NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY (NTNU)

NTNU – Trondheim
Norwegian University of
Science and Technology

MASTER THESIS

RESPONSE TO IMPACT OF CLIMATE CHANGE THROUGH COMMUNITY MANAGED FORESTS IN NEPAL: IS REDD+ PANACEA FOR COMMUNITY?

THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE MASTER OF SCIENCE DEGREE IN NATURAL RESOURCEMENT MANAGEMENT WITH SPECILISATION IN GEOGRAPHY, TRONDHEIM, NTNU.

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ASHOK BANIYA

DECLARATION

I hereby declare that except for references cited and duly acknowledged, the views expressed here are the product of my own research.

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Ashok Baniya

June, 2013, NTNU

Trondheim, Norway

DEDICATION

This thesis is dedicated to my late mother, Hum Kumari Baniya to whom I missed her forever recently when I was doing this thesis in Norway.

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ABSTRACT

The contemporary global politics is dominated by climate change agenda. The subsequent climate change conferences have recognized the role of forests conceptualized as REDD+ as one of the cheapest and quickest way to reduce the carbon emissions. However, what is less understood is that to what extent carbon trade in the context of REDD+ mechanism is beneficial to local forest dependent communities.

In the context of REDD+ pilot project which is implemented in Nepal since 2010, the extent of benefits of carbon trade to the local community was examined taking two case studies into account representing both Hill and Terai region which lies in lower temperate and tropical ecological regions respectively. The overall objective of this study is to examine whether the existing REDD+ mechanism implemented in Nepal is beneficial to the local community or not. A Household survey of total 70 households using systematic random sampling technique was administered to gather data related to the involvement of community forests users in taking benefits from, and cost to them incurred in forestry and carbon management activities, their personal characteristics, and people perception on climate change and its effects on livelihoods. Also, the carbon data was obtained from ongoing REDD+ project implemented in Nepal. With setting three scenarios 1) business as usual (no carbon trade), 2) with carbon trade plus scenario 1, and 3) only carbon trade, the analysis was performed with employing bivariate and multivariate statistical test, and regression analysis.

Analysis on whether carbon trade is beneficial to the local community forest user groups suggests that carbon trading will offer good incentive under certain conditions as mentioned in scenario 2. The first condition is that there should be no restriction on using forests products which are the reliable basis for earning subsistence livelihoods to the local community. The second condition is that the community should able to sell carbon at least at $ 10 per ton CO_2. It is also evident from the study that benefits from community forests outstrip the benefits from carbon trading, so carbon trading is only additional value to local community.

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ACRONYMS

AGTB	above ground tree biomass
AGSB	above ground sampling biomass
AGM	Annual General Meeting
ANOVA	analysis of variance
ANSAB	Asia Network for Sustainable Agriculture and Bio-resources
BB	below ground biomass
BGTB	below ground tree biomass
BPP	beneficiaries pay principle
CDM	Clean Development Mechanism
CER	certified emission reduction

CF	community forest
CFM	community forest management
CFUG	community forest management
CHAL	Chitwan-Annapurna Landscape
COP	Conferences of Parties
CO_2	carbon dioxide
dbh	diameter at breast height
DFO	District Forest Office
FAO	Food and Agriculture Organization of the United Nations
FCPF	Forest Carbon Partnership Facility
FECOFUN	Federation of Community Forestry Users-Nepal
FUC	Forest User Committee
Gt C	gigaton carbon or billion tones carbon (1Gt=1 x 10^{15} g)
GHG	greenhouse gas
GON	Government of Nepal
GPS	global positioning system
ICIMOD	International Centre for Integrated Mountain Development
IPCC	Intergovernmental Panel on Climate Change
LULUF	Land use, land use change and Forestry
LHG	litter, herb and grass
MOFSC	Ministry of Forest and Soil Conservation
MRV	monitoring, reporting and verification
NGO	Non-Governmental Organization
NORAD	Norwegian Agency for International Co-operation
NTFP	non timber forest products
NRP.	Nepali Rupees (1 US$= NRP. 85)
PES	Payment for environment services
PGP	Providers Gets Principle

PPP	Polluter Pays Principle
REDD	reduced emission from deforestation and degradation
RPP	REDD+ readiness proposal
SPSS	statistical package for social science
SOC	soil organic carbon
$tCha^{-1}yr^{-1}$	ton carbon per hectare per year
$tCO_2ha^{-1}yr^{-1}$	ton carbon dioxide per hectare per year
UNFCC	United Nations Framework Convention on Climate Change
VDC	Village Development Committee
WB	World Bank
WWF	World Wide Fund for Nature (World Wildlife Fund)

CHAPTER 1

INTRODUCTION AND PROBLEM STATEMENT

1.0 Introduction

With growing controversies, the discourse on rationality and reality of climate change is surfacing. As claimed by Intergovernmental Panel on Climate Change (IPCC), warming of the climate system is unequivocal, as is now evident from observations of increase in global average air and ocean temperature, widespread melting of snow and ice and raising global average sea level. Of the 12 warmest years recorded, 11 years fall between 1995 and 2006. Green house gas emissions caused by anthropogenic activities is behind the rise in global warming (IPCC, 2007).

Some of the examples likely to be happening due to climate change are flooding, drought, wildfire, insects, ocean acidification, and freshwater, terrestrial biological systems (IPCC, 2007). So it is evident that global warming poses one of the most challenging threats to planet (Rubbelke, 2011). However, the magnitude of impact is different, for example, the Least Developed Countries, like Nepal have contributed least to the emission of green house gases, but they are the most vulnerable countries to the effects of climate change and they have the least capacity to adapt to these changes (Huq et al.2003).

Some of the anthropogenic activities identified mostly responsible for increased concentration of carbon-dioxide in the atmosphere are burning of fossil fuels, and loss of forest. Change in forested land for development purposes such as agriculture expansion, and build up area are responsible for release of carbon sequestered in the forest biomass. Despite there is a wide range of uncertainty in estimating the amount of carbon released from land use change, approximately 1.6 GtC is estimated to be released per year into atmosphere (IPCC, 2007). The latest degradation rate is alarming with a global loss of around 13 million hectares per year and is contributing significantly to emission which accounts for more than 20% global annual human caused gas emissions (FAO, 2005, IPCC Fourth Assessment Report, 2007).

The role played by forest in global carbon cycle is significant because forest absorbs carbon through photosynthesis and sequesters it as biomass, and hence create a natural storage of carbon Forests act as a carbon sink when the uptake of carbon is higher than the release, and their expansion takes place in any given area. The result is that density of trees in any given forest area increase that give rise to increase in biomass and corresponding. It has been estimated that the amount of carbon absorbed in the soil and vegetation amounts to between 0.9 and 4.3 Gt annually (FAO, 2008). IPCC (2003) estimate that 50 % of the dry weight of tree biomass is carbon whatever the tree species is.

Realizing the role of forest on reducing carbon emissions, the Bali Action Plan placed significantly reduced emissions from degradation and deforestation (REDD)[1] activities on the agenda of forthcoming climate change negotiations (Singh, 2008). The REDD idea entails the idea that developing countries which are experiencing deforestation may on a voluntarily basis receive compensation if it reduces national deforestation rate in proportion to the amount of carbon that are thus produced. The REDD is perceived as cost effective mechanism which facilitate the conservation and restoration of forests can reduce emissions at low cost with potential co-benefits for adaptation and sustainable development (IPCC, 2007).

1.2. Problem statement

Intensive research on various aspects of community forests has been done. In Nepal currently, 1.1 million hectares of forests are being managed through active involvement of 14,000 community forests users groups benefitting approximately to 1.6 million households (FECOFUN, 2011). For example, evolution of community forests (CF) in Nepal, role of CF in reducing deforestation rate, bio-diversity conservation, and livelihood enhancement through improved provisioning ecosystem services, equity and distributional aspect are studied a lot. However, the role of community forest in mitigation of climate change, and increasing resilience of vulnerable community is not fully understood owing to limited studies in this regard.

In line with the problem cited above, research on mitigation and adaptation measures implemented in field level in Nepal is limited. Very recently few research articles on adaptation with a focus on agriculture, and impact of climate change on Himalaya are appeared in the scientific journals. For example, Shrestha et al. (2011) has studied on climate change in Nepal Himalaya, and Manandhar et.al (2011) study focused on the nature and extent of the effects of climate change on rural livelihoods which varies across Nepal on rural livelihoods in accordance with its highly diverse environmental conditions.

[1] REDD stands for reduced emission from degradation and deforestation in developing countries.

As the REDD+[2] is piloting in various developing countries like Nepal, design and setting up of a governance and payment for Community Forest under this ecosystem payment mechanism is evolving and is under discussion about whether community especially marginalized members will be benefitted or not. Community forest management may be one of the most cost effective ways to reduce carbon. But there is growing skeptic that if the forest resources use by local communities is not allowed, the carbon trading will not be attractive to them owing to mere carbon will not cover the cost forgone by not having access to harvesting of forest resources (Karky et al. 2010).

Recently, carbon measurements in larger scale both state and community forests are going on in Nepal. The outcomes of the estimation of carbon stock are yet to come (FECOFUN, 2011) However, some case studies on estimation of carbon pool by various types of forests have been done so far. For example, vegetation carbon pool was found largest in Dense Sal Forest (219 Mg/ha), and least in *Schima castanopsis* forest where the figure is 36 Mg/ha. The order among the forest types was Dense Sal forest followed by degraded forest; pine mixed and lastly was *Schima castanopsis* forest (Shrestha et al. 2008). Some years back, ICIMOD (2007) conducted research in the entire Himalayan region to calculate the average sequestration rate of community managed forests. However, this study has neither estimated rate of carbon sequestration nor has calculated the direct benefits derived from forests. Explicitly, this study has not spelled out whether carbon revenue may complement to direct benefits from the community forests.

As the concept of community forest management emerged in Nepal in response to the deteriorating condition of the state controlled forests in the late 1970's (Gilmour and Fisher, 1991), there is a prospect of community forest in Nepal that can, in principle, effectively and efficiently contribute to reduce global carbon emission. The problem this thesis addresses is whether benefits taken by local community from community forests can be enhanced from the implementation of REDD+ projects or not.

[2] REDD+ is a policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries. Policy-UNFCC Decision 2/CP.13-11 (Angelsen,2009)

1.3. Aim of the research:

In the context of REDD+ implementation in community forests in Nepal, the main purpose of the thesis is to contribute to the ongoing debate on formulating community friendly REDD+ policy based on the experiences of community forestry in Nepal.

1.4. Research questions

The main research question the study seeks to answer is: are the existing REDD+ mechanisms implemented in Nepal beneficial to the local community?

This main research question is divided into specific questions as follows:

1.Do the current community management policies in Nepal favor the implementation of REDD+?

2. How much carbon does the community forests sequester?

3. What is the value of direct benefits that local communities derive from the community forests? Do these benefits vary with socio-economic characteristics of households?

4. Do socio-economic factors affect in shaping perception on climate change?

5. Will carbon trading provide a good incentive to community? What would be the cost and benefits of carbon trade in community forestry under three alternative scenarios: a) No carbon trade- status quo (scenario I) b) With carbon trade plus existing usage pattern (Scenario 2) and, c) Only carbon trade (Scenario 3).

1.5 Methodology of the study

This research depends on sources ranging from global climate change literature review to biomass estimation data collected from the ongoing project implemented by the consortium led by ICIMOD[3] in Nepal.

The empirical material is based on two case studies, one in Gorkha and other in Chitwan District. These sites were specifically selected representing both Hills and Terai region which lies in lower temperate and tropical ecological regions respectively. This allows a comparison on how two community forests located in different climatic regions are sequestering carbon. More

[3] ICIMOD stands for The International Centre for Integrated Mountain Development which is a regional intergovernmental and knowledge sharing Centre serving its eight state members comprising of Hindu-Kush Himalaya. ICIMOD is based in Kathmandu Nepal.

importantly, these sites lie in Chitwan-Annapurna Landscape (CHAL), one of the prioritized conservation landscape of Nepal Government where climate change projects on a landscape level has been implemented since 2012. Obviously, the results from the research are expected to contribute to understand more on the dynamics of carbon projects.

The reason for selecting these sites is that REDD+ program has been implemented since 2010, and data has been already generated regarding the forest biomass, carbon sequestration and CO_2 estimation. From the REDD+ prospects in Nepal, the Hills and Terai are particularly important- the Hills because of community forests that have largely reversed deforestation and forest degradation since the 1990s (Gautam, 2003), and Terai due to its high rate of deforestation (Paudel et.al, 2013). Among the forest user groups in REDD+ project, Ludidamgadhe Community Forest User Group (CFUG) in Gorkha, and Dharpani CFUG in Chitwan was selected because both are the larger forest user groups in terms of the area, and they are accessible by road. Forest user groups with larger area were taken into account for this study because they sequester more amount of carbon in comparison to smaller forests.

In Chapter 4, two case studies are analyzed keeping forest management capacity in mind. The unit of analysis is community forest user group and it forest. A detailed socio-economic survey was conducted for determining the livelihood condition of forest user group members, and their reliance on forest. Similarly, perception of forest users on to what extent and in which ways climate change has impacted on livelihoods and bio-diversity has been analyzed. For both of this analysis, household is the sampling unit, and equal numbers of 35 households were selected from each community forest following the systematic random sampling technique. One reason for taking equal number of households is that sample greater than 30 follows the normal distribution (Kitchin and Tate, 2000) and the second reason is associated with the quick and easy field logistics to administer the questionnaire in the field.

The unit of analysis used for estimation of carbon is tones of CO_2. In terms of CO_2, this research examines the rate at which carbon is sequestered from the community forests where REDD+ is implemented since 2010.

The research collects both quantitative and qualitative data. Carbon data and socio-economic data are quantitative. Qualitative data includes used, among others, include information from literature reviews and focus group discussion.

As the research question is about to examine the cost benefits analysis of carbon trading in the community forestry, effort is to set three scenarios which include forestry with no carbon trade, with carbon trade plus existing usage pattern, and with only carbon trade. Further, since the hypothesis is about comparing these three scenarios, both descriptive and inferential statistical tools are employed with using SPSS (20.0 version) software.

1.6. Significance of the study

The existing knowledge on community forestry gives information on how benefits derived from the community are distributed, how equity, gender issue are incorporated and institutionalized, and to what extent community forestry has been succeeded in reducing deforestation rate, bio-diversity conservation, and livelihood enhancement through improved provisioning ecosystem services. However, the role of community forest in mitigation of climate change, and increasing resilience of vulnerable is less understood. The research will add knowledge on in what different circumstances, how carbon trade in community forestry will be beneficial to the community. Future carbon trade will be beneficial only if the existing basic utilization conditions of forestry provisioning services are maintained, and technical knowhow of measurement of forestry is enhanced to the selected user groups.

1.7. Outline of thesis

The thesis is organized into nine chapters with sub-sections. The Table 1.1 shown below illustrates the structure of the thesis with the questions to be answered by the respective chapters.

Table 1.1 Structure of the thesis

S.N	Chapters	Questions answered
Chapter 1	Problem statement and rationale of the study	What is the problem addressed in this study?
Chapter 2	Theory and concepts used	
	Neo-liberal economic theory dealing with climate change	What is the theory dealing with efforts to mitigate climate change

	Interrelationship between payment to environment services (PES), Clean Development Mechanism (CDM), and REDD+ policy	What is the linkage between the PES, CDM and REDD+ policy
Chapter 3	Methodology	What are the methods used to answer the questions of thesis
Chapter 4	Community Forestry Development in Nepal	What is the link between community forestry development and climate change polices in Nepal?
Chapter 5	Profile of the study sites including Role of Forest , Community Forestry and REDD+ development in Nepal	Have Forest User Groups management capacity to undertake REDD+ project?
Chapter 6	Potential of community forestry in sequestering carbon	Do community forests sequester carbon?
Chapter 7	Examining nexus of socio-economic characteristics of Forest Users Groups with community forests (dependency on forests), and influence of these factors in shaping perception on climate change	How is the relationship of socio-economic characteristics of Forest Users Groups with community forests, and influence of these factors in shaping perception on climate change?
Chapter 8	Cost-benefit analysis of carbon trading (economic analysis)	Is carbon trading beneficial to the local community?
Chapter 9	Conclusions	What are the result generated from the thesis, and policy implication?

CHAPTER 2
THEORETICAL PERSPECTIVES

2.1 Introduction

This Chapter provides answers to the questions pertaining to theories underpinning climate change, and endeavors to mitigate it. It starts with the linkage between neo-liberal economic theory of market mechanisms and carbon market. The focus will be on how climate change by some is seen as market failure. Much of the literatures do however, questioning whether carbon markets and its associated market based mechanism to trade in carbon would offer a solution for combating climate change. The Chapter concludes by providing theoretical rationale for the research questions presented in Chapter 1.

2.2 Climate change as market failure

Given that green gas house emission is perceived as externalities and thus represents an example of market failure, tackling this problem need to treat climate change as public good (Stern, 2003). Market failure refers to a market in which some elements of a free and competitive market are missing. There are three characteristics of market failure which include 1) externalities 2) non-excludability 3) open access resources (Ellis, 1996).

Externalities are the condition in which gain or losses associated with the product borne by the people who did not sell or buy the product. Climate change is a global phenomenon in which least developed countries like Nepal which has negligible contribution to global warming is severely affected (Huq et al.2003). Climate change has a trait of non-excludability because the whole world is affected by the impact of climate change, but the cost is not borne by the polluters. Global climate is public goods because private cost of using or polluting is lower than the social cost incurred by the community, and benefits and costs cannot be confined to single consumers.

2.3 The development of carbon markets and REDD+

2.3.1 Background

Governments usually use two types of policy instruments sometimes separately and sometimes in combination while dealing with environmental problem (Pearson, 2000)**.** These include regulatory instruments (command and control), and market instruments.

Command and control approach focus on the ban, and prohibitions which are directed by the government. There is no room expect either to comply or to be ready to be punished. Fortress conservation model and polluter pay model are some of the examples of regulatory approach.

As the name imply a market approach depend on policies that include tax, tradable permit, tax rebates, and fine which are based on market incentive directed by the market. In market based approach, polluter have options to choose the own abatement cost.

Where market are efficient and structure is in place, market based approach would be a efficient way to meet the goals, whereas regulatory framework would be cost effective where market is absent and government's structure are either weak or virtually absent to support the market.

So as to tackle the problem of market failure in climate change, developed countries came up with the ideas of cap and trade mechanism as a market instruments which as the name imply insists on combating climate change by regulating emission by setting cap, and then forming market. The idea of cap and trade mechanism led by Kyoto protocol was established as a binding commitment by the parties to the UNFCC in December 1997. Setting legally binding emission targets for the industrialized countries and also allowing markets for carbons is the key features of Kyoto protocol (UNFCC, 2003). In this way, Kyoto protocol heralded the new horizon in climate change discourse by opening the market for carbon in one hand, and trading carbon credit in other based on new liberal economic approach.

2.3.2 Development of the carbon markets

Caron trading and other market based payment mechanism originated from the concept of payment for environmental services (Hacken et al; 2010). Payment for environmental services initiatives aim to address market failure whereby the economic value provided by the ecosystem services are not captured by those who provide these services and who consequently lack incentive to conserve these resources (Engel et. al.2008). The explicit focus on externalities results in a shift from the commonly applied "Polluter Pays Principle' (PPP) to a 'Beneficiary Pays Principle' (BPP) or Providers Gets Principle' (PGP) (Pagiola et al., 2002 cited in Hacken et al; 2010). In this way, the core principle of payment to environmental service is positive externalities which purpose, for instance that farmers should be regarded not as 'polluters' or ‘destroyers’ of the environment, but rather as the potential environment services providers (Gauvin et al. 2010, Hacken et al; 2010).

Market based solutions are designed to reduce the negative externalities inherited in public goods in one hand, and setting compensation scheme through market in other. There are three types of payment mechanism in forestry sector which includes transfer payment approach, property right approach and market based approach (Richards, 2000). Of the three payment approach, Clean Development Mechanism (CDM) of the Kyoto protocol falls in the market based approach.

By creating carbon markets in the form of Certified Emission Reduction (CER) credits under the CDM, private sector investments can be directed towards climate friendly projects (Yamin et al, 2004). CDM also serves as a bridge between industrialized and non industrialized countries through transfer of clean technology, knowledge and experience exchange, and more importantly derive payments from CER (Karky,2006).

Despite the certified emission rate (CER) is included in clean development mechanism that fulfill Kyoto protocol commitment, community forestry management was never included in CDM because leakage from the avoided deforestation was considered to be a significant hazard and difficult to estimate and monitor (Schlamadinger et al;20007). Currently, only afforestation and reforestation are included in the CDM giving permits to large scale monoculture plantations that ignore bio-diversity conservation and sustainable management.

REDD+: evolution

The explicit inclusion of forest related activities particularly deforestation within United Nations Framework on Convention on Climate Change (UNFCC) has been continuously evolving. In this context, RED -with one D came into existence at COP 11 in 2005 at Cancun in Mexico. Thus the REDD came into being REDD when parties particularly Paua New Guinea and Costa Rica were invited to submit their views on issues relating to reducing emissions from deforestation in developing countries (UNFCC, 2005).

Later, UNFCC’s Subsidiary Body for Scientific and Technical Advice was asked to report at its meeting in December 2007 at COP13 in Bali, Indonesia. Accordingly, after serious of consultations and meeting, contentious issues like leakage, permanence, additionality and reference levels, monitoring, reporting and verifications were addressed (Angelsen et al., 2012).

At COP-13 in 2007, REDD+, the forest degradation-the second D was included in the UNFCC definition of REDD+.

In the Copenhagen Accord of 2009, The REDD+ was again recognized for the crucial role of forest in global mitigation efforts. The following year in Cancun (2010), the detailed REDD+ decision was agreed upon setting out to encourage developing countries to contribute to mitigation by accommodating different interests including reducing emission from deforestation and forest degradation: 1) conservation, to accommodate the interests of high forest, low deforestation countries and environmental NGOs 2) sustainable management of forests, to accommodate the interests of countries with an active forest use approach; and 3) enhancement of forest carbon stocks , to accommodate the interests of countries with growing forest stocks such as India and China (Angelsen et al;2012).

Linkage between REDD +, and PES

Sustainable management practices of forestry have been recognized in REDD+. The basic characteristics of REDD+ offers a financial incentive such that forest conservation is to become more profitable than forest degradation. The financial incentive mechanism is rooted in the principle of payment of environmental services because carbon sequestration and storage are public goods provided by forests and forest owners. Through a PES system, forests users (owners) can make more money for conserving their forest. There is currently no market mechanism like CDM to purchase the carbon credit however, voluntary markets are available in a market where companies and individuals can buy credits as corporate social responsibilities rather than the purpose of meeting the Kyoto targets. As the volunteer markets are not legally binding mechanism, effectiveness of such volunteer market is questionable (Taiyab, 2006).

REDD+ as a cheap and quick way to reduce carbon emission

REDD+ was fully integrated into the global climate change agenda at COP 13 in 2007. Angelsen (2012) has pointed that REDD+ is regarded as one of the most effective and efficient mitigation strategies available today because from donors to implementing countries have been motivated and committed to making the REDD+ successful.

Reduced Emission from Deforestation and Degradation (REDD)+ is expected to be a viable mechanism that will provide compensation for tropical forest nations to reduce deforestation, and potentiality also co-benefits for rural communities and bio-diversity (Collin et al.2011). Further, the launch of a REDD scheme by the UN Framework Convention on Climate Change provides a new incentive to improve global forest monitoring (Grainger et al; 2011).

According to Stern report (2003), the cost involved in eliminating deforestation is only US $ 1-2 per tCO2 on average which is very cheap compared to other options available. Considering REDD+ as easy and could be done quickly, it is more attractive to a range of stakeholders.

REDD+ and Community Forests

Through REDD+, understanding the relationship between various decentralized models for community or collaborative management and forest conservation outcomes has taken on renewed importance in the context of community involvement in forest conservation efforts (Hayes, 2010).

Over the past few decades of evolution of conservation polices beyond the traditional publicly managed protected area model has given rise to a range of governance regimes and new institutional arrangement. Under this new circumstance, governments have implemented decentralization policies which allow transferring forest management responsibilities from state to local actors and institutions, but the model is contextual therefore vary in the participation of community in forest management where co-management between government and local users exists (Agrawal et al.2008).

Further, Agrawal et. al (2009) argue that REDD+ outcomes can be enhanced by selecting existing and new community forest management sites with a stable technological and policy environment, low level of inter group conflict, and small and medium sized, and forest dependent user groups that have management experience

Various institutional factors such as land tenure, rule making authority, and rule enforcement process, and distribution of benefits among different actors have promoted dual goals of forest management which includes forest conservation and securing local livelihoods (Hayes, 2010).

Recognition of community forestry role in REDD+ is of particularly importance to Nepal because more than 13000 forests users groups are actively managing the forests since 1990 when the government decided to decentralize the forest policy to stop the forest from further degradation and deterioration.

REDD+, local people and indigenous community (benefits sharing mechanism, and land tenure)

Access to forests and the distribution of tenure right over carbon is critical for benefit sharing in REDD+ mechanism (Agrawal et.al, 2011). Angelsen et.al (2012) pointed out two main discourses on benefit sharing. The first discourse is associated with effectiveness and efficiency discourse, and emphasizes that benefits should be used as an incentive and distributed to communities who contribute to reduction of carbon emission through changing behavior or changing their action. The second discourse is more equity based, and focuses on the question of which actors have right to benefits from REDD+. In equity based benefit sharing approach, there are four main strands (Angelsen, 2012):

1. Benefits should go to actors with legal right (either customary or statutory)
2. Benefits should go to low carbon forest stewards (reward for sustainable forest management leading to reduce carbon emission)
3. Benefits should go to those incurring costs (implementation, transaction and opportunity cost)
4. Benefits should go to effective implementers (both private and public)

Of the four strands, benefits related to legal right holders are associated with land tenure which is important in REDD+ mechanism benefits sharing discourse. For example, in the context of REDD+ implementation in Nepal, local communities are only entitled to protect and manage the forests with no legal right to forest land as per the forest law (1993). However, the issue of property right over forest land and carbon has surfaced. As community forests in Nepal was developed in response partly to increased forest destruction and deforestation, the dilemma over tenure insecurity may foster frustration on local people and indigenous people who love and care forests since time immoral. In this regard, the comment made by Angelsen (2012) on potential risk of REDD+ is relevant. According to Angelsen (2012), land grabbing by outsiders and loss of local user rights to forests and forest land is one of the main reasons that many indigenous and local peoples have publicly threatened to oppose REDD+ under the banner 'No rights, no REDD+'

The problems of 'Doing REDD+': setting baseline, measurement, reporting and verification

There are some critical issues in the implementation of REDD+ in project level especially in accurate and transparent estimation of guesthouse (GHG) emission from deforestation and forest degradation and carbon stock enhancement (Estrada et.al,2012).

