). This binds them to a fixed land use which generally extends up to a minimum of fifteen to twenty years for most projects (Aggarwal, 2014; Thomas et al., 2010). The economic conditions of dependent people, utility and opportunity cost of land might alter during this period (Fosci, 2013; Ickowitz et al., 2017; Irawan et al., 2013). In the case of private land, it becomes all the more critical as land is one of the important assets of a family, which is used to tide over hardships through mortgage or sale across a large part of the developing world (Deininger, 2003).

In addition, project proponents like Haryana government allow only minimal external activities beyond the planned interventions to maximize carbon revenues, which practically means strictly fencing and guarding the project area (Dressler et al., 2012; Fairhead et al., 2012; Griffiths, 2007). In case of public or community lands, poor and marginal communities can lose their livelihood activities such as cattle grazing, fishing, fuel wood collection etc (Brimont et al., 2015; Sassi et al., 2014; Pokorny et al., 2013). Even in case of private lands, participants get into a formal or informal agreement with the managers for minimal interference in the project area, which may have a major impact on the livelihood especially of poor people. Effectively, local people lose control of their land for the project duration (Fairhead et al., 2012; Phelps et al., 2010a, 2010b; Sandbrook et al., 2010).

These changes adversely affect local peoples' ability to adapt to climatic changes (see Kongsager and Corbera, 2015; McElwee et al., 2017). Though there has been a strong push for building win- win approach or synergizing mitigation and adaptation in forest carbon projects, however it has been a 'laudable but elusive goal' due to complex social, economic, political and biophysical factors (Duguma et al., 2014; Kongsager et al., 2016; Kongsager and Corbera, 2015: 132).

7. Conclusion

This research with the help of predominant literature suggests that many forest carbon projects might have an adverse impact on the livelihoods and economic condition of poor and marginal communities (Kansanga and Luginaah, 2019; Chomba et al., 2016; Sassi et al., 2014; Dressler et al., 2012; Jindal et al., 2012; Mahanty et al., 2012; Palmer and Silber, 2012). Though, the evidence is still limited in scale and needs to be strengthened through further research but the available research points towards iniquitous distribution of costs and benefits across different stakeholders in forest carbon projects (Pasgaard et al., 2016; Poudel et al., 2015; Schroeder and McDermott, 2014). It also lends credibility to the argument that such projects are transferring the burden of the emission reduction to the poor communities in the developing world (IEN 2012;AIDESEP 2010;Lohmann 2009;Lohmann 2011). It raises questions on the 'efficient, effective and equitable' narrative of forest carbon projects (Angelsen, 2009; Angelsen et al., 2012; Rantala et al., 2015). A decade after its start, Haryana project was abandoned by a large number of participants, which makes the enterprise inefficient and ineffective even from a climate mitigation perspective. The poor and marginal people are forced to abandon the project and move to better economic land use options, otherwise they would most probably have fallen in the poverty trap (Martin et al., 2014; Pasgaard et al., 2016; Rantala et al., 2015).

This research makes a strong case for safeguarding the livelihoods of poor and vulnerable people in the forest carbon projects. There should be enough safety nets for marginal people independent of the project performance and economics, which is dynamic in nature. Some of the measures, which could be adopted in this context are as follows. First, the project areas should not be completely fenced off, which disrupts the existing livelihood activities of the marginal people. It is difficult and costly for the poor to shift to the alternative livelihoods hence, their existing activities such as grazing of cattle, fuelwood and fruit collection etc. should be allowed in a regulated way. Second, there should be provision of regular incentives at short intervals for their participation. Their economic situation is too fragile to hold for two to five years, which is the usual incentive period. Based on the economic analysis, they could be compensated on monthly or even at a shorter interval. Third, they should not be bound to fixed land use for the long duration especially in the case of private lands like Haryana project. As land is a precious resource for them, they should be allowed its free use for their wellbeing. Also, their participation should be made flexible so that, they can return to their traditional or other means if the project becomes too onerous for them. Finally, it will be highly useful to undertake extensive empirical research across different geographical and socioeconomic contexts to understand the livelihood impacts across different stakeholder categories and analyze these issues before the further expansion of forest carbon projects.

