ASSESSMENT OF REDD AND ITS EFFECT ON THE LIVELIHOOD OF LOCAL PEOPLE AT CFUGs: A CASE STUDY OF GORKHA, NEPAL

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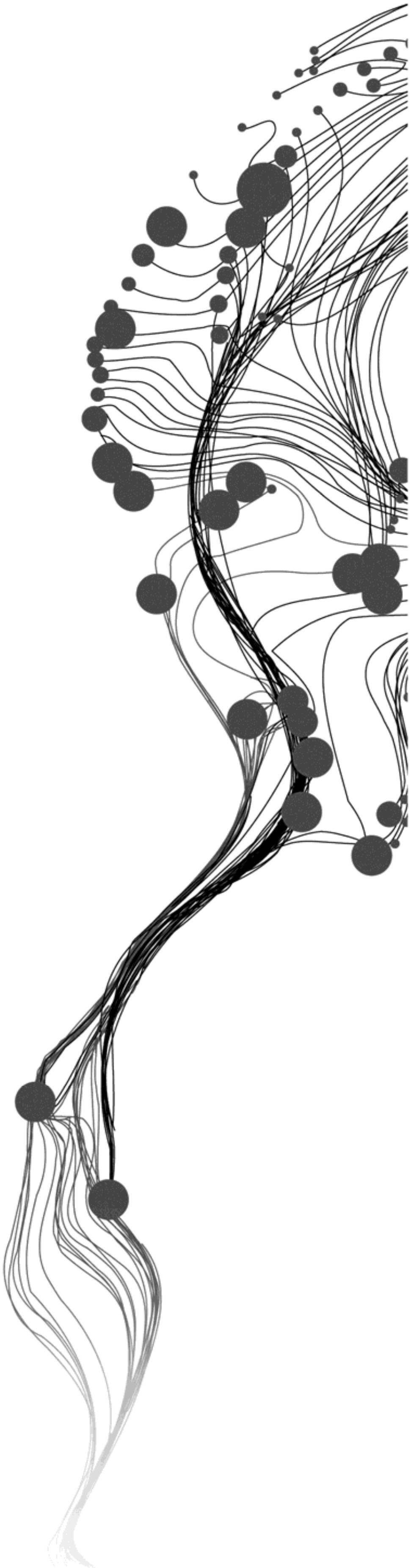

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SAHASH NATH ADHIKARI
Enschede, The Netherlands, [February, 2011]

Thesis submitted to the Faculty of Geo-Information Science and Earth Observation of the University of Twente in partial fulfilment of the requirements for the degree of Master of Science in Geo-information Science and Earth Observation.
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ABSTRACT

REDD (Reducing Emissions from Deforestation and forest Degradation) is a newly formed mechanism that allows industrialized countries to offset their emissions by purchasing carbon credits from the developing countries, which helps to reduce carbon emissions from deforestation and forest degradation. Nepal's Community Forests User Groups (CFUGs) are reducing emission through conservation and protection against deforestation. Thus it is essential to recognize the importance of the efforts of the group i.e. reward of Community Forests (CFs) by REDD incentives.

Nepalese society is a mixture of various socio-economic groups who live in different locations and thus make use of the forests in varying degrees. The level of dependency of the people on forests is different from one forest community group to another, which makes it impossible to adopt and implement a single REDD approach for the whole country. At least, a number of schemes are needed to correspond to the heterogeneity of Nepalese society. The proposed scenarios for CFs are Traditional scenario/Scenario 1, Scenario 2 (Business as usual + REDD Benefits) and Scenario 3 (REDD Management + No benefits from Forest).

This research adopts the following methodology. The land cover changes in the CFs and GF were seen from the year 2001 -2008 to see their potentiality to participate on REDD program for CFs. The forest management practices of a number of selected CFs were analyzed. To select the CFs on the basis of their socio-geographic heterogeneity, a focus group discussion was organized. A simple random sampling strategy was used for the selection of HHs from the selected CFs to find out the forest dependency of the local people. To find out the costs and benefits that will result from the implementation of REDD in the selected CFUGs, a series of focus group discussions were conducted with questionnaires being filled. The result from landcover change, forest dependency outcome and cost benefits analysis for CFs were analyzed to see the possible REDD scenarios in CFs.

The CF programme has helped to reduce the deforestation and forest degradation that give their potentiality to participate in REDD. Some of the CFs are well managing their forest than others. The management of CFs is directly linked with importance of CFs for their livelihood. The socio-economic characteristics, forest products used and population density of CF help to determine the dependency of CFUGs people on forest. The economic benefit from REDD for scenario 2 mostly depends on the forest area and population pressure of CFs, while for scenario 3, in addition to what has been mentioned before, the economic benefit also depends on forest products used from CFUGs.

The scenario 2 is more about continuing the harvesting of the forest resources in addition to the benefit from carbon revenue, which is better for those communities whose livelihood is mostly dependent upon forest products and who are also managing their CF well. Scenario 3 is more about preserving the forest and not allowing the forest products from the CF, which is better for those communities whose livelihood is mostly independent from forest products and who are not managing their CF properly. The socio-economic status of CFUGs and population pressure in CF have a greater role than forest products used by local people to determine the level of dependency of CFUGs people on forest and for CF management. Finally, it helps us in determining the best REDD scenarios for the CFUGs.

Keywords: CFUGs, REDD Scenarios, REDD, Land cover, Satellite Images, Remote Sensing and GIS.

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Sahash Nath Adhikari
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1. INTRODUCTION

1.1. Background

In the past 30 years, the global temperatures have been rising rapidly and continuously at around 0.2°C per decade, bringing the global mean temperature near the warmest level (Hansen, *et al.,* 2006). Anthropogenic climate change is caused by the emissions of carbon dioxide (CO_2) and other greenhouse gases (GHGs) that have accumulated in the atmosphere mainly over the past 100 years (Stern, 2007). The earth's vegetation and soil currently contain the equivalent of almost 7500 Gt CO_2 (Prentice, *et al.,* 2001), more carbon than that contained in all remaining oil stocked and more than double the total amount of carbon currently accumulated in the atmosphere.

The report from Intergovernmental Panel on Climate Change (IPCC) estimated 1.7 billion tons of carbon is released annually due to land use change, of which the major part is tropical deforestation (IPCC, 2001). Forest deforestation and degradation is the second leading causes in global warming. Tropical forest clearing accounts for roughly 20 % of the anthropogenic carbon emissions and destroys significant carbon sinks globally (IPCC, 2007). Forests are sink as well as source of GHGs emission. Generally studies have shown that forests store the most carbon when they remain undisturbed and are allowed to grow to maturity (Kirschbaum, 2003), consequently reducing carbon concentrations in the atmosphere.

Although Community managed forests are based on the principal to control deforestation and degradation activities, and such forests have more CO_2 stored than the unmanaged forests but avoiding deforestation to control CO_2 emissions is not recognized activity under the Clean Development Mechanism (CDM) of the Kyoto protocol (Banskota*, et al.*, 2007). Financial incentives to reduce rates of deforestation and forest degradation in tropical countries need much advancement , as it offer additional benefits, such as protecting biodiversity, preventing soil erosion and protecting the livelihoods of forest dependent populations (Peskett*, et al.*, 2006).

The reduction of carbon emissions from deforestation and degradation on tropical forests from the developing world have been acknowledged in United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP) 13 held in UNFCCC Bali (2007) under Reducing Emissions from Deforestation and Degradation (REDD) (UNFCCC, 2007a).

According to UNFCCC, (2007a), Nepal is on the 7th position out of 10 countries with the highest deforestation rate in the world. Nepal experienced an annual deforestation rate of 1.6 % of the forest area during the period (1979-1994). Nepal has total 4.2 million ha (29%) of forest area and an additional 1.6 million ha (10.6%) shrub land which accounts to approximately 40% of the land covered by forest (DFRS, 1999).

From the prospective of communities rights, 22 % of country's forest is now handed over to the local people as Community Forest (CF) so that the local people together manage, conserve and govern the handed over forest while the remaining 78% of the forest area is still managed by government (Pokharel*, et al.*, 2009).

Nepal has a long and successful history of decentralized forest management through Community Forest User Groups (CFUGs). The Community forest provides numerous inputs for subsistence of rural livelihood in terms of fuel wood, fodder, timber, NTFPs etc. (Karky*, et al.*, 2010). Due to the immense importance of forest in the livelihoods of the people, they conserve their forest now, without any carbon revenue (Karky*, et al.*, 2010).

Many of researches have been investigating the cost of reducing forest carbon emissions. Emission reduction from REDD could be one of the least cost solutions in reducing atmospheric carbon. Stern, (2007) reviewed the status of eight countries in the tropics and estimated that the cost of stemming deforestation to be less than $ 2 per t CO2 for 65% of the world's forest but it was very low from the market aspects. The report from IPCC (2007) estimated that reductions could be achieved at less than or equal to US$ 20 per t CO2 with large variation between regions to stabilize atmospheric concentration of CO2 at 450 ppm . While, World Bank recommended market price per t CO2 ranging from 1-15 US$ as suggested by (Neef, *et al.*, 2007).

The mean carbon sequestration rates for community forests in Nepal is 1.88 t C ha-1 year-1 or 6.88 t CO2 ha-1 year-1, under normal management conditions and after the extraction of forest products by local people to meet their sustenance needs (Banskota, et al., 2007). REDD is a new dimension added to the use of forests. Once an international agreement is reached on REDD, community forests, will be potential source of extra benefits by carbon conserved in their forests. This would add monetary value to the existing community forests (Bhusal, 2009).

REDD has the potential to generate significant benefits in addition to reduce GHGs emission for the developing country like Nepal. This includes positive impact on biodiversity and on sustainable development, including poverty reduction and strengthening indigenous peoples’ rights thus providing equal justice for the climate, biodiversity and sustainable development (Angelsen, 2008).

1.2. Scenarios

Traditional scenario / Scenario 1 / (Business as usual)

CFUGs obtain benefit from fuel wood, fodder and timber without receiving any payment from carbon. The costs include labour cost, day to day management cost and operation cost and forest protection cost etc. This scenario does not take carbon market/ REDD into consideration.

Scenario 2 (Business as usual + REDD Benefits)

CFUGs will obtain benefit from fuel wood, fodder and timber while also receiving payment from carbon. The costs include labour cost, day to day management cost, operation cost, forest protection cost and other additional costs for carbon management like forest survey, carbon measurement cost, making carbon reports and other miscellaneous costs.

Scenario 3 (REDD Management + No Benefit from Forest)

CFUGs managed forests for carbon sequestration and will receive benefit from carbon payment. The costs include overall cost from Scenario 2 and the additional cost for fuel wood, fodder, and timber

1.3. Problem statement and Justification

Over the past two years, The Government of Nepal (GoN), especially the Ministry of Forest and Soil Conservation (MFSC) engaged in facilitating and participating in REDD related interactions within Nepal and internationally. Yet, there is still a significant degree of confusion and uncertainty about whether, how and to what extent Nepal can benefit through REDD from international level (Ojha, 2009). The question of who will benefit from REDD also has overshadowed debates at the national level and still leading to a lot of confusion in Nepal. There is also a lack of clarity on what the benefits might be, how they relate to costs and what systems can be used for sharing benefits (Bleaney*, et al.*, 2009).

