

SANDEE



ECONOMICS & THE ENVIRONMENT

ICIMOD

FOR MOUNTAINS AND PEOPLE

Working Paper No. 100-15

# Baseline Considerations in Designing REDD+ Pilot Projects: Evidence from Nepal

Bishnu Prasad Sharma

Mani Nepal

Bhaskar S. Karky

Subhrendu Pattanayak

Priya Shyamsundar

Published by the South Asian Network for Development and Environmental Economics (SANDEE)  
PO Box 8975, EPC 1056, Kathmandu, Nepal.  
Tel: 977-1-5003222 Fax: 977-1-5003299

SANDEE research reports are the output of research projects supported by the South Asian Network for Development and Environmental Economics. The reports have been peer reviewed and edited. A summary of the findings of SANDEE reports are also available as SANDEE Policy Briefs.

National Library of Nepal Catalogue Service:

Bishnu Prasad Sharma, Mani Nepal, Bhaskar S. Karky, Subhrendu Pattanayak, and Priya Shyamsundar  
**Baseline Considerations in Designing REDD+ Pilot Projects: Evidence from Nepal**

(SANDEE Working Papers, ISSN 1893-1891; WP 100-15)

ISBN: 978-9937-596-29-9

**Keywords**

REDD+

Impact evaluations

Forest carbon

Co-benefits

Nepal

# Baseline Considerations in Designing REDD+ Pilot Projects: Evidence from Nepal

**Bishnu Prasad Sharma**

Tribhuvan University, Kathmandu, Nepal

**Mani Nepal**

South Asian Network for Development and Environmental Economics, Kathmandu, Nepal

**Bhaskar S. Karky**

International Centre for Integrated Mountain Development, Kathmandu, Nepal

**Subhrendu Pattanayak**

Duke University, NC, USA

**Priya Shyamsundar**

South Asian Network for Development and Environmental Economics, Kathmandu, Nepal

August 2015

South Asian Network for Development and Environmental Economics (SANDEE)

PO Box 8975, EPC 1056, Kathmandu, Nepal

## **The South Asian Network for Development and Environmental Economics**

The South Asian Network for Development and Environmental Economics (SANDEE) is a regional network that brings together analysts from different countries in South Asia to address environment-development problems. SANDEE's activities include research support, training, and information dissemination. Please see [www.sandeeonline.org](http://www.sandeeonline.org) for further information about SANDEE. SANDEE is financially supported by the International Development Research Center (IDRC), The Swedish International Development Cooperation Agency (SIDA), the World Bank and the Norwegian Agency for Development Cooperation (NORAD). The opinions expressed in this paper are the author's and do not necessarily represent those of SANDEE's donors.

## **International Centre for Integrated Mountain Development**

The International Centre for Integrated Mountain Development (ICIMOD) is a regional intergovernmental learning and knowledge sharing centre serving the eight regional member countries of the Hindu Kush Himalayan (HKH) region – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan. Our aim is to influence policy and practices to meet environmental and livelihood challenges emerging in the HKH region. To do this we bring together researchers, practitioners, and policy makers from the region and around the globe to generate and share knowledge, support evidence-based decision making, and encourage regional collaboration. ICIMOD delivers impact through its six Regional Programmes of Adaptation to Change, Transboundary Landscapes, River Basins, Cryosphere and Atmosphere, Mountain Environment Regional Information System, and Himalayan University Consortium. These regional programmes are supported by the four Thematic Areas of Livelihoods, Ecosystem Services, Water and Air, and Geospatial Solutions and underpinned by Knowledge Management and Communication. ICIMOD seeks to improve the lives and livelihoods of mountain women and men, now and for the future.

### **Comments should be sent to**

**Bishnu Prasad Sharma** (PhD)

Tribhuvan University, Nepal

Email: [bisunita@gmail.com](mailto:bisunita@gmail.com)

# Contents

Abstract	
<b>1. Introduction</b>	<b>1</b>
<b>2. Nepal's REDD+Context and Literature</b>	<b>1</b>
<b>3. Study Methods</b>	<b>3</b>
3.1 Key Design Indicators in REDD+ Implementation	3
3.2 Sampling Design and Data Collection	4
3.3 Matching and Selection of Comparison CFUGs	4
3.4 Carbon, Ecology and Bio-physical Data	5
3.5 Socio-economic Data	5
3.6 Results from the Balancing Test	6
<b>4. Baseline Findings and Analysis</b>	<b>6</b>
4.1 Forest Carbon in Treatment and Control Community Forests	6
4.2 Socio-economic Characteristics of Treatment and Control Communities	7
4.3 Forest Dependence and Household Cost and Benefit from Community Forests	7
<b>5. Discussion</b>	<b>8</b>
<b>6. Conclusions</b>	<b>9</b>
<b>Acknowledgements</b>	<b>9</b>
<b>References</b>	<b>10</b>
<b>Tables</b>	
Table 1: Distribution of dense and sparse plots by type of sampling plots	12
Table 2: Balancing test results	12
Table 3: Distribution of carbon stocks (tons per hectare) in sampled CFUGs (baseline survey, 2011)	12
Table 4: Ecological indicators in treatment and control CFs	13
Table 5: Socio-economic and livelihood characteristics of REDD+ and non-REDD+ households	13
Table 6: Household dependence by source of biomass (base year)	13
Table 7: Main forest product consumption in REDD+ and non-REDD+ households	14
Table 8: Difference in CF benefit and costs among REDD+ and non-REDD+ households	14
<b>Figures</b>	
Figure 1: Project timeline and sequence of activities	15
Figure 2: Conceptual framework and research design	15
Figure 3: Location of study area in Dolkha, Gorkha and Chitwan district	16
Figure 4: Average carbon per hectare in REDD+ and non-REDD+ CFs in 2011	16
<b>Appendix</b>	
Table A1: Socio-economic indicators and variables in baseline data	17

## Abstract

In this paper we discuss how three criteria – carbon effectiveness, cost efficiency, and equity and co-benefits – can be incorporated in the experimental design for Reducing Emissions from Deforestation and Degradation and enhancing forest carbon stocks in developing countries (REDD+). We discuss how additional design components can be introduced using a propensity score matching method in pre-selected study sites. Finally, we explain how this carefully designed study has helped to prepare the ground for a difference-in-difference framework for future outcome and impact evaluation. Given the lack of adequate data in developing country scenarios, and the mismatch between project implementation and impact evaluation, this paper highlights how a reliable baseline for forest carbon, ecology, and social and livelihood indicators could be created by collecting data at community level. This paper concludes with considerations for future outcomes and an impact evaluation of the REDD+ mechanism.

**Keywords:** REDD+, impact evaluations, forest carbon, co-benefits, Nepal

# Baseline Considerations in Designing REDD+ Pilot Projects: Evidence from Nepal

## 1. Introduction

Reducing emissions from deforestation and forest degradation (REDD) and forest carbon enhancement through improved forest management (REDD+) have emerged as potential climate change mitigation mechanisms, with attendant debates on their opportunities and challenges (Angelsen, 2008; Bosetti and Rose, 2011; FAO, 2011; Pistorius *et al.*, 2011; Visseren-Hamakers *et al.*, 2012). The success of REDD+ depends on its effectiveness, efficiency, and on the equity and co-benefits that it generates for forest-dependent communities. Evaluation of the success of REDD+ using credible scientific and methodologically sound designs requires ground level information on a wide range of indicators such as forest carbon, ecology, forest dependence and livelihood, including social safeguards (Hein and van der Meer, 2012). The best way to do this is to collect data before and after the program is implemented from carefully matched program and non-program communities using experimental or quasi-experimental design (Ferraro and Pattanayak, 2006; Pattanayak *et al.*, 2010; Caplow *et al.*, 2011). This approach helps to produce evidence on what REDD+ implementation has changed, net of other factors. Using the example of a REDD+ pilot project conducted in Nepal, we discuss how the project was designed and a baseline database prepared given the data constraints inherent in identifying comparable program and non-program communities. We conclude with a consideration of future outcomes and an impact evaluation of the REDD+ mechanism.

REDD+ is a performance-based incentive mechanism where developed countries with high carbon emissions pool resources to make incentive payments to forest-rich developing countries to reduce deforestation and forest degradation or to enhance carbon sequestration beyond a specified reference level or baseline. Other than sequestering carbon in the forest, REDD+ is expected to produce several co-benefits such as biodiversity conservation, enhancement of the socio-economic welfare of forest-dependent communities, improved forest governance, and ecological benefits (Sunderlin *et al.*, 2010). It also offers an opportunity to many forest-rich developing countries to obtain international assistance in up-scaling conservation efforts that contribute to carbon additionality.