The baseline for REDD+ project is the scenario to measure anthropogenic changes in carbon stocks in pools and emissions of GHGs that would occur in the absence of REDD+ project. Baselines or reference levels refer to both business –as- usual scenario, a prediction about what would happen without any REDD+ action, and a crediting baseline for rewarding a carbon rights holder (Angelsen, 2009). Also, this baseline should incorporate predictions on land use/land cover, and must be reassessed and revalidated every ten years (Estrada et.al, 2012). Establishing baseline is constrained by lack of capacities and availability of data against internationally recognized standards and methods.

There are some ways to overcome constraints pertaining to carbon measurement, monitoring and verification. One way to overcome the inability to monitor carbon can be through introducing low cost carbon monitoring technology such remote sensing technology (Agrawal et. al, 2011). Other way to overcome the monitoring and reporting problems would be to entrusting forest inventory work to local community through providing them training on mapping and inventorying forests (Herold et.al, 2009).

2.4 Critique on climate change and deforestation from political ecology perspective

According to Adger et.al (2001), there are two main discourses on climate change and deforestation. One is what can be termed as managerial discourse, and the second one is a populist discourse. The managerial discourse elicits institutional failure and population growth as a cause of climate change, and call for international action to act upon it. Being technocratic in principle, managerial discourse draws its authority from science and portray climate change is scientific certainty. The solutions this discourse offers is through relying on technology advancement to redefine the understanding of climate change science, get the price of carbon, and open carbon market.

The populist discourse (profligacy) insist that over consumption is the root cause of climate change, and suggest that only addressing this issue will solve the climate change problems. It put the blame on capitalism as it promotes over consumption that lead to exploitation of resources in the south by the North through technology intervention and neo-liberal economy policies.

However, Adger et.al (2001) observes that vulnerability and adaptability have little place in both discourses both of which portray society as fragile disempowered and helplessness resource dependent communities in the wake of global climate change. Both discourses are relevant to this study because climate change has a profound impact in Nepal despite the fact that she has very negligible contribution to climate change in the global scale.

Similarly, new-Malthusian and managerial discourse portrays deforestation as spiral of over population and consumption as inevitably leading to forest cover loss. The populist discourse recognize deforestation but present small farmers and land managers not as a active agent of change rather as victims because they have no other choice other than to involve in destruction to earn the livelihood. Multinational companies of the developed countries are the real villain of deforestation. These discourses are quite relevant to REDD+ because it contains elements of both the new Malthusian and managerial discourse and populist discourse. It has been observed that developed countries are pouring money in developing countries in an attempt to avoid deforestation, but it also has implication in the ground because local communities have to depend on cash received from donor agencies to undertake day to day forest management activities.

2.5 Critique on market based approach to tackle climate change

Though market based approach is claimed to be designed to tackle climate change problems, there are critiques to this approach which claim that benefits may not prevail as it is intended to have so.

The arguments are that neo-liberal economic principles often work against the interests of marginalized, and in favor of the elites and more powerful. Further, unfettered market (laissez-faire) that means transferring management of resources to the profit making private sector which gives rise to cut in public funding in natural resource management. The resultant effect is that forest dependent communities would face more vulnerable conditions than before. Liverman and Vilas (2006) argue that the environment is best be regulated by the state as markets do not place a high social value for the environment. In a subsistence based agrarian society like Nepal, where community managed forests have more social value, so monetary value derived from carbon credit may not reflect the true value of forest resources.

Leftist theorists criticize the market based approach on the ground that neo liberal economy is an another form of imperialism where resource are allocated property rights, then commodified and then exported to accumulate capital by the powerful nations (Liverman and Vilas ,2006). Accordingly, there is possibility that most pollution emitter industrialized countries may utilize carbon trade as securing their vested interest such that cheap pollution permits could be acquired from the developing countries.

Person (2000) has criticized that the carbon market is not free as carbon market was created through substantive negotiations based on cap and trade. That means carbon market is not free but is regulated by quotas. With regard to Nepal, how many quotas will be available for carbon credit is really a big question.

2.6 Summary

Despite the critiques on market based approach to mitigate climate change, neo liberal economic approach to correcting market failure and permitting markets to take control of regulating emissions have emerged as important innovative approach. In the context of Nepal, following the failure of state’s fortress conservation, responsibilities of managing state owned forests were transferred to local communities in Nepal in an attempt to reduce the cost of forest protection and management. Now the pertinent question is whether these forest user groups would get a dividend of the carbon market for their efforts managing and conserving the forests given the unresolved property right over forest and carbon pertaining to REDD+ mechanism.

CHAPTER 3
METHODOLOGY

3.1 Introduction

The chapter describes the methodological approach of my study. Research methodology is the general approach the research takes in carrying out the research project (Leedy and Ormrod, 2001). Kitchen and Tate (2000) are of the view that methodology is a coherent set of rules and procedures, which can be used to investigate a phenomenon or situation. According to Creswell (2003), methodology is more than dealing with what types of methods and strategies are employed for data collection and analyzing to reach inference, it also about theories and philosophies that position the research project. So methodology is not just a matter of practicalities and techniques, it is a matter of harmonizing and marrying up theory with practices (Shurmer-Smith, 2001). The selection of research design is based on the nature of the research problems or issues being addressed, the researcher's personal experience, and the audiences for the study (Creswell, 2003).

Primarily, this research project is based on mixed methods with incorporating both quantitative and qualitative methods where it is necessary. The rationale behind choosing the mixed methods is discussed in sub headings of this chapter.

This methodology part deals with the whole gamut of the research cycle with providing the answers to questions like why quantitative research method employed, how the entire research is designed, where it is being undertaken (research site), how the data were collected (sampling), and in what manner data are analyzed. Both descriptive and inferential statistics are used while analyzing the data. Also, this section provides the questions like what are variables and their relationships to each others.

3.2 Mixed methods and methodological justification

Mixed methods research is an approach to inquiry that combines or associates both qualitative and quantitative forms. Thus, it is more than simply collecting and analyzing both kinds of data so that the overall strength of a study is greater than either qualitative or quantitative research (Creswell, 2003). Mixed methods research resides in the middle of the continuum because it incorporates elements of both qualitative and quantitative approaches, and holds a pragmatic worldview (ibid). Of the mixed methods, sequential mixed methods procedures is of relevant to this study because this mixed method begins with a quantitative method in which theory or concept is tested, followed by a qualitative method involving detailed exploration with a few cases or individuals.

Based on the principles of mixed methods, this research collects both quantitative and qualitative data. Carbon data and socio-economic data are quantitative which were collected from secondary and primary sources respectively. Both open ended and closed ended questions were asked to the respondents. Qualitative data includes used in this research, among others, include a literature review and focus group discussion, and interview with key informants.

3.3. Research Design

Research designs are plans and procedures for research that span the decisions from broad assumptions to detailed methods of data collection and analysis (Creswell, 2003). The study incorporates both bio-physical and socio-economic data. Accordingly, the project used, firstly, the quantitative method which, for this research purpose, involves quantification of both direct benefits and carbon stock from the community forests. Household survey with administering semi structured questionnaire employed for estimation of directs benefits from the forest. Further, using carbon estimation data of base year from the REDD+ pilot project in Nepal served as secondary source to compare to what extent carbon stock has been changed in the subsequent years. Lastly, focus group discussion, and interview with key informants was taken in the field to know perception and attitude on climate change impact on livelihoods and bio-diversity.

The source of information and the corresponding survey tools employed to gather them is presented in Table 3.1. Multiple tools and methods were employed to check and verify the information collected from the different sources as per the need and field level conditions.

The questionnaire was prepared in English language, and it was, later, translated into Nepali Language. For administering the questionnaire this translated one was given to enumerators to undertake in the field. However,, household survey was not enough in collecting information regarding plans, policy and program, rule and regulation, and provisions of the government.

Structure conversation was fruitful as it helped to fill the information gap not filled by mere questionnaire. Similarly, qualitative information was collected by employing methods like RRA, formal and informal group discussions. It was the professional judgment of researchers to fill the gap of information whether it felt the need.

Table 3.1 Survey and tools for data and information collection

Tools	Sources						
	Households		Others				
	Gorkha	Chitwan	ICIMOD	ANSAB	FECOFUN	WWF	REDD cell
Survey questionnaire	√	√					
Structured conversation			√	√	√	√	√
P/RRA	√	√					
Group Discussion/KI	√	√			√		
Professional consultation			√	√	√	√	√
Observation	√	√					
Carbon data collection (secondary)	√	√	√	√			
Publication /statistics			√	√	√	√	√

3.3.1 Household survey

Information about quantities of forest products obtained from the community forestry was collected with employing semi- structured questionnaire survey. The survey team consisted of principal investigator, and two assistants who helped to administer the questionnaire survey. The research team based in community forests selected for the study. To fulfill the normal standard, at least sample size of 35 households from each Community Forests was selected to fulfill the research objectives.

Besides household survey, information was collected from focus group discussion and key informants available in the two forest user groups.

Determination of the Sample Size

Selection of sample size has tremendous effect on the outcomes of the study. Moreover, the demographic and location features of the study site in one hand, and the confidence level and margin of error of findings largely determine the sample size. Smaller samples are adequate for homogenous population, whether heterogeneous population demands larger sample sizes. The study was undertaken in two community forests representing two ecological zones of Nepal.

Multistage –area-sample design was employed using two stages to select households. In first stage, sample CFUGs was selected purposively. For this study purpose, relatively larger community forests in terms of size were selected in both sites. The second stage involved selection of households in each site following the systematic sampling method. As forest users' constitution has enlisted already the number of forest users, it served as sampling frame. Since extra questionnaire and sample size often required reducing response bias, an additional of 10% reserve samples was considered to reduce response bias. Exactly the equal number of 35 households was selected from each community forests. One reason for taking equal number of households is that sample greater than 30 follows normal distribution (Kitchin and Tate, 2000). Second reason is associated with the quick and easy field logistics to administer the questionnaire in the field. The Table 7.1 presents on the number of households in study areas.

Table 3.2 Number of sampling households

District Name	Ecological region	Selected CFUGs	Total HHs	Sample Number of HHs	Percentage HH sampled	Actual surveyed HHs
Chitwan	Sub-tropical	Dharpani	111	35	31	35
Gorkha	Lower temperate	Ludidamgadhe	522	35	7	35
Total			601	70	-	70

(Source: Field Survey, 2012)

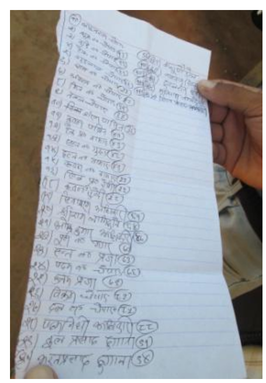


Photo 3.1 : List of HHs selected for HH survey in Dharpani CF

According to the principle of systematic random sampling, after deciding the sample size 35, interval was identified by dividing the sampling frame by sample size. After doing this, an integer was selected randomly between 1 and interval number, and lastly, the selection of every interval numbers was made in such a way that total selected numbers sum the sample size. However, in practical term when the interval is in decimal some rigorous procedure was employed. For example, from the total 111 HHs in Darpani Community Forest as shown in Table 7.1, we needed 35 HH for survey. Following the principle of systematic random sample, firstly we decided the interval number. The interval number was identified by dividing total households by required sample households (111/35). The resultant fraction was 3.17 (111/35). As the fraction owe decimals so it has two interval numbers; one is 3 and another is 4. As 0.17 is added for 6 times it comes to nearly 1, this means we used interval number 3 six times until the decimal comes to one. After identifying interval number, firstly an integer was selected randomly between 1 and 4. In

Dharpani CF, the first household was No 3 households as per the forest users name list enlisted in forest constitution. Following the same simple random sampling procedure 35 households were selected in Ludidamgadhe CF in Gorkha.

Forest biomass and carbon stock estimation

In natural science, forest biomass estimation is required to calculate the content of carbon stock and carbon sequestration rate. The secondary data on this aspect were collected from the ongoing project on REDD+. The REDD+ project has employed two category of methodology for biomass estimation: one methodology for forest inventory and other are carbon and CO_2 estimation. A brief description on each methodology is given below:

3.3.2 Methodology for forest inventory

As this research takes the result using the measurement guideline (ANSAB[4], 2011) into consideration adopted by ICIMOD and its consortium, details include briefly on how forest inventory was conducted to estimate the forest carbon.

REDD+ project has used the methodology for estimating biomass and carbon stock in the forest in accordance to the standard set by IPCC (2003) for LULUCF sector. Accordingly, the project has adopted the steps applied in the estimation process derived from the protocol developed by MacDicken (1997). The steps identified were: 1) boundary mapping, 2) survey for variance estimation and sample plot size, 3) calculating optimal sample intensity and, laying out of permanent plots.

1. Boundary mapping: The REDD+ project undertook spatial boundary mapping with using GPS set to mark co-ordinates with support from local enumerators. GPS points were used for geo-referencing. Moreover, satellite image and GPS Map (GPS map 60CS, Garmin) were used for verification.

2. Survey for variance estimation and sample plot size

After stratifying the forest based on forest types, dominant species, altitude, site quality ,age and aspect, pilot inventory was done to estimate the variance of the carbon stock in each startum ,and

[4] ANSAB stands for Asia Network for Sustainable Agriculture and Bio-resources was established in 1992, and headquarter in Kathmandu. ANSAB is a civil society organization works in South Asia with committed to bio-diversity conservation and economic development through community based enterprise oriented solutions.

to provide a basis for calculating the number of permanent plots. Accordingly, the REDD+ project is using stratified sampling methodologies with adequate representation of forest types. Circular sample plots were used in the project owing to relatively more easy to establish in the forests. The radius of each plot is 8.92 m for moderately dense vegetation. Several subplots are established within each plot with radius of subplot is 5.64 m for samplings. A subplot with a 1m radius are established for counting regeneration whereas a subplot with 0.56 m radius is established for sampling leaf litter, herbs, grass and soil.

3. Calculating optimal sample intensity and establishment of permanent plots

The numbers of permanent sample plots required for above ground biomass estimation are an important step in forest inventory. The numbers of permanent plots dependents on the size and types of forest stratum. For the research purpose, the Dharpani community forests of Chitwan district and Ludidamgade community forest of Gorkha comprised of 15 and 23 permanent plots respectively. The number of permanent plots was determined based on the area of entire watershed.

Table 3.3 Description of the study sites

District Name	Ecological region	Selected CFUGs	Area of forest (ha.)	Total number of permanent plots
Chitwan	Sub-tropical	Dharpani	172	15
Gorkha	Lower temperate	Ludidamgadhe	241	23

(Source: forest user constitution, and REDD+ project unit)

4. Methodology for carbon and Co_2 estimation

For the estimation of carbon pool in forests, data generated on above ground tree biomass (AGTB), above ground sampling biomass (AGSB), leaf litter, herb, and grass (LHG) biomass, soil organic carbon (SOC), and below ground biomass (BB) by REDD+ project was utilized for this research purpose to estimate the carbon and CO2. Chapter 5 gives details on how carbon measurement was carried out and in what ways carbon data has been analyzed and the outcomes of the analysis.

3.4 Analysis on Socio-economic condition, benefits from forests, cost incurred in getting forest products and carbon, and perception of climate change

So as to test the hypotheses, this research has to depend on scores of sources ranging from global climate change literature review to biomass estimation data collected from the ongoing project implemented by the consortium led by ICIMOD in Nepal. Moreover, in the study, two case studies are analyzed keeping forest management capacity in mind. The unit of analysis is community forest user group and the forest they are managing and conserving. A detailed socio-economic survey was conducted for determining the livelihood condition of forest user group members, and their reliance on forest. Similarly, perception of forest users on to what extent and in which ways climate change has impacted on livelihoods and bio-diversity has been analyzed. For both of this analysis, household is the sampling unit, and an equal number of 35 households was selected from each community forest following the systematic random sampling technique.

The data analysis was done using the SPSS computer software package (20.0). The excel program was used wherever necessary. The data were of two types, a set of secondary data drawn from available statistics at the local and national level, and a set of primary data collection in the field. The primary data were analyzed by categorizing the respondents into different groups. Specific tools like descriptive statistics cross tabulation, ranking, scaling and inferential statistics using particular tests for description, diagnosis and analysis has been employed. Descriptive statistics particularly maximum and minimum distribution, mean, standard deviation, frequencies, indices were computed as per the requirements.

Appropriate statistical tests (univariate and bivariate-t-test, F-test, X^2 –test) were used to test the relationships between the dependent and independent variables. Linear relationships between variables were determined by using correlation coefficients. Analysis of Variance (ANOVA) was used to determine differences in mean scores as necessary. Among the techniques of multivariate analysis, multiple regression analysis and logistic regression, analysis was used when and as needed.

Construction of indexes was an important technique for the analysis of field data and particularly, in order to make the comparison among different groups, and between genders and types of community activities indexing was done. Some data sets were qualitative in nature and this necessitates transformation of attributes through aggregation and quantification by weighing, scoring and computing index values.

All direct benefits derived from the community forests have been estimated. For this research purpose, operational definition of direct benefits categorically include firewood, timber, grass, litter, NTFPs, and carbon stock and sequestration rate as well. As this research question demand economic valuation of the direct benefits, it has been done accordingly. The unit of analysis for this question is households.

As the research question is about to examine the cost, benefits analysis of carbon trading in the community forestry, effort has been, of course, to set three scenarios which include forestry with no carbon trade, and with carbon trade plus existing usage pattern, and with only carbon trade. As the hypothesis is about comparing these three scenarios, both descriptive (including Chi square test) and inferential statistical tools (means comparison) will be employed with using SPSS (19.0 version) software.

3.4.1 Logistic regression analysis to predict perception of forest users

So far as measuring the perception of the local community on climate change and REDD+ program, logistic regression will be used owing to the dichotomous variables. The research is attributed to causal type of study of which involves the finding out the pattern and the strength of the relationships between dependent and independent variables. For empirical analysis, more than 10 separate binary variables as dependent variables, and 7 independent variables has been taken into account.

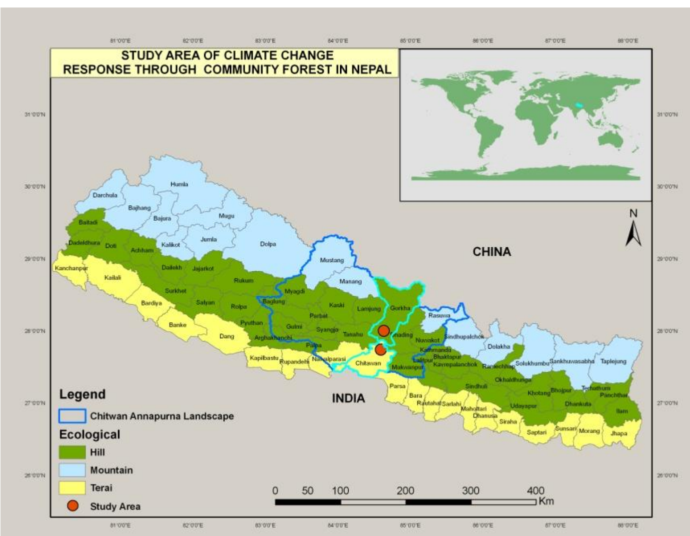
The Chapter 7 gives details on how both types of variables (dependent and independent) were employed in logistic regression equation for analyzing the perceptions of forest users groups on climate change and REDD+ program implemented in field sites.

3.5. Study sites

The two cases studies presented in this thesis were specifically selected representing both Hill and Terai region which lies in lower temperate and tropical ecological regions respectively. The reason for selecting these sites is that REDD+ program is being implemented since 2010, and data has been already generated regarding the forest biomass, carbon sequestration. More importantly, these sites lie in Chitwan-Annapuran Landscape (CHAL), one of the prioritized conservation landscape of Nepal Government where climate change projects on a landscape level has been implemented since 2012. Obviously, the results from the research are expected to contribute to understand more on the dynamics of carbon projects.

The site was in Gorkha and Chitwan District representing the tropical (lowland) and temperate (mid-hills) regions to compare results on how two community forests located in different climatic regions are responding to impact of climate change.

Gorkha district of Western Development Region of Nepal where REDD+ project is implemented since 2010. Ludi damgade community forest is one of the biggest community forests lying in Ludikhola watershed region, and is chosen purposively for this research. Situated at 1100 msl, the forest is expanded to 241 hectare with subtropical Sal (*Shorea robusta*) as dominant trees. With nearly 522 households is getting benefitting from the forests. The community forest is characterized by social diversity with various Indo-Aryan and Tibeto-Burman ethnic groups (Magar, Gurung, Tamang, Dalit, Bhramin and Chhetri) reside there.



Map 1: map of study site

The next site was Chitwan district of Central Development Region of Nepal where REDD+ project is implemented since 2010. Dharpani CFUG with an area of 90 ha is the other site selected purposively for this research. This forest provides services to 111 households with inhabitants from Tiebto Burman and Indo-Aryan Background living together.

The proposed fieldwork was undertaken in the REDD+ project sites. As the study is 'with' and 'without' carbon valuation, so study has focused on intra community forests dynamics. It is assumed, for estimation, that socio-cultural and biophysical condition of these two study sites is homogeneous.

The field work was carried out in autumn. As the monsoon begin in early June in Nepal, the fieldwork was carried out after monsoon in the months between November and December to avoid the rain in data collection. The detail profile of the study site is described in Chapter 5.

3.6 Issues from the field:

3.6.1 My position on research

On research position in this research, as a researcher my role was neutral when administering the questionnaire. I asked the only questions that were in questionnaire. However, to be a neutral while taking part in discussion or facilitating the forum is not value free. Fraser et. al (2009) argued that it is important to build friendship, as it establishes a rapport between the researcher and target groups. While interacting and facilitating the focus group discussion, the focus was to get more information from the vulnerable and poor forest user groups, so sustaining neutrality was not possible in this respect. Moreover, as a student of natural resource management, this topic was chosen to contribute to the field of natural resource management primarily in mitigating the source of climate change. Also from the societal perspective, it is imperative to know that to what extend poor and vulnerable communities perceive climate change variability, what their perceptions are, and how household characteristics shape the perception was the core thrust of this study.

3.6.2 Ethics and reflexibility

According to Fraser et. al (2009), ethical considerations in research are of importance in two ways ; it guides the researcher against any form of abuse of rights of the participants, and also protect informants. On the ethical part, in this research, informal and formal consent, anonymity of respondent (privacy) and confidentiality of information were considered.

Before approaching the community and its members, I took permission from the local authority, and consent from the community user groups as well. Also, I clarified to the community that the researcher is a student, and the sole purpose is to collect data for his own purpose. So, it has nothing to do with any project that helps them later. On top of that, I assured them that research will not harm them by any means.

Critical introspection on the process of collecting data is important. For example, if the randomly selected household owner become absent while administering the survey then what to do in this regard. Similarly, how to approach respondents primarily to women is important in a rural setting. The continuous reflection on what is going on not only on the survey, but also on behaving with the respondents is important. However, it is the beauty of quantitative research that there is little flexibility in adjusting in the research process.

3.6.3 Dealing with validity and reliability of data, completeness, representative samples / cases, generalization

Kitchin and Tate (2000) argued that a good research finding depends entirely on ensuring its validity and reliability of the collected data. To them validity "Concerns the soundness, legitimacy and relevance of a research theory and its investigation or practice (Kitchin and Tate, 2000 p.34). For this research purpose, validity is about measuring what we think we need to do so. If the research tools and techniques measure the things in line with research objectives and hypothesis, then it is called validity. Precisely speaking, both internal and external validity has real meaning and carries weight in this research. Based on the measurement, causal relationship has been established, and conclusion has been drawn from this study. So, internal validity is relevant in this research with controlling the condition. Similarly, the result stemmed from the study can be held to be true in for other cases, other people and setting so external validity will be in place in this research. The statistical tools and techniques to be used in sample forest in this research represent the population (whole forest) and thus have more possibility to generalize as told in external validity.

Reliability is concern with the consistency of research finding as to whether a research finding is to be trusted (Kitchen and Tate, 2000). The consistency is related with reliability which is about reproducing the consistent result with employing same tools in the same setting. For this research purpose, the sample size of 35 households is sufficient for this study purpose to be in normal distribution. Altogether 70 households have been used as sample from two sites. As a rule of thumb, the larger the sample size, the higher the consistency.

3.6.4 Relevance and quality of data, and limitations

Estimation of carbon from involve measurement of biomass from the forest, and has been done based on the data available from one going Reduced Emission from Deforestation and

Degradation Project (REDD+). Using raw data available from the project is relevant for this study project as to measurement of all trees in the sample plots by a single research is neither practicable nor feasible. So dependency on the secondary source is the limitation of this study. However, household's survey, focus group discussion provided ample opportunity to collect information pertaining to direct provisioning services and perception on climate change. Randomly sampled households served as a unit of analysis for this study, so these methods are useful and relevant for the study. In this context, it is quite important to avoid the peak season in which community members are heavily engaged in agriculture activities.

The study is broad based and demand much time and budget. In Nepal, recently, REDD+ program is implemented for the last two year, so the data generated from the REDD+ pilot program which has been used for this research. With support from NORAD, ICIMOD is implementing REDD+ project in Nepal since 2009, data sharing with ICIMOD and its implementation partner- Asia Network for Sustainable Agriculture and Bio-resource (ANSAB) has been crucial to the study.

One of the limitations in relation to data employed in this study is that carbon data were used collected from ANSAB. Despite the fact that carbon data was collected since 2011, this study accounted data from 2011 and 2012 because only disaggregates carbon data for this period was available to compare the data between the years. The carbon storage result in different pools presented in this thesis is based on the disaggregate carbon data (in Annex I) available to me but not in aggregate carbon storage results presented by ICIMOD and ANSAB. That is to say that there is different in carbon storage results in different pools analyzed by these studies, and carbon results available by ANSAB, and ICIMOD.

CHAPTER 4

COMMUNITY FORESTRY DEVELOPMENT IN NEPAL, AND ITS LINK TO CLIMATE CHANGE POLICIES WITH REFERENCE TO REDD+ INITIATIVE IN NEPAL

4.0 Introduction

Objective of this chapter is to answer the research question to what extent community forestry is relevant to responding climate change. Before moving on specific research questions in subsequent chapters, it is imperative to get know the linkage between the Community Forestry Management (CFM) paradigm, and climate changes policies, this chapter begins with the brief history of emergence of community forestry in Nepal, and later on the REDD+ development context with particular reference to climate change policies formulation and implementation in Nepal.

4.1 Community forestry evolution in Nepal in response to deforestation and degradation

Gilmour (1991) argue that the concept of community forestry emerged in response partly to the failure of the forest industries development model to lead to the socio-economic development, and partly to the increasing rate of deforestation and forest degradation in the Third World. Community forestry in Nepal has always existed, and it is a very old one-another case of old wine in a new bottle because communities have always interacted with their local environment since time immemorial. What is new is the formalizing of CFM by mainstreaming it into the national forestry policy (Karki, 2008). Both internal socio-political change and external factors are responsible for triggering the development of community forestry in Nepal.