Under Nepal's community forestry system, standing trees and the forest land are the property of the State. In this construction, the sequestered forest carbon cannot be considered the property of the CFUGs. There is a conflict between Section 43 of the Forest Act 1993, which recognizes CFUGs as autonomous and corporate bodies with perpetual succession; and Section 25, which entitles CFUGs to sell and distribute forest products independently by determining the price of forest carbon (Basnet, 2009).

According to Karky & Skutsch 2010, if forest resources use by local communities is not permitted, then carbon trading will not be attractive to them as income from carbon will not cover the cost foregone by not harvesting forest resources (Dhakal, 2009).

The authors who are optimistic about REDD and carbon financing in Nepal's forestry sector also have identified a number of challenges associated with future carbon financing in Nepal: the possibility of elite capture, uncertainty of carbon markets, domination of international experts in deciding the amount and value of carbon, nationalization of carbon revenues, complex methodologies (Ojha, 2009). In addition, the transaction costs of carbon trade related to forest monitoring and rule enforcement will be high due to the small size of community forests. To reduce transaction costs and consider the issue of national sovereignty regarding forest resources, Government Organizations (GOs) and Non-Governmental Organizations (NGOs) may be actively mobilized for implementing the programme. As a result, the REDD policy will potentially increase control of government agencies on both the net income and carbon credits from REDD projects (Dhakal, 2009).

In case, of Ludhi Khola Watershed in Gorkha District, GoN, Ministry of Forest and Soil Conservation (MFSC) have officially set 1888 ha of forest state land that will be managed by CFUGs under the Community forest management scheme. All together 32 Community forests are exists in the area. Currently, CFUGs are managing forest for firewood, timber, fodder etc. Already the REDD project was launch to estimate, model and map carbon in this area.

Even though, there are preparation projects and activities related to REDD, but the final result of REDD will not be known until 2012. Therefore the essence of study is first to assess what is the condition of the Community forests and Government forest .To find out whether CFUGs are managing CFs to stop deforestation so they can get financial benefit from REDD and assess the impacts of CFs in the livelihood of local people. At last we will try to compare different defined scenarios in Ludhikhola watershed from the holistic approach that involves environment, social and economic of REDD in the livelihood of local people.

1.4. Objectives

The main objective of this research is to assess the possible REDD scenario in different CFUGs

1.4.1. Specifics objectives

1. To determine the land cover changes of the Community Forest and Government Forest from the year 2001 to 2008 to determine the potentiality of participatory in REDD.
2. To determine the dependency of six CFUGs on forest for their livelihood.
3. To assess the individual costs and benefits of six CFUGs for REDD implementation.
4. To assess the best possible REDD scheme for each of the six different CFUGs of Ludhikhola watershed.

1.5. Research questions

1. What are the changes in Land cover in Community Forest and Government Forest from the year 2001 to 2008 to determine the potentiality of participation in REDD?
2. What are the changes in forestland in six Community Forests from the year 2001 to 2008 to determine the appropriate scenario in REDD?
3. How do the six different CGUGs make a livelihood from the forest?
4. Does distance from the road and city centre affect CFUG forest products used?
5. What are the costs and benefits of different defined scenarios for CFUGs?
6. What specific REDD schemes are suited for each of the six CFUGs?

1.6. Research Approach

The research started with a literarure review (CFUGs and their depenedency in forest, concept of REDD; REDD and incentives for CFUGs).This helped in defining and formulating the research problem, objectives and questions which is our first phase of the work.
In the second phase, the data requirements was collected from satellite and field data. In the third phase the data collected was analyzed against the intended goals. The process of the research approach is illustrated in the Figure 1-1.

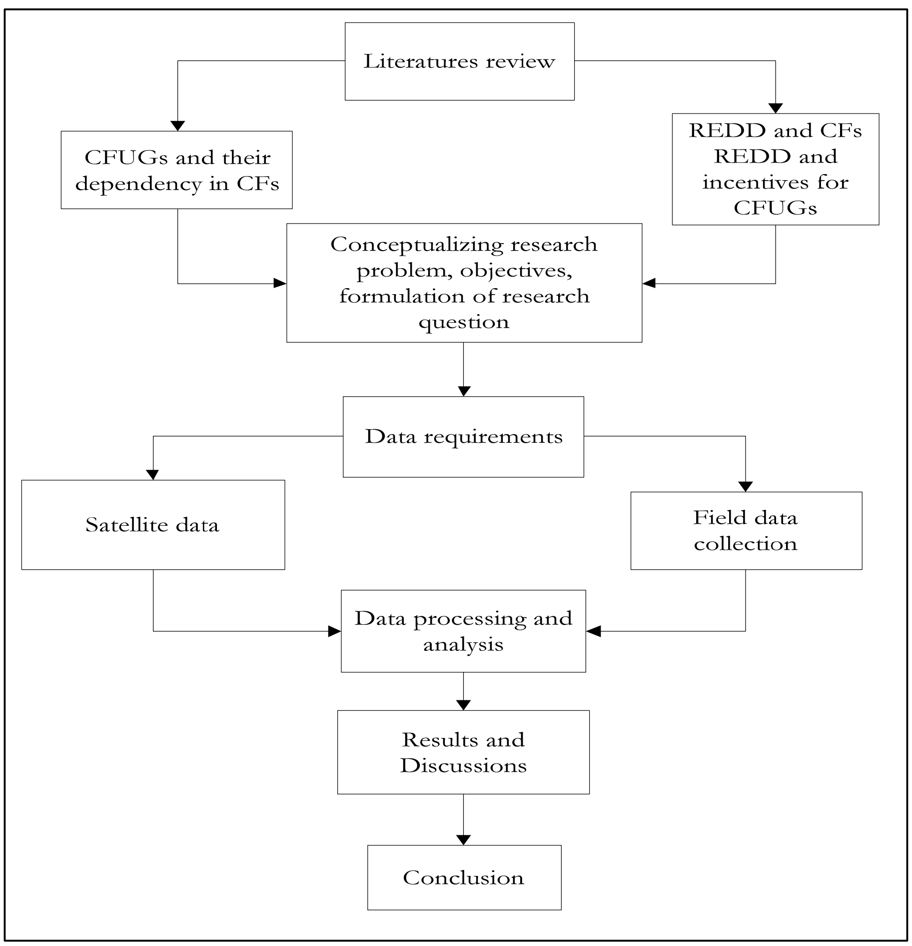

Figure 1-1 Theoretical framework of thesis

2. LITERATURE REVIEW

2.1. Theory and Concepts of REDD

REDD refers a broad sense of approaches and actions to reduce emissions from deforestation and forest degradation. In simple concept pay for them who reduce Deforestation and forest Degradation (Angelsen, 2008).It is a newly formed mechanism that allows industrialized countries to offset their emissions by purchasing carbon credits from developing world, that reduce emissions from DD by avoiding such activities so it can be a win-win strategy whereby host countries can be compensated for their land use while industrialized countries are expected to pay less than half of the prices than other types of carbon credits (Dhital, 2009).

It was in the Bali Action Plan (UNFCCC, 2007b) to acknowledge forests importance for future strategy to combat climate change and REDD to be the enormous potential to deliver biodiversity conservation and poverty alleviation outcomes.

2.2. Why REDD on Community Forests

Forests store more carbon dioxide (4500 GT CO_2) than the atmosphere (3000 GT CO_2) (Prentice, *et al.*, 2001) when they remain undisturbed and allowed to grow maturity. When forested lands are cleared and or converted into other land uses such as agriculture, or urban landscapes, the carbon earlier stored in the forests in the form of aboveground and below ground biomass and in the soil is released back into the atmosphere. According to the fourth Assessment Report of IPCC (2007) the total amount of CO_2 released from land-use change is estimated to be 1.6 Gt C per year over the 1990s. Deforestation contributes more than 18% of the global CO2 emissions, which is more than the total emissions coming from the transport sector (Stern, 2007).

Community Forests (CFs) were in a direction of reducing emission through conservation and protection against deforestation; through afforestation and reforestation and through improved forest management (Karky, 2008). So it is essential to recognize their importance i.e. reward of Community Forests (CFs) by REDD incentives.

2.3. Evolution of Community-based forestry in Nepal

Community based forest management as a mainstream forestry policy started around the late 1970s as an approach to mitigate increasing deforestation and forest degradation. For more than past three decades, the local communities have been involved in the management and utilization of forests in Nepal. The CF programme in Nepal has endowed over 14 thousands local CFUGs with rights to manage over 1 million hectares of forest as CFs (Kanel*, et al.*, 2004).

The formulation of the National Forestry Plan (NFP) in 1976 was a basic pillar for initiating CFs development in Nepal by allowing community management in the degraded forest land through the Panchayat Protected Forest Rules 1978 (GoN, 1978).

Then it was The Master Plan for the forestry sector (MPFS, 1989) to be the first comprehensive policy document which recognized the crucial role of people's participation in forest management that provides a 25 years policy and planning framework for the forestry sector which emphasized rights of local people in different regimes of forest governance.

Later it was the Forest Act 1993 that recognized the dominant role of Local people in the decision making process and provided grounds for benefit sharing between them from forest management activities (GoN, 1993) The spirit of new CF legislation in Nepal was the development of a partnership between the organised local communities and the Government.

The 1993 Forest Act guarantees non-interference from the government forest office in the operation of the CFUG and in the management of the community forest as long as the CFUG complies with the Forest Act and the Regulation and follows the CFUG's Operation Plan (Bhatia, 1999).

Further, the establishment of democracy from 1990 onwards, the forestry sector also received financial aid from the international donor agency. With greater levels of democracy at the grass root level, CFUGs expanded rapidly and this was further facilitated by policies named 1992 Decentralized Act. Following, the election held in April 2008, Nepal is already a Newly Federal Democratic Republic state in 28th May 2008. Now, Nepal is heading towards writing its seventh constitution on federal democratic republican lines. It is also important from CF's aspects how CFM policy for the Terai will develop under the new federal structure.

2.4. Community Forests and its importance for local people

From the last three decades, the world has realized that trees are not forests and forests are much more than trees" (Kant, 2004). The developed countries must have to realize that a forest is not only a bundle of tress or place for carbon stock but more than that it is one of the most cost-effective adaptation measures for forest dependent rural communities (Dangi*, et al.*, 2009).

Forest commons are vital for delivering multiple outcomes such as livelihoods, carbon sequestration and biodiversity conservation (Chhatre*, et al.*, 2008). Forest support millions of peoples in the developing world and helps to reduce poverty (Klooster*, et al.*, 2000).Forests provide a range of ecosystem services, which today have little direct cash-generating value (but do have significant indirect economic value to people's livelihoods. The lack of a cash compensation for the benefits from ecosystem services leads to forest degradation and deforestation, often with disastrous environmental and social effects (Gryze*, et al.*, 2009).

Most of the rural people in Nepal depend on traditional agriculture and livestock for their livelihood. Community forestry plays a vital role in the rural livelihood by providing fuel, construction material, and animal feed having an agro-based economy. Adhikari (2005) showed that community forestry contributes 14 to 22 % of household incomes of rural households in the mid-hill region of Nepal. Based on existing community forestry data, an average of 115 households depends on approximately 81 hectares of forest (Kanel, 2006).