[5] Carbon credits can be issued only after verification by a United Nations' designated third party

Author statement

Ashish Aggarwal prepared the research design, undertook data collection, analysis and writing. Dan Brockington helped with the research conceptualisation, theoretical framework, analysis and editing of paper.

Declaration of Competing Interest

There is no conflict of interests to be declared by the authors.

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References

Aggarwal, A., 2014. How sustainable are forestry clean development mechanism projects? —a review of the selected projects from India. Mitig. Adapt. Strateg. Glob. Chang. 19, 73–91.

Aggarwal, A., 2019. Neo-liberal conservation: analysing carbon forestry and its challenges in India. Econ. Polit. 54, 33–40.

Aggarwal, A., 2020. Improving forest governance or messing it up? Analyzing impact of forest carbon projects on existing governance mechanisms with evidence from India. For. Policy Econ. 111. https://doi.org/10.1016/j.forpol.2019.102080.

Angelsen, A., 2009. Policy options to reduce deforestation. In: Angelsen, A., Brockhaus, M., Kanninen, M., Sills, E., Sunderlin, W., Wertz-Kanounnikoff, S. (Eds.), Realising REDD+: National Strategy and Policy Options. CIFOR, Bogor, Indonesia, pp. 125–138.

Angelsen, Arild, McNeill, D., 2012. The evolution of REDD+. In: Angelsen, A., Brockhaus, M., Sunderlin, W.D., Verchot, L.V. (Eds.), Analysing REDD+: Challenges and Choices. CIFOR, Bogor.

Angelsen, A., Brockhaus, M., Kanninen, M., Sills, E., Sunderlin, W., Wertz-Kanounnikoff, S. (Eds.), 2009. Realising REDD+: National Strategy and Policy Options. CIFOR, Bogor, Indonesia.

Angelsen, A., Brockhaus, M., Sunderlin, W.D., Verchot, L.V. (Eds.), 2012. Analysing REDD+: Challenges and Choices. CIFOR, Bogor.

Asquith, N.M., Vargas Ríos, M.T., Smith, J., 2002. Can forest-protection carbon projects improve rural livelihoods? Analysis of the Noel Kempff Mercado Climate Action Project. Bolivia. Mitigation and Adaptation Strategies for Global Change 7, 323–337.

Blom, B., Sunderland, T., Murdiyarso, D., 2010. Getting REDD to work locally: lessons learned from integrated conservation and development projects. Environ. Sci. Policy 13, 164–172.

Boyd, E., May, P., Chang, M., Veiga, F.C., 2007. Exploring socioeconomic impacts of forest based mitigation projects: lessons from Brazil and Bolivia. Environ. Sci. Policy