4.2.1Internal factors

History of national forestry policy is embedded into subsequent changes in the political systems particularly started after the autocratic Rana Regime fell in 1950. Around the 50’s land reform policy went sea change. One of the results of this reform was to the promulgation of nationalization of private land policy which followed by rapid deforestation as forest users felt insecurity over the forests ownership they were managing and utilizing. Gilmour (1991) argued that community forestry flourished in Nepal when the nation exercised the multiparty democracy even if it lived shortly. In Partyless Panchayat system through which king ruled Nepal from 1960-1990, local community were helpless to manage the forests because it was necessary to get permission from the Panchayat system to exercise any kind of community level political activities like getting membership, originating assembly. However, the seed of community forestry was shown in this period seeing the alarming rate of deforestation in the country. The table below provides the glimpse of forest area changed since the first statistics were held in 1964.

Table 4.1 Forest and shrub land in Nepal

Report	Year	Forest land		Shrub land		Total	
		ha	%	ha	%	ha	%
Forest Statistics for the Terai and adjoining Regions (FSRO 1967)	1964	64022000	45.5	-	-	64022000	45.5
Land Resource Mapping Project: Summary Report (LRMP 1986)	1978-9	56160000	38.1	6892000	4.7	62852000	42.8
Master Plan for the Forestry Sector, Nepal (HMG/N 1989)	1985-6	54240000	37.4	7062000	4.8	62102000	42.2
1999 Forest Resources of Nepal (DFRS 1999)	1999	42680000	29.0	15602000	10.6	58282000	39.6

(Source: Poudel et. al (2013)

Forest inventories reveal that forest cover shrank over the last four decades. The latest national forest inventory found that during 1978-1994, annual deforestation was 1.7 percent (DFRS, 1999). One observation emerging from these inventories is that there is fairly a straight link between decreased forest area and increased shrub land area. For example, while there appear to be a gradual decrease in forest during 1979-1994, there is a steady increase in shrub land areas during the same period. This trend indicates both deforestation and degradation are happening in an opposite direction.

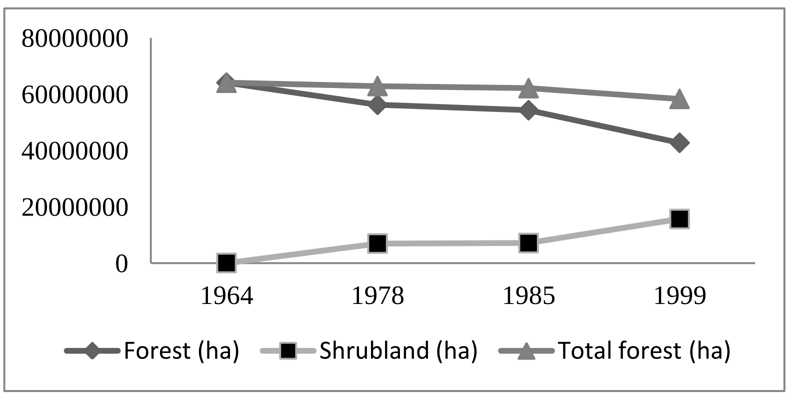


Figure 4.1 Deforestation Trend in Nepal

Seeing the deforestation and degradation trend as described above, Government seemed ready to amend the “Fortress Conservation Model” such that community got some liberty to manage some patches of forests in the name of Panchayat Forest. The 1976 National Forestry policy, 1978 Panchayat forest regulation, Panchayat protected forest regulation, 1982 decentralization act, 1987 master plan for the forestry sector are some of the policy intervention which gave some privilege to the local community to manage the forest.

After the reintroduction of multiparty democracy in Nepal in 1990, policy were designed in such a way that local participation, community empowerment were sought in development activities which gave rise to the community friendly forest act in 1993. Till date, about 1.1 million hectares of forests are being managed through active involvement of 14,000 community forests users groups benefitting approximately to 1.6 million households (FECOFUN[5], 2011). The act 1993 recognized the right of community forest user groups for the first time. Despite the ownership remained under the state control, forest user groups are entitled to guarantee of not interfering in the operation of groups in one hand, and management of forests in others. The forest regulation 1995 gives not only to collects forest products as per the forest operational plan, but also allow to involve in commercial utilization of timber linking it to market. In this way, forest users groups are getting economic incentive to protect and manage the forests.

As community forestry in Nepal gone through significant changes since its inception in the late 1970s, impressive achievements has been accomplished in term of developing and applying methodologies suitable for conditions in the Middle Hills. By and large, subsequent implementation of community forest produces the challenges like achieving equitable outcomes, and developing community forests as significant engines for community development in community endowed with rich forests (Gilmour, 2003).

Impressive gains have been spectacular in terms of improvement in forest coverage around the hills, and this occurred during 1980s.Changes in the perception from considering forest as a 'liability of the community to protect' to 'asset of users' took place, and it gave rise to the second generation issues. These include income generation, equity, active forest management, commercialization of forest products and so on. Among the second-generation issues, prominent

[5] FECOFUN stands for Federation of Community Forests User in Nepal. Established in 1995, FECOFUN is an autonomous, nonprofit national federation of forest users which aim to advocate for the rights of community forestry user groups. Its membership stands at about 8 million from almost all 75 districts of Nepal. (District is a local level administrative unit in Nepal).

are income generation and equity, which are substantially linked to the national agenda of poverty alleviation.

All the progress made in community forestry is not equally distributed all over Nepal. The progress is only confined to the hill and mountain region but not in Terai which have relatively productive forests particularly standing timber. Further, the identification of real users has complicated the progress in handing over forests to the local community in Nepal (Blakie and Springate-Baginksi(2007).

4.2.2. External factors

The external factor is equally responsible for triggering the development of community forestry in Nepal. The Theory of Himalayan Environment Degradation postulated by Eckholm (1975) drew world attention as he described the condition of Nepal's forest and the extent of deforestation as a severe 'crisis' responsible for affecting the entire Himalayan Region. This narrative links population increase with various environmental effects. The profound impact of the Theory of Himalayan Degradation appeared not only in the domestic environment policy of Nepal but also in the priority of major donors players in Nepal. For example, the theory hypothesized that all the accessible forests in Nepal will be vanished by 2000 owing to excessive exploitation of forests by the rural people. The World Bank (WB) in 1978 while reviewing of the forestry sector of Nepal alarmed that all the accessible forests in Nepal would disappear by 1993 in the hills and in the plain area by 2003. In this context, the WB called for immediate action to responding the alarming rate of deforestation in Nepal.

The hydrological aspects of the theory are important as the alleged hydrological effects of deforestation have played a major role in justifying the provision of substantial aid to the forestry sector in Nepal (Gilmour, 1991) and the wide spread acceptance of the theory provided a charter for action for government and aid agencies. Consequently, donors poured millions of dollars for experimenting and development of community forest management in Nepal. The Major donors contributing in this endeavor were from USA, UK, Switzerland, Netherlands, Australia, Denmark, Finland, Norway, Germany, and Japan. Also, the multinational agencies UNDP, and international conservation organization like Worldwide Fund for Nature (WWF), Regional organization ICIMOD also contributed substantially in the forestry and conservation sector development in Nepal.

Challenging the Theory of Himalayan Degradation for portraying the poor rural pheasants as villain of forest destruction of Nepal and flooding in the Gangetic Plain, the narrative was criticized and discredited (Ives, 2006) for having simplistic prediction, and for not mentioning the complex socio-economic and political causes behind the Himalayan degradation. However, donors are still taking the assumptions of the theory for justifying their contribution to the forestry sector in Nepal.

4.3 Socio-economic role of community forestry in Nepal

Forest is the major source of cooking fuel for the majority (64%) of population (CBS, 2011). Besides the fuel wood, most of the rural people in Nepal depend on traditional agriculture and livestock for their livelihood. Forest is the major components of farming system and plays a vital role in rural livelihood by providing fuel, construction material, and animal feed. Having an agro-based economy, Nepal has to develop and manage the existing forest resources to achieve the national goal of poverty reduction as mentioned in Tenth Five Year Plan (2002-2007). Community Forestry (CF) program has witnessed the silver jubilee that was initially launched to cope the problems of forest degradation as made alarm by the theory of Himalayan Environment Degradation in the late 70s. Later, Community Forestry has been adopted as a forest management strategy that ensures the participation of local people, called community forest user groups (CFUGs), in the management of forest and allow them to derive forest goods and services for the benefits. Kanel (2004) reported that CFUGs have enjoyed much autonomy in decision-making, such as access rules, forest products prices, mechanism for allocation of forest products, user fees and other important policies are agreed by user assemblies.

Kanel et.al.,(2004) reported that, based on data based on revenue generation, Community Forestry in Nepal can generate NR 1.8 billion a year, which is about the same as the total annual budget of the Ministry of Forest and Soil Conservation. This estimate doesn't represent the exhausted list that only includes annual harvest of timber, fuel wood, pine region and some medicinal and herbal products. Have all the products and services been included in the estimation, total benefits of CF would obviously be many times higher. Forest user groups are investing, including their participation, NRs 586 per hectare in managing their CF in comparison to the recipient money worth NRs 1865 per hectare annually. In addition, the fund rose from managing community forest, invest user this in community development and other perceived needs by the users. Therefore, community forestry is a catalyst less and development engines more in rural Hill of Nepal.

4.4 Climate change policies in the context of REDD+ in Nepal

This Chapter revealed that community forestry in Nepal has gone enormous change in the last 40 years with community friendly policy in place at the center, and effective forest user groups institutions at the grassroots level. Through intensive support from governments, donor agencies, and active participation of forest users, community forestry in Nepal has emerged as the best responsive measure to fight against deforestation, poor forest governance and poverty alleviation as well (GON, 2010). Seeing the success of Community Forests Management (CFM) in Nepal, the Government of Nepal (GON) has tried its best to synchronize CFM with the global climate change policy.

GON made its rapid progress immediately prior to the 15th session of the Conference of Parties (COP 15) to the UNFCCC held in Copenhagen in 2009. In July 2009, a climate change Council was established under the chair of Prime Minister of Nepal, and Cabinet meeting was organized in Kalapathar near the base camp of Mt. Everest. The cabinet meeting issued the Sagarmatha Declaration[6] on climate change as a symbolic gesture to draw the world attention to the impact of climate change in the Himalaya. Nepal developed a national adaptation of the plan of action in 2010, national framework for local adaptation plan of action in 2011, and national climate change policy in 2011. These policy tools will be helpful to access to international climate change fund, and least developed country fund and Adaptation Fund. Since Nepal is the least developed countries it, does not need to develop appropriate national climate change mitigation plan.

Nepal's journey to REDD+ began only after taking part in Conference of Parties (COP 13) of UNFCCC in Bali in 2007. Soon after, Nepal began to start dialogue on REDD+ Readiness. Following the approval of REDD+ Readiness Proposal (RPP) from World Bank's Forest Carbon Partnership Facility (FCPF) in 2008, Ministry of Forest and Soil Conservation established three tiers of REDD+ institutions which include Apex body for co-ordinating line Ministries, REDD+ Working Group for bringing the stakeholders, and REDD+ Cell for implementing and monitoring. The Table 4.2 gives details on the structure of REDD+ and Adaptation in Nepal.

[6] The 9 points Sagarmatha (Mt. Everest) Declaration mostly is an appeal to the international community to support Nepal in its effort to reduce the impact of climate change in the Himalaya.

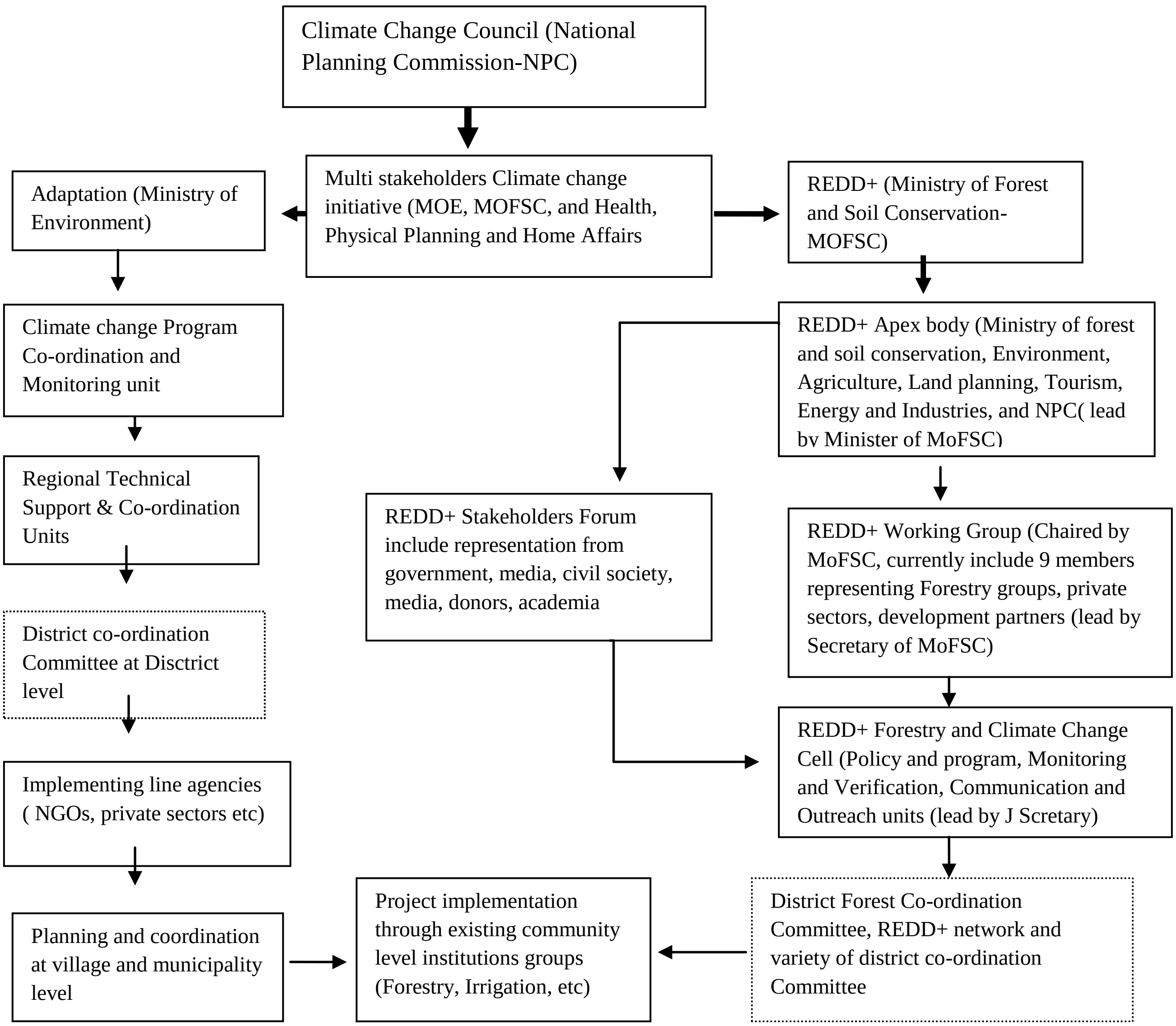


Figure 4.2 REDD+ and adaptation planning in Nepal (Source: West, 2012)

With support from FCPF through REDD+ Readiness Proposal (RPP), REDD+ Cell is conducting studies and developing policy initiatives. The cell is now co-ordinating REDD+ initiatives, conducting appraisal of deforestation and degradation, and facilitating exchange and sharing between the diverse projects, initiatives and institutions. Preparation of National REDD+ strategy is near completion under the REDD+ Cell.

In the initial face, all the stakeholders involved in REDD+ Cell has been actively participating and contributing to REDD+ process, particularly on developing RPP. As the REDD+ went on operation, complex issues has been emerged now. With referencing to field sites of this research, complexities of REDD+ in Nepal has been discussed in Chapter 6.

Of the REDD+ initiatives, the ICIMOD led consortium is implementing the REDD+ project since 2010 on watershed level representing mountains, hills and low altitude plain area. This thesis is based on the two implementing site of the REDD+ project. The profile of the study areas has been illustrated in details in Chapter 5.

CHAPTER 5
PROFILE OF CASE STUDIES: COMMUNITY FOREST MANAGEMENT PRACTICES

5.0 Introduction

Since management practices may affect the level of carbon sequestration in community forest, the kind of management practices is important from the climate change perspective. While shedding light on management regimes of the two sites, this Chapter illustrates how forests are managed in terms of their history, the evolution of management system, the administration, and day- to -day management practices, and how forest protection work are carried out.

The Chapter firstly introduces the research sites and provides details on the management of community forests. The data used for analyzing the management regimes of community forests is based on the community forest operational plans and focused group discussions. Ludidamgade CFUG in Gorkha district and Darpani CFUG in Chitwan district are the units of observation for this purpose.

In the context of carbon trade, this Chapter tries to answer to what extent the current forest user groups are capable to accommodate the extra responsibilities of carbon management. For communities to engage in the carbon trade, it is expected that they must develop the capacity that is compatible with the requirements of carbon trading and its norms and standards.

5.1. Case study 1: Ludidamgade community forest in Gorkha

Ludidamgade community forest is situated in Gorkha Municipality of Gorkha district of Western Nepal. Demographically the forest user group is more diverse in terms of ethnic groups. According to the revised constitution (2012), of the total 522 households in the municipality, 306 households are from Bhramin-Chhetri social groups, 75 from Dalit groups, and rest of the 141 households are from Tibeto-Burman social groups which include Magar, Gurung, Bhujel, and Newar ethnic groups. Ludidamgadhe CFUG has an executive body consisting of 21 members of which there is provision that 40% of the posts will be represented by women. However, women are represented by 33 % in forest user committee

Of the total 522 households, 25 households are rich, 405 are medium and 93 households are poor. This data is based on the wealth ranking conducted jointly by forests user groups and forest official (Forest constitution, 1996).

5.1.1 Brief history

After the restoration of democracy in 1990, the democratically elected government passed the pro community oriented forest law in 1993 paving the way for handing over all the accessible forests to the local communities with dual objectives of protecting, and managing the forests in one hand, and supporting livelihoods through the supply forest products in the other. Based on the forest law (1993), Ludidamgadhe community forest came into existence in 1994 as the governments started to handover the forest to the local community. With endorsement of Forest User Group (FUG) constitution, and management operational plan by the District Forest Office, Ludidamgadhe FUG started to restore forest by plantation, and cleaning the bushes to promote coppicing, and to manage forest in consultation within forest users. Concerted efforts on forest management rewarded the community forest to win a District as well as a National prize.

5.1.2 Administrative work

Ludidamgadhe community forest has a Forest User Committee (FUC) elected for two year tenure by the Annual General Assembly (AGM). As the constitution of FUGs has mandatory provisions to do so. AGM is a big event for the Forest User Group (FUG) which is called once a year of which 2/3[rd] majority is essential to elect the FUC, to amend the constitution and forest operation plan. In any other business of FUG, participants of more than 50% households are required to pass the resolution. FUG has its own office near the forest, and a member secretary who oversee the day to day activities

Photo 5.1 Office of Ludidamgahde CF

Ludidamgadhe FUG has its own fund that is raised through selling forest products, membership fee, money coming from enforcement, interest earned from group investment, grants received from donors and the government. It has its own bank account of which the chairperson and treasurer are the office bearers of the bank account. The member secretary has authorization to mobilize small petty cash worth of USD 17 (NRP 1500). The constitution has given the mandate to the FUC to spend money on three main headings; 1) 25 % on forest protection, 2) 35 % on welfare of disadvantaged groups, and 3) the remaining 40% on community development. Office management covers the salary of a secretary, and the transaction costs of FUC members. The annual audit is carried out through a registered auditor in the presence of all committee members, and the audited copy is sent to District Forest Office for endorsement.

In the constitution of FUG, there is a special provision to provide timber in concession for poor and disadvantages group to encourage them to participate in forest management. Similarly, the constitution has a provision that 10 % of the total fund is to be allocated to spend on women empowerment, awareness, and income generation activities with the aim to support increase the income of women.

5.1.3 Forest management practices

Forest management activities are carried out in 7 different blocks according to the provisions made in the 10-year forest operational plan (2003-2013) approved by the government. These 7 forest blocks have different levels of growing stock, and volume in theirs forest stands. Major forest management activities included in the operational plan are forest protection and silvicultural operation[7] (forest improvement). The details on forest management activities are described below:

a) Forest protection:

Improving the condition of the forest is one of the major objectives of forest operation plan. There is a provision of guarding forest done by each household on a rotational basis. Protection of forest from forest fires, taking precautions on forest fires by educating forest users, preventing forest encroachment, controlling grazing, promoting soil conservation and soil erosion control, promoting wildlife conservation, and water spring conservation. In addition, control on forest products smuggling and conservation education are the listed activities regarding the forest protection (Forest operation plan, 2003).

b) Forest improvement:

Major activities listed in the forest operation plan to improve forest condition are singling the individual seedlings to promote coppicing, pruning the tree (cutting the unwanted branches), thinning the forest to promote the desirable tree species in composition. Other forest

[7] Silvicultural operation in forestry means way of planting and caring for forests and the management of growing timber.

improvement activities included in the operational plan are the establishment of forest nursery to produce seedlings to restore forest cover in clearing, showing of grasses, and protection of herbal and medicinal plants (Forest operation plan, 2003).

IV) Forest utilization and distribution mechanism

Access to forest products is a key motivation factor behind protecting the forests. Accordingly, forest user committee makes decisions about timing to open the forest to collect forest products in different blocks. Before distributing the forest products, forest user committee collect demand for forest products from the forest users. Timber, firewood (dry and fresh), pole, wood required to construct agriculture tools, coal, grass and bedding materials are the forest products listed in the forest operational plan that are allowed to be collected in the community forests. The maximum quantity of forest products allowed to harvest, and subsequent selling prices is presented in Table A in Annex I.

Before making a decision about the distribution of forest products, an assessment for forests products is made between January and February each year. Only after the assessment of the capacity of the forest by the forest technicians and forest user groups, users are allowed to be collected based on their priorities. The priority basis for distribution is those who are subject to high risk of damages of losses due to natural hazard such as forest fires, landslide, and flooding. Farmers need wood for making agriculture tools and/or to construct new houses or repair old houses. The Table 5.1 gives a glimpse of demand of and supply for forest products in the community forests.

The Table 5.1 shows that community forest supplies most of demand for forest products. For example, of the total annual demand of timber, and firewood, community forest fulfil 93 % and 75 % of the demand for timber and firewood respectively. This is the same with other forest products as well. However, forest users groups should follow the annual allowable cut prescription available annually in the different management blocks of the forests. For example, the supply is further restricted according to variations in supply of forest products in different blocks. Variation in the supply of forests products is attributed to the capacity of forests which largely depend on the age of the forests. For example, forest blocks with mature trees have potential to supply more goods than other forest stands.

Table 5.1 Demand of and supply for forest products in Ludidamgadhe CF

S.N	Name of forest products	Unit	Demand/yr	Supply/yr	
				Private forest	Community Forest
1	Timber	ft^3	6000	400	5600
2	Pole	Nos	500	200	300
3	Firewood	T (tone)	600	150	450
4	Fodder/forage	T	300	90	210
5	Grasses	T	90	30	60
6	Bedding materials	T	600	0	600
7	Coal	T	60	0	60

(Source: Community forest operation plan, 2003)

According to Table B in Annex I, the timber and firewood supply potential in the year 2012 was 2100 cubic feet timber, and 42 tons of firewood respectively. This shows the discrepancies in the annual potential of forests as a whole, and what is actually available in the different forests blocks with different age.

V) REDD+ provision in forest constitution

After the Ludidamgade community forest was selected for the REDD+ pilot project in 2010, Forest User Groups amended the forest constitution in the same year to carry out REDD+ activities in their forest. With respect to the REDD+ implementation, 7 points amendment has been incorporated. The major highlights of the change made include seeking full participation of indigenous community in decision making, women and marginalized community. One of the major points included in the constitution is that Forest User Committee will not let the REDD+ program effect negatively on the livelihood of general forest users.

5.2 Case study 2 : Dharpani Community Forests

Dharpani community forest is situated in Saktikhor Village Development (VDC) of Chitwan district of Central Nepal. According to the forest constitution, of the total 111 households, 70 households are from indigenous community (Praja, Gurung, Tamang ethnic groups), 37 are from Bhramin-Chhetri community, and 4 from Dalit community. Dharpani CFUG has 11 members executive body of which 3 female are represented. Moreover, according to information on wealth ranking, 4 households are rich, 18 are medium, and 89 households are poor. It is one of the remotest community forests registered in Chitwan district.

5.2.1 Brief Background

Situated in the 13 km north of East West highway from Tandi Bazar, Dharpani community forest was handed over to community by the government in 2003 as per the forest law, 1993. Bisect by the small stream in the east, it is the typical forest dominated by broadleaved forest species. This forest is rich in wildlife which harbors tiger, deer, and many birds' species. The famous Barandavar biological corridor passes near this community forest serving sometimes as a buffer forest for the wildlife from the famous Chitwan National Park.

With the endorsement of Forest User Group (FUG) constitution, and management operational plan by district forest office Chitwan, Dharpani FUG started to restore forest by enrichment plantation, and cleaning bushes to promote coppicing, and to manage the forest in consultation within forest users.

5.2.2 Administrative work

Dharpani community forest has 11 members Forest User Committee (FUC) elected for two year tenure by the Annual General Assembly (AGM). The forest committee is led by an indigenous community member. There is a representation from women (3), Bhramin/Chhetri and Janajati communities. AGM is called once a year of which $2/3^{rd}$ majority is essential to elect the FUC, to amend the constitution and forest operation plan. In any other business of forest user groups (FUG), participants of more than 50% households are required to pass the resolution.

Regarding funding raising and mobilization part, FUG has its own funds that are raised through selling forest products, membership fee, money coming from enforcement, interest earned from group investment, and grants received from donors and government. It has its own bank account of which the chairperson, the secretary and the treasurer are the office bearers of the bank account. The constitution gives mandate to the FUC to spend fund on two main heading; 1) 25 % of the total fund must spend on forest protection, and 2) 75 % on community development. There is provision of carrying out an annual audit through registered auditor amidst all committee members, and sending the audited copy to the district forest office Chitwan (Forest Constitution, 2003).

5.2.3 Forest management practices

In order to meet the objectives of forest management, forest protection, forest management and utilization of forests, forest users groups carry out forest management activities in 4 different blocks according to the provisions made in the 5- year forest operational plan (2003-2007) approved by the government. Major forest management activities included in the operational plan are forest protection, and silvicultural operation. The details on forest management activities are described below:

a) Forest protection:

Improving the vitality and health of the forest is one of the major objectives of forest operation plan (Forest operation plan, 2003). Dharpani CFUG has appointed a forest guard to protect the forest. Sometimes, forest users committee and groups conduct patrolling on a bimonthly basis to monitor forest protection activities. There is also provision to reward the informants who collects reliable information on theft, illegal cutting, smuggling and other illicit activities that harm to forest.