A number of experimental projects are being implemented in different parts of the world to examine the effectiveness of REDD+ interventions and how they can be made to work better (Wertz-Kanounnikoff and Kongphan-apisak, 2009; Angelsen *et al.*, 2012; Sills *et al.*, 2014). In this paper we discuss an experimental project that made payments to community forest user groups to conserve forest carbon. We also discuss design issues related to evaluating the short-term outcomes and long-term impacts of REDD+ implementation on carbon, ecological and community socio-economic indicators, and social safeguards in a data deficient, low-income, developing country context.

## 2. Nepal's REDD+ Context and Literature

REDD+ has emerged as an international payment for ecosystem services (PES) mechanism and it is probably the largest PES in the world (Pattanayak *et al.*, 2010; Corbera, 2012). The lessons learned from PES in the field of conservation and its deductions for REDD+ have, however, remained inconclusive and unsatisfactory for several reasons. First, there is lack of methodological rigor due to poor design in the initial stages, particularly the lack of credible counterfactual or control group/s (Pattanayak *et al.*, 2010; Alix-Garcia *et al.*, 2012). Second, even in relatively methodologically sound designs, impacts are evaluated on a short term "output" rather than on a time series "outcome" basis.

REDD+ intervention is expected to produce economic gains for a group of beneficiaries at the cost of customary extraction practices that impose risks on resource-dependent marginal groups such as the poor, indigenous and tribal populations. Therefore, safeguards are at the centre of the REDD+ discourse in consideration with this likely trade-off. The United Nations Framework Convention on Climate Change (UNFCCC) held in Cancun in 2010 emphasized seven safeguard rules<sup>1</sup> to ensure no harm and to extract maximum benefit from REDD+ intervention (UNFCCC, 2011).

Nepal became one of the first countries to receive financial support for REDD+ preparedness; this support came from the Forest Carbon Partnership Facility (FCPF) of the World Bank. Nepal is currently in the process of developing its REDD+ strategy. The Government of Nepal wants to make the necessary preparations to enable the country to participate in and benefit from the emerging international REDD+ architecture (NPC, 2011; RFCCC/MFSC, 2013). To ensure that REDD+ can be implemented in an effective and beneficial manner, a three-layered institutional structure represented by major ministries, departments and units has been formed. The REDD Implementation Centre (formerly, the REDD Cell) is the focal point for REDD+ activities initiated by the Government of Nepal. A number of activities, such as national REDD arrangements and management, assessment of land use, drivers of deforestation and land use change, forest law, policy and governance, and National Forest Monitoring Systems are also in the process of being formulated.<sup>2</sup>

For a no-regret REDD+ implementation policy, countries, including Nepal, first of all need to establish pilot projects that provide reliable information on diverse REDD+ outcomes such as carbon additionality, permanency, ecological co-benefits, impacts on livelihood and poverty, social safeguards, and institutional arrangements in the future (Chhatre and Agrawal, 2009; Caplow *et al.*, 2011). In addition to the UNFCCC safeguard measures, more literature is emerging that emphasizes the importance of social safeguards, which are critical to mitigating the adverse effects of REDD+. Social safeguards should be able to address the concerns of a wide range of stakeholders that are vulnerable to the conversion of forest into a global market for carbon (Chhatre and Agrawal, 2009; Daviet and Larsen, 2012). Creating comprehensive and in-depth baseline information is essential for ensuring that REDD+ impacts and safeguards can be correctly measured and monitored so that REDD+ “Does no harm” and produces positive net benefits for forest-dependent local communities.

In this context, the Norwegian Agency for Development Cooperation (NORAD) supported a pilot “Design and setting up of a governance and payment system for Nepal’s community forest management under REDD+” via their Climate and Forest Initiative. The International Centre for Integrated Mountain Development (ICIMOD), the Federation of Community Forest Users Nepal (FECOFUN) and Asia Network for Sustainable Agriculture and Bio-resources (ANSAB) jointly implemented this REDD+ demonstration project from 2010 to 2013.<sup>3</sup> The project piloted a REDD+ seed grant payment and its long-term goal was to strengthen the capacity of civil society through a national demonstration payment mechanism for carbon credits in Nepal. Community forest user groups (CFUGs) are one of the largest and most effective civil society institutions involved in forest management at the grassroots level in rural Nepal, with over 18,000 groups spread over all 75 districts of the country (GON/MOF, 2014).

In this context, an experimental Forest Carbon Trust Fund (CTF) was established in 2011 to institutionalize a REDD+ payment mechanism and finalize modalities for REDD+ payment based on carbon and social safeguard criteria (CFRPN, 2011; Shrestha *et al.*, 2014). Instead of fully performance-based carbon payment, the modalities consisted of a combination of carbon enhancement, with a strong focus on safeguards for forest-dependent communities as criteria for carbon payment. According to these criteria, the REDD+ carbon payment was a function of six different components: baseline carbon stock, carbon increment, the percentage of indigenous, Dalit and

---

<sup>1</sup> The seven safeguard criteria are: respect national forest programs and international conventions and agreements; honor national sovereignty along with the enhancement of transparent and effective forest governance; respect the knowledge and rights of communities, including indigenous people; ensure the effective participation of indigenous people; conserve natural forests in order to conserve the ecosystem and social and environmental co-benefits while ensuring that they produce no perverse incentives for conversion; address the risks of reversals, and; reduce displacement of emissions (UNFCCC, 2011).

<sup>2</sup> In addition, an expert working group has been constituted to produce the information required for Reference Emission Level (REL), Measurement, Reporting and Verification (MRV), Strategic Environment and Social Assessment (SESA) and Environment and Social Management Framework (ESMF).

<sup>3</sup> Though the project started in 2009, the real inception of the project took place with the carbon baseline in 2010. The REDD+ incentive payment started in the second half of 2011 with the first inventory for carbon increment conducted and economic incentives in the form of REDD+ seed grant payments distributed to participating communities. The utilization of this REDD+ fund started only at the end of the 2011.



poor households, and the female population in communities. These last four parameters were used as social safeguards to protect forest-dependent communities from any adverse effects of REDD+. The REDD+ seed grant was distributed annually to the participating communities on the basis of the pre-determined weights of the six components for three consecutive years (2011-2013).<sup>4</sup>

ICIMOD and the SANDEE collaborated to design an additional research component with the objective of adding value to the planned REDD+ pilot to produce more comprehensive groundwork for evaluating the outcomes and impacts on forest carbon, ecology, livelihood and social safeguards (see Figure 1).

### 3. Study Methods

We discuss the key design issues that have emerged in the REDD+ literature. We examine the original REDD+ project and the additional components that were added once the experimental project sites were selected. We discuss how we overcame the design issue where the experimental project implementation preceded the research study design.

#### 3.1 Key Design Indicators in REDD+ Implementation

Discussions on international REDD+ architecture for REDD+ implementation as well as REDD+ project designs at national and sub-national levels provide important guidelines for ensuring at least four criteria: carbon effectiveness, cost efficiency, equity, and co-benefits, often called “3E + co-benefits” (Angelsen and Wertz-Kanounnikoff, 2008; Sunderlin *et al.*, 2010). From an operational point of view carbon effectiveness requires REDD+ communities to generate a carbon increment above the reference level; this condition is necessary to make communities eligible for REDD+ payments. Cost efficiency at national or sub-national levels ensures that REDD+ implementation costs do not exceed REDD+ payments to create positive REDD+ rent. Equity implies that communities, particularly forest-dependent households such as poor and marginalized groups within communities, are not deprived of forest-based resources when REDD+ is implemented, and that they are adequately compensated for the loss of benefits they receive from the forest.

Ensuring co-benefits imply Pareto efficiency, which means that there is an improvement in, or at least no worsening of, livelihood, poverty status, biodiversity, forest governance and local development activities as a result of a REDD+ program to enhance forest carbon. The concept of equity and co-benefits can be ensured by the provision of social and ecological safeguards through a framework with a clearly defined set of goals, functions, rules and institutions. A complete safeguard system anticipates potential risks and opportunities, plans to avoid harms, plans to produce benefits, manages actions by implementing these plans, monitors the processes and outcomes, and responds to problems and grievances (Daviet and Larsen, 2012). Though the UNFCCC safeguard guidelines encompass international, national, and local safeguard measures, safeguard indicators at the pilot level mainly need to identify potential risks and opportunities for forest-dependent communities and their forest ecosystems. These indicators should be reliable, precise, measurable, time-bound and appropriate for cross-validation to enable future scientific outcomes and impact evaluation.

Accordingly, the study design consisted of preparing the groundwork for collecting baseline and end-line information from both treatment and control sites. We use the terminology: “Treatment community” or “REDD+ community” for REDD+ Project communities and “Control communities” or “non-REDD+ communities” for comparable non-REDD+ communities.