10, 419–433.
Brimont, L., Ezzine-de-Blas, D., Karsenty, A., Toulon, A., 2015. Achieving conservation and equity amidst extreme poverty and climate risk: the Makira REDD+ project in Madagascar. Forests 6, 748–768.
Brown, D., Seymour, F., Peskett, L., 2008. How do we achieve REDD co-benefi ts and avoid doing harm? In: Angelsen, A. (Ed.), Moving Ahead With REDD. CIFOR, Bogor, Indonesia, pp. 107–118.
Brown, D.R., Dettmann, P., Rinaudo, T., Tefera, H., Tofu, A., 2011. Poverty alleviation and environmental restoration using the Clean Development Mechanism: a case study from Humbo. Ethiopia. Environmental management 48, 322–333.
Bryman, A., 2004. Social Research Methods, 2nd ed. Oxford University Press, Oxford.
Bumpus, A.G., Liverman, D.M., 2011. Carbon colonialism? Offsets, greenhouse gas reductions, and sustainable development. In: Robbins, P., Watt, J.M., Peet, R., Robbins, P., Watt, J.M. (Eds.), Global Political Ecology. Routledge, pp. 203.
Chomba, S., Kariuki, J., Lund, J.F., Sinclair, F., 2016. Roots of inequity: how the implementation of REDD+ reinforces past injustices. Land Use Policy 50, 202–213.
Corbera, E., Kosoy, N., 2009. Carbon Forestry Projects: Global Evidence and Insights From Kenya. [WWW Document]. URL http://tyndall.ouce.ox.ac.uk/prog4/events/adaptationworkshop260409/corbera.pdf (accessed 11.10.07). .
Creswell, J.W., Clark, V.L.P., 2007. Designing and Conducting Mixed Methods Research. Sage Publications, London.
Deininger, K.W., 2003. Land Policies for Growth and Poverty Reduction. World Bank Publications.
Dressler, W., McDermott, M., Smith, W., Pulhin, J., 2012. REDD policy impacts on indigenous property rights regimes on Palawan Island, the Philippines. Hum. Ecol. 40, 679–691.
Duchelle, A.E., Simonet, G., Sunderlin, W.D., Wunder, S., 2018. What is REDD+ achieving on the ground? Curr. Opin. Environ. Sustain. 32, 134–140.
Duguma, L.A., Minang, P.A., van Noordwijk, M., 2014. Climate change mitigation and adaptation in the land use sector: from complementarity to synergy. Environ. Manage. 54, 420–432.
Ebeling, J., Yasué, M., 2008. Generating carbon finance through avoided deforestation and its potential to create climatic, conservation and human development benefits. Philos. Trans. Biol. Sci. 363, 1917–1924.
Eliasch, J., 2008. Climate Change: Financing Global Forests. The Eliasch Review. Office of Climate Change, London, UK.
Fairhead, J., Leach, M., Scoones, I., 2012. Green Grabbing: a new appropriation of nature? J. Peasant Stud. 39, 237–261.
Fosci, M., 2013. Balance sheet in the REDD+: Are global estimates measuring the wrong costs? Ecol. Econ. 89, 196–200.
Griffiths, T., 2007. Seeing'RED'?'Avoided Deforestation'and the Rights of Indigenous Peoples and Local Communities. [WWW Document]. URL http://www.forestpeoples.org/sites/fpp/files/publication/2010/01/avoideddeforestationredjun07eng_0.pdf (accessed 5.9.12). .
Hamrick, K., Gallant, M., 2017. Fertile ground: state of forest carbon finance 2017. Forest Trends.
Harvey, C.A., Dickson, B., Kormos, C., 2010. Opportunities for achieving biodiversity conservation through REDD. Conserv. Lett. 3, 53–61.
HFD, 2008. Small Scale Cooperative Afforestation CDM Pilot Project Activity on Private Lands Affected by Shifting Sand Dunes in Sirsa, Haryana, Project Design Document. [WWW Document]. URL. http://cdm.unfccc.int/Projects/DB/TUEV-SUED1229620290.53/view.
HFD, undated, 2020. Project Concept Note (PCN) for Small Scale Cooperative Afforestation CDM Pilot Project Activity on Private Lands Affected by Shifting Sand Dunes in Sirsa, Haryana. Government of Haryana, Panchkula.