Other measures are protection of forest from forest fire through construction of fire lines in the sensitive forest areas, education of forest users on the impact of fires, and control of grazing are the listed activities with respect to the forest protection.

b) Forest improvement through silvicultural practices

Major silvicultural activities listed in forest operation plan to improve forest condition are to promote coppicing, promoting regeneration, climber cutting, pruning the tree (cutting the unwanted branches), thinning the forest to promote the desired forest species composition. Forest users group’s occasionally carry out plantation through establishing nursery, and promote forest based income generation activities such as herbal and medicinal plant cultivation with targeting to poor and marginalized families. All forest improvement activities are carried out according the schedule mentioned in the operational plan.

IV) Forest utilization and distribution mechanism

The forest user committee makes a decision on the timing let access to open the forest to collect forest products on different blocks. In the Dharpani community forest there are valuable timber species like Sal (*Shorea robusta*), and Saj (*Terminalia spp.*). Permission from the government is required to utilize these species as timber. After getting permission, interested forest users get access to forest products such as timber, firewood (dry and fresh), pole, and wood for making agriculture tools, and for coal production, grass and bedding materials are the forest products listed in forest operational plan that is allowed to collect from the community forests. The maximum quantity of forest products allowed for harvesting, and subsequent selling prices is listed in Table C in Annex I.

The Table D in Annex I show that community forest fulfills 70% of the total annual demand for timber. Whereas the privately owned forests fulfill a significant demand for firewood, pole, bedding materials and other forest products as shown in the Table D in Annex I.

5.3 Comparing the two sites's management regimes

These two case studies show that communities are managing the forests according the approved forest operation plan and the constitution. Both cases demonstrate the similarities in the objectives about the restoration of community forest, fulfillment of forest users needs, and to reduce deforestation. Both forests are well protected in terms tree and vegetation cover. However, the two sites have different communities which use different languages to communicate. Despite the fact that Nepali is a lingua franca, the much marginalized Chepang ethnic group of Dharpani CF are illiterate and cannot read the operational plan and forest constitution which is, in addition, is written in Nepali language. Without clearly understanding the rules, regulations and provisions, it is obvious that active participation in forest management cannot be anticipated. Further, despite the fact that, the Chepang ethnic group is in majority, their proportionate and judicious representation in vital posts of forest user committee is far from being in relation to the population. The local elite's dominance in the user committee has implication in the governance of forests such that equitable distribution of forest products is not incorporated in the forest constitution.

The case is different in Ludidamgadhe CFUG where most of the community members can speak Nepali, and community members are equitably represented in the forest governance system. Executive members are well informed in the latest development in community forestry. For example, the Ludidamgadhe CFUG was selected for implementing the REDD+ project, and they promptly amended the constitution to incorporate conditions of the REDD+ project as seven points amendments (Forest constitution, 2003). It is obvious that well recorded forest stock estimation, active participation of users in forest management, accessibility, and intensive monitoring of governments are prerequisites for CFUGs to attract the REDD+ fund to their communities.

CHAPTER 6
CARBON SEQUESTRATION POTENTIAL OF COMMUNITY FORESTS

6.1 Introduction

The purpose of this Chapter is to answer the research question to what extent community forests in the study sites sequester carbon. After introducing the research sites, this Chapter quantifies the level of biomass and carbon sequestered in each community forests. The carbon data used in this section was collected from the project management unit of a REDD+ project implemented by a consortium led by ICIMOD. The unit of analysis used to calculate state and change in carbon stocks is tones of CO_2. Carbon data collected by ANSAB from two years (2011 and 2012) has been used to meet the research purpose as presented in Table E and F in Annex I. The analysis shows how community forests contribute to store and sequester CO_2 in biomass and soil. The results are presented and also are compared it to the findings of other studies.

6.2 Methodology for carbon and CO2 estimation

For the estimation of carbon pool in forests, data generated on above ground trees (>5 cm diameters) biomass (AGTB), above ground samplings (>1 cm to <5 cm) biomass (AGSB), leaf litter, herb, and grass (LHGB) biomass, soil organic carbon (SOC), and below ground biomass (BB) by REDD+ pilot project was utilized to estimate the carbon stocks. The estimation of carbon stocks did not include the dead wood and fallen stumps (Table E and F in Annex I). The estimation the carbon pools presented below is based on the carbon measurement guideline (2010) prepared by Asia Network for Sustainable Agriculture and Bio-resources (ANSAB) and International Centre for Integrated Mountain Development (ICIMOD).

6.2.1 Above ground tree biomass (AGTB)

The numbers of permanent sample plots required for above ground biomass estimation is an important consideration in forest inventory. The Darpani Community Forest and the Ludidamgade Community Forest were sampled with 15 and 23 permanent plots respectively, and the number of permanent plots was determined based on the area of entire watershed (ANSAB, 2010).

The selection of a reliable allometric equation is an important step in calculating above ground tree biomass (AGTB). Accordingly, the allometric equation $AGTB = 0.0509 * pD^2H$ used in this case incorporates 3 variables which include diameter at breast height (dbh) in cm, tree height in m. and wood denstiy p in gram per cm^3. The unit of AGTB is a ton per hectare. After taking the sum of all the individual tree weights (in kg) in a sample plot, and dividing it by the area of a sampling plot ($250m^2$), the biomass stock density is attained in kg per m^2. Then the value is converted to a ton per ha by multiplying it by 10 to get AGTB. Half of this change in biomass was taken as the carbon sequestration rate expressed in t/ha (MacDicken 1997 cited in Karky, 2008). The biomass stocks of a sampling plot is converted to carbon stock after multiplication with the IPCC (2006) default carbon fraction of 0.47 which means that 47% is the conversion rate from biomass stock to carbon stock which applies to all carbon pool described in this section.

The following regression model was used to calculate above ground biomass assuming that forests are moist (ANSAB, 2010).

$AGTB= 0.0509*pD^2H$

Where,

0.0599 is constant (intercept)

AGTB =aboveground tree biomass (kg)

p= wood gravity (kgm^{-3});

D =tree diameter at breast height (DBH) (cm); and

H =tree height (m)

6.2.2 Above ground sapling biomass (AGSP)

The biomass value of sapling counted only the individuals below 5 cm diameter in breast height (dbh) for the estimation of biomass. Using the standard formula (ANSAB, 2010) mentioned below, the biomass standard densities were converted to carbon stock densities. The following allometric regression model was used to calculate above ground tree biomass.

$log\ AGSB= log(AGSB) = a+b\ log\ (D)$

Where,

Log = natural log (dimensionless)

AGSB =aboveground sapling (saplings measured below 5 cm dbh) biomass (kg)

a = intercept of allometric relationship for saplings (dimensionless)

b = slope allometric relationship for saplings (dimensionless)

D =tree diameter at breast height (DBH) (cm); and

6.2.3 Biomass estimation of leaf litter, herb and grass (LHG)

According to measurement guideline, subplots of $1m^2$ plots were placed randomly, and all above grounds parts were harvested, then weighted to determine the weight. A subsample was then weighted, oven-dried to constant weight (at 60 ˚C). Thus, the biomass of herbs was determined. All herbaceous lice and debris on the ground level was harvested. To avoid contamination with soil, material on the forest floor was collected carefully. The resultant biomass was derived provided in ANSAB (2010) and converted to carbon stock. The following formula was used to calculate the LHG biomass (ANSAB, 2010) :

$LHG = (W_{field}/A.W_{subsampledry}/W_{subsamplewet})*10$, where:

LHG = biomass of Litter, Grass, and Herb ($t\ ha^{-1}$)
W_{field}= weight of the fresh field sample, destructively sampled within an area of size A (kg)
A= size of the sample collection area (m^2)
$W_{subsample\ dry}$ = weight of the oven-dry sub sample taken to estimate moisture content (g) and
$W_{subsample\ wet}$ = weight of the fresh sub-sample taken to estimate the moisture content (g)

6.2.4 Below Ground Biomass

Below ground biomass estimation is much as more difficult than above ground estimations. The IPCC (2003) recommends the use of such default ratios based on root: shoot ratio for different types of forests. For Nepal, the root shoot ratio value of 1:5 was used (ANSAB, 2010).

6.2.5 Estimation of soil organic carbon (SOC)

According to the information provided by the measurement guideline (ANSAB, 2010), soil samples were collected at 0-10, 10-20, and 20-30 cm depths. Thereafter, samples were transported to the laboratory and oven dried at 70^0C. Samples from each of the tree depths were composted and mixed, and prepared for carbon measurement by removing stones and plant residues greater than 2 mm. Soil organic carbon was calculated in a ton per hectare using a standard formula in Pearson et.al (2007).

$SOC = p*d*\%C$, Where,

SOC= soil organic carbon stock per unit area (tha^{-1})
p = soil bulk density (gcm^{-3})
d = the total depth (30 cm) over which the sample was taken, and
%C= carbon concentration in percentage

6.3 Results on carbon stock, carbon sequestration rate, and comparisons

The analysis consisted in the calculation of different carbon pools of the forests and sequestration rates by comparing the increase in carbon pool between 2011 and 2012.

6.3.1 Forest biomass in different pools

As mentioned above 6.2 section, the total biomass was calculated with summing up the carbon in above ground tree biomass (AGTB), carbon in above ground sapling biomass (AGSB), carbon in below-ground biomass (BGTB), carbon in litter (LB), herbs and grass (GHB), and soil organic carbon (SOC). Carbon stock is expressed in ton carbon per ha (tC/ha). The average above ground tree biomass (AGTB) in Ludidamgadhe is 146.415 t ha^{-1}, whereas the figure for Dharpani CFUG is 339.35 t ha^{-1}. Of the total biomass, the AGTB comprised the highest proportion (78-81%), followed by BGTB (16%). The proportion of AGSB and LB was below 5 % in both cases, whereas the contribution of GHB was lower than 1 % and was very negligible. Total biomass per ha in Dharpani (418.45 t ha^{-1}) was greater than in the Ludidamgadhe (188.31 tha^{-1}) as shown in Table 6.1

Table 6.1 Annual variations in tree biomass in Community Forests

Forest name	year	Tree density (trees /ha	Above ground biomass	Below ground biomass	Above ground sapling biomass	Litter biomass	Grass and herb biomass	Total biomass
			AGTB tha^{-1}	BGTB tha^{-1}	AGSBtha^{-1}	LBtha^{-1}	GHBtha^{-1}	tha^{-1}
Ludidamgadhe (23 plots)	2011	1881	139.52	27.90	6.84	8.81	0.53	183.60
	2012	1906	153.31 (+)	30.66(+)	5.43(-)	3.1(-)	0.53	193.03(+)
Average			146.415	29.28	6.135	5.955	0.53	188.31
(%) of total biomass			78	16	3	3	0.28	100
Dharpani (15 Plots)	2011	1381	377.70	75.54	6.47	5.26	0.14	465.11
	2012	1452	301.01(-)	60.20(-)	5.46(-)	4.88(-)	0.25(+)	371.80(-)
Average			339.35	67.87	5.96	5.07	0.195	418.45
(%) of total biomass			81	16	2	1	0.04	100

(Source: ANSAB, 2012)

The ANOVA analysis in Table H in Annex I suggests that there is a significant difference ($p<0.00$) in biomass quantity between the community forests in all pools except the sapling biomass and litter biomass which show negligible differences in the biomass accumulation. However only significant difference ($p<0.00$) in litter biomass were observed in litter biomass between the years 2011 and 2012. The amount of biomass in different pools varied according to the type of forests.

6.3.2 Annual changes in forest biomass

Change in above and below ground tree biomass

Table 6.2 demonstrate that the highest average change in above ground biomass was in 13.79 t ha^{-1}) Ludidamgadhe CF in Gorkha. The case was the same with below ground biomass where annual change was 2.76 t ha^{-1}. A possible reason for increase in biomass in this forest could be the restriction put on cutting down larger trees for timber purpose.

However, the annual change in above and below ground biomass in Dharpani CF of Chitwan was negative. The figure for AGTB and BGTB was -76.69 and -15.34 respectively. The Figure 1 denotes AGTB against of Community Forests User Groups and Years which also shows the variation in biomass change.The reason for declining in forest biomass in Dharpani CF could be attributed to increase in forest fire and timber smuggling.

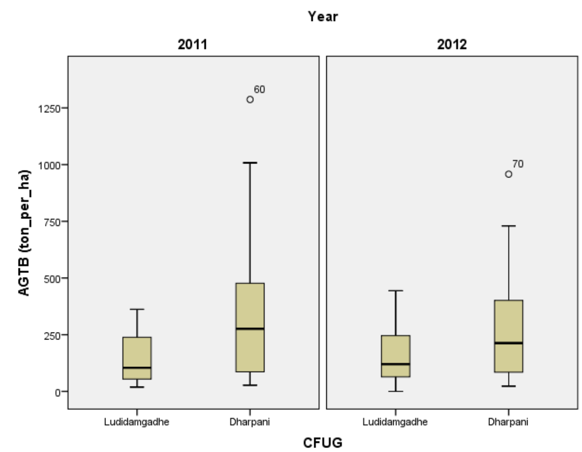


Figure 6.1 Comparison of Above Ground Tree Biomass

Table 6.2 Change in above ground tree biomass

Forest name	year	Above ground biomass AGTB tha^{-1}	Change (t ha^{-1})	Below ground biomass BGTB tha^{-1}	Change (t ha^{-1})
Ludidamgadhe (23 plots)	2011	139.52	+13.79	27.90	+2.76
	2012	153.31		30.66	
Dharpani (15 Plots)	2011	377.70	-76.69	75.54	-15.34
	2012	301.01		60.20	

(Source: ANSAB, 2012)

6.3.3 Change in above ground sapling biomass, litter biomass and grass and herbs biomass

In both community forests, the change in above ground sapling biomass and litter was negative. The figure for Ludidamgadhe CF is larger than the Dharpani CF. However, there was no change in grass and herbs biomass in Ludidamgadhe CF ,whereas there was slightly positive change in Dharpani CF.

Table 6.3 Change in above ground tree, litter, and grass and herbs biomass

Forest name	year	Above ground sapling biomass	Change (t ha^{-1})	Litter biomass	Change (t ha^{-1})	Grass and herb biomass	Change (t ha^{-1})
		AGSB tha^{-1}		LB tha^{-1}		GHB tha^{-1}	
Ludidamgadhe (23 plots)	2011	6.84	-1.41	8.81	-5.81	0.53	0
	2012	5.43		3.1		0.53	
Dharpani (15 Plots)	2011	6.47	-1.01	5.26	-0.38	0.14	+0.11
	2012	5.46		4.88		0.25	

(Source: ANSAB, 2012)

The reason for declining above ground sapling biomass in both forests may be attributed to the lopping of leaves for fodder to livestock. The possible cause for declining in litter biomass was that an excessive amount of litter was extracted to make animal bed, used to produce manure to use as fertilizer for the crops. No substantial change was observed in herbs and grass biomass in any of the forests probably due to the fact that there has been ban for grazing for the couple of years, so fewer disturbances in the forest floor caused by livestock possibly resulted in increase change in herbs and grass biomass.

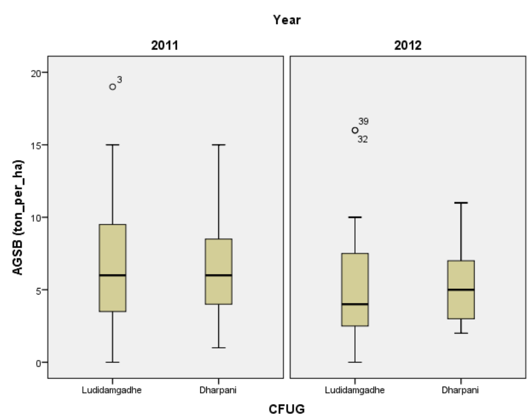


Figure 6.2 Above Ground Sapling

The Figure 6.2 shows above ground tree biomass in two Community Forests in 2011 and 2012.

6.3.4 CO2 Sequestration

The unit of analysis used for estimation of carbon is a ton of CO_2. This research examines the rate at which carbon was sequestered from the community forests where REDD+ is implemented since 2010. The positive net change biomass (Δ $Yr=Yr_2-Yr_{1>0}$) between yr_2 and Yr_1 is taken as annual bio-mass accumulation.

Table 6.4 Biomass, carbon, and CO2 sequestration data from 2 sites

Community Forests Name	Year	Total biomass tha^{-1}	Total forest carbon tha^{-1}	Total soil carbon tha^{-1}	Total carbon tha^{-1}	CO_2 per ha tCO_2ha^{-1}
Ludidamgadhe	2011	183.60	86.30	96.50	182.80	670.88
(241 ha)	2012	193.03	90.71	96.50	187.21	687.06
Average		188.315	88.505	96.5	185.005	678.97
Proportion (%)			48	52	100	
Dharpani (172 ha)	2011	465.11	218.60	109.60	328.20	1204.49
	2012	371.80	124.82	109.60	234.42	860.32
Average		418.455	171.71	109.6	281.31	1032.40
Proportion (%)			61	39	100	

(Source : ANSAB,2012)

The proportion of biomass carbon in Ludidamgadhe CF is 48 % while the figure is 61 % for Dharpani CF. The ANOVA analysis in Table I and J in Annex I suggest that there is a significant difference ($p<0.000$) in total biomass, soil carbon, and resultant CO_2 between the community forests.

6.3.5 Annual change in Total biomass and carbon in 2 sites

The total biomass (all plots) was compared between 2011 and 2012 to estimate the annual change in carbon stock. Later, annual increment in biomass was converted to carbon and carbon-dioxide equivalent.

Only in the Ludidamgadhe CF there was demonstrated the annual increment in biomass. The figure for annual change in biomass in the forest was 9.43 $tha^{-1}yr^{-1}$, and resultant change in carbon (carbon sequestration was 4.43 $tha^{-1}yr^{-1}$. The annual ate for CO2 sequestration was 16.22 $tha^{-1}yr^{-1}$.

Table 6.5 Annual variation in carbon stock in 2 Community Forests

CFUG Name	Year	Total biomass tha^{-1}	△ Biomass $tha^{-1}yr^{-1}$	△ Carbon $tha^{-1}yr^{-1}$	△ CO_2 $tha^{-1}yr^{-1}$
Ludidamgadhe (241 ha)	2011	183.60	9.43	4.43	16.22
	2012	193.03			
Average		188.31	9.43	4.43	16.22
Dharpani (172 ha)	2011	465.11	-93.31	-43.86	-160.51
	2012	371.80			
Average		418.45	-93.31	-43.86	-160.51

(Source: ANSAB, 2012)

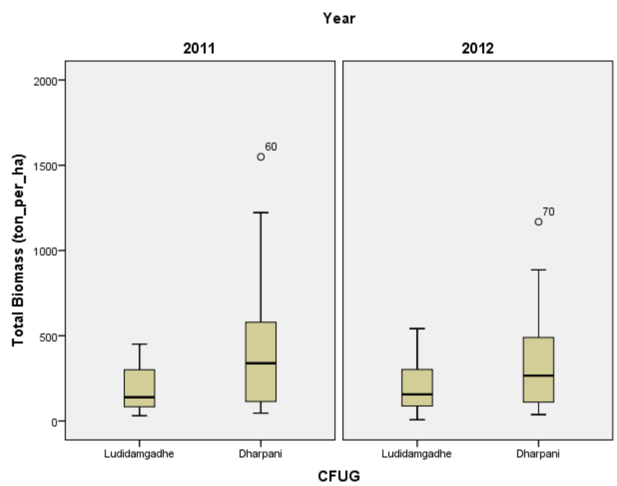


Figure 6.3 Change in Total Biomass between Year 2011-2012

The reason why there was carbon increment in Ludidamgahde, and not in Dharpani CF can be related to the local micro-climatic characteristics and to the management practices. The Ludidamgadhe CF is mixed forest and silvilcultural operations are carried out regularly. Moreover, forest users in Gorkha were more aware of forest protection and how to apply sustainable management of forests. However, Ludidamgadhe CF showed annual increment only in above ground tree biomass. The meaning is that forests Users were interested only on protecting standing big trees but not saplings and regeneration.

The reason for declining forest biomass in Dharpani CF is likely that this forest is located in the low land, accessible area which facilitates the illegal extraction of timber and where the productivity of the forest is considered to be higher than Mid Hills and Mountains. But the growing timber smuggling, forest fire couple with the non compliance with the rules and regulations set in forest operational plan were the probable cause of declining (forest degradation) in the forest biomass in Dharpani CF.

6.3.5 Comparison of results with others studies

In the wake of REDD+ implementation in Nepal in recent years, studies on forest carbon stock demonstrated different results. For example, Karky (2008) conducted a forest inventory in three community forests in similar climatic regions of Nepal to the ones in this study. He estimated the annual increment of carbon ranged from 1.13 t ha^{-1} to 3.1 tha^{-1}. Banskota *et al.* (2008) found 3.7 ton per ha annual forest carbon increment in community forest in Uttarakhand, in India. Most recently, Bhattari *et al.* (2012) estimated the annual increment in Carbon ranging from 1.46 to 2.19 t ha^{-1} in forests representing all ecological regions of Nepal. The results of the current study are a bit larger than the range of estimates already made. Thy study demonstrated that community forests not only sequester carbon but also contribute to carbon release. In this respect, the result showed that forests act as both carbon sink and carbon source.

There are some limitations of the methods to capture carbon discussed in this Chapter. For example, despite timber extraction, also underground biomass remains in the soil which is not fully captured in the allometric equation.

CHAPTER 7

HOUSEHOLDS CHARACTERISTICS OF FOREST USER GROUPS, AND PERCEPTION ON CLIMATE CHANGE

7.0 Introduction:

The objective of this Chapter is to find out whether and how community forest members will be affected if they sold carbon credit, and what would be meaning for them in terms of livelihood if there exists restriction in CF in forest product extraction. Also, this Chapter explore to what extent forests users are aware on the perceive impact of climate change so that they can proactively take part in REDD+ program. The main thrust of this Chapter is to know the relationships of household's characteristics with forests and perception on climate change.

The data used for analyzing the socioeconomic profile forest users group, their dependency on forests, and perception on climate change is based on household survey and interview with key informants, and for this purpose, household is the unit of analysis. At the end of the section of this Chapter, study finding are presented, and are also compared to the other findings.

7.1 Socio-economic profile of CFUG Households

Socio-economic data were collected through household survey, focus group discussion, and key informants to examine the link between Community Forest User Groups and livelihood. Analysis on the link is important because socio-economic information of FUG households and their dependency on forest resources serves as background to give an answer to the research question to what extent carbon trading in line of REDD+ mechanism will have an impact on livelihood under 3 scenarios: no carbon trade (status quo), utilizing forest products plus carbon trade, and only carbon trade. The next Chapter 8 will illustrate details on the impact of carbon trading on livelihood on these 3 scenarios.

This section begins with how sample size for household survey was determined, and then elaborates on socio-economic condition of forest user's households, then on the use of forest products by households, and lastly on perception of climate change.

7.2 Findings on livelihood conditions of CFUG members

This section highlights the brief discussion on the socio-economic factors. The socio-economic data collected from the CFUG households in two research sites reflect the household characteristics and their interrelationship with community forests. Field survey (2012) is the source of information for all Tables presented under this section.

This section presents the livelihood conditions of CFUGs based on:

1. Demographic characteristics (age, sex, marital status, household size)
2. Literacy
3. Occupation
4. Economic class and ethnicity
5. Land ownership
6. Livestock
7. Use of forest products as direct benefits derived from community forests

I) Demographic characteristics

For this research purpose, demographic characteristics included in this section are age, sex, marital status, and household size. These characteristics help to understand the nexus between the population and its dependency on forest products.

7.2.1 Respondents Age Structure:

Age structure of the sample respondents shows that women respondents were relatively younger (38.65 yrs.) than men (44.32).

Table 7.1 Respondents average age by sex

Sex	Mean age	N
Female	38.65	26
Male	44.32	44
Total	42.21	70

(Source: HH survey, 2012)

Similarly, in terms of age group, the distribution patterns demonstrate that more than 80% respondents fall under the age groups of 15-59 years, while just 8.6-14 % fall under the age groups of 60+ years age group. Majority of respondents represented the economically active population of the CFUGs in both sites. Table 7.3 below shows the respondents by age and sex category.

Table 7.2: Respondents by age and sex

Site	Age Group	Sex		Total
		Female	Male	
Ludidamgadhe CFUG	0-14 years	0	1	1(2.9 %)
	15-59 years	14	17	31(88.6%)
	60+ years	1	2	3(8.6%)
Subtotal		15 (43%)	20 (57%)	35 (100 %)
Dharpani CFUG	0-14 years	0	0	0
	15-59 years	10	20	30 (86 %)
	60+ years	1	4	5(14 %)
Subtotal		11 (30%)	24 (68 %)	35(100 %)

(Source: HH survey, 2012)

7.2.2 Respondents by social groups

The analysis on respondents belongs to different ethnicity indicates that Bhramin and Chhetri constituted more than 61.4% the total respondents followed by indigenous community (32.9 %).

Table 7.3: Respondents by social groups

Sites	Social groups (N=70)			Total
	Bhramin/Chhetri[8] No(%)	Indigenous[9] No(%)	Dalit[10] No(%)	
Ludidamgadhe	28 (80)	3(8.6)	4(11.4)	35(100)
Dharpani	15(42.9)	20(57.1)	0	35(100)
Total	75(61.4)	23(32.9)	4(5.7)	70(100)

(Source : HH survey, 2012)

This happens due to the fact that studies areas are predominated by this Bhramin/Chhetri (53.8%). In the sample, of the total respondents 70, 32.9 % were from the Indigenous community

[8] Bhramin-Chhetri belongs to Indo-Aryan linguistic family which follows caste system which is as an institution and system, is hierarchical differentiation of ritual status and occupy uppermost (ILO, 2005)
[9] Indigenous community are the ethnic groups belongs Tibeto-Burman linguistic family (ibid)
[10] Dalit belongs to lowest rung in the caste hierarchy. The term is also used to identify the vulnerable and poor groups of people who are oppressed, suppressed and exploited (ibid)

that is the perfect reflection of the population (33.8%) of the same community in both sites. However, Dalits were relatively less represented (5.7%) as compared with their total population (12%). The reason for less representation of the sites was that Dalit lives in scatter manner to serve their clients in the community.

7.2.3 Household size

As there is a relation between the household size and usage pattern of forest products in the Community Forests, so it is important to analyze the household size in the research sites. It was found that, the average size of household was 5.09. The average household size was lower in Ludidamgadhe (5.06 persons) than Dharpani (5.11 persons). However, this difference in size was not statistically significant.