After the selection of the treatment and control communities, we identified indicators for the above-mentioned four criteria, as well as safeguards critical for REDD+ success and discuss how these can be ensured by citing examples from the baseline findings. The indicators of carbon effectiveness are the carbon stocks in above- and below-ground biomass; the indicators of cost effectiveness are the costs borne and the benefits accruing to households from community forests; the indicator for equity is the distribution of cost and benefit by income and social status, such as ethnicity and Dalit/non-Dalit status; and the indicators for co-benefits are the ecological variables, such as reduction in the incidences of forest fires, floral and faunal diversity and density, and change in household assets

<sup>4</sup> The respective weights assigned were 24%, 16%, 10%, 15%, 20% and 15%.

from community-forestry-initiated activities such as provisions of livestock, biogas plants or improved cook stoves bought via grants or soft loans (for details, see Table A1 in Appendix). Since REDD+ piloting projects cannot wait very long, a near term REDD+ intervention outcome evaluation was also designed that was broadly based on three dimensions namely carbon impacts, ecological impacts and household welfare and livelihood (Figure 2).

The baseline data for this study was collected in 2011 after identifying treatment and matching control sites using propensity scores. The household survey was conducted during August–November 2011. The household survey covered forest-related activities and household economic activities during 2010–2011 before the REDD+ payments were utilized by the community to ensure that the baseline scenario was not contaminated by the intervention of the project. The carbon data in the treatment community forest was collected by the project from February–April 2011. Carbon data in the control community forest was collected during July to August 2011.<sup>5</sup> Consultations with forestry experts assured us that this time lag would not affect carbon stocks enough to make any significant difference when the end-line data are collected with similar time gaps. Any impact evaluation in the future should consider these timings to ensure that the carbon, ecological, and community socio-economic data are collected after equal intervals from both the treatment and control communities.

### **3.2 Sampling Design and Data Collection**

The REDD+ project was undertaken in three districts – Dolkha, Gorkha and Chitwan – which represent three ecological regions: the high altitude mountains, mid-hills and lowland Terai, respectively (See Figure 3). A total of 105 CFUGs with more than 10,000 hectares forest area (58 from Dolkha, 31 from Gorkha and 16 from Chitwan)<sup>6</sup> from the three districts were included in the pilot project. There were more than 18,000 households in the study area. These 105 communities made the total population for the treatment group, from which 21 communities were randomly selected (seven from each district) for this study. An equal number of matching control communities were selected from these districts using a propensity score matching process (discussed in section 3.3). The analysis that follows is based on the seven treatment and seven control communities in each of the three districts, making a total of 21 treatment communities and 21 control communities.

### **3.3 Matching and Selection of Comparison CFUGs**

The project sites were three watersheds of small river systems in three ecological regions and were similar to a large number of such river systems in Nepal, allowing for generalization of results. Ensuring a set of statistically matching control communities for each set of REDD+ project communities was challenging. It is to be noted that the impact evaluation study was designed after the project sites were chosen. This, however, represents a common issue in development intervention in many developing countries where design of impact evaluation study comes after the projects are implemented. In our study, the control communities were identified on the basis of the following objective criteria: (i) they did not adjoin the treatment community (to avoid the effect of carbon leakage); (ii) they had similar topographical and forest characteristics; and (iii) they had similar socio-economic, forest use, infrastructure and market access characteristics to the treatment communities.

We used the CIFOR technical guidelines when selecting REDD+ treatment and control sites (Sunderlin *et al.*, 2010) with some modifications for a propensity score matching (PSM). The PSM is a statistical method of identifying matching treatment and control groups based on similarities in observed characteristics. CIFOR guidelines suggest the use of eight variables: deforestation pressure, NGO presence, strength of forest tenure, number of active community groups, population size, extent of forest cover around the village, forest dependence, and distance to the main road. These eight indicators have been extended to a list of 22 variables, which have been used in Brazil, Cameroon, Indonesia, Tanzania and Vietnam for the selection of matching villages for REDD+ experiments. Our study adopted these variables but made necessary adjustments for local conditions and listed a total of 26 observable indicators. The data for these 26 variables were collected from the Operational Plan (a document

<sup>5</sup> This three-month gap was due to the fact that the research design took time and the REDD+ intervention was carried out by a separate organization. Such issues are very common in actual project implementation in developing countries unless the project is designed for research purposes. This REDD+ project didn't have the impact evaluation component when the project was conceptualized.

<sup>6</sup> Splitting larger CFUGs into convenient smaller ones as per demand of local communities is a routine process. These 105 CFUGs were later further reconstituted in different years into 65, 31 and 16 in Dolkha, Gorkha and Chitwan respectively, making a total of 112 CFUGs by the end of the project in 2013 (ANSAB/FECOFUN/ICIMOD/NORAD, 2010; Shrestha *et al.*, 2014).

approved by the District Forest Offices during registration or renewal of registration by the CFUGs, and focus group discussions (FGDs) with key informants. These 26 variables were again later regrouped into 11 variables, e.g. the area of the community forest and the number of community households were combined to generate a new variable, the number of households per hectare of community forest.

The PSM based on these variables consisted of creating a weighted average, where weights are the inverse of the elements of the variance-covariance matrix of these 11 variables for each of the potential communities so that the noisiest variable received the lowest weight. The study identified a subset of seven REDD+ and seven non-REDD+ CFUGs for which index values were close as measured by the mean value for each of the 11 variables. That is for the set of variables in the control communities, the mean for each variable was statistically similar for the mean in the REDD+ communities. Instead of following one-to-one matching of REDD+ and non-REDD+ communities, the study selected clusters of seven matching REDD+ and seven non-REDD+ communities using Mahalanobis Metric (Jagger *et al.*, 2010).

Once the matching treatment and control communities were identified, the data collection for carbon, ecological and bio-physical as well as community socio-economics, forest dependence, and other livelihood indicators followed.

### 3.4 Carbon, Ecology and Bio-physical Data

The project prepared GIS maps of the sampled community forests and marked sample plots in the study area which were categorized into dense and sparse plots. Accordingly, there were 153 plots across the selected 21 treatment CFUGs. Using similar methods, 124 plots were identified in the 21 control CFUGs as comparison plots (Table 1).

Carbon inventory data were collected using technical guidelines developed for the project. These guidelines follow an international standard (ANSAB/ FECOFUN/ICIMOD/NORAD, 2010). The general plot size for carbon measurement was 8.92 m radius with several sub-plots of smaller sizes. For instance, a 5.64 m radius plot was created to measure above-ground sapling biomass, while a 0.56 m radius plot was used to measure litter, herb, and grass biomass and soil organic carbon.

Besides carbon data, the project collected bio-physical data such as altitude, slope, aspect, soil type, soil depth and forest type, and ecological data such as signs of forest fires, timber extraction, encroachment, grass cover, tree cover among others. Data on ecological indicators were recorded by trained foresters based on observed signs of human activity at the sample plots. To ensure consistency, the carbon stock, ecological and bio-physical data was collected from control sites using exactly the same method used in the project plots.

### 3.5 Socio-economic Data

For the collection of socio-economic data, the households in the control and treatment communities were first stratified into three groups: indigenous households, Dalits, and “other” households (Brahmins and Chhetris). This categorization was followed by maintaining records of ethnic distribution and analyzing equity in the distribution of most of the public sector services such as health, education and community forestry in Nepal. Dalits are the most disadvantaged occupational group in Nepal. The “other” household categories were considered to be socio-economically privileged groups. A total of 15 households were selected from each of the 21 treatment and 21 control communities using random sampling in proportion to the households in each of these three stratum. This gave a total of 210 households (105 REDD+ households and 105 non-REDD+ households) in each district. A total of 315 REDD+ households and 315 non-REDD+ households from three districts were surveyed, making a total of 630 households surveyed.

While designing the socio-economic survey instrument, several rounds of field visits and focus group discussions were conducted to obtain first-hand information on local conditions, agricultural and forestry-related practices in the three topographical regions. Accordingly, the survey questionnaire collected a wide range of information in various categories to ensure that even minor impacts of the interventions could be captured, along with possible provision for cross verification. These sections were: general (household roster, education, occupation etc.);

forestry (extraction of forest products from various types of forest management regimes including community managed forests, production and transaction costs for community managed forests, and household perceptions on community forest governance); household assets and annual food and non-food consumption, major sources of family income and coping mechanisms against risks; the presence of external agencies, household involvement in social organizations, incidence of acute and chronic sickness and workdays lost, self-perceived household welfare status, access to public services such as banks, roads, and police stations. The data on local agricultural wage rates was collected as a proxy for the opportunity cost of time.

The questionnaire was pre-tested in the non-matched REDD+ and non-REDD+ communities in Chitwan district and accordingly revised to ensure coherence, flow and ease of response for participants. Graduate students were trained and employed as enumerators to administer the survey. In order to get quality data, a quality control mechanism was used where an enumerator filled the survey, a second enumerator verified it, and a team supervisor monitored the entire process. The data were managed using CSPro, a data management software.