In Nepal, 72% of the population living below the poverty line (31% of the total population of the country) is forest dwellers, largely comprising indigenous communities (MFSC 2008). These people not only extract timber, firewood, fodder and other NTFPs for subsistence use, but also sell these products to earn a living. Furthermore, they convert the forest land for farming or practise slash and burn cultivation, or both. The forest these people use has the highest potential to be included in the REDD mechanism (Dhital, 2009).

From the policy aspects, the Three Year Interim Plan (2007/08-2009/10) developed by the National Planning Commission has recognized the role forestry and their contribution to forest based economic growth, social development, good governance and environmental services to the CFUGs (GoN, 2008).

2.5. Can REDD brings new incentive for CFUGs in Nepal

Initiatives to reduce emissions from REDD will directly affect the 14 to 22% of the rural households in the mid-hill region of Nepal whose income depends upon CFs and who are among the world poorest. REDD mechanisms are more likely to succeed if they build on the interests of local communities and indigenous groups.

The findings from "How REDD can be designed to benefit local people while also reducing emissions" from six countries (Brazil, Indonesia, Madagascar, Mexico, Tanzania and Nepal) suggest that the success of REDD and its impacts on communities will depend on the linkages between incentives and long term development opportunities, resource rights and political participation for marginalised forest communities, as well as their distribution across different levels (community, district, nation) and entities (communities, timber industry and local government) (Wollenberg*, et al.*, 2009).

2.6. Nepal's involvement in REDD

Nepal has demonstrated international commitment in playing its role in global climate change by signing the United Nations Framework Convention on Climate Change (UNFCCC) at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in June 1992. Nepal ratified the Convention on 2nd May in 1994, and this convention came into force in Nepal on 31st July in 1994. Besides these Nepal is already a party of Ramsar Convention, Convention of International Trade of Endangered Flora and Fauna (CITES) and World Heritage Convention (WHC) that shows its commitment to enter the global environment sectors.

REDD is a newly emerged policy and processes are already underway in Nepal. The World Bank Forest Carbon Partnership Facility has selected Nepal as one of its partner countries and the Readiness Plan Idea Note (R-PIN, 2007) submitted by Ministry of Forest and Soil Conservation (MFSC) was approved by World Bank in July 2008.

MFSC is responsible for formulating forest policies and administering the country's forest resources. MFSC is current structure that administers the forest resources of the country through five departments. Of the five, Department of Forest (DoF), and the Department of National parks and Wildlife Conservation (DNPWC) and their subsidiary structures are mainly responsible to conserve, manage and implement forestry programs in the field. Federation of Community Forest User Groups (FECOFUN) a broad based organization was established in 1995 with a view to complement government initiatives related community forest management. It is now working as an advocacy and lobbying organization to protect the rights of community forest users.

Designated National Authority (DNA) has been established under the Ministry of Environment, Science and Technology (MoEST) and is responsible to deal and facilitate financing procedures to international carbon markets. A clear lack is noticed concerning the roles and responsibilities between two major entities MoEST and MFSC to proceed REDD process in Nepal .To institutionalize the climate change issues in the country, the GoN has formed a coordination forum, the Climate Change Network (CCN). The CCN is chaired by the Secretary of the MoEST and is mainly activated as an advisory forum before and after having the CoP meetings of UNFCCC. Nepal is in a process of R-PLAN development. A numbers of meetings, consultations and an interaction program were undertaken but at an ad hoc basis.

Enthusiasms of MFSC and forest related organizations seem quite encouraging. MFSC has not initiated to form a separate unit of carbon finance or a related cell authorized to deal with climate change and forest service's payments.

2.7. Funding and Financing REDD Activities

The incentives for REDD need to respond the local deforestation conditions, local capabilities and local development opportunities and focus in the process of distribution of REDD incentives, benefits and political participation across different levels of decision making and interest groups of local forest communities (Wollenberg*, et al.*, 2010). Before going to REDD project, forest communities should be informed and must have given different choices. From the social perspective, continuity in livelihood practices should be an option for indigenous groups, long term residents or the very poor for whom alternative livelihoods may not exist or where changing livelihood strategies or participating in new programmes may be too risky (Wollenberg*, et al.*, 2009).

The lower price of carbon could make REDD (carbon sequestration) project less attractive as it is due to the price of carbon local people are interested in the projects so the cheap REDD carbon credits may reduce its effectiveness as an emission reducing strategy (Dudley, 2010). REDD mechanism needs to provide the financial and technical assistance for developing plans to manage forest through participatory planning with rural communities and support for developing agricultural and animal husbandry policies that reduce pressure on existing forests (Wollenberg*, et al.*, 2010).

2.8. REDD policy

The discussion is continue at the international level to implement the appropriate REDD policy for the local communities of developing countries whose livelihoods are dependent on forest resources for both subsistence and commercial way. These communities have been engaged in managing and conserving forest resources to meet their subsistence needs hence they will be affected by REDD if their national governments decide to participate in this policy (Karky*, et al.*, 2009).

Policy makers must see the impact of REDD project on the indigenous and local peoples and design in such a way that optimum benefit can be achieved. The benefit will be optimum when other complementary activities like NTFPs collection, sustainable timber harvesting and eco-tourism could be carried out with the REDD project (Manandhar, 2009).

Karky (2008) in his research developed three scenarios for REDD and found scenario 2, as the best option in Nepal's CF for REDD schemes to be implementation.

2.9. Conceptual Framework

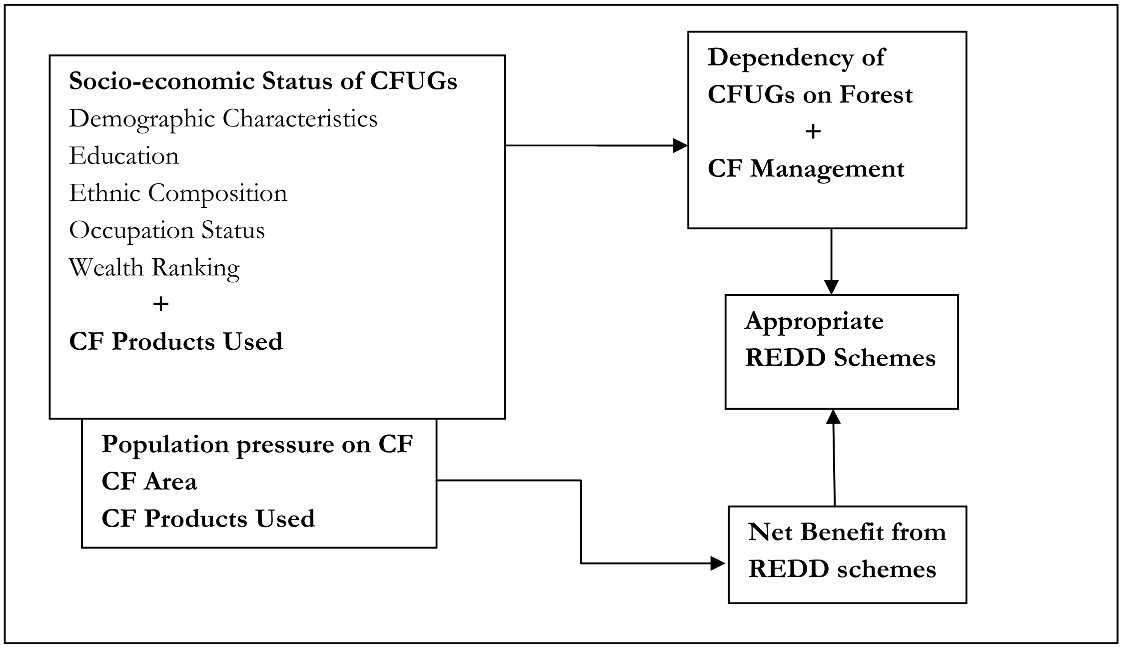

Figure 2-1Conceptual Framework of the research

CFs are managing their forests well so REDD has introduced in this forest. A few studies were carried out to assess the appropriate REDD schemes to be implemented in CFs for Nepal. The scenarios that will introduce after REDD implementation are Scenario 2 and Scenario 3. Literature says that the Scenario 2 is the best for CF of Nepal (Karky, 2008). The factors like socio-economic status of CFUGs (Demographic Characteristics, Education, Ethnic Composition, Occupation Status, Wealth ranking); Spatial characteristics (distance from city center and highway) and forest products used influence the level of dependency of local people on CF and management of CF. Previous literatures may have overlooked these differences.

This is the proposition that I offer. Because Nepalese society is a mixture of various socio-economic groups living in different locations which make use of the forest in varying degrees, there can be no single REDD approach for the whole country. At best, a number of schemes are needed to fit into the different situation that the heterogeneity of Nepalese population offers.

3. METHODS AND MATERIALS

This chapter describes how the research was conducted, the methods used for data collection, the techniques used for the data analysis and all materials have been used for this research work.

3.1. Study Area

Ludhi Khola watershed is located in the Gorkha district of the Western Development Region of Nepal (Fig 3-1). This watershed area consists of Tropical Upper and Sub-tropical lower forest, covering the altitudinal range of 318m to 1714m. Of the total watershed area (5750 hectares), 1888 ha is covered by Community Forest Area with 31 CFUGs. This watershed is characterized by social diversity with the presence of Magar, Gurung, Tamang, Dalit,Newar, Brahmin and Chhetri (ICIMOD*, et al.*, 2010).

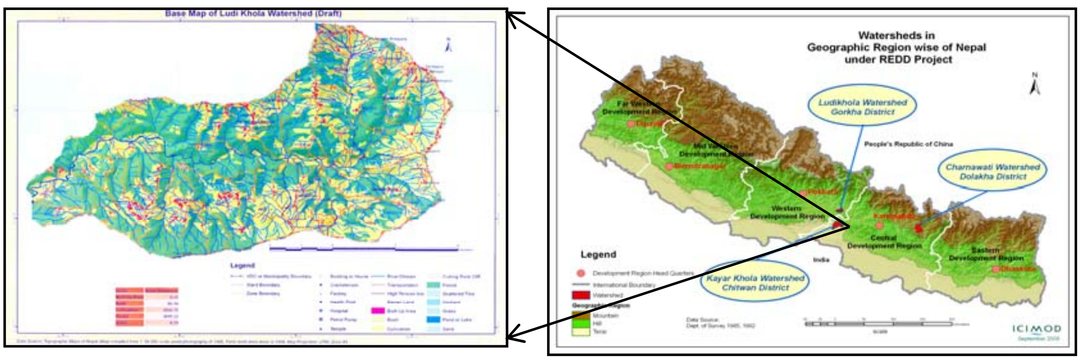

Figure 3-1 Map of Ludhi Khola Watershed Gorkha District, Source: (ANSAB, 2009)

3.2. Climate

The district's average daily temperature is 14.5° C with an average annual rainfall in the range of 1972 to 2000 mm. More than 80 % of total rain occurs between June and September i.e. during monsoon season period. Record for the Maximum rainfall within 24 hrs is 141.0 mm. (Lamichhane*, et al.*, 2009).

3.3. Vegetation/ Forest types

Major forest type in the study area is a broad leaf forest with little needle-leaf forest.. The broad leaf dominant species include *Shorea robusta*, and *Schima wallichii.* Apart from these few other species like *Mangifera indica, Ficus racemosa, Terminalia chebula Bombax ceiba* were also present in the study area. While the needle-leaf major species is *Pinus roxburghii* is the dominant conifer.