Table 7.4 Respondents by household size

CFUG Name	Mean	Std.Deviation
Ludidamgadhe	5.06	1.65
Dharpani	5.11	1.32
Average	5.09	1.49

(Source: HH survey, 2012)

The household size also varied by cast/ethnicity. The average households size was highest among Dalit community (5.50) followed by Indigenous community households (5.17), and lowest in Bhramin//Chhetri households (5.0). Households of all ethnic groups have more household members than that of the national average (4.70) according to the national census (CBS, 2011). However, the average household size was not statistically significant be it was in projects sites or ethnicity.

Table 7.5 HH size by Ethnicity

Ethnicity	Mean	N	Std.
Bhramin/Chhetri	5.00	43	1.51
Indigenous	5.17	23	1.55
Dalit	5.45	4	1.00
Total	5.09	70	

(Source : HH survey, 2012)

7.2.4 Respondents' Educational Attainment by sex and social group in community CFs

As education level is the reflection of empowerment of community members to be engaged in carbon management, and forest management, so this section analyze the attainment of education level by the CFUG members.

The Table 7.6 shows the difference in the illiteracy level in terms of sex and sites. In both sites, women respondents' literacy rate was above 50 %. In terms of educational level nobody was found to be graduated from University in both sites. Similarly, of the total educated respondents, no females were found passing beyond primary.

Table 7.6 Respondents by sex, education in both sites (N=70)

Category	Sex	Literacy %		Total %(N)	Education level %				Total %(N)
		Illiterate	Literat		Primary	Secondar	Higher-secondary	Undergraduat	
Ludidamgadh	Female	27.7	73.3	100(15)	60	20	20	0	100(15)
	Male	21.1	78.9	100(20)	35	30	20	15	100(20)
	Total	23.5	76.5	100(35)	45.7	25.7	20.0	8.6	100(35)
Dharpani	Female	45.5	54.5	100(11)	100	0	0	0	100(11)
	Male	33.3	66.7	100(24)	79.2	12.5	4.2	4.2	100(24)
	Total	37.1	62.9	100(35)	85.7	8.6	2.9	2.9	100(35)

(Source: Field Survey, 2012)

level in Dharpani CF, however percentage of female passing beyond primary education for Ludidamgadhe was 40 %. The figure for educated respondents crossing secondary and higher secondary plus education was 45.7 % in Ludidamgadhe CF whereas the figure for Dharpani CF was below 10%. The Table 7.6 showed that the overall level of education of men's respondents was higher than that of women respondents. In terms of site, the literacy rate in Ludidamgadhe (76.9) was found higher in comparison to Dharpani CF (62.9). However, none of the Forest User Groups in terms of education attainment by sex found significantly different at 5 % level of significance.

7.2.5 Respondents' economic category

From the Table 7.7 it was found that Dharpani CF comprised of more poor households (57.1 %) than Ludidamgadhe CF (11.4 %). However, the later CF comprised of more than 85% medium class. The proportion of well off families in both sites was found to be less 6 %. In terms of social groups, Indigenous people were found to be poorer than Bhramin/Chhetri social group in

Dharpani CF. However, the Dailts fall under the category of medium class. The probable reasons for finding more poor in Dharpani CF was that the Chepang indigenous social group are more deprived of basic facilities like health, education, and economic opportunities than other social groups owing to their less influence in social and economic power spectrum of the country.

Table 7.7 Respondents by economic class

Site	Social groups	Economic class % (N=70)			Total
		Poor	Medium	Well off	
Ludidamgadhe	Bhramin-Cheetri	14.3	85.7	0	100(28)
	Indigenous	0	67.7	33.3	100(3)
	Dalit	0	100	0	100(4)
	Total	11.4	85.7	2.9	100(35)
Dharpani	Bhramin-Cheetri	47.7	46.7	6.7	100 (15)
	Indigenous	65	30	5	100 (20)
	Dalit	0	0	0	0
	Total	57.1	37.1	5.7	100 (35)

(Source: Field Survey, 2012)

From the Chi square test analysis, it was found to have statistically significant ($p<0.02$) between the two sites among the social groups, but found no strong co-relations between the sites.

7.2.6 Land distribution pattern

In terms of land distribution, Dharpani CFUG consisted of nearly 77% of marginal and small scale farmers with land holding size <0.5 ha. Whreas, Ludidamgadhe CFUG comprised of nearly 60 % of medium and rich farmers with land holding size >0.5 ha. At the national level, 47.3 % of farmers own <0.5 ha whereas only 27.4 % of farmers own between 0.5 and 1 hectare of land (CBS, 2011).

Table 7.8 Land distribution

Site	Social groups	Land distribution % (N=70)				Total
		Margina <0.2 ha	Small 0.2-0.5 ha	Medium 0.5-1.0 ha	Rich >1.0 ha	

Ludidamgadhe	Bhramin-Cheetri	10.7	32.1	42.9	14.3	100 (28)
	Indigenous	0	33.3	33.3	33.3	100(3)
	Dalit	0	25	25	50	100(4)
	Total	8.6	31.4	40	20	100 (35)
Dharpani	Bhramin-Cheetri	20	33.3	46.7	0	100 (15)
	Indigenous	45	50	5	0	100 (20)
	Total	34.3	42.9	22.9	0	100 (35)

(Source: Field Survey, 2012)

It was found to have strong association ($p<0.003$) between the two CFs in terms of land holding size while performing the Chi square test.

7.2.7 Comparing demographic characteristics of the two sites

From the demographic analysis made aforementioned, it was found that study approached relatively adult respondents with average age of 42.41 year. Similarly, the female respondents comprised between 30-43 %. It was found that Ludidamgadhe CFUG seemed more advanced in terms of education, and economic condition parameters. In comparison to Ludidamgadhe CFUG, Dharpani CFUG found with having bigger household size, less literacy, more poor households having small and marginal farm land. This result on demographic characteristics will help to understand to what extent, and in what ways forest users depend on forest products as described in below section.

7.3 Use of forest products by CFUG members

Access to and control over forest resource management is one of the important characteristic of community forestry policy in Nepal. In the context of REDD+ mechanism in place, carbon management should be seen in relation to the existing usage pattern of forest products that this thesis has focused on. This section quantifies the Forest User Groups dependency on forest products that include firewood, fodder, timber, bedding materials, grasses, non timber forest products. Also, this section estimate the cost incur by CFUG households in forest management by calculating the fee they have to pay for forest products, the labor contribution, and transaction cost they need to bear in forest management. More elaboration in benefits and cost of forest products including forest carbon has been presented in Chapter 8.

7.3.1 Firewood as a source of energy

According to National Population and Households Census Report available by Central Bureau of Statistics of Government of Nepal in 2011, about two third (64 %) of the total households in Nepal use firewood as usual source of fuel for cooking, followed by cow dung (10.38%). In the last couple of decade, using fuel wood as a source of energy has been decreased from 80.6 % in 1996 (Amatya, 1998).

Table 7.9 Consumption of Firewood

CFUG Name	Social groups	Mean	N	Std deviation
Dharpani CF	Bhramin/Chhetri	1948.00	15	1514.64
	Indigenous	2610.00	20	1229.86
	Average	2326.28	35	1378.54
Ludidamgadhe CF	Bhramin/Chhetri	1405.71	28	1282.82
	Indigenous	1400.00	3	1248.99
	Dalit	2100.00	4	600.00
	Average	1484.57	35	1216.83
	Average in both sites	1905.4286	70	1358.57415

(Source: HH survey, 2012)

Based on the household survey, estimation of firewood consumption as a source of energy has been presented in the Table 7.9 Energy use data is important because it shows the dependency of Forest User Group households on forests for meeting their energy requirement. Equally important from the climate change perspective is that energy use data shows the fuel wood consumption rate per households with respect to biomass increment rate.

The data presented in Table 7.9 shows the average household consumption of fuel wood per year. Accordingly, household in Dharpani CFUG in Chitwan consumes fuel wood equal to 2326.28 $kgyr^{-1}$ whereas the figure for Ludidamgadhe CF is 1484.57 $kgyr^{-1}$.

From the Table 7.9, it was found that indigenous social group consumed more fuel wood (2452.1739 $kgyr^{-1}$) followed by Dalit (2100 $kgyr^{-1}$) whereas Bharamin/Chhetri consumed the lowest amount of fuel wood (1594.8837 $kgyr^{-1}$). This showed the negative relationship between the prosperity and rate of fuel wood consumption because Bhramin/Chhetri who is better well off than other social groups could possibly rely on biogas and LP gas.

In two sites the highest consumption of fuel wood (2326.28 $kgyr^{-1}$) in Dharpani CF co-related with the highest population density (1.55 person per ha of forest) whereas the opposite was true for Ludidamgadhe which had the lowest consumption rate (1484.57 $kgyr^{-1}$) with lowest population density (0.46 person per ha of forest). So the population adjusts their fuel wood necessity according to forest size they have available.

The ANOVA test showed that there was no significantly different in consumption of firewood within the sites and social groups as well ($p<0.009$).

While comparing this result with the other research data on fuel wood consumption in mid Hills of Nepal, it was found to be within the range of estimates made already. For example, the Biogas Support Program (BSP, 2001) estimated that fuel wood consumption rate per household per year was between 2071 to 2307 kg. Similarly Mahat et. al (1987) in Gilmour and Fisher (1991) estimated 1049 kg of firewood per households with household size of 5.3 members.

7.3.2 Comparing Household consumption of fuel wood and biomass growth rate in community forests

From the sustainable management of forests, and REDD+ perspective, it is important to look into relation of household consumption of fuel wood with annual growth rate of biomass of community forests. Of the data presented in Table 7.10, biomass increment data was taken from the Table 6.5 of the previous Chapter 6, whereas the data on fuel wood consumption were referred from the Table 7.9.

The Table 7.10 below revealed that only the Ludidamgadhe CF showed the incremental carbon sequestered (4.35 per HH ty^{-1}) even after the extraction of fuel wood (1.4 t yr^{-1} per HH) indicating sustainable management of forest. However, the case in Dharpani CF was quite different because it had negative biomass growth which may be attributed to the over extraction of firewood, and other forest products. For example, the Table 7.10 shows that consumption of firewood was found to be 2.3 tone per household per year which is tremendously higher figure in comparison to the Ludidamgadhe CF.

From the Table 7.10 it has been evident from Ludidamgadhe CFUG that the lower the consumption of firewood contributes to higher the biomass increment. So the consumption of firewood can have an impact on the sustainable management of forest affecting the carbon trade in the long run.

Table 7.10 Household consumption of fuel wood in relation to biomass growth in two sites

CFUG Name	Year	Total biomass tha^{-1}	△ Biomass $tha^{-1}yr^{-1}$	Total Biomass increment in CF tyr^{-1}	Biomass Increment Per HH tyr^{-1}	Fuel wood Consumption Rate per HH tyr^{-1}
Ludidamgadhe	2011	183.60	9.43	2272.63	4.35	1.4
	2012	193.03				
Average		188.31	9.43			
Dharpani	2011	465.11	-93.31	Negative increment	Negative increment	2.3
	2012	371.80				
Average		418.45	-93.31			

(Source: ANSAB, 2011 & Field Survey, 2012)

7.3.3 Dependency on fodder, grass, litter, timber, and fruits

Livestock keeping in the hill farming system is an important enterprise owing to an important source of manure, as well as drought power to cultivate the farmland. Forest provides fodder (leaves), and bedding material (green and dry leaves used in the floor of livestock yard). Leaves from the forest are mixed with dung to make compost used for manure in agriculture field. Farmers build their livelihood by selling milk products and thus earn cash to meet the eventualities of the rural society. Therefore livestock rearing, agriculture and community forest are all linked in a subsistence economy in Nepal (Gilmour and Fisher, 1991).

Here in this study, cows and buffalos were only included in cattle category as the majority of households kept them for oxen to cultivate farm field, and milk purpose respectively. The Table K in Annex I clearly indicate that households of Ludidamdadhe CF kept more cattle (5.54) than Dharpani CF (4.0) in Chitwan district. Livestock keeping by inter- social groups suggests that there was no significant difference between the social groups keeping the livestock ($p<0.10$) in both sites.

The Table 7.11 shows the forest product consumption by the households of each social group in two sites. In both cases, the households having more livestock utilized more fodder and grass. For example, in Dharpani CFUG, Bhramin/Chhetri kept more livestock (4.33) than Indigenous group (3.75) so former group harvested 3.9 tyr^{-1} of fodder and 3.0 tyr^{-1} of grass whereas indigenous group harvested 2.9 tyr^{-1} grass and 2.8 tyr^{-1} of fodder.

Table 7.11 Forest products litter, grass, and fodder and timber consumption

CF Name	Social Groups	Mean	Litter kg)	Grasss((g)	Fodder kg)	Timber cft^3)	Fruits (kg)
Dharpani	Bhramin/Chhetri	Mean	1320.00	3080.00	3920.00	0.6	0
		Std. Deviation	2074.06	4036.83	3548.68	2.32	
	Indigenous	Mean	1422.00	2310.00	3442.50	3.6	106.80
		Std. Deviation	2481.17	2972.00	2833.32	16	303.45
	Total	Mean	1378.29	2640.00	3647.14	2.31	61.03
Ludidamgadhe	Bhramin/Chhetri	Mean	707.86	3160.71	2330.36	1.5	136.79
		Std. Deviation	758.86	2593.59	1608.43	5.8	405.68
	Indigenous	Mean	1600.00	2833.33	2666.67	0	66.67
		Std. Deviation	2116.60	3013.86	2516.61	0	115.47
	Dalit- group	Mean	550.00	4000.00	1000.00	1	0
		Std. Deviation	550.76	2245.37	353.55	2	
	Total	Mean	766.29	3228.57	2207.14	1.31	115.14

(Source : HH Survey, 2012)

The similar harvesting practices were followed by Ludidamgadhe CF as well where Indigenous group kept more cattle (6.67) than Bhramin/Chhetri group (5.46) so previous group harvested more quantity of fodder (2.6 tyr^{-1}) than the later group (3.1 tyr^{-1}). As Dalit was not represented in Dharpani CF, it was compared within the Ludidamgadhe CF only where this group harvested least amount of fodder and litter than the other groups living in the same community. Probably because Dalit kept few cattle as they work as wage labor in agriculture field owned by other social groups so have less time to rear the livestock on their own.

From the Table 7.11, it is evident that households of Dharpani CF utilized more timber (2.31 cft^3yr^{-1}) than the households of Ludidamgadhe (1.31 cft^3yr^{-1}) CF. The probable reason behind the utilization of more timber in Dharpani CF was that more timber was required to construct houses because the size of houses are relatively bigger in low land than the houses in Hills.

So far as the consumption of fruits is concerned, average annual amount of fruits consumption per household in Ludidamgdhe CF found to higher (115.14 kg) than the forest users of Dharpani (61.03 kg). It is interesting to note particularly in Darpani CF was that the marginalized Chepang group which constituted the majority of Indigenous population in CFUG depend on the fruits found in forest to earn their subsistence livelihood. The fruits available on forest include banana, pineapple, mango, berry etc.

7.3.4 Summary and Issues

1. From the study, it was found that prosperous forest user group utilizes less forest products thus have less dependency (in terms of consumption) on forest products. The showcase of Ludidamgahe CF offered a good example which is more prosperous in terms of socio-economic indicators (small household size, more literacy rate, more well off people with larger land holding size) but utilize lesser amount of forest products (firewood, timber, litter and firewood) of the total 6 forests products listed in this study. So, it is imperative that attention should be paid on improving the socio-economic status of forest user groups which have a good impact on sustainable management of forest in the long run.

2. From the study, it was found that despite lower population density, the rate of consumption of firewood may increase leading to negative biomass rate as evident from Dharpani CFUG which has larger per capita forest area (2.17 $haHH^{-1}$) but utilized more firewood (2.3 tone of firewood per household annually) in comparison to Ludidamgade CF which has less per capita forest (0.46 $haHH^{-1}$) but utilized less amount of firewood (1.4 tyr^{-1}) with positive biomass increment. The study reveled that there is strong negative relationship between fuel wood consumption and biomass increment. From the REDD+ perspective, it is important that every community forests who intend to participate in carbon trading should have positive biomass increment to get benefits.

3. Although the quantity of consumption of forest products varied with different social groups, from the analysis, it is evident that community forest users with indigenous origin rely more on forest products to fulfill their necessities From the REDD+ perspective, selling carbon will definitely have a more impact in indigenous forest users if crediting carbon is limited to forests where harvesting is totally prohibited. Also, this will add an extra social economic burden on the existing users. The next Chapter 8 will look more on this issue while making analysis on the cost benefits of carbon trade in the context of community forests management in the research sites.

7.4 Which household characteristics are more influential in shaping perception on climate change?

The REDD+ program was implemented in research sites assuming that local community were aware on climate change and its impact on their livelihood at the time of project implementation. In line with the context, this section aims to investigate to what extent, forest user groups perceives climate change as threats or opportunity to their agrarian livelihoods. The hypothesis as mentioned in Chapter 1, this section want to test that perception of people on climate change impact is significantly influenced by the household characteristics such as gender, cast, age, education, household size, and economic status. The test is relevant because community members of different socio-economic categories think differently on climate change, and its real and potential impact on livelihood and nature based assets.

7.4.1 Perspectives on the importance of public perception on climate change

Nepal approached REDD+ not only as a mitigation approach but also a means of contributing to development and poverty reduction through adaption , so Nepal placed community forestry at the hearts of REDD+ and adaptation strategies (West, 2012). As the adaptive friendly REDD+ implementation is to be implemented, it is important to know how local forest users groups perceive climate change in their local context. In other words, communities facing climate change should perceive that the changes are indeed taking place in order to implement any coping or adaptation strategies in more effective ways (Luni et.al,2012). Moreover, understanding of public perception to climate change is essential in the development of adaptation strategies (Jalon et.al, 2013), and garnering co-operation and support from the local community to mitigate climate change from adopting low carbon lifestyles (Semenza et.al, 2008).

Despite the fact that climate change is a universal phenomenon, it is also important to note that climate change indicators and manifestations are entirely local. In this context, there is growing emphasis on bottom up planning that climate change studies should be conducted at the local level where climate change coping strategies adoption by the local community really occurs (Smit and Wandel, 2006).

With bottom up planning through empowerment of local forest user groups to map out local climate change impacts, adaptation needs and enhancing resilience, adaptation friendly REDD+ strategy enable to trigger synergy between mitigation and adaption (West, 2012). More importantly, capacity building of local community is imperative to strengthen synergy between these two approaches through seeking collaboration within and between national and local level institutions.

Against this background, this section attempts to understand to what extent local forest users are well informed on climate change, and its perceived impact on their livelihood and biodiversity. More specifically, given the heterogeneous social, economic and cultural structures of Nepal, it is important to know which socio-economic variables are more influential in shaping the perception than others so that appropriate climate change adaptation and mitigation strategies could be formulated and implemented suit to the local context.

Of the households characteristics, following socio-economic variables was taken into account:

1.**Income status** 2. **Gender** 3.**Cast** 4. **Age** 5. **Education** 6. **Household**

For the purpose of measuring perception of climate change, perception was defined in terms of a dichotomous (yes/no) or binary variables. Variables were assigned 1, for example, if the value increased, and 0 otherwise. In the empirical analysis, 9 separate binary variables as dependent variables, and 6 independent variables has been taken into account based on previous literatures and specific local characteristics of local study community. The detail descriptions of both types of variables are presented in Table 7.12.

7.4.2 Model specification

Studies on climate change perceptions have adopted various models to analyze the factors determining perception: ordinal and nominal logistic regression, probit selection models and binomial probit model (Luni et.al, 2012). For this study purpose, binary logistic regression model was used owing to the dichotomous variables in shaping the perception of forest users. The following logistic regression model characterizing perception by households is specified as follows:

$$In[p_i/1-p_i] = B_0 + B_1X1_i + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + B_kX_{ki}$$

Where subscript *i* denote the *i*-th observation in the sample, p is the probability of the outcome, B_0 is intercept term and B_1, $B_2 \ldots\ldots$ B_k is the coefficients of each explanatory variables X_1, $X2 \ldots\ldots X_k$. It is important to note that estimated coefficients do not directly imply the change in corresponding explanatory variables on probability of the outcomes occurring. Besides, these coefficients reflect the effect of individual explanatory variables on its log of odds $In\ [p_i/1-p_i]$. If the log of odds positively or negatively associated to an explanatory variable, odds $[p/1-p]$ and probability $[p]$ are also positively or negatively related to the independent variables. In addition, relationship is linear in log of odds and non linear for odds, and probability of outcomes.

The *X*- variables involved in the logistic regression model for perception are defined in Table 7.12 along with their summary statistics.

Raising temperature and change in rainfall pattern (water) are the well-known indicators for global climate change impact (IPCC, 2007). Taking this fact into consideration, all variables selected in this study are either associated with temperature or water. Of the total 9 dependent variables, and 6 independent variables, the binary dependent variables used in logistic regression were overall warming status (assigning 1 if value increase or yes, and 0 otherwise), decrease in number of water springs, early flowering, and the emergence of new pests. Similarly other response variables included were rain fall intensity, decreased amount of water, and forest fire, change in local forest species, and appearance of alien species. Independent variables (inputs) hypothesized to influence in perception in the model were class, age, gender, caste, education, and household size. These explanatory variables are the socio economic determinants of forest user group’s perception on climate change. Except age and household size all variables are used in model as dummy variables. Owing to heterogeneous Nepalese society, it would be interesting and useful to see which of these variables are more influential than others to shape perception of climate change by different walk of forest users' members with different age, and sex with different economic base.

Table 7.12 Descriptions of variables in logistic regression model with descriptive statistics

Independent Variables	Unit	Mean (Std. deviation)
Poor	Dummy ; 1= Poor income group, 0 =otherwise	0.34(0.47)
Gender	Dummy ; 1= Male, 0=otherwise	0.67(0.47)
Caste	Dummy; 1= Bhramin/Chhetri, 0=otherwise	0.61(0.49)
Age	Age of the respondents	42.21(13.54)
Education	Dummy; 1=Literate, 0=otherwise	0.70(0.49)
Household size	Number of members in the family	5.09(1.49)
Dependent variables	Unit	Mean (Std. deviation)
1.Increased warming	Dummy;1=yes,0=otherwise	0.60(0.49)
2.Drying of water in pounds and lakes	Dummy;1=yes,0=otherwise	0.40(0.49)
3.Early flowering	Dummy;1=yes,0=otherwise	0.90(0.29)
4.Increse in pest appearance	Dummy;1=yes,0=otherwise	0.60(0.49)
5.Rainfall intensity	Dummy;1=increase,0=otherwise	0.34(0.47)
6.Decresed in rainfall amount	Dummy;1=increase,0=otherwise	0.65(0.46)
7.Cases of forest fire	Dummy;1=increase,0=otherwise	0.61(0.49)
8.Change in forest species	Dummy;1=yes, 0=otherwise	0.47(0.50)
9.Emergence of invasive species	Dummy;1=yes, 0=otherwise	0.80(0.4)

7.4.3 Factors facilitating perception

Maximum likelihood estimates of parameters in the logistic regression models characterizing perception of forests users of both sites are presented in Table 7.13. Also presented in Table 7.13 are the effects of independent variables on odds and log odds, the log likelihood ratio (-2LL) tests, Cox and Snell R^2, Chi square test probability.

From the Table 7.13, of the six explanatory variables, only literacy rate found to be positively associated with log of odds of perception on rising temperature in a significant manner. Poor households were found negatively associated with log of odds of perception on raising temperature. No explanatory variables seemed significantly associated with the perception on drying of water and early flowering.

From the Table 7.13, we can see that there was a significant relationship between the log of odds and hence odds of perception and explanatory variables included in the model suggesting some variables were significant and some were not. As Log likelihood ratio, Cox and Snell R^2 values in Table S in Annex I suggest that the estimated perception models had a good explanatory power. For each response

Table 7.13 Results from the binary logistic regression

Response variables	Sex		Cast		Literacy		Economic Class		Age		Family Size	
	B	Exp(B)	B	Exp(B)	B	Exp(B)	B	Exp(B)	B	Exp(B)	B	Exp(B)
Warming	-1.5	0.2	-0.6	0.5	4.4	79.34**	-2.1	0.12**	0	1	0.1	1.1
Dry of water	-41.3	0	-1.6	0.2	18.4	108	-0.3	0.8	0	1	-0.7	0.5
E. Flowering	1.3	3.6	-19	0	-0.1	0.9	-0.8	0	-0.1	0.9	0.3	0.7
Ncrpest	-1.5	0.2	-0.6	0.5	4.4	79.341**	-2.1	0.12**	0	1	0.1	0.7
Intensity	-3.6	0.026**	-1.9	0.15**	1.4	3.9	0.2	1.2	0	1	0.4	1.4
Rainfall amount	-3.6	0.02**	-1.8	0.2	1.34	3.8**	0.1	1.2	0	1	0.4	1.4
Forest fire	2.1	8.52**	-0.5	0.6	3.8	44.25**	0	1	0	1	0	0.97*
Change in forest species	-1.5	0.22**	-0.2	0.8	0.6	1.7	-0.3	0.7	0	1	0.3	1.3
Invasive species	-0.1	0.9	1.2	3.30*	0.1	1.1	-0.1	0.9	0	1	-0.2	0.9

Note: ***,**, * indicate significant at 1% ,5% and 10% level of significance respectively

With regard to perception on the emergence of new crop pest, of the explanatory variables, education found positively associated whereas poor economic class found associated negatively.

Of the 6 explanatory variables, sex (male), Cast (Bhramin/Chhetri social group) were found to be negatively associated with log of odds of perception that rainfall has been intense in recent years, whereas education level and family size showed positive relation with the same variable.

Regarding perception on forest fire, sex (male), literacy, and family size found positively associated with the perception on growing forest fires incidents.

From the Table 7.13 we can see that sex (male), and cast (Bhramin/Chhetri social group) were found negatively associated, whereas family size found positively associated with the perception that there has been changed in forest composition due to climate change.

Similarly, Caste (Bhramin/Chhetri social group), and age was found to be significantly associated in a positive manner with logs of odds of perception on colonization of forest by invasive species.

One of the interesting finding emerged from the analysis is that education was found to be significantly associated with perception on raising temperature, emergency of new crop pest, rainfall amount and forest fire. The probable reason for a positive association of education with these response variables is that educated person has more access to information on climate change. For example, educated persons read more articles and news coverage on climate change, so they showed comparatively more concern over climate change and its effects on agriculture and forest. Finding of this study on the influence of education level in shaping climate perception resemble with other findings. For example, Sampei (2009) found the positive correlation of mass media coverage on climate change with public concern for the issue.