### **3.6 Results from the Balancing Test**

After the household baseline survey was completed, a balancing test was conducted using 11 indicators to see whether the selected treatment and control communities were balanced. The balancing test indicated that there was statistically significant difference between the mean values for two of the five household level variables for the treatment and control households while for the other, the differences were not statistically significant. The two variables with statistically significant difference were the number of local organization/NGOs in the community and the percentage of households in the CFUG with liquid petroleum gas (LPG). The difference in these two variables between the treatment and the control communities needs to be taken into account for impact evaluation of the REDD+ intervention. The difference in community level variables for which data was collected for matching were not statistically significant for the treatment and control communities. Table 2 provides the mean difference tests of the variables used for matching.

## **4. Baseline Findings and Analysis**

In presenting the baseline findings we discuss the issues a researcher would face while conducting an impact evaluation of similar interventions at the community level in low income developing countries. We mainly discuss how the variables identified in the impact evaluation design differed for the treatment communities and the control communities and what insights they provide for a reliable impact evaluation in similar settings.

### **4.1 Forest Carbon in Treatment and Control Community Forests**

The analysis of the various components of forest carbon stocks in the REDD+ and control community forests indicated that there were statistically significant differences (Table 3). Differences existed in herb, litter and sapling biomass as well as soil organic carbon. Herb, litter and sapling biomass constituted a very small share of the forest biomass. Interestingly, there was no statistical difference in tree biomass density (measured in tons per hectare) between the two kinds of communities. This indicates that in terms of tree biomass density, the treatment and control groups were similar. However, due to the differences in the soil carbon, which makes up more than one-third of the total forest carbon stock, there was a statistically significant difference in the forest carbon stock between the REDD+ and non-REDD+ CFUGs, with REDD+ communities having a higher carbon density compared to the control communities, with variations between the districts.

The difference in carbon stock between the treatment and the control community forests in Dolkha was not statistically significant but it was significant for Gorkha and Chitwan. The high carbon stock in REDD+ forests in Chitwan was probably due to the project area being dominated by a more dense regeneration compared to the relatively sparse natural forests in the control areas (Figure 4).

The carbon stock in sampled plots varied between 61 to 618 tons with a mean of 249 tons per hectare in REDD+ community forests across the three districts. It varied from 50 to 498 with a mean of 221 tons per hectare in control community forests. Future studies on carbon impact of REDD+ should examine the carbon stock increment

in the sample plots for the two kinds of forests a few years after the intervention.

The change in the forest carbon stock in the REDD+ project communities versus the business-as-usual situation does not tell the whole story. The ecological baseline data supplemented information on the drivers of such change for validation of the carbon stock change and other forest related behavior at the community level. The ecological indicators mainly provided information on human-forest interface (Table 4).

The baseline data on various ecological indicators showed that compared to non-REDD+ community forests, the REDD+ pilot community forests had higher incidences of forest fires (29% vs. 13 %) and more signs of encroachment (22% vs. 6%) . However, they also had lower open grazing (31% vs. 50%), lower timber extraction (29% vs. 40%), low soil erosion (10% vs. 24%) and low wildlife signs (48% vs. 81%). This indicates that the REDD+ pilot and control sites had mixed status in human-forest interface indicators and REDD+ sites were not initially good compared to non-REDD sites when considering multiple aspects of forest management.

## 4.2 Socio-economic Characteristics of Treatment and Control Communities

This section analyses whether REDD+ project communities are different to non-REDD+ communities in terms of household socio-economic characteristics. These characteristics are: household size, literacy status of household head, agriculture landholding, livestock units, per capita consumption and percentage of households receiving remittances from abroad, among others. The average household size and number of literate households in the treatment and control communities were close to the national average of 4.9 per household and 68% respectively (CBS, 2012). This indicates that the study area is representative of general national characteristics. The average per capita consumption per year was higher than the national average of around 34,000 rupees. This difference is probably due to the exclusion of forest products in national survey estimates. The percentage of households receiving remittance income was close to the national average of 17% (CBS, 2011). There was no statistically significant difference in biogas installed (around 10 %) while there was a statistically significant difference in households with improved cook stoves (ICS). ICS were owned by 15% treatment households while this figure was only 8% for control households. Overall, these findings showed that there were no statistically significant differences in the major household characteristics of the treatment and control households. The findings are summarized in Table 5.

## 4.3 Forest Dependence and Household Cost and Benefit from Community Forests

Households in Nepal depend upon forest products for their living. Firewood, fodder-grass and leaf-litter are some of the most important products that rural households extract from forests. The findings show that private land is the primary source for regular forest biomass extraction, followed by community forest.<sup>7</sup> In addition, households extract forest products from leasehold forest, government forest, and open access forest. Households supplement any deficit by making local purchases. Leasehold forests are forest regimes that are managed by groups of households on a 40-year lease with authority to manage and extract forest products granted by the government. About 19% of REDD+ community households and 11% of non-REDD+ community households were members of leasehold forest groups. Government-managed forests are forests managed by the government. Open access land refers to areas such as river banks or open spaces in which strict property rights are not defined. It is important to consider these facts when analyzing the impact of REDD+ on forest dependence (Table 6).

Comparing forest dependence between REDD+ treatment and control communities measured in terms of the quantities of extraction of firewood, fodder-grass and leaf-litter also revealed mixed results. For instance, firewood extraction per household was statistically different between treatment and control communities for Gorkha, and Dolkha. Fodder-grass extraction was different for Gorkha but not for Chitwan and Dolkha. On the other hand, leaf-litter collection was statistically different for Chitwan but not for Dolkha and Gorkha (Table 7).

Interestingly, the differences combined for all three districts were statistically significant for treatment and control communities for all three forest products – firewood, fodder-grass and leaf-litter. This indicates that these overall differences and district wise variations in extraction of forest products need to be taken into account when outcome

<sup>7</sup> Households own private forest generally with agro-forestry or forests growing naturally in private wasteland not suitable for agriculture.

or impact evaluations are undertaken.

We also compared the costs and benefits of community forest participation among REDD+ treatment and control communities (Table 8). The production cost of forest management activities, such as forest thinning and pruning, in the community forest was higher for control households compared to treatment households (Rs. 1445 vs. 1021). The transaction costs involved in community forest management, such as the value of time spent in CFUG meetings and the time spent visiting forest offices, were not statistically different.

Not only the cost of production, but the value of biomass collected from the community forests were higher for the control group compared to the treatment group. In spite of the higher production costs borne by non-REDD+ communities, the benefits derived from community-forest-initiated activities (that include several components such as grants for improved cook stoves, income-generating activities, employment for local people) were lower compared to those received by their REDD+ counterparts (NPR 578 vs. 1196). The gross value of extraction from community forest biomass was over NPR 13,000 and 17,000, and its share as a percentage of household consumption was 8.32% vs. 10.80% for treatment and control communities respectively; the difference was statistically significant. Due to higher biomass collection by control communities, the net benefit from community forest participation was higher for control communities compared to treatment communities. Thus, the treatment and control communities were different in the baseline in terms of forest-related costs and benefits and this should be taken into account in future impact evaluation.

## 5. Discussion

REDD+ has huge potential for climate change mitigation via forest carbon sequestration. However, there are a number of critical issues in REDD+ that make it risky, controversial, sensitive and uncertain (Verchot *et al.*, 2012; Visseren-Hamakers, 2012). The potential of REDD+ depends upon how successfully the 3E+ co-benefits criteria are addressed and safeguards incorporated to ensure that “no harm” and positive benefits accrue to forest-dependent communities and forest ecosystems. In this regard, methodologically sound designs are prerequisite for evidence-based credible impact evaluation. This paper discusses how a quasi-experimental design using PSM provides potential for incorporating these issues as part of an impact evaluation framework, using the example of a pilot experiment in Nepal. The balancing test indicated that there might be differences between treatment and control groups matched through community level data. These communities, when compared through micro level data collected at household level, indicate that the unmatched variables need to be controlled for while undertaking the impact evaluation. These imbalances also indicate how hard it is to establish matching control groups. This is mainly because developing countries often lack the necessary data on forest bio-physical, ecology and socio-economics at the local level needed to undertake scientific impact evaluation studies, and also program implementation precedes the design phase of the impact evaluation. Scientific impact evaluation might also suffer from potential selection bias, with REDD+ activities being implemented in relatively carbon-rich and convenient forests, as indicated in the literature (Wertz-Kanounnikoff and Kongphan-apisak, 2009). The carbon stocks in these experimental areas were also generally higher for REDD+ communities with district wise variations, while other results were mixed. These imbalances need to be methodologically considered while also controlling for the imbalanced variables when the final impact analysis is undertaken.