3.4. Forest management

Community forest and Government managed forests are the major forest management regimes in the study area. Community forest occupies 1888 ha whereas the government forest comprises of 380 ha which is situated in the southern part of Ludhikhola watershed.

3.5. Method

The methodological flow chart is shown in Fig 3-2. It consists of different steps according to our objectives. At last, we will combine all our objectives to get the final result.

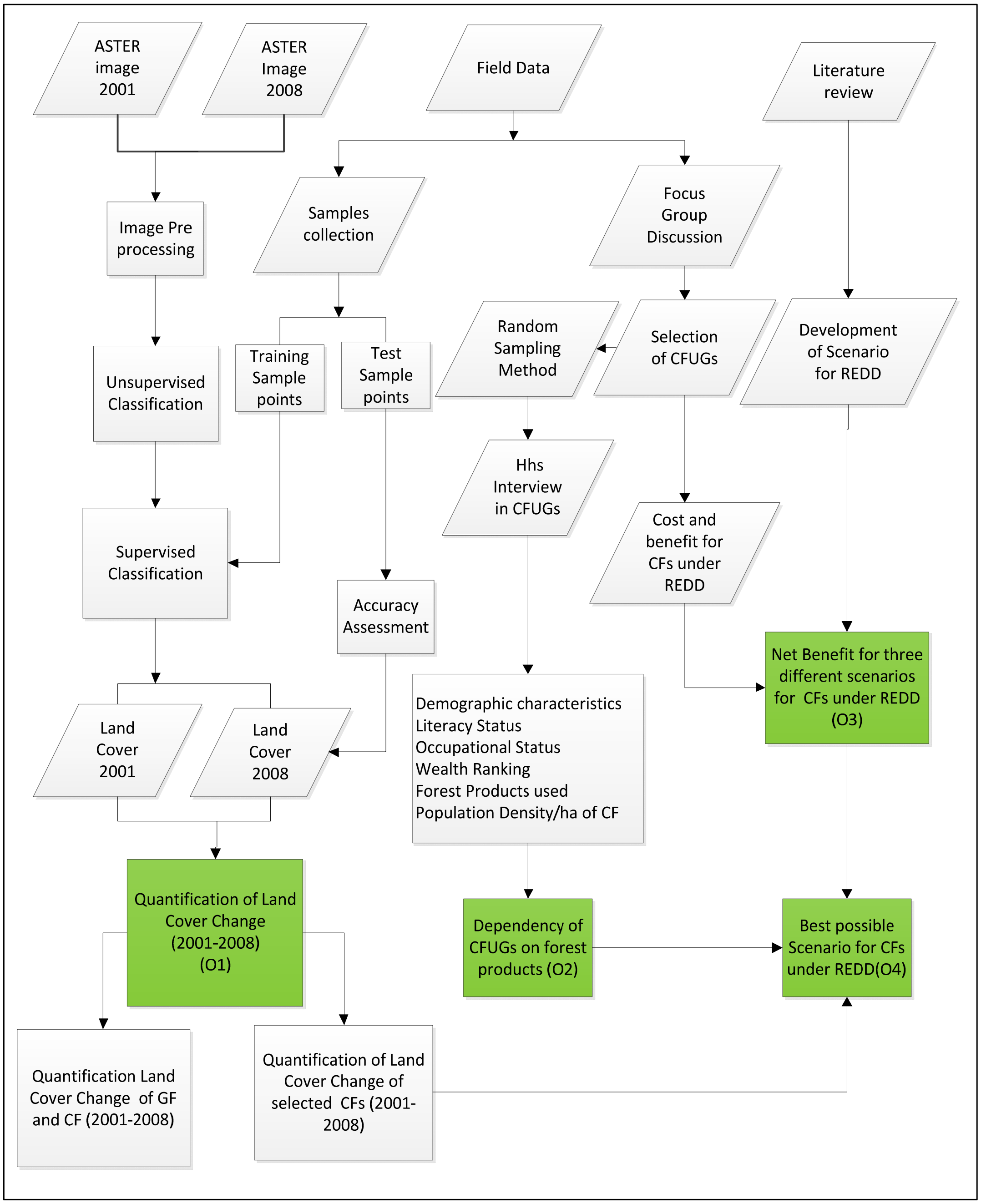

Figure 3-2 Flowchart of Methodology used in the research

3.6. Materials

The imageries and map used for the study were ASTER images of 2001 and 2008, Ortho-rectified Geo-Eye imagery 2009 and topographic map of 1994. The details of their acquisition date, resolution and bands were shown in Table 3-1.

Table 3-1 Images and maps used in this research

Datasets (Image/Maps)	Acquisition Date	Resolution	Bands
ASTER image	April 6, 2001	15 m	14
ASTER image	April 22, 2001	15 m	14
ASTER image	Feb 21, 2008	15 m	14
Ortho-rectified Geo-Eye imagery	Nov 2, 2009	0.5 m	4
Topographic Map	1994		

3.6.1. Instruments and software

Software used for this study was ERDAS Imagine 10 to process remotely sensed data especially to classify land cover change. ArcGIS version 10 was used to process data in GIS operation especially for GIS analysis. SPSS and MS Excel were used for statistical analysis, MS word, Microsoft Visio for the thesis writing and MS power point for presentation of research.

Table 3-2 Software packages used in this research

S.N	Software	Purpose
1	ArcGIS version 10	GIS analysis
2	Erdas Imagine 2010	Image processing and remote sensing applications
3	SPSS	Statistical analysis
4	Microsoft Excel	Statistical analysis
5	Microsoft PowerPoint	Presentation of research
6	Microsoft Visio	Diagrammatic representations
7	Microsoft Word	Writing thesis

3.7. Pre-fieldwork

3.7.1. Image acquisition and pre-processing

The geo referenced Aster images were acquired from ITC RSG Lab. First, the provided images were changed from HDF format to IMG format. The images were then re projected to UTM zone 45N coordinates with WGS 84 datum. Ortho-rectified Geo-Eye image was obtained from ICIMOD (International Centre for Integrated Mountain Development) before the fieldwork. The date of the image acquisition was November 2, 2009.

3.7.2. Unsupervised Classification

The unsupervised classification is useful technique to stratify input images into spectrally homogenous areas for training and validation ground truth data collection (Kuemmerle, *et al.,* 2006). Prior to collecting field data the unsupervised classification of the image was done so it can be used in the field and it can be the basis of three land cover classes (forest, agriculture and river).

3.7.3. Sampling strategy

3.7.3.1. Land cover sampling

For mapping land cover change sample points were collected in both government and community forests by using "stratified random sampling" methods which is an efficient way to collect samples in a short span of time (King, *et al.,* 2004). This stratified random sampling helps us to select and recorded the random coordinate points in several places, representative for the strata. Altogether 112 sample points were collected for the whole stratum. It was classified into 3 classes of land cover types which are forest, agriculture and river.

3.7.3.2. HHs survey

Due to the huge population residing in the study area, it was not possible to carry out household survey in all the CFUGs, thus only six CFUGs based on the focus group discussion were considered for the study. From these six CFUGs, the households (HHs) for HH survey were selected based on simple random sampling strategy. 132 HHs were visited during the field.

3.7.4. Scenario Development

To analyse the costs and benefits of selected CFUGs for REDD implementation three scenarios were adapted from Karky (2008). The scenarios were developed as Traditional Benefit /Scenario 1 (Business as usual), Scenario 2 (Business as usual + REDD benefits) and Scenario 3 (REDD Management + No Benefit from Forest) to conduct costs and benefits analysis for each CFs targeting for REDD implementation.

3.7.5. Questionnaire Development

The questionnaires were developed (Annex 1) for interview to collect data based on demographic characteristics and livelihood status of the CFUGs like education level, occupation characteristics, ownership of farm size etc. In addition information of forest products (fuel-wood, fodder and timber) utilization by the sample HHs were also collected .Information on the forest condition in the past was obtained from different forest dependent community and forestry professionals. Also questionnaires were developed (Annex 2) for Focus Group Discussion to find out the costs and benefits for six CFUGs upon REDD implementation.

3.8. Field data collection

Different datasets were collected in the field including the ground truth data to assess the land cover, data to assess the forest dependency and cost and benefit for CFs upon REDD implementation. Relevant secondary data was also collected.

3.8.1. Land cover change

The land cover change in the watershed was seen from the year 2001-2008. To assess the land cover change, the geographic coordinates of the different land cover classes (forest, agriculture and river) were recorded by using Garmin GPS and iPAQ total of 112 samples were collected. Ancillary dataset of 111 samples were collected from ICIMOD were used due to time constraint. All 223 sample points collected were divided into training and test samples. They were collected from circular sample plot of area of 500 square meters and a radius of 12.62 meters in flat area. In case of slope a correction table was used to correct the radius since it increase as the slope increase. Several bio-physical data were collected from these plots. Vegetation data such as tree species, DBH, crown cover percentage, slope, elevation and aspect. A standard data Tale sheet were used to collect these types of data.

3.8.2. Focus group discussion

Focus group discussions were organized, firstly to select the CFs for HHs and study the forest dependency of the local people. It was held in Birenchok CF and the following CFs (Table 3-3) was selected for further analysis.

Series of focus group discussions were done in the selected CFUGs to find out costs and benefits that will incur upon implementation of REDD and questionnaires (Annex 2) were filled to get the results.

In the field the focus group discussion was held in the Birenchok of Gorkha district. Only six CFs out of 31 CFs were selected to assess forest dependency based on the criteria given in the Table 3-3 below.

Table 3-3 Selection criteria of CFs

S.N	Community Forest	Selection Criteria
1.	Badahare	Dominant Indigenous People
2.	Birenchok	Near Highway Road
3.	Lamidanda	In a Remote Area
4.	Ludhi Damgade	Large CF Area
5.	Ram Laxman	Small CF Area
6.	Shikar	Near City Centre

3.8.3. Selection of Sample Households (HHs)

The household (HH) was taken as a sampling unit. The household survey was conducted in 132 houses which correspond to the 15% in selected CFs based on the total HHs. But in case of Ludi Damgade, because of its large population, only 35 HHs were interviewed which accounted to 8% of the total population. Table 3-4 shows the details of the interviewed HHs.

Table 3-4 Interviewed HHs

Community Forest	Address	Total HHs	Interviewed HHs	Percentage
Badahare	Gorkha Municipality 10	160	25	16
Birenchok	Gorkha Municipality 8	158	26	16
Lamidanda	Bakrang 5, Gorkha	90	15	17
Ludi Damgade	Gorkha Municipality 6 & 7	450	35	8
Ram Laxman+	Bakrang 1, Gorkha	60	9	15
Shikar	Gorkha Municipality 8	130	22	17
Total		1048	132	

3.8.4. Secondary Data Collection:

Secondary data were collected from GoN, Ministry of Forest and Soil Conservation; Department of Forest, Nepal; GoN, Ministry of Environment, Science and Technology; Federation of Community Forestry Users, Nepal (FECOFUN) and ICIMOD. And Operation plan from each selected six CFs were photocopied and brought for analysis, other relevant information from different organizations INGOs (International Non Government Organizations), NGOs, CBOs (Community Based Organizations) were also collected.