Of the explanatory variables, sex (male) showed significantly negative association with three response variable (rainfall intensity, amount of water, change in forest composition), but was found to be positively associated with a log of odds of perception of forest fire. It is quite interesting to note that male are the bread winner in the household in Nepalese society despite to be less informed on what is going on with quantity of water. Similar is the case with male engagement in the forest where majority of works related with carrying of grass and fodder is performed my female, so male are less informed on the composition of forest species in community forests. Finding of this study is similar with the study conducted by Capstick et.al. (2013), which showed that male were less concerned with the climate change than the female were. Contrary to this finding, male positive perception on log odds of increased incident of forest fires is attributed to the more visibility nature of forest fires in summer.

The explanatory variable-caste seemed negatively associated with a log of odds of rainfall intensity, amount of water, and change in forest species but showed positive relation with log of odds of emergence of invasive species in community forests. It is quite natural to see that the upper caste social group (Bhramin/Chhetri group) who are more privileged than other social groups (Bennett, 2005) engage more in skilled work other than agriculture and forestry activities, so they are less concerned with what is happening on rainfall, quantity of water, and forest species composition. Positive association of this social group with emergence of invasive species is attributed to the abundance of invasive shrub (*Chromoleaena odorata)* everywhere in all ecological zones of the country (Joshi et.al, 2006).

The independent variable-economic class (poor and non poor) was found to be negatively associated with the log of odds of increased warming, and log of odds of increased crop pest but found positively associated with a log of odds of increased rainfall intensity. Both negative and positive association of poor with these dependent variables would probably be attributed to their more engagement in non agriculture activities owing to very less land (<0.5ha) they have to earn their livelihood. Lesser engagement of poor in agriculture field means their little exposure to warming and, and lesser observation on emergence of agriculture pest. However, as intense rainfall trigger landslides and flooding, it is more visible so positive direction on perception on intense rainfall is obvious.

The factor-age was found not significantly associated with almost all response variables.

The last independent variable-family size incorporated in the Table 7.13 was found to be significantly associated with log of odds of increased rainfall intensity, decreased amount of rainfall water, and increased cases of forest fires in a positive direction. The probable reason for the positive association of family size is that households members adopt multiple occupation resulting to access to and sharing information on more field like rainfall, its amount and forest fire as well.

Also from the Table 7.12, it was found that the majority of respondents (60%) were of the view that they experienced a rise in temperature, noticed early flowering, and experienced the emergence of unwanted pests in their farm land. Also, majority of respondents noticed that amount of water coming from rainfall was going down, experienced increased forest fire incidence, and observed colonization from invasive species in their forests. However few respondents (<50%) opined that they observed drying of water in water bodies, noticed intense rainfall, and experienced change of forest species in their places.

7.4.4 Summary and issues

Study on local perception on climate change gives important insights to the REDD+ implementers at a grass root level, and policy makers at macro level. From the study, it was found that education linked significantly to shape perception on climate change implying that information dissemination on cause and effect of the climate change is important to take into account. Giving emphasis on educating the local community will help to motivate them to engage in both adaption and mitigation activities. Logistic regression analysis also demonstrates the importance of education through information dissemination and community level services which are the important facet of educating the local community and that can be performed through garnering support from local NGO and local government bodies including forest user groups because these locally based institutions can transfer information, and conduct climate change awareness campaign effectively on participatory way.

Caste, gender, and economic class are more or less stable social structure in Nepalese context, so they tend to more resilient to be changed itself. Therefore, by conducting climate change education campaign, women, lower cast and indigenous people should get more support through treating them as a target group by both government and non-government bodies. More specifically, there is need to expand small scale meteorological facilities to monitor temperature and rainfall records by these target groups.

The cross tabulation figures in regression analysis suggests that almost all response variables except early flowering and drying of water found significantly associated with one or more socio-economic factors.

As the forest users perceive that climate change is happening, it provides ample opportunity to implement the REDD+ program in more effective way. In other ways, the ongoing REDD+ may have contributed to enhance awareness on climate change, but the scope of this study was not to include the effect of REDD+ program on climate change perception.

CHAPTER 8

IS CARBON SEQUESTRATION BASED CARBON TRADE BENEFICIAL TO FOREST USER GROUPS?

8.0 Introduction

To what extent the Community Forests demonstrated the capacity to sequester carbon was discussed in Chapter 6. The Chapter 7 showed to what extent CFUGs rely on forests products to fulfill their necessities, and what they think on climate change. The aim of this Chapter is to answer whether carbon trading in light of REDD+ mechanism will be beneficial to CFUGs who are managing and protecting their forests.

With keeping 'with and without carbon trading' in the nucleus of discussion, this Chapter starts with the estimation of cost of carbon sequestration based on analysis made on sequestration rates by the Community Forests in Chapter 6. Literature available on a comparative study on cost of abating carbon from other projects implemented around the globe will be compared with the results from the research sites. Setting the year 2011 as baseline to compare carbon credit with subsequent year, this Chapter will explain how three alternative scenario were created and compared to each other based on the gross margin analysis. To be the carbon trade more profitable to the CFUGs, the net gain must be above of what currently forest users are deriving benefits from the forests they are managing.

As the price of carbon varies spatially and temporally, this Chapter has incorporated two carbon prices ($1 and $ 10 per tCO2[11]) to serve as low and mid price (conservative price) to weigh the benefits of forests management and carbon measurement under three different scenarios. Comparing the price of carbon at these different scenarios will allow us to make a judgment on which scenario is best suitable to Forest User Groups. It is important to note that the cost will increase in managing forest for extra carbon credit, and the cost for marketing carbon will also rise accordingly.

In Nepal, scores of REDD+ project are being implemented in local and sub-national level, so there is no national level baseline to serve as a reference level (Karky, 2008). As two

[11] The Forbes magazine (www.forbes.com) estimated the price of per ton of CO_2 at $ 28.24 in 2012 has claimed that the price is consistent with European Union prices. Synapse (2012) has projected the price of per ton CO2 for 2020 at $15; $20 and $ 30 in low, mid and high case respectively (http://www.synapse-energy.com).

measurements years 2011 and 2012 has been incorporated into this study, the previous year 2011 is the reference point for this research.

All values pertaining to gross and net benefits (both monetary and non-monetary) of forest products derived from Community Forests are expressed in US$ (1US$=85NPR). Detail valuation process of products is mentioned in valuation section of this Chapter.

8.1 Review of studies on cost for reducing carbon

Numerous literatures available globally on cost of reducing carbon suggest a range of carbon cost. After reviewing 8 countries responsible for 70% emission it was found that emission savings from avoided deforestation could yield reductions in CO2 emissions under $5/tCO2 (based on opportunity cost), and planting new forests cost estimated at around $5/tCO2 - $15/tCO2 (Stern, 2007).

Cost of REDD project incorporates opportunity cost, implementation cost and transaction cost (WB, 2009). In this thesis context, opportunity cost is the foregone benefits that forest users should lose if sanction is imposed for not allowing harvesting forest products such as firewood, fodder, timber. Estimating this cost is the single most problem in estimating the cost of carbon (WB, 2009).

Implementation cost involves the actions leading to reduced deforestation such as cost of and guarding a forest to prevent illegal harvesting of forest products in community forests. Implementation costs also comprise the capacity building activities (training, research, political, legal and regulatory process) that are necessary to make the REDD program happen.

Transaction cost involves a REDD payment (the buyer and the seller, or donor and recipient) to ensure that a certain amount of emission reductions has been achieved. The costs incurred the process of identifying the REDD program, negotiations and transaction, and monitoring, reporting and verifying the tons of emission reductions.

The World Bank (2009) quoting Boucher's (2008) review presented the cost of mean opportunity cost of US$2.51/tCO2, with 18 out of the 29 estimates at less than US$2/tCO2 and

28 out of 29 at less than US$10/tCO2. The mean opportunity costs for Asia was found highest (US$2.90/tCO2, and lowest for Africa (US$2.22/tCO2, whereas the cost for Americas was US$2.37/tCO2.The average costs of implementation and transaction costs together was US$1/tCO2 or 20 % of the opportunity cost (WB, 2009). However, a case study in Tanzania showed different where implementation cost exceed opportunity cost of carbon conservation with medians of USD$6.50 and US$3.90 per tCO2 respectively (Fisher et. al, 2011). In the context of this thesis, the analysis of the literatures aforementioned on cost of carbon reduction will help to compare with the carbon offsetting cost[12] involved in community managed forests of the research sites.

8.2 Baseline for the carbon management

Setting baseline with regard to existing community managed forest is rather complex when compared to CDM where afforestation and reforestation project start from degraded forest with no cover since 1990 (Karky, 2010). As communities are managing forests since time immemorial, setting the exact base point is rather difficult. So this thesis takes the reference point started from the year 2011. There are two components while managing carbon. One is increased carbon (sink of carbon), and other is avoided emissions from deforestation and degradation (source of carbon). The Graph 8.1 illustrates these two components. The line *ab* is the real carbon increment in biomass measured between 2011 and 2012.

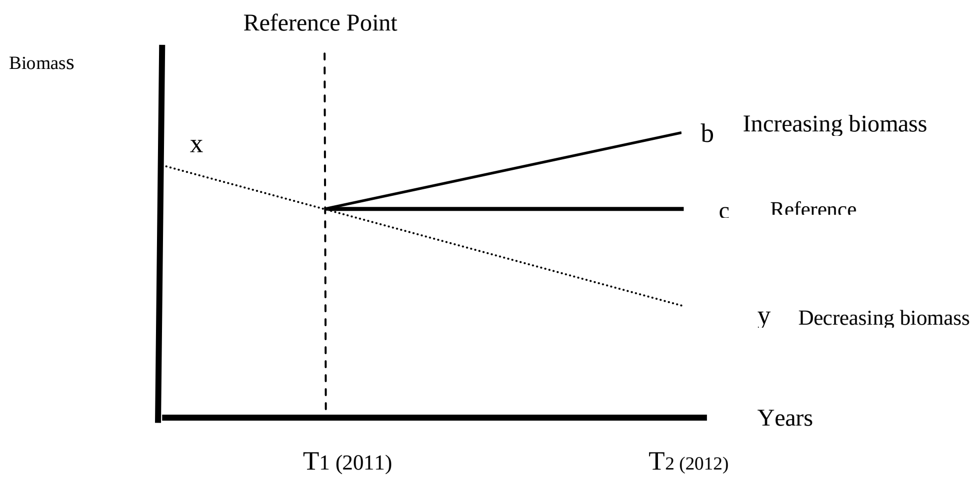


Figure 8.1: Baseline for community managed forests (Source: Adopted from Karky et.al (2010)

[12] Carbon offsetting is the carbon substituting through non carbon fuel (Wind, solar, biogas etc). Afforestation, reforestation and community forests (sink of carbon) are also carbon offsetting projects which offset carbon.

The line *xy* shows the business as usual scenario with declining biomass. The assumption is that no management occur at T_1, and after management intervention, increment in biomass started that is shown by line *ab* which reversed the declining trend *ay*. Only emission avoided indicated by triangle *yac* is credited under the second component.

In this thesis, I have accounted the rate of carbon increment (triangle *cab*), and not avoided deforestation (triangle *yac*) due to score of reasons: 1) there are no exact data showing the historical deforestation trend, 2) There is uncertainty in establishing reference point because community are managing the forests since time immoral, so it is difficult to find out the time when the increment of biomass started. 3) As the REDD+ program in Nepal is implemented in sub national and local level, Government of Nepal has no national level baseline yet to compare the relative progress made in biomass in each project sites.

The section below gives details on how different scenarios were created and analyzed for estimating the cost of carbon offsets in community forests.

8.3 Valuing benefits and costs to local communities with setting three scenarios

8.3.1 Three forest management scenarios

This section looks into the cost and benefits of carbon management. For this to happen, this thesis has set 3 different scenarios which are listed in the Box 8.1. The scenario 1 is about business as usual which deals with management of forests by community without intending to get benefits from carbon management. The benefits included were from the harvesting of forest products (firewood, fodder, timber, litter, grass, fruits), whereas the cost included labor and cash contribution for management and protection of forest, and fee paid for forest products.

The scenario 2 is the addition of carbon management to scenario 1. After meeting the subsistence needs from forest products, communities sell carbon credit. In this scenario, additional benefits included carbon revenue from forest at the rates $1 and $10 per tones CO_2, whereas additional cost included, carbon project preparation, carbon measurement, carbon monitoring, carbon marketing and verification (carbon implementation with additional cost in forest protection, carbon monitoring and verification).

The scenario 3 is the case of forest managed for carbon sequestration only in which forests users are not allowed to extract the forests products. As no forest products are allowed to extraction, annual fuel wood consumption estimated from the socioeconomic survey is converted into carbon credits. Benefits stated in scenario 1 and scenario 2 are additional cost to scenario 3 as their usages are foregone.

Box 8.1 : Forest activities pertaining to cost and benefits

	Scenario1	Scenario 2	Scenario3
Benefits	Fuelwood Fodder Litter Grass Fruits	Fuelwood Fodder Litter Grass Fruits Carbon revenue	Carbon revenue (carbon sequestration plus carbon saved from fuel wood consumption)
Cost	-Labor and cash contribution on forest management and protection -Fee for paying forest products	-Labor and cash contribution on forest management and protection -Fee for paying forest products -Carbon project preparation -Carbon measurement -Carbon monitoring -Marketing and verification	-Labor and cash contribution on forest management and protection -Fee for paying forest products -Carbon management -Carbon measurement -Carbon monitoring -Marketing and verification Opportunity Cost -Fuel wood (foregone) -Fodder(foregone) -Litter(foregone) -Grass(foregone) -Fruits(foregone)

8.3.2 Valuing Benefits and Costs to CFUGs

All gross and net benefits (both monetary and non-monetary) of forest products derived from Community Forests are expressed in US$ (1US$=85NPR). In rural areas of Nepal, bhari[13] instead of kg is used to express the weight for solid matter so conversion of forests products that were collected in bhari was converted later into kg, and further into tone to express the biomass in terms of tone per hectare of CFs.

[13] 1 Bhari firewood = 30 kg;1 bhari fodder and grass=25 kg, and 1 bhari litter =20 kg (Gurung et. al, 2011)

The price for a bundle (1bhari=30kg) of firewood is available in the market where vendors frequently sell firewood of 30 kg (1 bhari) at NRP 300 ($ 3.53). However, the price for fodder, grass and litter are not available in the market. So for calculating the value of these products in monetary terms, Forest User Groups were asked as to how much quantity of these products they carried in a day. Based on the discussion, it was found that forest users spent a day to carry 2 bhari of fodder and grass, and 3 bhari of litter. Based on the discussion with forest users, the wage of labor per day in a rural area was found NRP 250 (US$2.94), the net labor wage was used to calculate the value of these products by dividing the total bhari of forest products they carried in a day. It was easy to calculate the value of timber and fruits because the fee for timber is mentioned in forest operational plan, and the monetary value for fruits is available in the market.

Valuing gross benefits

Based on Box 8.1, the gross benefits were calculated following the aforementioned calculation procedures which are based on household survey. Households were asked about how many forests products they utilized per year. Then the derived products were converted into monetary terms although forest products like firewood, grass, litter, fodder, fruits and timber are not sold in the market. Hence the benefits from utilizing forests products were expressed in dollar that each household derived annually. According the Table L in Annex I, it was found that both CFUGs in average derived more benefits from firewood ($ 156.92 HH^{-1} yr^{-1}), followed by grass (115.07 $HH^{-1}yr^{-1}$) and fodder (114.79 $HH^{-1}yr^{-1}$). The least benefits were derived from timber (1.17 $HH^{-1}yr^{-1}$) preceded by fruits (31.09 HH^{-1} yr^{-1}) and by litter (39.42 $HH^{-1}yr^{-1}$). No significant different observed between the value of benefits derived from the forest products expect in fodder (0<0.018).

In terms of total gross benefits between the two community forests, Dharpani CF derived more gross benefits ($ 426.46 $HH^{-1}Yr^{-1}$) than Ludidamgadhe CF ($365.25 $HH^{-1}Yr^{-1}$). In both cases, indigenous group derived more benefits ($427.99 $HH^{-1}Yr^{-1}$) than Bhramin/Chhetri groups ($379.84 $HH^{-1}Yr^{-1}$) and Dalits ($ 360.48 $HH^{-1}Yr^{-1}$). The details of total gross benefits are shown in Table M in Annex I. This analysis showed the more dependency of Indigenous groups on forest products.

Valuing costs

According to the Box 8.1, the cost calculation included total forest management and protects cost, and the total amount paid in cash to purchase forest products from community forests. The Table N in Annex I give details on cost pertaining to forest management and protection cost. According to the Table C in Annex II, total management and protection cost in Dharpani CF ($ 85.38 $HH^{-1}yr^{-1}$) seemed more than in Ludidamgadhe CF ($ 42.44$HH^{-1}yr^{-1}$).

In terms of the total amount paid for buying forest products as per constitution, forest users of Dharpani CF paid more fee ($ 9.28$HH^{-1}yr^{-1}$) than Ludidamgadhe CF ($1.40 $HH^{-1}yr^{-1}$). The Table O in Annex I based on Box 8.1 gives details on cost pertaining to forest management and protection cost.

The Table P in Annex I showed the total cost incurred in forest management, forest protection, and fee paid. According to Table E, the total cost in Dharpani CF ($97.17 $HH^{-1}Yr^{-1}$) was more than Ludidamgadhe CF ($31.85 $HH^{-1}Yr^{-1}$) which was significantly different ($p<0.050$). In terms of the distribution of total cost among the social groups, it appeared that Indigenous groups borne more cost ($101 $HH^{-1}Yr^{-1}$) than other Bhramin Chhetri groups ($48 $HH^{-1}Yr^{-1}$) and Dalit ($33 $HH^{-1}Yr^{-1}$).

Net monetary and non-monetary benefits

After deducting the cost from gross benefits aforementioned, net benefits were derived as shown in Table Q Annex I. The average net benefits derived from community forests was $333.11 $HH^{-1}yr^{-1}$ in Dharpani CFUG, whereas the figure was $339.86 $HH^{-1}yr^{-1}$ in Ludidamgadhe CFUG. Though forest users of Ludidamgadhe CFUG derived slightly more benefits, the difference was not significant. In terms of distribution of net benefits among the social groups, Bhramin/Chhetri derived more benefits than the Indigenous groups in both CFUGs.

8.3.3 Results from the two sites under 3 scenarios

From the biomass assessment derived from the CFUGs of research sites and financial assessment from the household survey, gross marginal analysis was carried out only for one year in which estimation is based on real time data.

Scenario 1 (no carbon trade)

In Table 8.1, we see the benefits after cost are deducted in terms of monetary and non-monetary values under Scenario 1 which represents business as usual for both sites. As carbon trading is not considered, and it is obvious that benefits and costs associated with carbon trading are not included. It is important to note that forest plays a vital role in providing subsistence needs to the local households where most of the benefits except timber utilized by households are not valued in monetary terms. As the proportion of monetary value is less than 1 % (Table E in Appendix II), we can see how important is the nonmonetary values (almost 99%) derived from the forest products to the households of the community.

From the Table 8.1,we see that Ludidamgadhe CF derived more benefits valued at $ 177406 than Dharpani CF ($37308).

Table 8.1 Value of net benefits under Scenario 1 (Business as usual)

US$	Yr 2012
Ludidamgadhe CF: net gain	1,77,406
Ludidamgadhe CF: net gain per HH	339.86
Dharpni CF: net gain	37,308
Dharpani CF: net gain per HH	336.11

(Source: Carbon data from ANSAB (2012) and HH Survey, 2012)

At the household level, the total net benefits stood at $339.86 whereas in Dharpani CF the value was $ 336.11. In both community and household level, net benefits were derived more in Ludidamgadhe than Dharpani CF. Despite the variation in values between the two CFUGs which is largely attributed to the size of forests and size of households, it is clear that benefits derived from community forests provide incentive for the community in managing and conserving their forests.

Scenario 2 with Trading at $1 and $ 10 rates (Carbon trade with forest resource extraction)

The Table 8.2 shows the gains at CFUG and household levels under Scenario 2 where carbon trading takes place in Community Forest at two different prices, at $1 and $10 per tCO2. Under this scenario, CFUG members are permitted to extract forest products as they would do under scenario 1. Hence under this Scenario, the forest inventory, carbon assessment, carbon project preparation were included as an additional cost, whereas carbon revenues as additional benefits. Unfortunately, as Dharpani CF did not sequester carbon, consequently calculation of carbon trading in this CF is not relevant. The Box 8.2 gives details on how net benefits and carbon revenue was calculated.

Table 8.2 Scenario 2 Carbon trading at $1 and $10 Per t CO_2 with forest resource extraction

	US $ 1 per tCO_2	US $ 10 per tCO_2
US $	Yr 2012	Yr 2012
Ludidamgadhe CF: net gain	1,75,260.74	2,10,441.92
Ludidamgadhe CF: net gain per HH	335.74	403.14
Ludidamgadhe CF: net carbon revenue	3,909.02	39,090.02
Ludidamgadhe CF: net carbon revenue only per HH	7.47	74.88

(Source : Carbon data from ANSAB (2012) , and HH survey, 2012)

When the selling price for tCO2 is $1, net gain for Ludidamgadhe CFUG is over $ 175260.74, and at $10 rate, the net gain goes up to over $ 210441.92 after deducting the cost incurred in forest inventory, forest assessment, and REDD+ project preparation.

At household level net benefits stood at $ 335.74 per year at $1 rate, and $403.14 at $ 10 rate.

It is interesting to know that the proportion of carbon revenue of the total gain was just $ 3909.02 (2.15 % of the total gain $181315.02 with carbon revenue before deducting cost) at $1 rate, and $39090.02 (18 % of the total gain $216496.2 before deducting cost) at $10 rate under Scenario 2.

Box 8.2

Net gain Calculation procedure at $1 rate (Scenario 2)

Step 1 : Calculate net gain of forest products (A) : $177406 ($339.86* 522 HH)

Step 2 : Calculate carbon revenue (B) : $3909.02 (1$*16.22 tCO2per ha*241ha)

Step 3 : Calculate cost in carbon trading (C) : $ 6053.92 ($1.57 per tCO2*16.22 tCO2/ha*241 ha

Step 4 : Calculate total net gain : A+B-C =$ 175260.74

It is not profitable to sell CO_2 at \$1 rate under Scenario 2 because carbon revenue (\$3909.02) was quite below than the cost incurred in carbon trade (\$6053.92). However, it seemed profitable to sell CO_2 at \$10 because carbon revenue jumped to \$ 39090.2 was higher than the carbon cost which remained the same (\$6053.92). The cost in carbon trade was \$1.57 per tCO_2. The total cost was calculated taking into account carbon project preparation, carbon measurement, Carbon project preparation, and carbon monitoring and carbon verification as stipulated in Box 8.1. The cost calculating procedure is described in Box 8.3.

Also, it is interesting to note that FUGs derived fewer benefits under this scenario at \$1 (\$ 175260.74) compared to 'business as usual' scenario (\$177406) owing to additional cost of carbon inventory and carbon management. However, it seemed profitable by 18 %{(210441.92-177406)/177406} to take part in carbon trade under Scenario 2 at \$10 (\$210441.92) when compared to 'business as usual (\$177406) under scenario 1.

Scenario 3 with Trading at \$1 and \$ 10 rates (Carbon trade without forest resource extraction)

Under Scenario 3, only gain from carbon revenue is taken into the calculation, and consequently forest resource is not permitted to be harvested. It is an ideal Scenario because investors would become more assure on the carbon output by minimizing the risk arise from forest deforestation and degradation, illegal logging and forest fire by keeping he forest users out the scene of forest management. Under this Scenario, forest user groups who depend on forest resources to fulfill their necessities should scarify for earning carbon revenue that is foregone cost (opportunity cost[14]) for forest users. More specifically, all benefits (both monetary and non-monetary) derived from CF under Scenario 1 are included in foregone cost as mentioned in Box 8.1. However, annually fuel wood consumption per household as mentioned in Chapter 5 is converted to tCO_2, and considered as additional carbon

Box 8.3 (Scenario 3)
Net gain Calculation procedure at \$1 rate

Step 1 : Calculate carbon revenue (A) : \$ 6781.74 (1\$*28.14 tCO_2per ha*241ha)

Step 2 : Calculate the opportunity cost (B) = \$177406 (\$339.86* 522 HH)

Step 3: Calculate the implementation cost (C): \$6781.74 (28.14CO_2/ha *241 ha)

Step 4: total cost in carbon trading (D) : \$ 184124.2 (B+C)

Step 4 : Calculate net gain : A-D =-\$ 177342.5

[14] **Opportunity cost** is the cost of any activity measured in terms of the value of the next best alternative forgone (that is not chosen). It is the sacrifice related to the second best choice available to someone, or group, who has picked among several mutually exclusive choices (www.wikipedia.com).

sequestered by forest (1.5t/hh/yr firewood consumption in Ludidamgadhe CF). The Table R in Apppendix I show how both carbon sequestration from biomass and firewood was converted into tCO2.

The Table 8.3 suggests that revenue coming from selling CO2 both at $1($6781.74) and $10 ($67810.4) rate are not sufficient to offset the foregone cost of forest products (-$177342.5). Consequently, there were losses in selling CO2 owing to higher cost incurred primarily from foregoing the forest product than the carbon revenue sold in both rates.

Table 8.3: Scenario 3 carbon trading at $1 and $10 Per t CO2 without forest resource extraction

	US $ 1 per tCO_2	US $ 10 per tCO_2
US $	Yr 1	Yr 1
Ludidamgadhe :net gain	-177342.5	-116306
Ludidamgadhe :net gain per HH	-339.74	-222.81

Source: (Carbon data from ANSAB (2012), and HH survey, 2012)

With the restriction on usage of forest products, net loss at household level was valued at -$339.74 at $1 rate, and at -$222.81 at $10 rate, whereas the cost in carbon trade seemed $27.15 per tCO2. Provided the competitive price in the international market, it would be more profitable if CO2 can be sold at $27 ($176325).

8.3.4 Discussion on net benefits from three Scenarios:

Based on the analysis of community managed forests and carbon trading under three Scenarios at community and household level, it is found that:

1. Scenario 1: At both community and household level, Ludidamgadhe CFUG derived more benefits than Dharpani CFUG. For example, Ludidamgadhe CFUG derived more benefits valued at $ 177406 compared to Dharpani CF ($37308). At the household level, the total net benefits stood at $339.86 in Ludidamgahe CFUG whereas in Dharpani CFUG the value was $ 336.11 suggesting not much difference in value between them. Further, as the proportion of monetary value is less than 1 % (from timber) we can see how important is the nonmonetary values (almost 99%) derived from the forest products to the households of the community. High proportion of non-monetary value derived from community forests is the economic rationale for protecting and managing the forests.