The findings from the baseline indicate that there were differences in carbon stock between the treatment and the control communities due to differences in soil organic carbon in the treatment versus comparison groups. The findings also showed that there were differences in forest product extraction between the treatment and the comparison groups, with more forest extraction of firewood, fodder-grass, and leaf-litter in control communities. However, the benefits of community-initiated activities, which also constitute the social safeguard measures of community forest management, were higher in the treatment communities, though the net benefits from community forests were higher in the control communities. This indicated that there might have been some higher level of external intervention in the treatment communities compared to the control communities. It is obvious that more pro-active communities are able to bring in more development projects and this could be an issue of political economy at the local level. The findings regarding forest product extraction also indicated that there were district

wise differences that need to be addressed in impact analysis.

## 6. Conclusions

What REDD+ really does hold for the future in terms of effectiveness, efficiency and equity along with co-benefits, collectively known as 3E + co-benefits, is the most critical question for REDD+ success in mitigating climate change. Credible answers to this question can be best provided by a pilot REDD+ project that is comprehensive regarding the overall dimensions of REDD+ and considers forest carbon, ecology, forest dependence and livelihood, as well as social safeguards. REDD+ safeguard indicators are receiving greater attention worldwide as a way of identifying risks and opportunities and of helping policymakers to address problems and grievances. A counterfactual scenario created using scientific methodology provides an opportunity for reliable impact evaluation in the future by producing information on what would have happened without the project. Data availability for statistically sound matching is a problem in a developing country context and collecting reliable baseline data, particularly from control sites, is resource intensive and time consuming at the very least and still carries with it the possibility of the unavailability of relevant indicators. Sometimes researchers miss opportunities to conduct such research due to a lack of coordination between project implementation and the research team – we almost missed this opportunity in our case. Employing a balancing test of the *ex ante* variables with *ex post* variables and controlling for such variables from a set of methodologically sampled matching counterfactual groups provides a methodological solution in the context of quasi-experimental designs.

Socio-economic projects, including forestry projects, are implemented on the basis of some assumptions and pre-defined objectives. Incorporating additional components into pilot projects can enhance the value of such projects, with marginal cost implications. This article has tried to show that incorporating appropriate design components can add value and create scope for further scientific research and reliable impact evaluations in the future.

## Acknowledgements

This study was conducted with financial and technical support from the South Asian Network for Development and Environmental Economics (SANDEE) and the International Centre for Integrated Mountain Development (ICIMOD). While both ICIMOD and SANDEE are funded by multiple donors, we would like to particularly thank NORAD for supporting the pilot REDD+ project and, by extension, some of these analyses. The authors are thankful to ANSAB for conducting the carbon inventory. We would like to thank the field survey team comprised of students from Patan Multiple Campus, Tribhuvan University. We are very grateful to the households, CFUG members, and the FECOFUN District Offices of Dolkha, Gorkha and Chitwan for their support of this study.

## References

- Alix-Garcia, J.M., E.N. Shapiro, and K.R.E. Sims (2012), 'Forest conservation and slippage: Evidence from Mexico's national payments for ecosystem services program', *Land Economics* **88**(4): 613-638.
- Angelsen, A. (ed) (2008), *Moving ahead with REDD: Issues, options and implications*, Bogor, Indonesia: Center for International Forestry Research (CIFOR).
- Angelsen, A., M. Brockhaus, W.D. Sunderlin, and L.V. Verchot (eds) (2012), *Analysing REDD+: Challenges and choices*, Bogor, Indonesia: Center for International Forestry Research (CIFOR).
- Angelsen, A. and S. Wertz-Kanounnikoff (2008), 'What are the key design issues for REDD and the criteria for assessing options?' in A. Angelsen (ed), *Moving ahead with REDD: Issues, Options and Implications*, Bogor, Indonesia, Center for International Forestry Research (CIFOR).
- ANSAB/FECOFUN/ICIMOD/NORAD (2010), 'Forest Carbon Stock Measurement: Guidelines for measuring carbon stocks in community-managed forests', Asia Network for Sustainable Agriculture and Bio-resources/Federation of Community Forest User Nepal/International Centre for Integrated Mountain Development/ Norwegian Agency for Development Cooperation, Kathmandu, Nepal.
- Bosetti, V. and S.K. Rose (2011), 'Reducing carbon emissions from deforestation and forest degradation: issues for policy design and implementation', *Environment and Development Economics* **16**(04): 357- 360.
- Caplow, S., P. Jagger, K. Lawlor, and E. Sills (2011), 'Evaluating land use and livelihood impacts of early forest carbon projects: Lessons for learning about REDD+', *Environmental Science & Policy* **14**(2): 152- 167.
- CBS (2011), *National Living Standard Survey 2011*, Government of Nepal, National Planning Commission Secretariat, Kathmandu: Central Bureau of Statistics.
- CBS (2012), *National Population and Housing Census 2011*, Government of Nepal, National Planning Commission Secretariat, Kathmandu: Central Bureau of Statistics.
- CFRPN (2011), Operational Guidelines of Forest Carbon Trust Fund: Community Forestry REDD+ Project Nepal, [Available at] <http://communityredd.net/assets/files/REDD-FCTF-Operational-Guidelines-English.pdf>
- Chhatre, A. and A. Agrawal (2009), 'Trade-offs and synergies between carbon storage and livelihood benefits from forest commons', *Proceedings of the National Academy of Sciences* **106**(42): 17667- 17670.
- Corbera, E. (2012), 'Problematizing REDD+ as an experiment in payments for ecosystem services', *Current Opinion in Environmental Sustainability* **4**(6): 612- 619.
- Daviet, F. and G. Larsen (2012), 'Safeguarding Forests and People: A Framework for Designing a National System to Implement REDD+ Safeguards', World Resources Institute.
- FAO (2011), *State of the World's Forests 2011*, Rome: Food and Agriculture Organization of the United Nations.
- Ferraro, P.J. and S.K. Pattanayak (2006), 'Money for nothing? A call for empirical evaluation of biodiversity conservation investments', *PLoS biology* **4**(4): e105.
- Hein, L. and P.J van der Meer (2012), 'REDD+ in the context of ecosystem management', *Current Opinion in Environmental Sustainability*, **4**(6): 604- 611.
- Jagger, P., E.O Sills, K .Lawlor, and W.D Sunderlin (2010), 'A guide to learning about livelihood impacts of REDD+ projects', Occasional paper 56, Center for International Forestry Research (CIFOR), Bogor, Indonesia.
- GON/MOF (2014), *Economic Survey: Fiscal Year 2013/14*, Government of Nepal, Ministry of Finance, Kathmandu.
- GON/ NPC (2011), *Three Year Plan 2011-2013*, Government of Nepal, National Planning Commission, Kathmandu.
- Pattanayak, S.K., S. Wunder, and P.J. Ferraro (2010), 'Show me the money: Do payments supply environmental services in developing countries?', *Review of Environmental Economics and Policy* **4**(2): 254- 274.
- Pistorius, T., C. Schmitt, D. Benick, S. Entenmann, and S. Reinecke (2011), 'Greening REDD+-challenges and opportunities for integrating biodiversity safeguards at and across policy levels', *German Journal of Forest Science*, Allg. Forst-u.Jagd Zeitung **182**(5/6): 82- 98, [Available at] <http://www.sauerlaender-verlag.com/fileadmin/content/>



dokument/archiv/afjz/182\_2011/Heft3/\_03\_\_Pistorius\_6143.pdf

- RFCCC/MFSC (2013), *Mid Term Report: World Bank FCPF Grant on REDD Readiness, REDD Forestry and Climate Change*, Ministry of Forest and Soil Conservation, Kathmandu.
- Shrestha, S., B.S. Karky, and S. Karki (2014), 'Case Study Report: REDD+ Pilot Project in Community Forests in Three Watersheds of Nepal', *Forests* **5**: 2425- 2439.
- Sills, E.O., S.S Atmadja, C. de Sassi, A.E. Duchelle, D.L. Kweka, I.A.P. Resosudarmo, and W.D Sunderlin, (eds) (2014), *REDD+ on the ground: A case book of subnational initiatives across the globe*, Bogor, Indonesia: Center for International Forestry Research (CIFOR).
- Sunderlin, W. D., A.M. Larson, A. Duchelle, E.O. Sills, C. Luttrell, P. Jagger, ... and A.D. Ekaputri (2010), *Technical guidelines for research on REDD+ project sites*, Bogor, Indonesia: Center for International Forestry Research (CIFOR).
- UNFCCC (2011), *The Cancun Agreements: Outcome of the work on the Ad Hoc Working Group on Long-Term Co-operative Action under the Convention*, Report of the Conference of the Parties on its 16th session, Cancun, 29 November- 10 December, 2010.
- Verchot, L.V., M. Brockhaus, W.D. Sunderlin, and A. Angelsen (2012), 'CIFOR's Global Comparative Study on REDD+ (GCS)' in A. Angelsen, M. Brockhaus, W.D. Sunderlin, and L.V. Verchot (eds), *Analysing REDD+: Challenges and Choices*, Bogor, Indonesia: Center for International Forestry Research (CIFOR).
- Visseren-Hamakers, I.J., A. Gupta, M. Herold, M. Pena-Claros, and M.J Vijge (2012), 'Will REDD+ work? The need for interdisciplinary research to address key challenges', *Current Opinion in Environmental Sustainability* **4**(6): 590-596.
- S. Wertz-Kanounnikoff and M. Kongphan-apirak (2009), 'Emerging REDD+: A preliminary survey of demonstration and readiness activities', Working Paper No. 46, Center for International Forestry Research, Bogor, Indonesia.