3.9. Post field work and data analysis

3.9.1. Image classification

Image classification is a means to convert spectral raster data into a finite set of classification that represent the surfaces types seen in imagery (Tempfli*, et al.,* 2009). Images classification can be done using a supervised and unsupervised approach. Supervised classification technique using maximum likelihood (MLC) classifier is widely used in remote sensing (Zheng, *et al.,* 2005), in particular for land cover mapping. The Aster image of 2008 was classified into three major classes' forest, agriculture and river. Similarly the classification of Aster Image of 2001 was done on the basis of spectral reflectance on Aster Image 2008. Secondary data about the land cover in 2001 was also used to classify Aster image of 2001. Classified (Supervised) image of 2008 was validated on the basis of test samples.

3.9.2. Accuracy assessment

Accuracy assessment is to express the degree to which the derived images classification agrees with reality (Foody, 2002). The accuracy was assessed using the independent dataset collected in the field. Training and test points were divided in 70:30 ratio, hence, 67 test samples were used for accuracy assessment. Confusion matrix was developed to each classification result. This matrix includes user and producer accuracies and overall accuracy.

3.9.3. Quantification of land cover changes (ha)

The area coverage of land cover identified in the image of 2001 was compared with land cover identified in the image of 2008 to find the land cover changes of CFs and GF and forestland changes within CFs. Change can be either positive or negative as such both negative and positive change of land covers was analysed. The land cover change quantification was done using Arc GIS and excel.

3.9.4. Assess Forest dependency of CFUGs

The CFUG's dependency of forest products was analysed through the information based on demographic characteristics (education level, occupation characteristics, wealth ranking) of CFUGs, quantities of forest products used throughout the year per HHs of CF and population density per ha of CF. The process of finding dependency was shown in Annex 3.

Ranking: The CFs that show less dependent on the forest for their living they got the highest ranking as 6 while the CFs which show more dependent on the forest for their living they got the lowest ranking as 1. Because of six CFs, the ranking was from 1, 2, 3, 4, 5 and 6 depending on their forest based living.

Forest products ranking:
The ranking for six CFs was done according to their forest products used. The more forest products used make them more dependent in forest based living and less forest products used make them less dependent on forest based living so accordingly the ranking was done for six CFs.

Socio-economic ranking:
Education ranking: The concept for ranking education was based on the fact of the largest percentage of CFUGs getting higher education the more chance of getting good job that makes them less dependent on forest based living while the case is reverse for the smallest percentage of CFUGs getting higher education make them more dependent upon forest based living.

Wealth ranking:
The wealth ranking was first standardized by multiplying the percentage of rich, medium and poor by 3, 2 and 1 of each CFs. The rich people are the one who were less dependent upon forest based living so they

were multiplied by highest number. The middle class people are the one which were more dependent than rich on forest based living so they were multiplied by 2. The poor people are the one which were the most dependent upon forest based living so they were multiplied by 1. Then the standardized average was calculated and it was ranked from 1 to 6. The highest the average the less dependent on forest based living and get highest number and so on.

Occupation ranking:
The occupation was first standardized by multiplying the percentage of occupation status of CFUGs (only dependent upon agriculture+ livestock by 1, dependent upon agriculture + livestock + remittance by 2 and agriculture + livestock + skilled work by 3 and agriculture + livestock + unskilled work by 1. The assumption was based on the fact of those people who were only dependent upon agriculture + livestock and agriculture + livestock + unskilled work) show highest dependency on forest based living than other types of occupation. Then the standardized average occupation was ranked according to 1 to 6 for each CFs. The least number they are the most dependent upon forest products from this occupation aspects.

Calculating the dependency:
The average of forest products, education, wealth ranking and occupation was taken and it was divided by population density per ha of CF that gives us the actual dependency of CFUGs on forest based living

3.9.4.1. Forest products used with spatial relationship

The calculated forest products was then tried to be related with spatial characteristics. The distance of the CF from the city centre and distance from highway were observed if they made any change on consumption pattern of forest products for CFUGs.

3.9.5. Costs and benefits of six CFUGs for REDD implementation

Benefit and costs were only estimated for direct use values that were directly used by the locals and easily valued; other indirect use values and option values and other non-use values were not included in the valuation as this was not a total economic valuation of a forest but only a gross margin analysis under change management scenarios. The whole process for calculation costs and benefits for six CFs was adopted from (Karky, 2008). Table 3-5 shows the costs and benefits for CFs for each Scenario.

Table 3-5 Cost and benefits for CFs from each Scenario

Scenario 1	Scenario 2	Scenario 3
Benefits from Community Forest		
Fuel-wood	Fuel-wood	
Fodder	Fodder	
Timber	Timber	Carbon Revenue from Scenario 2
B_1	Carbon Revenue (B_2)	Additional Carbon Revenue by not consumption of fuel-wood (B_3)
Costs for Community Forest		
Labour	Labour	Labour
Management	Management	Management
Forest Protection	Forest Protection	Forest Protection
	Carbon Measurement	Carbon Measurement
	Carbon Report	Carbon Report
	Miscellaneous costs	Miscellaneous costs
		Fuel-wood (foregone)

		Fodder (foregone)
		Timber (foregone)
C_1	C_2	Fodder (foregone) (C_3)

3.9.5.1. Calculating costs to Local Communities for each scenario

This was done by Focus Group discussion in each CFUGs and cost was calculated based on their assumptions. The whole process in preparation of first REDD proposal, was done by ICIMOD, ANSAB and FCOFUN, (INGOs and NGOs) so the cost of initial REDD proposal was not accounted for calculation of the cost. Once the REDD programme is in action, this cost will be invested by CFs. For scenario 3, the market price of foregone forest products (timber, fodder and firewood) was added in the costs. The cost for each scenario is shown in Annex 4.

3.9.5.2. Calculating monetary value of forest products

The total forest products (Timber, Fodder and Firewood) used by the CFs in a year were converted into market price. For the forest products sold in markets such as timber was calculated with direct market price of that area. For products which are not traded in the local market such as firewood and fodder were calculated by surrogate prices as suggested by (Khanal, 2001). The process for calculation market price for forest products was shown in Table 3-6. The detailed calculation of monetary value of forest products is shown in Annex 5.

Table 3-6 Process for calculation market Price for Forest products

Market price for Timber	Market price for Firewood	Market price for Fodder
1 cu ft of timber = NRs. 1000 (If people have to get this timber from CF, they have to pay royalty almost NRs. 35 and labour charge for cutting timber is NRs. 300). So, their net benefit = NRs.665	The value of firewood was estimated on the basis of the value of alternative fuel kerosene. Where one bhari (30 kg) of firewood is equivalent to 2.83 litres of kerosene. Price of kerosene is now NRs. 80 For firewood: 30 kg = 2.83 litres of kerosene Based on this: 30 kg of firewood = NRs. 226.4	The value of fodder was estimated on the basis of rice straw. 10 bundles rice straw = 1 bundle of fodder 1 bundle rice straw = NRs. 5 So, One bundle (30 kg) fodder = NRs. 50

3.9.5.3. For estimating CO_2 in Scenario 2

The CO_2 in scenarios 2nd will be the mean annual carbon sequestration in Community Forest under current management condition after local people have extracted forest products to meet their sustenance needs. It will be adapted from (Karky, 2008), that will be (1.88 t C ha-1 year-1, or 6.89 t CO_2 ha-1 year-1).

3.9.5.4. For estimating additional CO_2 in Scenario 3

In this scenario CFUGs will not be able to collect the forest products so that the forest growth would be maximized will be better for carbon stock accumulation. The additional carbon revenue will be not using fuel-wood consumption per HHs/yr from each CFs that will be converted into t CO_2 as CFs will no longer have permission to extract fuel wood from the CFUGs. (1 kg of firewood = 1.8333 kg of CO_2). This is shown in Annex 6.

3.9.5.5. For calculation of carbon revenue in Scenarios 2 and 3

Potential incremental benefits from carbon finance for the forest was calculated by multiplying annual quantity of carbon stock with market value per US$ 5 t CO_2 (World Bank recommended market price per t CO_2 ranging from 1-15 US$ as suggested by (Neef*, et al.*, 2007).The US$ 5 per t CO_2 was considered for minimizing risk from the market aspects. The whole ha of CFs area was considered as the payment under REDD in Nepal's as they are managing their forest in a sustainable manner at least over a decade (Karky*, et al.*, 2010; Rana, 2008).

3.9.5.6. To assess the best possible REDD scheme for six CFs

All the findings from Land cover change, livelihoods of local people on CFs, and costs and benefits for each CFs under REDD implementation (economic aspects) are analyzed at the end to find out possible REDD scheme for six CFs.

4. RESULT

4.1. Land Cover

The landcover classification was done in Aster image of 2001 and 2008. Images were classified into three classes i.e. forest, agriculture and river to see the forestland changes in CFs and GF and also with in CFs.
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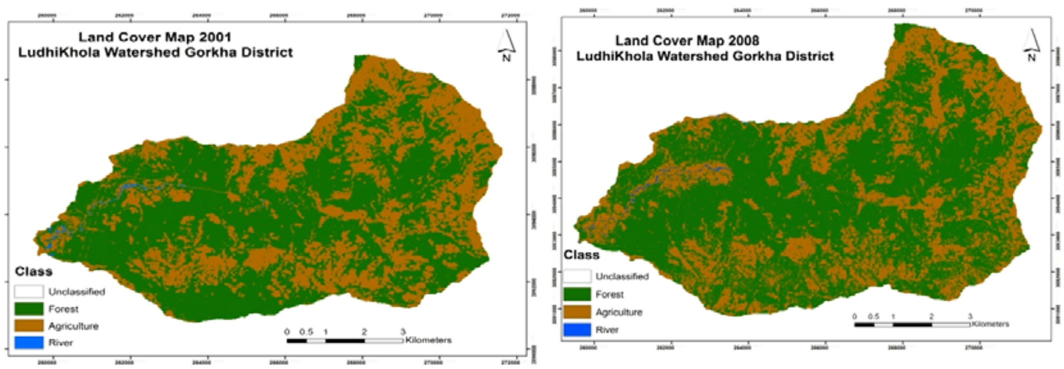

Figure 4-1 Land Cover Map of 2001 and 2008 of Ludhi Khola Watershed

4.1.1. Accuracy Assessment:

The overall accuracy obtained in the field was 75.64% for the Aster image 2008. The accuracy of the image 2001 could not be assessed due to the lack of reference material such as land cover maps with a credible accuracy or aerial photographs at the same period. The accuracy assessment for 2008 image is shown in Table 4-1. In general the overall accuracy of this classification is reasonable.

Table 4-1 Accuracy Assessment for 2008 images

ACCURACY TOTALS					
Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Unclassified	1	1	0	---	---
Forest	80	105	76	95.00%	72.38%
Agriculture	70	48	41	58.57%	85.42%
River	5	2	1	20.00%	50.00%
Totals	156	156	118		
Overall Classification Accuracy = 75.64% Overall Kappa Statistics = 0.5282					

4.1.2. Land Cover Change for GFs (2001 to 2008)

Following figures Fig 4-2 & 4-3 show the land cover map of Government Forests (GFs) for the year 2001 and 2008 respectively. The Land Cover change for GFs is shown in Table 4-2.