2. Scenario 2: Under Scenario 2, it was not profitable to sell CO2 at $1 rate in Ludidamgadhe CF because carbon revenue ($3909.02) was quite below than the cost incurred in carbon trade ($6053.92). However, it seemed profitable to sell CO2 at $10 because carbon revenue jumped to $ 39090.2 which seemed higher than the carbon cost which remained the same ($6053.92). Under this Scenario, proportion of carbon revenue of the total gain was 2.15 % ($3909.02) at $1 rate, and 18 % ($39090.02) at $10 rate. Also, the cost incurred in carbon trade estimated to $1.57 per tCO2. From the same cost benefit perspective, the FUG derived fewer benefits at $1 ($ 175260.74) compared to 'business as usual' scenario ($177406). However, it seemed profitable to take part in carbon trade under Scenario 2 at $10 ($210441.92) when compared to 'business as usual ($177406) under scenario 1. Dharapni CF cannot take part in carbon trade owing to negative carbon sequestration but could be part of REDD+. So, it has been clear that only the CF like Ludidamgadhe can take part in carbon trade because it sequestered carbon and are able to make gain by selling carbon credit.
3. Scenario 3: From the analysis it is found that revenue generated from selling CO_2 both at $1($6781.74), and $10 ($67810.4) rate are not sufficient to offset the foregone cost of forest products (-$177342.5). Consequently, there were losses in selling CO_2 owing to higher cost incurred primarily from foregoing the forest products. Also the cost in carbon trade increased from $1.57 per tCO2 under Scenario 2 to $27.15 per tCO2 under scenario 2.
4. Comparing the all Scenarios, it is found that Scenario 2 is the attractive option in which forest users are permitted to extract forests products with making monetary income by selling carbon credit. Generating carbon revenue $ 39090.02 (equivalent to NPR 3.3 millions) at $10 rate is a huge amount to the local community that can be judiciously used both in the interests of community welfare and forests as well.
5. Given the competitive current per tCO2 (>$10 rate) in the international market, other FUGs would be attracted to take part in carbon trading seeing the success stories of the CFUG like Ludidamgadhe in Gorkha district.

In terms of cost of carbon trade, finding of this study on cost of carbon trade per was 1.57 tCO2 resemble with the other studies. For example, Karky et.al (2010) found cost of carbon trade per tCO2 in similar ecological setting ranging from ($0.55 to $3.70) under the situation in which forest users are permitted to use forest products. However, cost of carbon trade per tCO2 raised in Scenario 3 ($26.15 per tCO2) which contradict with the World Bank (2009) finding on the same cost (US$2.51/tCO2). The reason for more opportunity cost in this study context was that forest users depend largely on forest products to earn their livelihood, whereas the case in study conducted by the World Bank was different because the study was carried out in tropic forests of Indonesia and Brazil where timber extraction does matter. However, the average implementation cost found in this study was 26 % of the opportunity cost which is more or less same with the similar finding of WB which was 20 % of the opportunity cost (2009).

Comparing results with REDD+ distribution modality purposed by ICIMOD

The ongoing REDD+ pilot project implemented by ICIMOD has proposed the distribution modality with giving more emphasis on social sector. Under this modality, 60 % of the carbon money coming from forest carbon trust fund (FCTF) supported by NORAD will go to the social sector whereas 40 % payment will go to carbon stock (26%), and carbon increment (14%). The money channeled to the social sector has further been disaggregated so that 10 % is allocated on the basis of share of population belonging to indigenous households, 15 % to Dalit marginalized community, 15 % to the female population, and 20 % to poor households (ANSAB, 2012). If the international support organization such as NORAD provides US $ 10000 to the REDD+ project then the resultant distribution pattern will be as follows in two community forests.

Table 8.4: Carbon fund distribution modality in Nepal

Community orest Name	Carbon stock (2011) (24%)	Carbon ncrement 16%)	Indigenous eople (10%)	Dalits HH 15%)	Female Population (15%)	Poor HHs (20%)	Total Payable 100 % (US$10000)
Ludidamgadhe	86.3 tha^{-1}	9.43 tha^{-1}	141	75	2662	93	
	86.3/551.41*0.24	100*0.16	141/211*0.1	100*0.15	2662/3228*0.15	93/182*0.2	
	US$ 361	US$1600	US$669	US$1500	US$1239	US$1022	US$6391
Dharpani	465.11 tha^{-1}	0	70	0	566	89	
	465.11/551.41*0.24		70/211*0.1	0	566/3228*0.15	89/182*0.2	
	USD 2025	0	USD332	0	US$271	US$981	US$3609
Total	551.41 tha^{-1}	9.43 tha^{-1}	211	75	3228	182	

(Source: Forest operational plan 2003, and ANSAB, 2012)

The Table 8.4 suggests that Ludidamgadhe will get nearly 2/3rd of the total fund received from REDD+ project not only because it sequester carbon, but also because it have more indigenous households, have Dalit households, have more female population, and more poor households than Dharpani CF. The Darpani Forest User Group will get a relatively small amount of benefits because of having relatively small numbers of households along with relatively small target households such as dalit, indigenous, poor and female population. But the Dharpani Community Forest will be rewarded despite the fact that it doesn't sequester carbon but because it has a larger carbon biomass. Overall, this benefits distribution modality suggests that social sector outweigh to carbon compensation implying that there is even less incentive for rewarding biomass increment (only 16%). The larger community forest such as Ludidamgadhe with many poor households, Dalit, and indigenous households will get more benefits from this modality.

It may be that this equity skewed modality is socially inclusive so is politically acceptable but the modality has not paid more attention to carbon increment (carbon removal) which is the core objectives of REDD+ mechanism.

8.3.5 Conclusions and issues:

1. Community forests in Nepal are flourishing not only because it provides direct benefits to the local community but because community are enjoying liberty to manage their forests under their terms and conditions recognized by the forest law (1993). In this context, carbon trading at the rate $ 10 will offer good incentive for community under certain condition (Scenario 2). The condition is that there should be no restriction on using forests products because these are the reliable basis for earning subsistence livelihoods. Without carbon trading, community can live, but with restriction on use of forest products, their basis for subsistence earning will be jeopardized, and in this point they will reluctant to comprise on their interests.

2. In terms of cost of carbon abatement under Scenario 2 suggests that it offers a cheap way to mitigate the climate change. The results also show that under REDD+ mechanism forest users should allow to use the forest products as it also lower the opportunity costs primarily arise from forgoing this cost under Scenario 3.

3. If Scenario 2 is acceptable to the carbon credit buyer, it will be good news to the forest users because they will earn substantial cash earning by selling carbon credit (NRP 3.2 million), and this earning can be used in the interests of both community and forest. However, from the carbon credit buyers/investors perspective, they want to ensure on the quality of carbon sequestration rate by the community forests seeing that forests users are using forest products as usual. In this

context, monitoring, reporting and verification (MRV) component of REDD+ is of more relevant to tackle the carbon credit quality issues. Otherwise, for the local forest users to sell the carbon credit by complying with the stringent carbon selling global standard would not offer attractive incentive to take part in carbon credit market. So the evolution of forest user friendly MRV procedure under REDD+ mechanism is an important step in carbon trade.

4. Carbon monitoring and implementation is difficult for forest users to implement because they should rely on forest technicians to carry out forest inventory, and monitoring biomass increment. The REDD+ pilot program is easy for them because the project cover all the cost of carbon implementation and monitoring cost except protecting the forests. At a time when carbon sellers (local forests users) should perform all things ranging from carbon assessment, management to taking part in carbon price negotiations and verification process, the carbon trading task will be sure to be a tough job to implement. In this regard, policy and institutional backup to local forest users from government and supportive agencies is imperative and of course, crucial to reduce the implementation, monitoring and verification cost.

5. Setting national level baseline for carbon stock is necessary because it will allow comparing and bringing consistence outcomes of carbon stock from the sub-national and projecting level measurement.

6. The benefits distribution modality is socially acceptable because it has given emphasis on social inclusion while distribution benefits received from the international community. However over emphasis on social sector (60 %) will jeopardize the objectives of REDD+ because relatively small proportion (16%) is purposed to allocate to carbon increment (carbon removal) which will lead to less motivation to local forest users to work more on forest protection and sustainable forest management.

9. CONCLUSIONS

9.0 Introduction

This Chapter presents the overall conclusions of the study. It describes the main findings of the research and how they relate to the research questions stipulated in Chapter 1. Lastly, it ends with a concluding remark with making some recommendations in the area of research and implementation pertaining to REDD+ mechanism in Nepal.

9.1 Addressing the research questions

This thesis was guided by one board research question with a subset of smaller questions stipulated in Chapter 1. The answers to the research questions presented in the introduction are discussed below.

The overall issue that this study set out to explore is whether the existing REDD+ mechanism implemented in Nepal beneficial to the local communities?

The first question raised in connection with main research question was: Do the current community management policies in Nepal favor the implementation of REDD+?

As shown in Chapter 4, community forestry was evolved in Nepal in response to the increasing rate of forest degradation and deforestation. After the Government of Nepal got ready to amend the "Fortress Conservation Model" in lieu of its failure to meet conservation and livelihood goals, communities were allowed to manage degraded patches of forests (Gilmour, 2003). From the analysis shown in Chapter 4, it is evident that both internal factor mostly the failure of government to protect the forests, and the external factor represented by donor agencies based on the theoretical base of "Theory of Himalayan Degradation" contribute to triggering the development of community forestry.

Observing the success stories of community forests in terms of its contribution in livelihood and conservation, community friendly forest policies mostly forest act (1993) and forest regulation (1995) provided CFUGs more autonomy in decision-making, such as access rules, forest products prices, mechanism for allocation of forest products, user fees and other important policies are agreed by user assemblies (Kanel, 2004).

With community friendly policy at the center, and effective forest user groups' institutions at grass root level, community forestry in Nepal has emerged as the best responsive measure to fight against deforestation, poor forest governance and poverty alleviation (GON, 2010), and Government of Nepal attempts to synchronize community forestry with the global climate change policy.

In line with discussion made in theoretical perspective in Chapter 2 that understanding the relationship between decentralized model such as community management and forest conservation outcomes has taken on renewed importance through REDD+ (Hayes, 2010), the finding of this thesis revels that community forestry in Nepal which is the decentralized policy has already incorporated the basic elements of REDD+ (deforestation, degradation, and livelihood). The Chapter 4 provides a sufficient basis those community management policies in Nepal favor the REDD+.

The second question raised in the introduction Chapter was: How much carbon does community forests sequester? Chapter 6 gives details on how much carbon can be derived from community forests. Before determining the carbon sequestration rate, the total biomass was calculated with lumping the carbon in above ground tree biomass (AGTB), carbon in above ground sapling biomass (AGSB), carbon in below-ground biomass (BGTB), carbon in litter (LB), herbs and grass (GHB), and soil organic carbon (SOC). While comparing the biomass content in two community forests, the average above ground tree biomass (AGTB) in Ludidamgadhe community forest was 146.415 t ha^{-1}, whereas the figure for Dharpani CF was 339.35 t ha^{-1}. Of the total biomass, the AGTB occupied the highest share of pie (78-81%), followed by BGTB (16%). Proportion of AGSB and LB was below 5, whereas the contribution of GHB was below than 1 %. Total biomass per hectare in Dharpani was greater than the Ludidamgadhe. Despite the higher proportion of tree biomass in Dharpani CF which lie in tropical eco-regions, it was found to have negative carbon sequestration whereas the Ludidamgadhe CF which lie in temperate zone found capable to sequester carbon (excluding soil carbon).

From the study, it was found that only the community forest in a hilly area (temperate zone) showed a positive sequestration rate. Fit well with other finding, for example, Blakie et. al (2007) who argues that community forestry progress is only confined to the hill and mountain region but not in Terai (tropical area) which have relatively productive forests particularly standing timber. From this point, the finding of this study has potential to generalize in similar ecological regions of Nepal.

Due to the lack of national reference (which is yet to develop) to measure deforestation and degradation in Nepal, this study accounted only for the carbon sequestration rate. Payment received from positive carbon sequestration rate will provide an incentive to the local community who are involved in forest conservation and carbon enhancement, one of the integral parts of REDD+ mechanism.

The third question raised in the introduction Chapter was: What is the value of direct benefits that local communities derive from community forests? Do these benefits vary with socio-economic characteristics of households?

The Chapter 7 dealt with how much direct benefit that local community derived forest products from community forests. Forest provides fodder (leaves), and bedding material (green and dry leaves used in the floor of livestock yard). Leaves from the forest are mixed with dung to make compost used for manure in agriculture field. Farmers build their livelihood by selling milk products and thus earn cash to meet the eventualities of the rural society. Therefore livestock rearing, agriculture and community forest are all linked in a subsistence economy in Nepal (Gilmour and Fisher, 1991).

In Chapter 7, it is evident that households having more livestock utilized more fodder and grass. For example, in Dharpani CFUG, Bhramin/Chhetri kept more livestock than Indigenous groups The similar harvesting practice was followed by Ludidamgadhe CFUG as well where Indigenous group kept more cattle than Bhramin/Chhetri group, so previous group harvested more quantity of fodder than the later group. It has been more evident that Dalit kept few cattle because they have less time to rear the livestock on their own to work as wage labor in agriculture field owned by other social groups.

As evident from Chapter 7, households of the Dharpani CF utilized more timber than the households of Ludidamgadhe CF. In terms of consumption of fruits, average annual amount of fruits consumption per household in Ludidamgdhe CF found to higher than the forest users of Dharpani CF.

In terms of benefits expressed in monetary terms from utilizing forests products annually by every household, it was found that both CFUGs in average derived more benefits from firewood harvesting followed by grass, fodder, litter, and fruit, and lastly by timber. No significant different observed between two community forest user groups in terms of benefits derived from forest products expect in fodder (0<0.018) (Source : the Table L in Annex I)

In terms of total gross benefits between the two community forests, Dharpani CFUG derived more gross benefits than Ludidamgadhe CFUG. In both cases, indigenous group derived more benefits than Bhramin/Chhetri groups and Dalits. This analysis showed that Indigenous groups dependent more on forest products.

From the study, it was found that prosperous forest user group utilizes less forest products thus have less dependency (in terms of consumption) on forest products. The case of Ludidamgadhe CFUG offered a good example where the more prosperous households in terms of socio-economic indicators (small household size, more literacy rate, more well off people with larger land holding size) but utilize lesser amount of forest products (firewood, timber, litter and firewood) of the total 6 forests products listed in this study.

Although the quantity of consumption of forest products varied with different social groups, it was found that community forest users with indigenous origin rely more on forest products to fulfill their necessities. From the REDD+ perspective, selling carbon will definitely have more impact on indigenous forest users if they are not allowed to utilize forests products. Explicitly, carbon trade will probably add an extra social economic burden on the existing users.

As discussed in theoretical perspective in Chapter 2 that community forests with dependent forest user groups, low level of inter groups' conflict, and small and medium sized (Agrawal et.al, 2009) have potential to enhance the REDD+ outcomes. The finding from this study reveals that Ludidamgadhe CF have more potential to fulfill the REDD+ objectives then Dharpani CF.

The fourth question raised in the introduction Chapter was: Is there any influence of socio-economic factors in shaping perception on climate change?

As Nepal approached REDD+ not only as a mitigation approach but also a means of contributing to development and poverty reduction through adaption , Nepal placed community forestry at the hearts of REDD+ and adaptation strategies (West, 2012). To make REDD+ mechanism an adaptive friendly approach, it is important to know how local forest users groups perceive climate change in their local context. In other words, communities facing climate change should perceive that the changes are indeed taking place in order to implement any coping strategies in more effective way.

To measure the perception on climate change, 6 socio-economic variables were taken into account: 1.Income status, 2. Gender, 3.Cast, 4. Age, 5. Education, 6. Household.

The majorities of respondents (60%) were of the view that they had experienced a rise in temperature, noticed early flowering, and experienced the emergence of unwanted pests in their farm land. Also, majority of respondents noticed that amount of water coming from rainfall was going down, they had experienced increased forest fire incidence, and observed colonization from invasive species in their forests.

The cross tabulation figures in regression analysis in Chapter 7 suggests that almost all response variables except early flowering, and drying of water found to be significantly associated with one or more socio-economic factors while measuring perception on climate change

As evident from Chapter 7, of the 6 socio-economic variables, education found significantly associated with log of odds of perception on raising temperature, emergency of new crop pest, rainfall amount and forest fire. The probable reason for a positive association of education with these response variables is that educated person has more access to information on climate change.

Cast, gender, and economic class are more or less stable social structure in Nepalese context, so they tend to more resilient to be changed itself. Therefore, by conducting climate change education campaign, women, lower cast and indigenous people should get more support through treating them as a target group by both government and non-government bodies.

In summary, forest users perceived that climate change is really happening, and it is impacting their daily life.

The fifth question raised in the introduction Chapter was: Will carbon trading provides good economic incentives to communities?

The Chapter 8 investigates whether carbon trading is attractive to the local community or not. Community forests in Nepal are flourishing due to two main reasons. Firstly, community forests provide direct benefits to the local community. Secondly, communities are enjoying liberty to manage their forests under their terms and conditions recognized by the forest law (1993). In this context, carbon trading for the community will offer good incentive under certain conditions (Scenario 2). The first condition is that there should be no restriction to forest users to use forest products because these products are the reliable basis for earning subsistence livelihoods. The second condition is that the community should able to sell carbon price at least at $ 10 per ton CO_2. It seemed profitable to sell CO2 at $10 because carbon revenue jumped to $ 39090.2 which seemed higher than the carbon cost which remained the same ($6053.92). Under the Scenario 2, proportion of carbon revenue of the total gain was 2.15 % ($3909.02) at $1 rate, and 18 % ($39090.02) at $10 rate. Also, the cost incurred in carbon trade estimated to $1.57 per tCO2. From the same cost benefit perspective, the FUG derived fewer benefits at $1 ($ 175260.74) compared to 'business as usual' scenario ($177406). However, it seemed profitable to take part in carbon trade under Scenario 2 at $10 ($210441.92) when compared to 'business as usual ($177406) under scenario 1.

It is evident from the analysis that without carbon trading, community can live but with restriction on use of forest products, their basis for subsistence earning will be jeopardized, and in this point people might be reluctant to comprise on their interests. The result on carbon trading also show that under REDD+ mechanism, forest users should allow to use the forest products as selling carbon under scenario 2 also lower the opportunity costs primarily arise from forgoing these cost under Scenario 3.

As discussed in theoretical perspective on REDD+ in Chapter 2 that benefits should go to those who managed forest sustainably leading to reduce carbon emission (Angelsen (2012), finding from Chapter 8 reveals Community Forests have potential to take part in REDD+ mechanism to get benefits from REDD+ projects.

Further as discussed in Chapter 2 (theoretical perspective) that market based approach is a another form of imperialism where resource are allocated property rights, then commodified and then exported to accumulate capital by the powerful nations (Liverman and Vilas ,2006). REDD+ is a payment to environmental services mechanism in which forest services is commodified as CO_2, and is exported to industrialized societies when carbon markets will be in place. The line of thinking is that local communities who are managing and protecting the forests should not be vulnerable in the name of selling carbon credit through REDD+ mechanism.

There are other important big challenges to the local community regarding managing carbon in community forests and selling carbon in volunteer market. Discussion made in theoretical perspectives in Chapter 2 reveals that carbon monitoring and reporting problems can be overcome by entrusting forest inventory work to the local community through providing them training on mapping and inventorying forests (Herold et.al, 2009). However, there is growing concern that carbon monitoring and implementation are difficult to undertake for forest users because they should rely on forest technicians to carry out forest inventory, and monitoring biomass increment. The current REDD+ pilot program is easy for them because the project cover all the cost of carbon implementation and monitoring cost except protecting the forests. At a time when carbon sellers (local forests users) should perform all things ranging from carbon assessment, management to taking part in carbon price negotiations and verification process, the carbon trading task will be of tough job to execute. To make the carbon trade more beneficial to the local community through reducing implementation, monitoring and verification cost, policy and institutional backup to local forest users from government and supportive agencies is imperative.

9.2 Recommendations

Based on the findings presented above, I have made some recommendations which are described as follows:

9.2.1. Establishing Baseline

Owing to lack of nationally prepared internally recognized reference level to compare the change in biomass, this thesis took 2011 as a baseline to compare the carbon stock in 2012. The REDD Cell set up within Ministry of Forest and Soil Conservation, Government of Nepal is responsible for co-coordinating the REDD readiness process in Nepal under Forest Carbon Partnership Facility (FCPF). Nepal REDD Readiness Preparation Proposal (2010-2013) prepared by REDD Cell has mentioned that the ongoing new Forest Resource Assessment with support from Government of Finland is entrusted to conduct forest resource assessment over a whole country and is planning to generate national level baseline data ranging from the extent of forest, to status of present forest cover, growing stock, both wood and non wood products, forest within protected areas. Once the forest assessment complete in 2014, the generated data will provide the basis for setting historical reference level of carbon stock changes for Nepal to date (GON, 2010).

As REDD+ main objective is to achieve reduced emission, Government of Nepal should come up with internationally accredited baseline so that it must evaluates emission level in which future carbon payment based.

9.2.2. Ensuring role of the local community in Monitoring, Reporting and Verification (MRV)

Nepal REDD Readiness Preparation Proposal (R-PP) envisioned creating clearinghouse as a central entity for all REDD related information that will be empowered with the right to engage in carbon transaction (GON, 2010). The reason cited for establishing proposed central level entity for carbon transaction is to harmonize the systems at sub national level which will result to reduce high degree of transaction cost owing to fragmented nature of forests. Although broad based participation of stakeholders in the management of registry is sought, the role of local community in monitoring, reporting and verification is not mentioned properly despite the fact that community role's role in reversing deforestation and deforestation is recognized in R-PP.

This thesis showed that community are engaged in carbon inventory, and monitoring of carbon stock change, so with minor capacity building package in carbon related activities they can perform monitoring and reporting in effective and efficient way. However, there is doubt that the proposed centrally managed carbon registry mechanism will jeopardize the role of community in monitoring, reporting and verification (MRV). Therefore it is imperative to give local community space in MRV process to maintain ownership over carbon as well.

9.2.3. Utilization of forest products

This thesis demonstrated that community rely on forest products for energy, making manure for agriculture, timber for house construction, and to some extent for food. Therefore attraction on community forests is attributed to the unfettered liberty to the local community to utilize forests products based on the rule and regulations they prepared, and endorsed by the government. The thesis also demonstrated that income derived from selling carbon is only additional for them (Scenario 2 in Chapter 7), so payment from carbon credit cannot substitute for the benefits derived from community forests. The overall lesson is that local community cannot compromise to the liberty they are enjoying using forest products. Based on the results from this thesis, it is imperative that the emerging REDD+ mechanism in Nepal should incorporate communities' interest associated with their dependency on forests, and their role in carbon governance.

9.2.4. Carbon right and benefits, and forest tenure issue

Benefit sharing is important because it creates positive incentives for reducing emissions, but it must be seen as fair otherwise (equity perspective), it will threaten the legitimacy of and support for REDD+ (Angelsen, 2012). In Nepal context, government is *de facto* owner of forests. Communities only enjoy management and use rights and the benefits of all forest products from forests handed over them. As the concept of forest carbon is new to Nepal, carbon ownership remains unclear. However, the REDD readiness preparation proposal (R-PP) in Nepal has proposed that carbon could be treated as a forest product (or service) in which existing benefit sharing mechanism based on current practices would apply at least in above ground biomass (GON, R-PP, 2010) indicating that carbon benefits would partially channeled to local community who are managing the forests handed over to them for protection and management. Given this context, carbon right is still a unsolved property right issue in Nepal. Interestingly, the ongoing REDD+ pilot project implemented by ICIMOD has proposed the distribution modality. Under this modality, 60 % of the carbon money coming from forest carbon trust fund (FCTF) supported by NORAD will go to the social sector whereas 40 % payment has gone to carbon stock (26%), and carbon increment (14%). The larger community forests with many poor households, Dalit, and indigenous households will get more benefits from this modality. It is imperative that Nepal

R-PP should come up with the benefits distribution modality that seek to balance both carbon effectiveness and carbon equity distribution which are the two sides of REDD+ mechanism.

9.2.5 Concluding remarks

Of the policy an instrument dealing with environmental problems, market instrument which is based on neo liberal economic approach is taken as efficient measure to tackle the climate change problems provided markets are efficient and market structure are in place. However, there is a persistent concern that whether markets have negative implications on forest dependent vulnerable communities or not. This question is particularly relevant to Nepal because local communities are protecting and managing the forests to fulfill the livelihood objectives.

This research showed that local communities will be benefitted from the carbon market only when they have the opportunity to sell carbon credit at $ 10 per ton CO_2, and are allowed to use forests products as well. This finding imply that forest dependent communities perceive benefits from selling carbon credit only as value add to their existing benefits derived from the community forests.

In the international carbon policy context, monitoring, reporting and verification (MRV) is a pressing issue because carbon buyers/investors want to ensure the quality of carbon sequestration rate with stringent carbon selling global standard in place of which it would be very difficult for local forest community to comply the carbon standard. From the carbon buyers' perspective, how can they be ensured that there would be perennial increment in carbon stock with allowing forest users to use forest products? In this regard, there is risk that the perceived trust deficit between the buyers and sellers (local community) will let the entire REDD+ mechanism defunct. So creating win –win situation to both carbon buyers (market) and carbon sellers (local community) is a big challenge in front of REDD+ mechanism.

In the national context, the REDD readiness preparation proposal (R-PP) in Nepal has proposed that carbon could be treated as a forest product (or service) in which existing benefit sharing mechanism based on current practices would apply at least in above ground biomass. The implied meaning is that carbon benefits would partially channeled to the local community who are managing the forests handed over to them for protection and management. Until and unless the distribution of carbon benefits is categorically mentioned in upcoming forest policy amendment, carbon right would remain an unsolved property right issue in Nepal.

The issues rose by this thesis primarily the interests of the local community needs to be addressed in REDD+ mechanism if the carbon emission effort to be effective. It is hoped that the next environment conference after 18th Chief of Party conference held in Doha in 2012, will try to resolve the issues mentioned in this thesis.