## Tables

**Table 1: Distribution of dense and sparse plots by type of sampling plots**

CFUG Type	Dolkha		Gorkha		Chitwan		Subtotal		Total
	Dense	Sparse	Dense	Sparse	Dense	Sparse	Dense	Sparse	
Treatment	29	3	37	6	63	15	129	24	153
Control	29	10	28	7	34	16	91	33	124

Source: Project raw data from ANSAB/ICIMOD/FECOFUN and field survey, 2011.

**Table 2: Balancing test results**

Matching Variables	REDD+ n=21	Non-REDD+ n=21	Difference (REDD+ - Non- REDD+)
<b>Variables from household survey</b>			
Number of local organizations/NGOs	3.08 (0.09)	2.37 (0.07)	0.71*** (0.11)
Percentage of households with LPG	0.25 (0.02)	0.18 (0.02)	0.07** (0.03)
Percentage of HHs with biogas among large ruminant owners	0.10 (0.02)	0.08 (0.02)	0.03 (0.02)
Firewood collection time from CF in minutes	229.06 (5.79)	218.23 (5.30)	10.84 (7.85)
Average time taken to reach public facilities	83.81 (3.14)	81.90 (2.42)	1.91 (3.97)
<b>Variables from matching data</b>			
Years of CFUG handover	10.9 (1.35)	9.9 (1.15)	1.00 (1.17)
Income per hectare from CFUG product	2683.00 (912.36)	3399.10 (1216.23)	-716.09 (1520.4)
Growing stock per hectare in CFUG	4918.45 (1212.2)	3924.41 (627.32)	994.04 (1364.90)
Household per hectare CFUG	2.59 (0.45)	2.42 (0.44)	0.16 (0.63)
Indigenous and Dalit population in community	69.05 (5.90)	71.29 (6.46)	-2.24 (8.75)
Quality forest cover	77.14 (2.25)	78.81 (1.79)	-1.67 (2.88)

Figures in parentheses are standard errors; \*, \*\* and \*\*\* denote t-statistics significant at 10%, 5% and 1% level of significance respectively.  
Source: Field survey, 2011.

**Table 3: Distribution of carbon stocks (tons per hectare) in sampled CFUGs (baseline survey, 2011)**

Forest biomass/Carbon (in tons per hectare)	REDD+ n= 153		Non-REDD+ n= 124		Difference (REDD+ - Non-REDD+)		t-statistics
Herb biomass	0.37	(0.04)	0.49	(0.04)	-0.13	(0.05)	-2.36**
Litter biomass	4.55	(0.28)	3.10	(0.27)	1.44	(0.40)	3.63***
Sapling biomass	6.91	(0.88)	3.39	(0.34)	3.52	(1.03)	3.43***
Tree biomass	242.91	(17.06)	232.23	(13.62)	10.68	(22.57)	0.47
Soil organic carbon	106.00	(3.24)	86.90	(3.54)	19.10	(4.81)	3.97***
Total forest carbon	248.56	(9.99)	221.17	(8.64)	27.39	(13.56)	2.02**

Note: Conversion factor for tree biomass into carbon stocks in tons = 0.47, as suggested by IPCC (2006; ANSAB/ICIMOD/FECOFUN 2010). Figures in parentheses are standard error; \*, \*\* and \*\*\* refer to difference statistically significant at 10%, 5% and 1% level.  
Source: Project raw data from ANSAB/ ICIMOD/ FECOFUN and field survey, 2011.

**Table 4: Ecological indicators in treatment and control CFs**

Ecological indicators	REDD+ n= 153		Non -REDD+ n= 124		Difference (REDD+ - Non-REDD+)		t-statistics
Occurrence of forest fires	0.29	(0.04)	0.13	(0.03)	0.16	(0.05)	3.233***
Signs of fodder collection	0.58	(0.04)	0.52	(0.04)	0.06	(0.06)	0.96
Signs of grazing	0.31	(0.04)	0.50	(0.05)	-0.19	(0.06)	-3.32***
Signs of firewood collection	0.48	(0.04)	0.59	(0.04)	-0.11	(0.06)	-1.85*
Timber extraction	0.29	(0.04)	0.40	(0.04)	-0.12	(0.06)	-2.03**
Encroachment	0.22	(0.03)	0.06	(0.02)	0.16	(0.04)	3.83***
Soil erosion	0.10	(0.02)	0.24	(0.04)	-0.14	(0.04)	-3.10***
Signs of wildlife	0.48	(0.04)	0.81	(0.04)	-0.33	(0.06)	-5.96***

Note: The indicators were measured in binary variables, Yes = 1, No = 0. Figures in parentheses are standard errors; \*, \*\* and \*\*\* refer to difference statistically significant at 10%, 5% and 1% level.

Source: Project raw data from ANSAB/ICIMOD/FECOFUN and field survey, 2011.

**Table 5: Socio-economic and livelihood characteristics of REDD+ and non-REDD+ households**

Characteristic Variables	REDD+ n=315		Non-REDD+ n=315		Difference (REDD+ - Non- REDD+)		t-statistics
HH size	5.20	(0.12)	5.21	(0.13)	-0.00	(0.17)	-0.02
HH head is literate (Y = 1, else = 0)	0.72	(0.03)	0.66	(0.03)	0.06	(0.04)	1.55
Agri. landholding (ha)	0.59	(0.03)	0.61	(0.03)	-0.02	(0.04)	-0.41
Livestock (TLU)	2.43	(0.10)	2.39	(0.10)	0.04	(0.14)	0.27
PC consumption (Rs. '000)	51.89	(2.48)	48.68	(2.82)	3.20	(3.76)	0.85
Remittance earning HH (Yes = 1, No = 0)	0.16	(0.02)	0.20	(0.02)	-0.04	(0.03)	-1.25
Households with bio-gas (Yes = 1, No = 0)	(0.10)	(0.02)	0.09	(0.02)	0.0)	(0.02)	0.67
Households with improved cook stove (Yes = 1, No = 0)	0.15	(0.02)	0.08	(0.02)	0.07	(0.03)	2.88***

Note: HH refers to household. Figures in parentheses are standard errors; \*, \*\* and \*\*\* denote t statistics significant at 10%, 5% and 1% level of significance respectively.

Source: Field survey, 2011.

**Table 6: Household dependence by source of biomass (base year)**

Source	Percentage of household extracting/using forest products by							
	REDD+ community group (n=315)				Non-REDD+ community group(n=315)			
	Firewood	Fodder-grass	Leaf-litter	All/some products	Firewood	Fodder-grass	Leaf-litter	All/some products
Community forest	66.7	51.7	22.2	74.3	76.2	56.5	34.0	84.1
Private land	83.2	86.7	34.0	91.1	79.4	89.2	38.1	91.7
Leasehold forest	17.8	15.2	2.9	19.4	9.5	8.3	2.9	11.1
Government forest	1.0	0.3	0.6	1.0	1.0	0.0	0.3	1.3
Open access	2.9	2.9	1.6	4.8	1.6	1.0	0.6	2.2
Purchase	7.9	1.9	0.3	9.2	8.6	2.9	0.0	10.8
All sources	97.1	91.4	51.1	97.8	97.8	95.2	59.7	99.0
Non-users	2.9	8.6	48.9	2.8	2.2	4.8	40.3	1.0

Note: All sources refer to either of the various sources combined and do not add up to column total. Non-users are households that do not collect or use forest products from any of the sources.

Source: Field survey, 2011.