Ickowitz, A., Sills, E., de Sassi, C., 2017. Estimating smallholder opportunity costs of REDD+: a pantropical analysis from households to carbon and back. World Dev. 95, 15–26.
IPCC, 2014. Climate Change 2014: Mitigation of Climate Change. Cambridge University Press.
Irawan, S., Tacconi, L., Ring, I., 2013. Stakeholders' incentives for land-use change and REDD+: the case of Indonesia. Ecol. Econ. 87, 75–83.
Jindal, R., Kerr, J.M., Carter, S., 2012. Reducing poverty through carbon forestry? Impacts of the N'hambita community carbon project in Mozambique. World Dev. 40, 2123–2135.
Kanowski, P.J., McDermott, C.L., Cashore, B.W., 2011. Implementing REDD+: lessons from analysis of forest governance. Environ. Sci. Policy 14, 111–117.
Kansanga, M.M., Luginaah, I., 2019. Agrarian livelihoods under siege: carbon forestry, tenure constraints and the rise of capitalist forest enclosures in Ghana. World Dev. 113, 131–142.
Kerr, J., Foley, C., Chung, K., Jindal, R., 2006. Reconciling environment and development in the clean development mechanism. J. Sustain. For. 23, 1–18.
Kongsager, R., Corbera, E., 2015. Linking mitigation and adaptation in carbon forestry projects: evidence from Belize. World Dev. 76, 132–146.
Kongsager, R., Locatelli, B., Chazarin, F., 2016. Addressing climate change mitigation and adaptation together: a global assessment of agriculture and forestry projects. Environ. Manage. 57, 271–282.
Lipper, L., Cavatassi, R., 2004. Land-use change, carbon sequestration and poverty alleviation. Environ. Manage. 33, S374–S387.
Mahanty, S., Milne, S., Dressler, W., Filer, C., 2012. The social life of forest carbon: property and politics in the production of a new commodity. Hum. Ecol. 40, 661–664.
Martin, A., Gross-Camp, N., Kebede, B., McGuire, S., 2014. Measuring effectiveness, efficiency and equity in an experimental Payments for Ecosystem Services trial. Glob. Environ. Chang. Part A 28, 216–226.
McElwee, P., Nguyen, T., Hai, V., Nguyen, D.V., Tran, N.H., Le, H.V.T., Nghiem, T.P., Thi Vu, H.D., 2017. Using REDD+ policy to facilitate climate adaptation at the local level: synergies and challenges in Vietnam. Forests 8, 11. https://doi.org/10.3390/f8010011.
Miles, L., Kapos, V., 2008. Reducing greenhouse gas emissions from deforestation and forest degradation: global land-use implications. science 320, 1454–1455.
Mutabazi, K.D., George, C., Dos Santos, A., Felister, M., 2014. Livelihood implications of REDD+ and costs-benefits of agricultural intensification in REDD+ pilot area of Kilosa. Tanzania. Journal of Ecosystem & Ecography 4, 1.
Nakhooda, S., Norman, M., Barnard, S., Watson, C., Greenhill, R., Caravani, A., Canales Trujillo, N., Banton, G., 2014. Climate Finance: Is It Making a Difference. A Review of the Effectiveness of Multilateral Climate Funds. Overseas Development Institute., London.
Nelson, K.C., de Jong, B.H.J., 2003. Making global initiatives local realities: carbon mitigation projects in Chiapas. Mexico. Global Environmental Change 13, 19–30.
Ojea, E., Loureiro, M.L., Alló, M., Barrio, M., 2016. Ecosystem services and REDD: estimating the benefits of non-carbon services in worldwide forests. World Dev. 78, 246–261.
Palmer, C., Silber, T., 2012. Trade-offs between carbon sequestration and rural incomes in the N'hambita Community Carbon Project. Mozambique. Land Use Policy 29, 83–93.
Pasgaard, M., Sun, Z., Müller, D., Mertz, O., 2016. Challenges and opportunities for REDD+: a reality check from perspectives of effectiveness, efficiency and equity. Environ. Sci. Policy 63, 161–169.