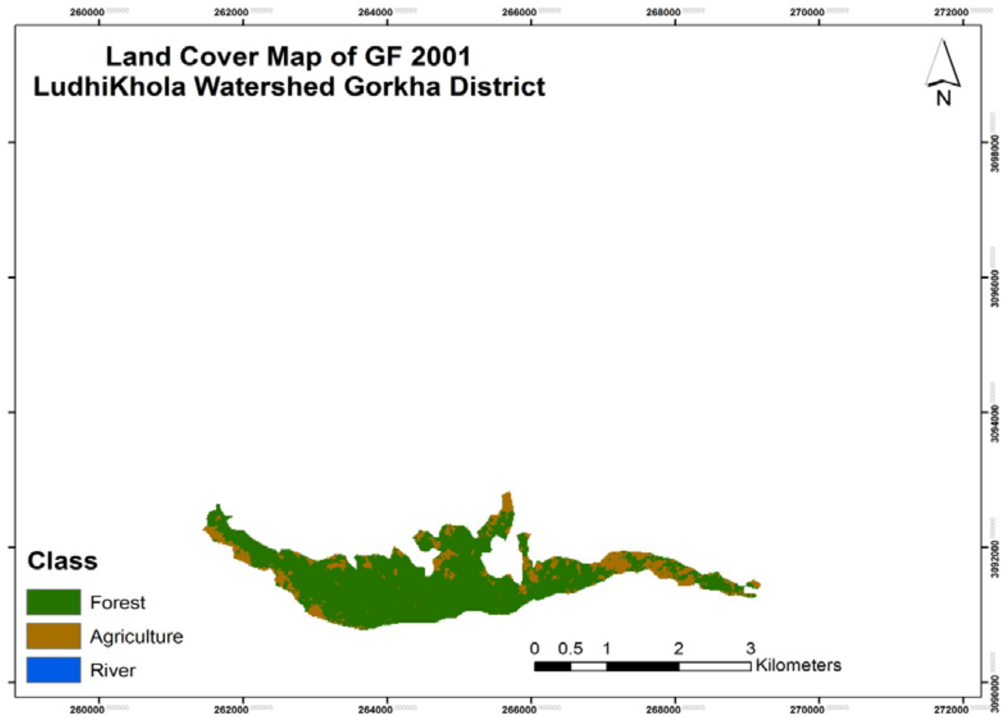

Figure 4-2 Land Cover Map of GF 2001

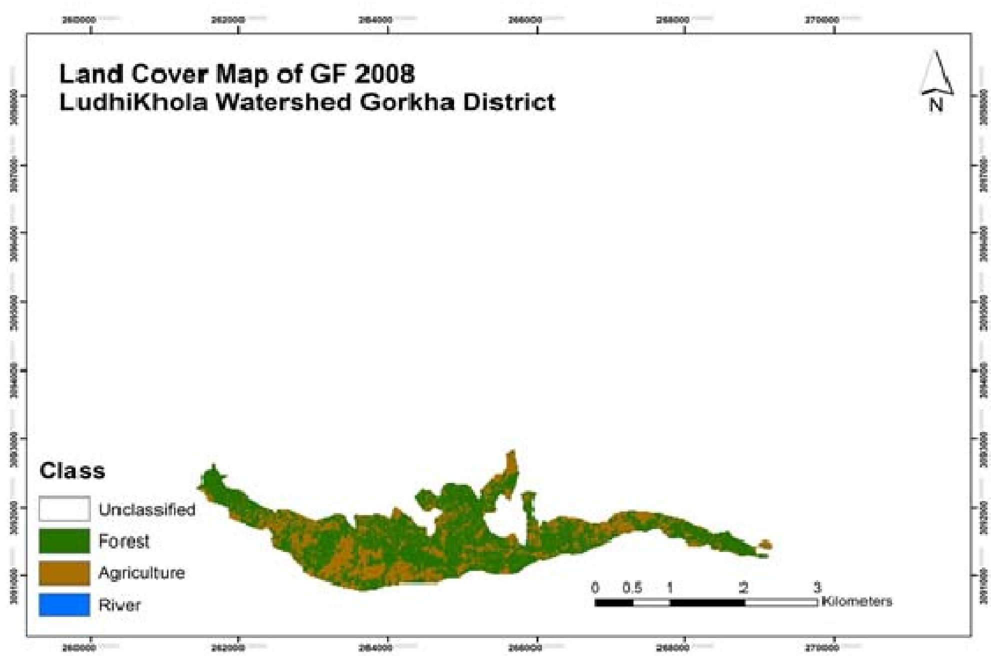

Figure 4-3 Land Cover Map of GF 2008

Table 4-2 Land Cover Class of GFs for the year 2001 and 2008

Land Cover Class (ha)	Government Forests		Diff (+/-)
	2001	2008	
Forest	409.41	326.70	-82.71
Agriculture	86.89	169.87	+82.98
River	0.02	0.06	+0.04
Unclassified		0.06	
Total	496.31	496.69	

As shown in Table 4-2, from the year 2001 to 2008, the government forest area has decreased from 409.41 ha to 326.70 ha at the same time the agriculture land increased from 86.89 ha to 169.87 ha.

4.1.3. Land Cover Change for CFs (2001 to 2008)

Following figures Fig 4-4 & 4-5 show the Land Cover Map of Community Forests (CFs) for the year 2001 and 2008 respectively. The Land Cover change for CFs is shown in Table 4-3.

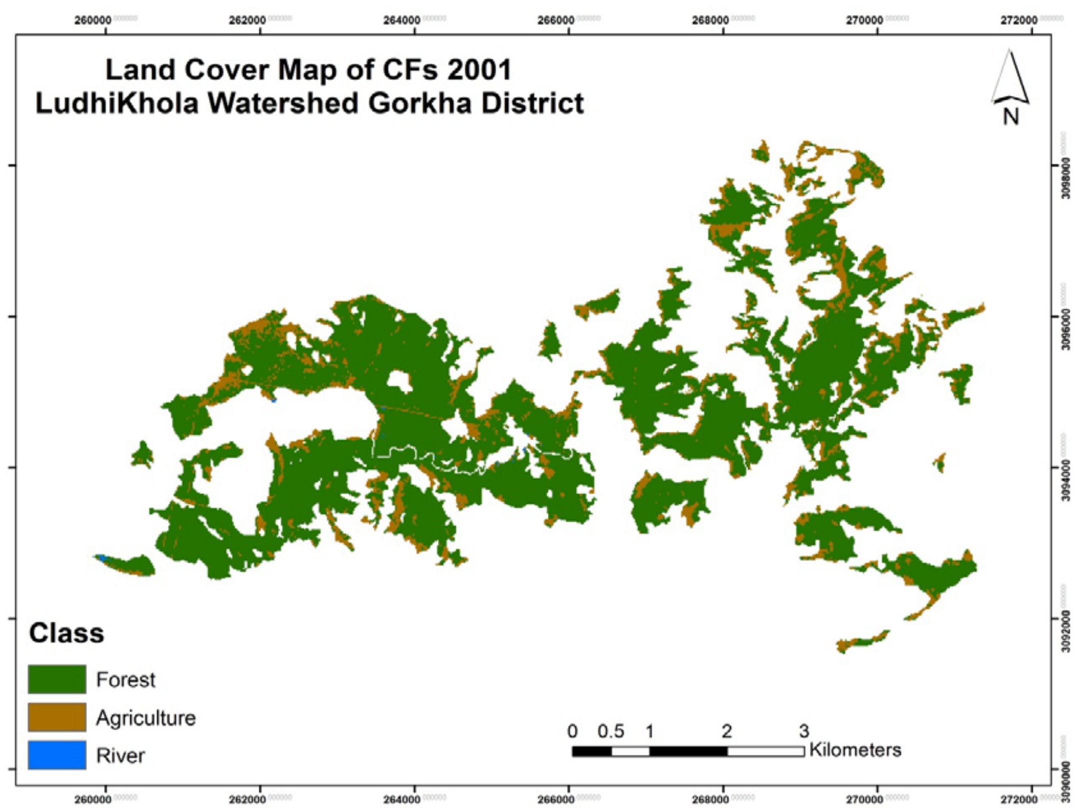

Figure 4-4 Land Cover Map of CF 2001

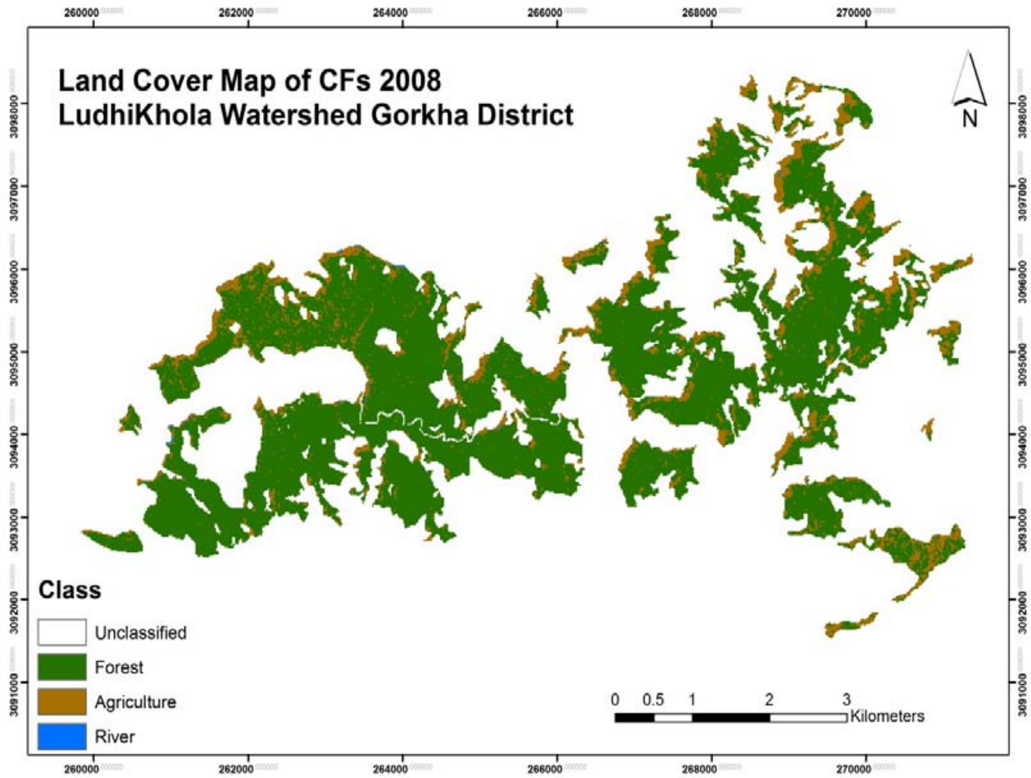

Figure 4-5 Land Cover Map of CF of 2008

Table 4-3 Land Cover Class of CFs for the year 2001 and 2008

Land Cover Class (ha)	**Community Forest**		**Diff (+/-)**
	2001	**2008**	
Forest	1605.51	1609.71	+4.2
Agriculture	291.08	286.28	-4.8
River	0.14	2.49	+2.38
Unclassified	0.00	0.12	+0.12
Total	1896.73	1898.61	

As shown in Table 4-3, from the year 2001 to 2008, the community forest area has increased from 1605.51 ha to 1609.71 ha in CFs at the same time the agriculture land decreased from 291.08 ha to 286.28 ha.