**Table 7: Main forest product consumption in REDD+ and non-REDD+ households**

Forest product consumption	Districts	Mean collection of forest products (Bhari)				
		REDD+ n=315		Non -REDD+ n=315		Difference (REDD+ - Non-REDD+)
Firewood	Dolkha	63.71	(2.52)	69.33	(2.06)	-5.62* (3.25)
	Gorkha	45.54	(2.77)	59.12	(2.99)	-13.58*** (4.07)
	Chitwan	55.43	(2.16)	59.18	(2.60)	-3.75 (3.38)
	All districts	54.90	(1.50)	62.55	(1.51)	-7.65*** (2.12)
Fodder-grass	Dolkha	499.31	(25.90)	486.06	(18.21)	13.26 (31.66)
	Gorkha	406.97	(27.16)	507.31	(28.23)	-100.34** (39.18)
	Chitwan	451.20	(22.22)	500.57	(30.37)	-49.37 (37.64)
	All districts	452.50	(14.65)	497.98	(15.06)	-45.49** (21.01)
Leaf-litter	Dolkha	157.49	(14.09)	182.97	(12.41)	-25.49 (18.78)
	Gorkha	40.11	(7.41)	55.66	(10.91)	-15.54 (13.19)
	Chitwan	62.4	(8.65)	98.51	(13.41)	-36.11** (15.96)
	All districts	86.67	(6.67)	112.38	(7.68)	-25.71** (10.17)

Note: Bhari is a back load; 1 Bhari = approximately 25–30 kg.

Figures in parentheses are standard errors; \*, \*\* and \*\*\* denote t statistics significant at 10%, 5% and 1% levels of significance respectively.

Source: Field survey, 2011.

**Table 8: Difference in CF benefit and costs among REDD+ and non-REDD+ households**

Characteristic Variables	REDD+ n=135		Non-REDD+ n=315		Difference (REDD+ - Non-REDD+)		t-statistics
Annual CF production cost to household (thinning, pruning etc; Rs. '000)	1.02	(0.09)	1.45	(0.13)	-0.42	(0.16)	-2.69***
Annual CF transaction cost to household (Rs. '000)	0.78	(0.07)	0.74	(0.05)	0.05	(0.08)	0.53
CF biomass value (gross, Rs. '000)	13.25	(0.74)	17.01	(0.95)	-3.76	(1.21)	-3.12***
Income from CF-initiated activities (Rs. '000)	1.20	(0.15)	0.58	(0.09)	0.62	(0.18)	3.50***
Net benefits to households from CF(Rs. '000)	11.35	(0.74)	14.70	(0.96)	-3.35	(1.21)	-2.77***

Figures in parentheses are standard errors; \*, \*\* and \*\*\* denote t statistics significant at 10%, 5% and 1% levels of significance respectively.

Source: Field survey, 2011.