Pendrill, F., Persson, U.M., Godar, J., Kastner, T., Moran, D., Schmidt, S., Wood, R., 2019. Agricultural and forestry trade drives large share of tropical deforestation emissions. Glob. Environ. Chang. Part A 56, 1–10.
Perman, R., Ma, Y., McGilvray, J., Common, M., 2003. Natural Resource and Environmental Economics. Pearson Education.
Peskett, L., Seth, P., Brodnig, G., 2012. Carbon Livelihoods: Social Opportunities & Risks of Cabon Finance. [WWW Document]. URL http://www-esd.worldbank.org/sdvpubs/index.cfm?Page=Search&DocID=565 (accessed 2.13.12). .
Phelps, J., Guerrero, M.C., Dalabajan, D.A., Young, B., Webb, E.L., 2010a. What makes a 'REDD'country? Glob. Environ. Chang. Part A 20, 322–332.
Phelps, Jacob, Webb, E.L., Agrawal, A., 2010b. Does REDD+ threaten to recentralize forest governance. Science 328, 312–313.
Pokorny, B., Scholz, I., De Jong, W., 2013. REDD+ for the poor or the poor for REDD+? About the limitations of environmental policies in the Amazon and the potential of achieving environmental goals through pro-poor policies. Ecol. Soc. 18, 3. https://doi.org/10.5751/ES-05458-180203.
Poudel, M., Thwaites, R., Race, D., Dahal, G.R., 2015. Social equity and livelihood implications of REDD+ in rural communities—a case study from Nepal. Int. J. Commons 9, 177–208.
Rantala, S., Kontinen, T., Korhonen-Kurki, K., Mustalahti, I., 2015. Equity in REDD+: varying logics in Tanzania. Environ. Policy Gov. 25, 201–212.
Reynolds, T.W., 2012. Institutional determinants of success among forestry-based carbon sequestration projects in Sub-Saharan Africa. World Dev. 40, 542–554.
Sandbrook, C., Nelson, F., Adams, W.M., Agrawal, A., 2010. Carbon, forests and the REDD paradox. Oryx 44, 330–334.
Sassi, C., Sunderlin, W.D., Sills, E.O., Duchelle, A.E., Ravikumar, A., Resosudarmo, I.A.P., Luttrell, C., Joseph, S., Herold, M., Kweka, D.L., 2014. REDD+ On the Ground: Global Insights From Local Contexts, in: REDD+ on the Ground: a Case Book of Subnational Initiatives Across the Globe. Center for International Forestry Research (CIFOR), pp. 420–439.
Sathaye, J., Makundi, W., Dale, L., Chan, P., Andrasko, K., 2005. GHG Mitigation Potential, Costs and Benefits in Global Forests: a Dynamic Partial Equilibrium Approach. Ernest Orlando Lawrence Berkeley National Laboratory.
Schalatek, L., Caravani, A., Nakhooda, S., Watson, C., 2012. Climate Finance Thematic Briefing: REDD+ Finance. [WWW Document]. URL http://www.odi.org.uk/sites/odi.org.uk/files/odi-assets/publications-opinion-files/7912.pdf (accessed 11.12.04). .
Schroeder, H., McDermott, C., 2014. Beyond carbon: enabling justice and equity in REDD+ across levels of governance. Ecol. Soc. 19, 31–33.
Stern, N., 2007. The Economics of Climate Change: the Stern Review. Cambridge University Press.
Stickler, C.M., Nepstad, D.C., Coe, M.T., McGrath, D.G., Rodrigues, H.O., Walker, W.S., Soares-Filho, B.S., Davidson, E.A., 2009. The potential ecological costs and cobenefits of REDD: a critical review and case study from the Amazon region. Glob. Chang. Biol. 15, 2803–2824.
Streck, C., Parker, C., 2012. Financing REDD+. In: Angelsen, A., Brockhaus, M., Sunderlin, W.D., Verchot, L.V. (Eds.), Analysing REDD+: Challenges and Choices. CIFOR, Bogor.
Thomas, S., Dargusch, P., Harrison, S., Herbohn, J., 2010. Why are there so few afforestation and reforestation Clean Development Mechanism projects? Land Use Policy 27, 880–887.
UNFCCC, 2012. Report of the Conference of the Parties on Its Seventeenth Session, Held in Durban from 28 November to 11 December 2011. [WWW Document]. URL http://unfccc.int/resource/docs/2011/cop17/eng/09a01.pdf (accessed 5.12.07).