4.1.4. Comparison of CFs and GF

Overall, the comparison of CFs and GF has indicated that during the period of 2001-2008, the rate of deforestation and degradation was under control at the Community Managed Forest i.e. (0.25 % forest area increased in CFs) whereas the deforestation and degradation has been increased in case of GFs i.e. (20% forest area decreased in GF). This is shown in Table 4-4.

Table 4-4 Comparison of forest area (ha) in CFs and GFs (2001-2008)

Land Cover Class (ha)	Community Forests		Government Forests	
Year	2001	2008	2001	2008
Area in (ha)	1605	1609	409	326
Area Diff (ha)		4	83	
%	0.249221184	Increased	20.29339853	Decreased

4.1.5. Land Cover Change for selected CFs (2001 to 2008)

Following Figures 4-6 & 4-7 showing the Land Cover Map of selected CFs for the year 2001 and 2008 respectively, Land Cover change for selected CFs (2001-2008) is shown in Table 4-5.

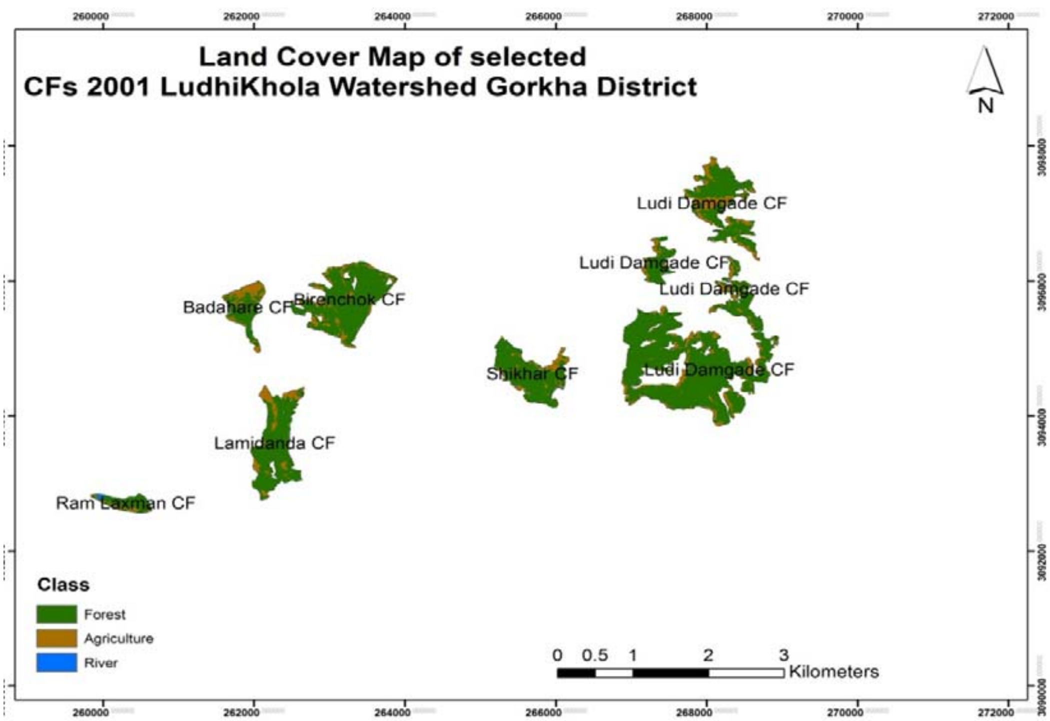

Figure 4-6 Land Cover Map of selected CFs 2001

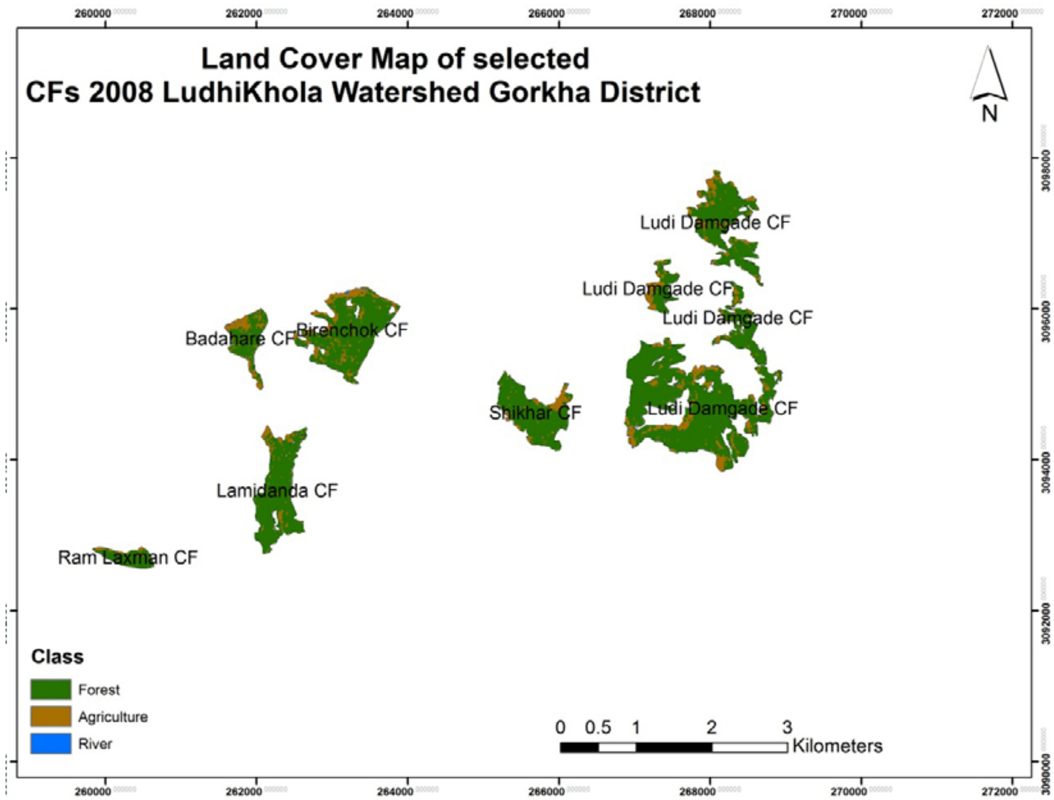

Figure 4-7 Land Cover Map of selected CFs 2008

Table 4-5 Land Cover Class of Selected CFs for the year 2001 and 2008

Community Forest	Area in ha (2001)	Area in ha (2008)	Difference Area (ha)	+/- (%)
Badahare	16.62	18.45	1.83	10.98
Birenchok	73.44	68.54	-4.90	-6.67
Lamidanda	52.28	56.95	4.66	8.92
Ludhi Damgade	230.93	234.10	3.17	1.37
Ram Laxman	10.63	11.65	1.02	9.62
Shikar	43.93	44.85	0.92	2.09

In five CFs the forest area (ha) has increased though the range is not similar. The smaller the area of Community forests, the more increment in area from the year 2001 to 2008 in. But in Birenchok CF, the area of CF has decreased by about 7%.

Forest area is increasing in CF because of the care given by community, thus it is sustaining and continue like a sustainably managed forest. While the government forest area is decreasing because it has no protection against the use of people. Consequently, people are using it for several purposes and therefore, it is degraded and deforested.

4.2. Forest Dependency

4.2.1. Demographic Characteristics

The demographic characteristics include size of CFUG households, the ethnicity of forest user groups.

4.2.1.1. Size of CFUGs Households

Size of CFUG households has greater impacts on forest products used. The larger the size of family the higher the chance of using more forest products. On average the majority of HHs have Medium size family i.e. 61% of the HHs have family size ranging between 5-8 as shown in Table 4-6.

Table 4-6 Percentage distribution of households by family size

Community Forests	Small (1-4)	Medium (5-8)	Large (9+)	Total
Badahare	32	60	8	100
Birenchok	15	73	12	100
Lamidanda	30	56	14	100
Ludi Damgade	26	60	14	100
Ram Laxman	33	54	13	100
Shikar	32	68		100
Average	29	61	10	100

4.2.1.2. Per ha Population Density

Badahare CF has the highest population density of 27 persons per ha of forest and the Lamidanda has the lowest population density of 6.6 persons per ha of forest. Due to the highest population in per ha of forest they can be managing their forest effectively or the forest can be degraded leading to deforestation. It's all depends on people's perception on managing and utilizing their forest resources. The population density is shown in Table 4-7.

Table 4-7 Population Density per Ha of CF

CF	Total HHs	Total population	Population/HHs	Area CF (ha)	population Density per ha of CF
Badahare	160	696	4.4	25.8	27.0
Birenchok	158	909	5.8	83.6	10.9
Lamidanda	90	408	4.5	61.6	6.6
Ludi Damgade	450	1936	4.3	270.7	7.2
Ram Laxman	60	252	4.2	13.3	19.0
Shikar	130	650	5.0	30.4	21.4

4.2.1.3. Ethnic composition

In Nepalese context, Ethnic composition is very important characteristics to be looked at from forest management perspective because each ethnic characteristic have its own role in management of forests. Bahun, Chhetri and Newar are the upper class caste people, they are either rich or in medium class. They have sufficient land and livestock. Indigenous people are also mostly in medium class assumed to be good manager for the forests product, they know how to manage forest for maximum benefit for themselves and in a sustainable way. But Dalit caste shows different characteristics, they have little land and because of that, their livelihood depends on seasonal works. They are mostly poor and uneducated. Thus directly they don't seem to be active consumer of forest products but indirectly they are the main consumer or passive consumer. This is because they are responsible for illegal cutting of timber, collecting firewood and sell it to the market. In Badahare CF the dominant caste is Indigenous i.e. 44% while in Lamidanda the majority of Dalit people are living i.e. 40 %. The ethnic composition is shown in Table 4-8.

Table 4-8 Percentage of people by ethnicity

Community Forests	% of population in ethnicity				Total
	Bahun + Chhetri	Newar	Indigenous	Dalit	
Badahare	36	4	44	16	100
Birenchok	69	8	12	11	100
Lamidanda	43	3	14	40	100
Ludi Damgade	63	5	6	26	100
Ram Laxman	65		20	14	100
Shikar	77	1	8	14	100
Average	58.8	3.5	14.2	23.5	100

Indigenous people are the non-Hindu groups of people, their native language is not Nepali (*khas kura*). They have distinct cultural practices as defined by the National Foundation for the Development of Indigenous Peoples (NFDIN), an apex body established under the Ministry of Local Development, Government of Nepal.

Dalit refers to the groups of people who were treated as the sudra (i.e., untouchables) category in terms of Hindu varna (e.g., Social) system. Mostly in the past (and even at present), these people were treated as untouchables as mentioned in the Old Legal Code 1910 BS.

4.2.2. Education level amongst CFUG Household Members

Education level has an important role in determining the capacity of CFUG members to undertake carbon measurement activity and also in determining the management regime. Education provides opportunity for people to be engaged in other services which ultimately reduce their dependency on forest. From the education aspects Ludhi Damagade has the most educated people followed by Birenchok CFs. The education level is shown in Table 4-9.