## Figures

Figure 1: Project timeline and sequence of activities

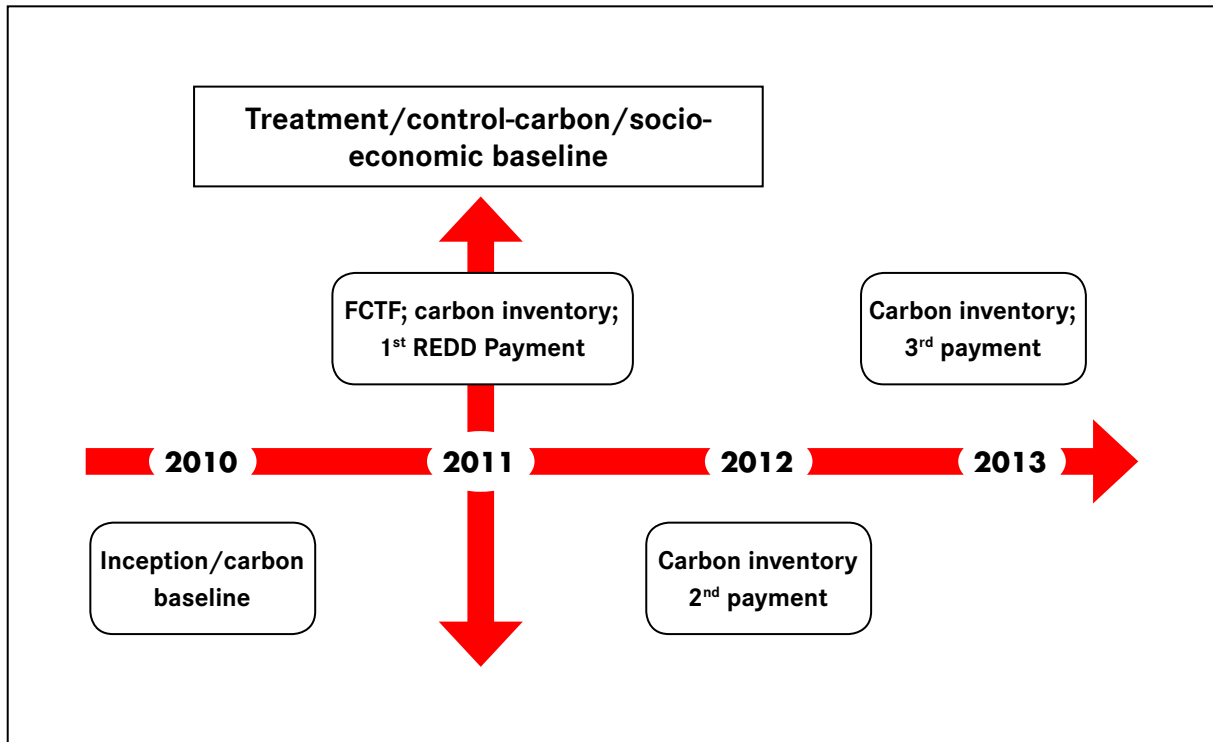


Figure 2: Conceptual framework and research design

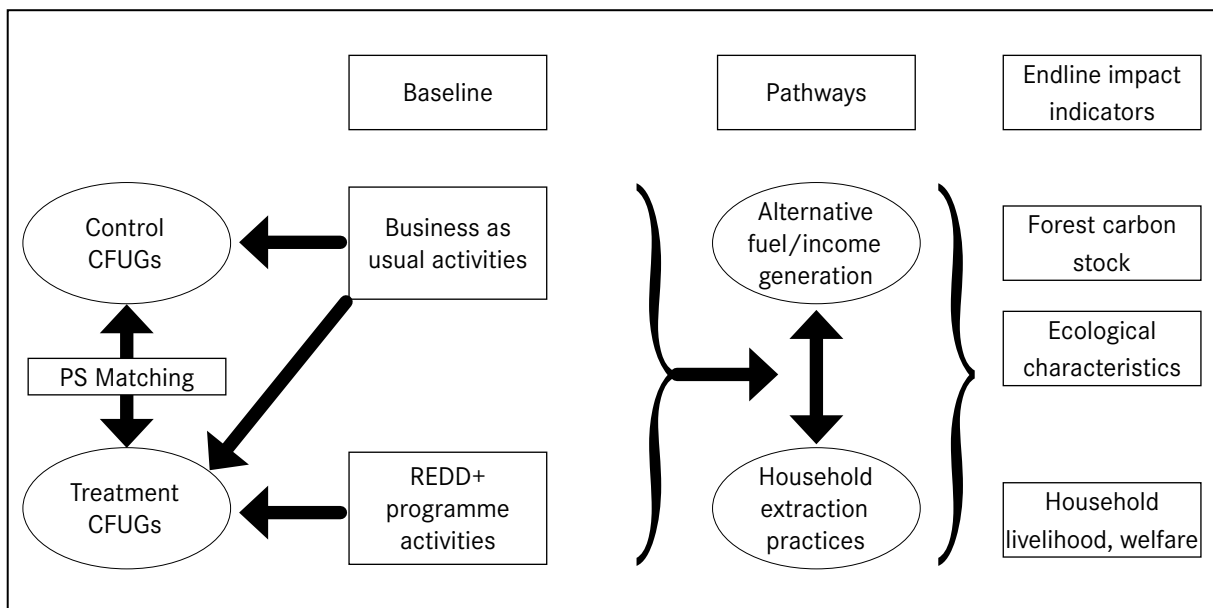


Figure 3: Location of study area in Dolakha, Gorkha and Chitwan district

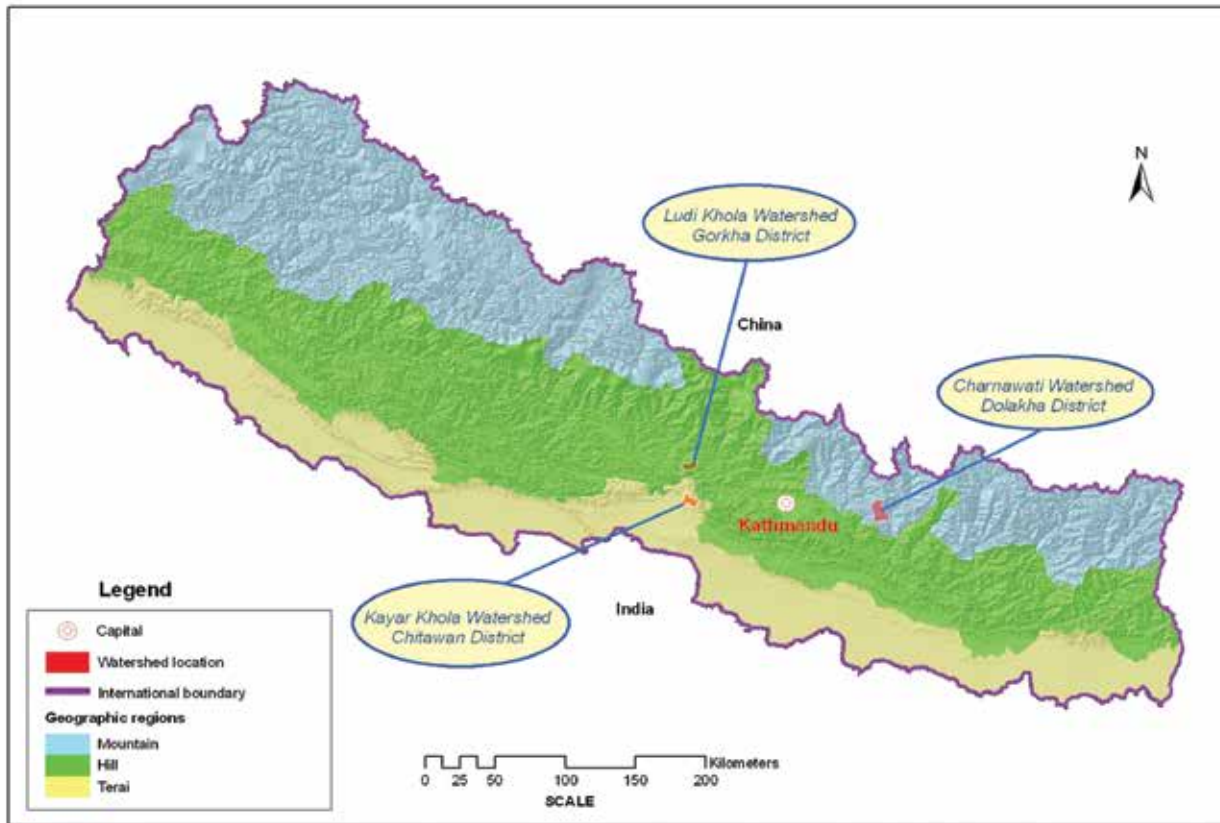
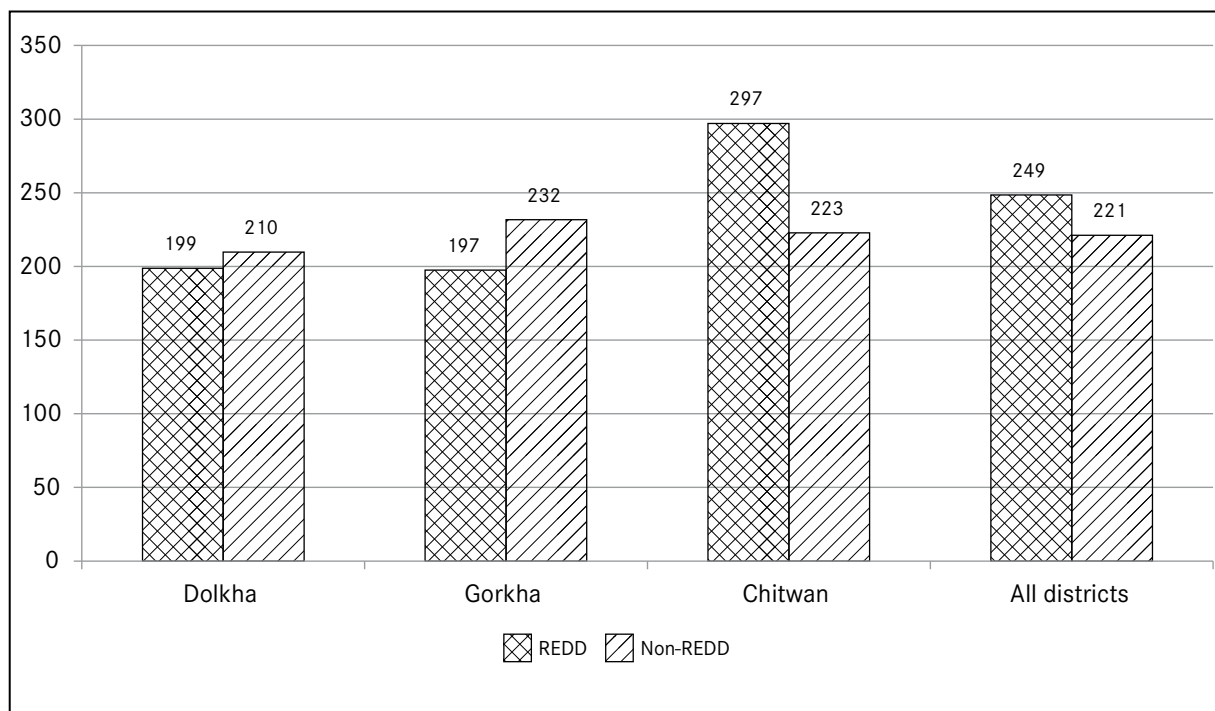


Figure 4: Average carbon per hectare in REDD+ and non-REDD+ CFs in 2011



Source: Field Survey 2011

## Appendix

**Table A1: Socio-economic indicators and variables in baseline data**

S. No.	Indicator Category	Indicators
n: REDD+ community households = 315, Non-REDD+ households = 315		
<b>1. Household socio-economic demographic</b>		
1.1	Household identification	District, name of CF group, name of household head, detailed address, phone/mobile contact
1.2	Ethnicity/caste status	indigenous group/Dalit/Others
1.3	CF membership status	Executive/general member
1.4	Household head	Gender, age, literacy status
1.5	Household details	Family members name, sex, age, education, occupation
<b>2. Forest dependence, cost/benefit components of participation and household perception of CF management</b>		
2.1	Sources, volume of forest product extractions and local prices	Community forests, private land, Government-managed forests, leasehold forest, open access land, purchase; firewood, leaf-litter, fodder-grass collection by season; timber, other NTFPs (wild fruits, vegetables etc.); local prices of forest products
2.2	Production and transaction cost	Time spent in forest guarding and forest silviculture operations, time spent in meetings and other activities, time taken to collect major forest products, membership fees, prevailing local wage rate
2.3	Perceptions about CF management	Participation, abiding by rule of law, equity in benefit sharing, restrictiveness of extraction rules; equity in utilization of CF funds
2.4	Observed biodiversity indicators	Plant species diversity, animal and bird species observed
2.5	Benefits received from CF-initiated activities	Employment in CF management activities, grants (livestock, soft loans), skills training, distribution of improved cook stoves, biogas, provision of fodder-grass and saplings; benefits from local development activities (drinking water, schools, roads etc.)
<b>3. Livelihood</b>		
3.1	Land holdings	Irrigated land, un-irrigated land, waste land
3.2	Livestock-holding	Cows, buffalo, goats, sheep, pigs, fowls
3.3	Housing quality/assets	Source of drinking water, toilets, rooms, kitchens. electricity, phone, television, mobiles, bicycles, motorbikes, cars
3.4	Fuel dependence	Firewood, LPG, bio-gas, kerosene; Improved/traditional cook stoves
3.5	Major sources of income	Agriculture, service, remittance, business, livestock
3.6	Household consumption	Food consumption, non-food consumption, consumption of durables
3.7	Incidence of diseases	Days of chronic diseases; acute diseases
3.8	Livelihood crisis/coping mechanisms	Events of livelihood crisis: sources of financing to cope with crisis
3.9	Perceived happiness index	Household income, family health, community harmony, environmental quality, state of law and order
3.10	Access to credit	Credit access, sources of credit and interest rates
<b>4. Social capital, external agencies</b>		
4.1	Presence of external agencies	Governmental programs, I/NGO programs; beneficiary or not
4.2	Presence/participation in community organizations	Presence, membership in organization
4.3	Access to public services	Distance to health post, bank, police station, high school

Note: CF refers to community forests.

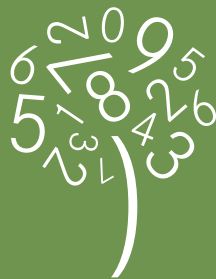












## SANDEE

P.O. Box 8975, E.P.C 1056, Lalitpur, Nepal

Street address: c/o ICIMOD, Khumaltar, Lalitpur, Nepal

**Tel:** 977 1 5003222, **Fax:** 977 1 5003299, **Email:** [info@sandeeonline.org](mailto:info@sandeeonline.org), **Web:** [www.sandeeonline.org](http://www.sandeeonline.org)

### SANDEE Sponsors