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APPENDICES

ANNEX I. TABLES

Table A : Forest products available to forest users

Forest product type	Maximum quantity allowed	fee per unit	Time to collect
Timber	50	30 per cft^3	
Firewood (Fresh)	Not specified	NRP 5 per 30 kg (1 bhari)	At the time of forest improvement
Firewood (dry)	Not specified	Free	3 days of each month
Pole	Nos 2 per households	NRP 5	
Wood for agriculture implements (plough)	Nos 2 per households	NRP 10	
Coal for blacksmith	Not specified	Free of cost	2 days of each month
Grass and bedding materials	Not specified	Free	
Forest products for religious purpose	Not specified	Free	

(Source: Community forest operation plan, 2003)

Table B : Supply of forest products in different year

Pool	Timber(cft^3)	Firewood (t)	Bedding(t)	Yr
Tree	2200	315	12	2010
Pole	1900	81	54	2011
Pole	2100	42	2.4	2012

(Source: Community forest operation plan, 2003)

Table C : Description of quantity, price and time to collect forest products

Forest product type	Maximum quantity allowed	Price per unit	Time to collect
Timber	-	$80/ft^3$	-
Firewood	Not specified	NRP 5 per 30 kg (1 bhari)	At the time of forest improvement
Pole	Not specified	NRP 5	To be utilized after leftover forest products from clearing the forest

Wood for agriculture implements (plough)	Not specified	NRP 20	
Coal for blackmsith	Not specified	Not specified	

(Source: Community forest operation plan, 2003)

Table D: Demand and supply of the forest products

S.N	Name of forest products	Unit	Demand/yr	Supply/yr		
				Private	Forest	others
1	Timber	ft^3	2775	270	1955	550
2	Pole	Nos	1110	660	200	250
3	Firewood	t (tone)	383	287	38	58
4	Bedding materials	t	233	175	31	27
5	Grasses	t	200	150	30	20

(Source: Community forest operation plan, 2003)

Table E : Dharpani Community Forest : forest biomass and carbon

Year	Plot	AGTB (ton_per_h)	BGB (ton/per/ha)	AGSB (ton/per/ha)	Herb biomas (ton/per/ha)	Litter biomass (ton/per/ha)	Total Biomass (ton/per/ha)	Total plant carbon (ton/per/ha)	Total soil carbon (ton/per_ha)	Total carbon (ton/per/ha)
a	**d**	**e**	**f = e*0.20**	**g**	**h**	**i**	**j = e+f+g+h+i**	**k = j*0.47**	**l**	**m = l + k**
2012	44	349.76442	69.952884	4.569512	0.718514	3.3181228	428.323452	201.312022	110	310.912022
2012	54	748.68692	149.73738	3.910211	0.085799	12.612318	915.032635	430.065338	110	539.665338
2012	75	62.104214	12.420843	11.74846	0.021133	0.0363311	86.3309783	40.5755598	110	150.17556
2012	85	436.20161	87.240323	1.278752	0.191885	5.7163189	530.628892	249.395579	110	358.995579
2012	100	72.116732	14.423346	6.359501	0.200339	3.6589962	96.7589144	45.4766898	110	155.07669
2012	101	31.800205	6.360041	10.70698	0.091716	3.6046292	52.5635672	24.7048766	110	134.304877
2012	150	276.49231	55.298463	1.804662	0.130178	5.1087872	338.834404	159.25217	110	268.85217
2012	158	159.75251	31.950502	9.160528	0.155114	9.7601999	210.778854	99.0660614	110	208.666061
2012	177	1007.6502	201.53004	5.447015	0	7.8530344	1222.4803	574.565742	110	684.165742
2012	181	422.21445	84.442889	3.690791	0.084531	9.0439341	519.476591	244.153998	110	353.753998
2012	208	27.361022	5.4722045	7.824269	0	5.5834211	46.2409168	21.7332309	110	131.333231
2012	216	168.58125	33.71625	14.70748	0.143703	3.132584	220.281267	103.532196	110	213.132196
2012	219	99.552104	19.910421	7.975031	0.13525	4.0559628	131.628768	61.8655209	110	171.465521
2012	234	1286.5331	257.30662	2.019534	0.016061	3.5856437	1549.46097	728.246658	110	837.846658
2012	237	516.73255	103.34651	5.838136	0.12257	1.7803088	627.820076	295.075436	110	404.675436
2011	44	303.94593	60.789186	2.42303	0.04368	7.2188402	374.420665	175.977713	110	285.577713
2011	54	127.3975	25.479499	2.681053	0.42084	5.1574201	161.136307	75.7340645	110	185.334064

2011	75	63.352733	12.670547	10.20248	0.18984	4.5554201	90.9710218	42.7563802	110	152.35638
2011	85	355.50266	71.100533	3.009873	0.13818	4.5408	434.29205	204.117264	110	313.717264
2011	100	74.310529	14.862106	6.834321	0.05922	2.2093399	98.2755156	46.1894923	110	155.789492
2011	101	30.053691	6.0107383	6.567972	0.09996	6.45	49.1823618	23.11571	110	132.71571
2011	150	279.03656	55.807312	3.442644	0.48216	5.3113598	344.080037	161.717618	110	271.317618
2011	158	213.36679	42.673357	5.66061	0.3801	4.1159601	266.196813	125.112502	110	234.712502
2011	177	958.44454	191.68891	8.230704	0.09912	9.2819804	1167.74525	548.840266	110	658.440266
2011	181	685.79653	137.15931	3.02819	0.15246	3.8364601	829.972944	390.087284	110	499.687284
2011	208	23.063534	4.6127068	3.241007	0.15498	6.3863598	37.4585875	17.6055361	110	127.205536
2011	216	128.25619	25.651237	10.63069	0.60984	4.0127601	169.160713	79.5055349	110	189.105535
2011	219	95.373842	19.074768	5.342804	0.37128	2.6565399	122.819234	57.7250401	110	167.32504
2011	234	447.48421	89.496843	3.379411	0.19614	4.5683201	545.124927	256.208716	110	365.808716
2011	237	729.78436	145.95687	7.287812	0.29904	2.9042201	886.2323	416.529181	110	526.129181

(Source: ANSAB, 2012)

Table F :Ludidamgadhe Community Forest User Group : forest biomass and carbon

Year	Plot	AGTB (ton/per/ha)	BGB (ton/per/ha)	AGSB (ton/per/ha)	Herb biomas (ton/per/ha)	Litter biomass (ton/per/ha)	Total Biomass (ton/per/ha)	Total plant carbon (ton/per/ha)	Total soil carbon (ton/ha)	Total carbon (ton/per/ha)
2011	4	30.89654396	6.17930879	3.84677477	0.1405307	2.7156457	43.778804	20.5760378	95.7	116.27604
2011	15	140.25179	28.050358	5.24441448	1.3628075	3.8691484	178.77852	84.0259036	95.7	179.7259
2011	22	74.264673	14.8529346	19.2537484	0.3558599	1.2959234	110.02314	51.7108755	95.7	147.41088
2011	33	29.47241754	5.89448351	12.7484154	0.2005962	3.4441284	51.760041	24.3272193	95.7	120.02722
2011	34	19.49200597	3.89840119	1.07980308	3.2067061	2.9785891	30.655505	14.4080876	95.7	110.10809
2011	42	103.6260398	20.725208	0	0.0906649	14.268778	138.71069	65.1940247	95.7	160.89402
2011	43	82.02845364	16.4056907	7.15170578	0.1507305	4.5071096	110.24369	51.8145344	95.7	147.51453
2011	44	19.91591516	3.98318303	14.2587069	0.4436916	7.9158917	46.517388	21.8631726	95.7	117.56317
2011	47	61.00623333	12.2012467	9.73204726	0.0351327	2.5828808	85.557541	40.2120442	95.7	135.91204
2011	51	309.1786224	61.8357245	2.79523807	0.2404517	5.8435501	379.89359	178.549986	97	275.55999
2011	57	361.7728821	72.3545764	6.74977695	0.0705458	9.8281054	450.77589	211.864667	97	308.87467
2011	58	97.36352028	19.4727041	3.58362457	0.8316449	14.517407	135.7689	63.8113833	97	160.82138
2011	95	249.5154083	49.9030817	3.73974969	0	13.352704	316.51094	148.760144	97	245.77014
2011	114	107.0903538	21.4180708	15.0023548	0.2965902	11.790765	155.59813	73.1311233	97	170.14112
2011	117	265.2900412	53.0580082	3.36663126	1.1605273	12.681933	335.55714	157.711856	97	254.72186
2011	122	45.53505562	9.10701112	3.36009267	1.9757778	13.137534	73.115471	34.3642716	97	131.37427
2011	123	252.911338	50.5822676	3.7339682	0	12.278599	319.50617	150.167901	97	247.1779
2011	129	83.14138084	16.6282762	9.54022209	0	25.832533	135.14241	63.5169338	97	160.52693
2011	130	209.3390529	41.8678106	6.05171657	0.2036884	5.6362209	263.09849	123.65629	97	220.66629
2011	135	267.5523893	53.5104779	5.5262294	0.0854498	5.8644575	332.539	156.293332	97	253.30333
2011	148	124.9763089	24.9952618	8.96429532	0.0208656	4.9985525	163.95528	77.0589836	97	174.06898
2011	153	47.84672852	9.5693457	9.24204772	0.8843059	13.696801	81.239229	38.1824377	97	135.19244
2011	159	226.5370358	45.3074072	2.4621425	0.4292361	9.5005601	284.23638	133.591099	97	230.6011

2012	4	34.3397575	6.8679515	1.9061683	0.17	2.71	45.997677	21.6189083	95.7	117.31891
2012	15	161.0220667	32.2044133	4.19071424	1.52	1.28	200.22153	94.1041212	95.7	189.80412
2012	22	70.79670709	14.1593414	3.74695417	0.15	0.48	89.339413	41.989524	95.7	137.68952
2012	33	22.65010836	4.53002167	8.00448081	0.83	3.17	39.185541	18.4172042	95.7	114.1172
2012	34	0.35290117	0.07058023	0.99174425	1.70	3.46	6.5780657	3.0916909	95.7	98.791691
2012	42	145.7848812	29.1569762	0	0.02	5.10	180.06279	84.62951	95.7	180.32951
2012	43	107.6854883	21.5370977	8.09050037	0.28	1.16	138.75175	65.2133207	95.7	160.91332
2012	44	31.28809361	6.25761872	10.3279042	0.35	2.37	50.593657	23.7790186	95.7	119.47902
2012	47	77.58472895	15.5169458	15.599801	0.65	0.90	110.24444	51.8148848	95.7	147.51488
2012	51	335.4168426	67.0833685	1.62272136	0.21	6.19	410.51974	192.944279	97	289.95428
2012	57	443.8217706	88.7643541	5.85367219	0.38	3.35	542.16865	254.819264	97	351.82926
2012	58	119.537571	23.9075142	6.58723937	0.04	5.60	155.67138	73.1655507	97	170.17555
2012	95	298.6518041	59.7303608	2.84856065	0	2.09	363.32482	170.762663	97	267.77266
2012	114	161.5079193	32.3015839	9.96322386	0.95	2.72	207.43761	97.4956753	97	194.50568
2012	117	101.1963151	20.239263	2.5601529	0.50	1.77	126.25683	59.3407106	97	156.35071
2012	122	53.48521553	10.6970431	15.7862006	2.46	5.01	87.436049	41.0949432	97	138.10494
2012	123	270.3955581	54.0791116	3.35580845	0.38	1.90	330.10843	155.150961	97	252.16096
2012	129	86.80476308	17.3609526	2.95009688	0	5.13	112.24881	52.7569419	97	149.76694
2012	130	223.7639459	44.7527892	4.71000718	0.44	4.11	277.77427	130.553908	97	227.56391
2012	135	267.7535068	53.5507014	2.16084112	0.51	1.76	325.72745	153.091901	97	250.1019
2012	148	139.6343866	27.9268773	6.86340366	0	2.43	176.85719	83.1228782	97	180.13288
2012	153	57.4848756	11.4969751	6.51484378	0.46	1.19	77.147465	36.2593083	97	133.26931
2012	159	315.0612086	63.0122417	0.2642674	0.22	7.10	385.66314	181.261675	97	278.27167

(Source: ANSAB, 2012)

Table G : Summary of biomass in different pools

Name of Forest User Groups		AGTB tha^{-1}	AGSB tha^{-1}	BGTB tha^{-1}	LB tha^{-1}	GHB tha^{-1}	Total biomass tha^{-1}
Ludidamgadhe	Mean	146.4	6.2	29.3	.5	6.0	188.4
	N	46	46	46	46	46	46.0
	Std. Deviation	110.6	4.6	22.1	.7	5.2	131.4
	Sum	6736.0	285.0	1348.0	21.2	276.0	8666.0
	Std. Error of Mean	16.3	0.7	3.3	.1	0.8	19.4
Dharpani	Mean	339.3	6.0	67.8	.1	5.1	418.4
	N	30.0	30.0	30.0	30.0	30.0	30.0
	Std. Deviation	332.4	3.4	66.5	.3	2.6	398.2
	Sum	10180.0	179.0	2035.0	2.0	154.0	12551.0
	Std. Error of Mean	60.7	0.6	12.1	.0	0.5	72.7

Total	Mean	222.6	6.1	44.5	.3	5.7	279.2
	N	76.0	76.0	76.0	76.0	76.0	76.0
	Std. Deviation	243.0	4.2	48.6	.6	4.3	290.6

(Source : ANSAB, 2012)

Table H : Comparison of biomass between the forest user groups

Biomass categorization		Sum of Squares	df	Mean Square	F	Sig.
above ground tree biomass (ton/per/ha)	Between Forest User Groups	675652.6	1	675652.6	13.32	0.00
	Within Forest User Groups	3754182	74	50732.2		
	Total	4429834.5	75			
above ground sapling biomass (ton/per/ha)	Between Forest User Groups	0.52	1	1	0.05	0.82
	Within Forest User Groups	1312.2	74	17.7		
	Total	1313.2	75			
below ground biomass (ton/per/ha)	Between Forest User Groups	26955.1	1	26955.1	13.28	0.00
	Within Forest User Groups	150239.9	74	2030.3		
	Total	177195	75			
Herb biomas (ton/per/ha)	Between Forest User Groups	2.8	1	2.8	8.74	0.00
	Within Forest User Groups	23.9	74	0.3		
	Total	26.7	75			
Litter biomass (ton/per/ha)	Between Forest User Groups	13.6	1	13.6	0.72	0.4
	Within Forest User Groups	1404.2	74	19		
	Total	1417.8	75			
Total Biomass	Between Forest User	960346.9	1	960346.9	13.22	0.00

(ton/per/ha)	Groups					
	Within Forest User Groups	5375293.9	74	72639.1		
	Total	6335640.8	75			
Total soil carbon (ton/per/ha)	Between Forest User Groups	3256.2	1	3256.2	21992	0.00
	Within Forest User Groups	11	74	0.1		
	Total	3267.2	75			
Total carbon (ton/per/ha)	Between Forest User Groups	266831.4	1	266831.4	16.58	0.00
	Within Forest User Groups	1190657.8	74	16090		
	Total	1457489.2	75			
Total plant carbon (ton/per/ha)	Between Forest User Groups	212624.4	1	212624.4	13.25	0.00
	Within Forest User Groups	1187459.3	74	16046.7		
	Total	1400083.7	75			

(Source : ANSAB, 2012)

Table I (ANNOVA) : Variation in CO_2 in forest user groups by years

		Sum of Squares	df	Mean Square	F	Sig.
TotalCO_2	between forest user groups	101825.593	1	101825.593	.386	.536
	within forest groups	19528950.126	74	263904.731		
	Total	19630775.719	75			

(Source: ANSAB, 2012)

Table J (ANNOVA) :Variation in CO_2 between forest user groups

		Sum of Squares	df	Mean Square	F	Sig.
TotalCO_2	between forest groups	3593925.150	1	3593925.150	16.584	.000
	within forest user groups	16036850.569	74	216714.197		

	Total	19630775.719	75			

(Source : ANSAB, 2012)

Table K : Cattle size

CFUG Name	Social Group	Mean	N	Std. Deviation
Dharpani CFUG	Bhramin/Chhetri	4.33	15	3.994
	Indigenous	3.75	20	4.077
	Total	4.00	35	3.993
Ludidamgadhe CFUG	Bhramin/Chhetri	5.46	28	3.180
	Indigenous	6.67	3	5.774
	Dalit group	5.25	4	1.500
	Total	5.54	35	3.212

(Source: Household survey, 2012)

Table L : Total Gross Benefits by Forest Products in USD $ (Per HH yr^{-1})

CFUG Name		Fiewood	Timber	Fodder	Grass	Litter	Fruit
Dharpani CFUG	Mean	191.58	1.50	143.03	103.53	50.67	21.54
	N	35.00	35.00	35.00	35.00	35.00	35.00
Ludidamgadhe CFUG	Mean	122.26	0.85	86.55	126.61	28.17	40.64
	N	35.00	35.00	35.00	35.00	35.00	35.00
Total	Mean	156.92	1.17	114.79	115.07	39.42	31.09
	N	70.00	70.00	70.00	70.00	70.00	70.00

(Source : Household survey, 2012 : Fodder difference only $p<0.018$)

Table M :Total Gross Benefits Per HH Y^{r-1} (USD $)

CFUG	Social Groups	Mean	N	Std. Deviation	Std. Error of Mean
Dharpani	Bhramin/Chhetri	413.85	15.00	370.74	95.72
	Indigenous	435.92	20.00	389.51	87.10
	Total	426.46	35.00	376.17	63.58
Ludidamgadhe	Bhramin/Chhetri	361.63	28.00	293.17	55.40
	Indigenous	375.10	3.00	356.30	205.71
	Dalit	360.48	4.00	123.65	61.82
	Total	362.65	35.00	277.64	46.93
Total	Bhramin/Chhetri	379.84	43.00	318.91	48.63

	Indigenous	427.99	23.00	378.17		78.85
	Dalit	360.48	4.00	123.65		61.82
	Total	394.56	70.00	329.76		39.41

(Source : Household survey, 2012)

Table N : Total Forest Management and Protection Cost Per HHyr-1 USD ($)

CFUG Name	Social Groups	Mean	N	Std. Deviation	Sum	Std. Error
Dharpani CFUG	Bhramin/Chhetri	70.00	15.00	66.99	1050.00	17.30
	Indigenous	96.91	20.00	242.33	1938.24	54.19
	Total	85.38	35.00	186.68	2988.24	31.55
Ludidamgadhe CFUG	Bhramin/Chhetri	44.75	28.00	85.35	1252.94	16.13
	Indigenous	38.24	3.00	45.28	114.71	26.14
	Dalit	29.41	4.00	2.40	117.65	1.20
	Total	42.44	35.00	77.02	1485.29	13.02
Total	Bhramin/Chhetri	53.56	43.00	79.54	2302.94	12.13
	Indigenous	89.26	23.00	226.52	2052.94	47.23
	Dalit	29.41	4.00	2.40	117.65	1.20
	Total	63.91	70.00	143.39	4473.53	17.14

(Source : Household survey, 2012)

Table O : Total amount paid for buying forest products per $HHyr^{-1}$ in USD ($)

CFUG Name	Social Groups	Mean	N	Std. Deviation	Sum	Std. Error
Dharpani CFUG	Bhramin/Chhetri	9.76	15.00	19.99	146.35	5.16
	Indigenous	8.91	19.00	15.15	169.29	3.48
	Total	9.28	34.00	17.17	315.65	2.95
Ludidamgadhe CFUG	Bhramin/Chhetri	1.08	27.00	1.55	29.24	0.30
	Indigenous	0.31	3.00	0.07	0.94	0.04
	Dalit	4.35	4.00	3.40	17.41	1.70
	Total	1.40	34.00	2.05	47.59	0.35
Total	Bhramin/Chhetri	4.18	42.00	12.48	175.59	1.93
	Indigenous	7.74	22.00	14.35	170.24	3.06
	Dalit	4.35	4.00	3.40	17.41	1.70
	Total	5.34	68.00	12.77	363.24	1.55

(Source : Household survey, 2012)

Table P : Total Cost Per HHyr^{-1} in USD ($)

CFUG Name	Social Groups	Mean	N	Std. Deviation	Sum	Std. Error
Dharpani	Bhramin/Chhetri	79.76	15.00	84.55	1196.35	21.83
	Indigenous	110.92	19.00	253.53	2107.53	58.16
	Total	97.17	34.00	195.81	3303.88	33.58
Ludidamgadhe	Bhramin/Chhetri	30.82	27.00	31.91	832.18	6.14
	Indigenous	38.55	3.00	45.33	115.65	26.17
	Dalit	33.76	4.00	1.07	135.06	0.54
	Total	31.85	34.00	30.53	1082.88	5.24
Total	Bhramin/Chhetri	48.30	42.00	60.42	2028.53	9.32
	Indigenous	101.05	22.00	236.51	2223.18	50.42
	Dalit	33.76	4.00	1.07	135.06	0.54
	Total	64.51	68.00	142.92	4386.76	17.33

(Source : Household survey, 2012 :)

Table Q :Net Benefits to HH^{-1}yr^{-1} (USD $)

CFUG Name	Social Groups	Mean	Std. Deviation	Std. Error of Mean
Dharpani CFUG	Bhramin/Chhetri	334.09	424.19	109.52
	Indigenous	332.34	608.84	139.68
	Total	333.11	527.76	90.51
Ludidamgadhe CFUG	Bhramin/Chhetri	342.18	292.16	56.23
	Indigenous	336.55	313.70	181.11
	Dalit	326.71	123.12	61.56
	Total	339.86	273.16	46.85
Total	Bhramin/Chhetri	339.29	339.98	52.46
	Indigenous	332.91	571.93	121.94
	Dalit	326.71	123.12	61.56
	Total	336.49	417.07	50.58

(Source : Household survey, 2012)

Table R : Biomass growth and CO2 sequestration rates for Ludidamgadhe CF

Particulars	Unit	Yr0	Yr1
Biomass	t/ha	183.60	193.03
Biomass growth rate	t/ha/yr		9.43
Total biomass in forest (241 ha)	tC		46520.23
Total C	tC		1067.63
C per ha	tC/ha		4.43
Total CO_2 per ha	CO2/ha		303.42
CO_2 sequestration rate	t/ha/yr		16.22
CER revenue at $1 per tCO_2	$/ha		16.22
CER revenue at $10 per t CO_2			162.2
Total CER revenue @ US $1	$ in 241 ha		3909.02
Total CER revenue@US$10	$ in 241 ha		39090.2
Fuelwood consumption	t/hh/yr		1.5
CO_2 per hh from fuelwood	CO_2/hh/yr		5.50
In whole CFUG from all HHs	CO_2/yr		2873.61
CO_2 per ha (from fuelwood only)	CO_2/ha/yr		11.92
CER sequestratation +fuel wood saved	CO_2/ha/yr		28.14

Table S : Perception on climate change : value in Logistic regression

Response variables	Exaplanatory. variables	Sex		Cast		Literacy		Economic Class		Age		Family Size	
	CFUG Name	B	Exp(B)	B	Exp(B)	B	Exp(B)	B	Exp(B)	B	Exp(B)	B	Exp(B)
Warming (-2LL : 47.04, C&NR^2:0.49, Chi:0.232	Ludidamgadhe	-20.8	0.0	-39.7	0.0	39.8	0.0	-23.9	0.0	0.0	1.0	-1.8	172.0
	Dharpani	-19.9	0.0	2.1	8.5	22.3	465.0	-2.7	0.1	0.0	1.0	0.3	1.4
	Both	-1.5	0.2	-0.6	0.5	4.4	79.34**	-2.1	0.12**	0.0	1.0	0.1	1.1
Dry of water(-2LL : 23.37, C&NR^2:0.63, Chi:0.32	Ludidamgadhe	-52.7	0.0	0.6	1.8	18.5	1032.0	-15.5	0.0	0.2	1.2	-0.7	0.5
	Dharpani	-128.2	0.0	-39.7	0.0	30.7	2074.0	27.4	8197.0	-1.5	0.2	-2.3	0.1
	Both	-41.3	0.0	-1.6	0.2	18.4	108.0	-0.3	0.8	0.0	1.0	-0.7	0.5
E. Flowering(-2LL : 25.39, C&NR^2:0.20, Chi:0.43	Ludidamgadhe	4.4	84.1	-22.4	0.0	-3.6	0.0	-4.7	0.0	-0.3	0.8	-0.5	0.6
	Dharpani	-4.1	0.0	-9.6	0.0	-7.0	0.0	-3.8	0.0	-0.7	0.5	7.4	1663.0
	Both	1.3	3.6	-19.0	0.0	-0.1	0.9	-0.8	0.0	-0.1	0.90*	0.3	0.7
Ncrpaste(-2LL : 47.04, C&NR^2:0.49, Chi:0.329)	Ludidamgadhe	-20.8	0.0	-39.7	0.0	39.8	194.0	-23.9	0.0	0.0	1.0	-1.8	0.2
	Dharpani	-19.9	0.0	2.1	8.5	22.3	465.0	-2.7	0.1	0.0	1.0	0.3	1.4
	Both	-1.5	0.2	-0.6	0.5	4.4	79.341**	-2.1	0.12**	0.0	1.0	0.1	0.7

Intensity(-2LL : 55.76, C&NR2:0.387, Chi:0.61)	Ludidamgadhe	-2.4	0.09**	-3.3	0.036**	2.5	12.3	1.45***	4.3	0.0	1.0	0.8	2.28***
	Dharpani	-146.0	0.0	-45.0	0.0	37.4	175.0	23.8	211.0	-2.0	130.0	13.3	599.0
	Both	-3.6	0.026**	-1.9	0.15**	1.4	3.9	0.2	1.2	0.0	1.0	0.4	1.4
R Amount(-2LL : 55.50, C&NR^2:0.38, Chi:0.67)	Ludidamgadhe	-2.4	0.09**	-3.3	0.036**	2.5	12.27*	1.5	4.3	0.0	1.0	0.8	2.28*
	Dharpani	-146.3	0.0	-47.2	0.0	37.9	283.0	24.4	399.0	-2.0	0.1	13.4	662.0
	Both	-3.6	0.02**	-1.8	0.2	1.34**	3.8	0.1	1.2	0.0	1.0	0.4	1.4
Forest fire(-2LL : 51.66, C&NR^2:0.43, Chi:0.36)	Ludidamgadhe	3.2	24.59**	-2.3	0.1	1.7	5.4	2.4	11.5	-0.1	0.9	-0.4	0.7
	Dharpani	50.9	1.21E+	-7.8	0.0	354.3	7.1E+	19.0	9.31E	-3.3	0.0	43.2	5.56E
	Both	2.1	8.52**	-0.5	0.6	3.8	44.25**	0.0	1.0	0.0	1.0	0.0	0.97*
ChginFspecies(-2LL : 86.65, C&NR^2:0.13, Chi:0.81)	Ludidamgadhe	-1.8	0.15**	-0.6	0.57*	1.7	5.4	-20.8	0.0	0.0	1.0	-0.1	0.5
	Dharpani	-1.3	0.3	0.8	2.3	-0.8	0.4	-0.1	0.9	0.0	1.0	0.6	1.83*
	Both	-1.5	0.22**	-0.2	0.8	0.6	1.7	-0.3	0.7	0.0	1.0	0.3	1.3
Invasspecies(-2LL : 63.31, C&NR^2:0.092, Chi:0.23)	Ludidamgadhe	-1.6	0.2	3.5	33.64**	-20.5	0.0	-2.3	0.1	0.1	1.10*	-0.2	0.9
	Dharpani	0.6	1.8	0.9	2.5	1.2	3.4	0.8	2.3	0.0	1.0	-0.2	0.8
	Both	-0.1	0.9	1.2	3.30*	0.1	1.1	-0.1	0.9	0.0	1.0	-0.2	0.9

(Source : Household survey, 2012)