Table 4-9 Education Level

Community Forests	0	1	2	3	Total
Badahare	8	40	48	4	100
Birenchok	4	35	46	15	100
Lamidanda	7	46	40	7	100
Ludhi Damgade	0	23	40	37	100
Ram Laxman	8	50	43	7	100
Shikar	9	45	41	5	100
Average	5	40	43	12	100

Illiterate = 0; Under High school; S.L.C to Bachelor Degree =2; Above Bachelor Degree =3

4.2.3. Occupational Characteristics of CFUG Members

Agriculture and livestock is the major occupation of the people living in study area. But the dependency of people on agriculture and livestock is the highest in Badahare and Ram Laxman CFUG. Thus, these

CFUGs are more dependent on forest products compared to others. In case of Birenchok and Ludhi Damgade majority of people are in Government of Nepal (GoN) works, skilful work and business in additional to agriculture and livelihoods activities. This makes CFs less dependent on forest products from occupation standpoint. The case for Lamidanda and Shikar is quite interesting from the livelihood aspects. More than 30% of the local people are involved in unskilled work in additional to agriculture and livelihood activities. These unskilled local people were often dependent on forests to support market oriented activities such as fuel wood selling, alcohol distilling, timber selling etc. The occupation status is shown Table 4-10.

Table 4-10 Occupational Status

Community Forests	A	B	C	D	Total
Badahare	36	32	25	7	100
Birenchok	8	27	57	8	100
Lamidanda	7	33	25	35	100
Ludhi Damgade	23	23	46	8	100
Ram Laxman	33	22	36	9	100
Shikar	23	27	20	30	100
Average	22	27	34	17	100

Where, A = Agriculture + Livestock
B = Agriculture + Livestock + Remittance
C = Agriculture + Livestock + (GoN services/skilled work + Business + pension)
D = Agriculture + Livestock + unskilled work (seasonal agricultural & labour work + porter)

4.2.4. Ownership of farm area

Having seen that CFUG household members are mainly dependent on the agriculture sector for employment for their primary occupation, it is important to see the ownership of their farming land to better understand their agriculture based livelihood. The Ownership of farm area and its size are shown in Table 4-11.

Table 4-11 Sample households farm size distribution (1 Ropani=5478 square Ft)

Community forests	% of Land less people	Average Ropani of Low land (Irrigated land)per HHs	Average Ropani of Up Land (Un irrigated Land) per HHs
Badahare	4	2.0	8.7
Birenchok	11	2.4	9.3
Lamidanda	7	1.3	6.9
Ludhi Damgade	3	4.6	9.5
Ram Laxman	11	2.8	9.3
Shikar	13	2.6	3.9
Average	8	2.62	7.93

The area and quality of land determine the degree of dependency of people on the forest. Agriculture is the mainstay of livelihood of the majority of the respondents in studied CFs. Income diversification and off farm activities would reduce pressures on forest land. Low area of land without trade off and inadequate income from off-farm activities pose the threats to increase pressure on the forest. Besides, land less people are the one to pose serious threats to increase pressures on the forest. In case of

Birenchok though the percentage of land less people is high, but the majority of them are involved in business.

4.2.5. Classification of sample HHs into Rich, Medium and Poor

HHs in study area are classified into three levels: rich, medium and poor category. The major criteria used for the categorization in well-being classes are the extent of land owned, house, food sufficiency from private land, employment (permanent and temporary), facility in the houses and literacy rate in each HH. The approach taken here is the same method used by Richards *et al.,* (1999) for the study in participatory forest management. The wealth ranking is shown in Table 4-12.

Table 4-12 Wealth ranking of HHS in percent

Community Forests	Rich	Medium	Poor	Total
Badahare	12	80	8	100
Birenchok	12	85	4	100
Lamidanda	-	67	33	100
Ludi Damgade	31	63	6	100
Ram Laxman	11	78	11	100
Shikar	32	27	41	100
Total	19	67	14	100

4.2.6. Quantity of forest products fulfilled from own farm land

Forest products that local people need for their daily life can also be fulfilled from their own farm land although in a small amount. For this the quantity of unfertile land (upland) land plays an important role, the more the quantity of upland the less people dependent on forest products. Due to the expensive labour work, migration of youth, unavailability of irrigation facility and quality of this upland areas, people they don't enjoy agriculture in these lands now a days. Thus, it can be good alternative for them for finding firewood and fodder. But for timber purpose, more or less, all people dependent on community forests. Table 4-13 shows the percentage of forest products fulfilled from own land.

Table 4-13 Percentage of quantity of forest products fulfilled from own farm land

Community forests	**Firewood**	**Fodder**	**Timber**
Badahare	10%	25%	-
Birenchok	12%	28%	
Lamidanda	10%	20%	-
Ludhi Damgade	18%	35%	-
Ram Laxman	12%	28%	-
Shikar	10%	25%	-

Source: ("Operation Plan for CFUGs," 2007/08 to 2017/18)

4.2.7. Use of Forest Products by CFUG Members

Access to and uses of forest resources in a sustainable manner are the key of CFM policy in Nepal Himalaya. If carbon management is to be added to the existing CFM, carbon market mechanisms must be seen in relation to the current benefits obtained from these forests. This section quantifies the household's dependency on fuel wood and fodder which is the most important forests product they rely on.

4.2.7.1. Fuelwood as a source of Energy

Out of the total energy consumed in the country of Nepal, firewood is 72% followed by cattle dung (7%) and agriculture residue (5%) (Katuwal & Bohara, 2009). The results of HHs survey show that fire-wood is an important source of energy to the rural livelihood and shows the dependency of CFUG member on forest for meeting their energy requirements. This has been illustrated in Table 4-14 which shows the dependency of people on fuel-wood consumption. The average fuelwood consumption from each CFs were 2.75 t/yr but only 12% of the total need is fulfilled from their own farm while 88% of the fuel-wood is obtained from CF, which in itself is a proof of high dependency of people on forest resources.

Table 4-14 Fuel wood consumption rate per HHs

Community Forest	Total consumption fuel wood per year (t/yr)			
	Total consumption (t/yr)	Own farm		CF (t/yr)
Badahare	3.2	10%	0.32	2.88
Birenchok	2.4	12%	0.288	2.11
Lamidanda	2.8	10%	0.28	2.52
Ludhi Damgade	2.7	18%	0.486	2.21
Ram Laxman	2.8	12%	0.336	2.46
Shikar	2.6	10%	0.26	2.34
Average	2.75	12%	0.328	2.42

4.2.7.2. Cooking Status used

A major pressure on community is the energy demand for cooking. The technology used for cooking determines the amount of fuelwood a household consumes. Figure 4-8 shows the percentage of the people in different forest community group who are mainly dependent on the use of firewood.

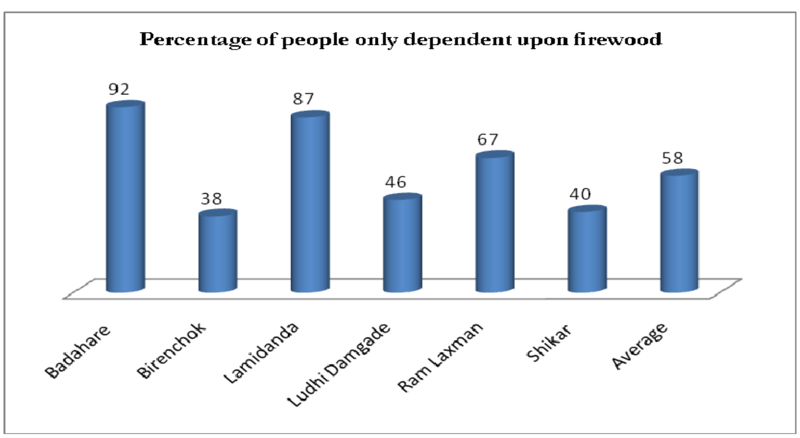

Figure 4-8 Percentage of CFUGs only dependent on firewood

In Badahare 92% of local people used only firewood for their cooking propose, it was lowest in Birenchok i.e. 38% of local people only used firewood while others 27% used firewood with Biogas and another rest used LPG Gas with firewood with 35%. More details can be seen in Annex 7.

4.2.7.3. Consumption of fodder from forest

A typical characteristic of the CFUG members is that they have livestock to support their subsistence livelihood. Livestock husbandry , agriculture and community forest are all intricately linked with subsistence economy (Gilmour & Fisher, 1991). The consumption of fodder from CFs was highest in Ram Laxman and Badahare and least in Birenchok. The fodder consumption is shown Table 4-15.

Table 4-15 Fodder consumption rate per HHs

Community Forest	Total consumption fodder per year from HHs (t/yr)			
	Total consumption (t/yr)	from own farm		from CF (t/yr)
Badahare	8.32	25%	2.08	6.24
Birenchok	5.48	28%	1.53	3.94
Lamidanda	7.34	20%	1.47	5.87
Ludhi Damgade	7.77	35%	2.72	5.05
Ram Laxman	9.75	28%	2.73	7.02
Shikar	6.73	25%	1.68	5.05
Average	7.57	27%	2.035	5.53

We tried to standardize the livestock because of the unequal quantity of fodder grazing since buffalo feed more than cow and buffalo so as goats feed less fodder than buffaloes and cows. The conversion factors are: Buffalo =1; Cow/ox = 0.7; Goats = 0.15 i.e. we multiply buffalo by 1; cow/ox by 0.7 and Goats by 0.15 to make a common rate consumption in livestock adapted from a manual of economic analysis from Richards, *et al.,* (2004). Table 4-16 shows the average livestock in each CF. More details can be seen in Annex 8.

Table 4-16 Average Livestock in each CF

Livestock s	Badahare	Birenchok	Lamidanda	Ludhi Damgade	Ram Laxman	Shikar
Cows	1.3	0.4	0.6	0.2	0.4	0.3
Oxen	0.8	0.5	1.1	0.8	1.3	0.8
Buffaloes	0.8	0.5	0.4	1.5	1.2	0.6
Goats	0.7	0.6	0.6	0.8	0.9	0.5
Total	3.6	1.9	2.6	3.2	3.8	2.2

Ram Laxman had the largest number of livestock per HHs (3.8) followed by Badahare (3.5) and the lowest number of livestock was Birenchok (1.9) followed by Shikar (2.2).

4.2.7.4. Consumption of Timber from Forest

Average consumption rate of timber per annum for each HHs was 0.37t/yr for each. Birenchok CF was the highest 0.50 t/yr of consumption per HHs and Ram Laxman and Badahare has the lowest of 0.32 t/yr and 0.33 t/yr. Table 4-17 shows the timber consumption per HHs.

Table 4-17 Average Timber consumption Per HHs

CF	Cft/yr	kg/yr	Kg/t
Badahare	15	327	0.33
Birenchok	23	502	0.50
Lamidanda	15	333	0.33
Ludhi Damgade	19	403	0.40
Ram Laxman	15	322	0.32
Shikar	16	348	0.35
Average	17	372	0.37

The timber was converted from Cft to kg considering one Cft is equivalent to 21.67 kg (765 kg/cu.m average of *Shorea robusta* 880 kg/cu.m and *Pinus roxburgii* 650 kg/cu.m). These figures were taken from Jackson (1994) for the average yield of *Shorea robusta* and other related species in Nepal.

4.2.7.5. Consumption trend of timber by Rich, Medium and Poor

Timber is consumed by each and every HHs for constructing their buildings. Thus, consumption varies from one CFs to another and affected by their wealth category. The rich people uses more timber than Medium and poor people. The average timber consumption per HHs for rich is 23.9 cub ft /yr which is double than poor and more than Medium (Table 4-18).

Almost in all CFs the consumption of timber show similar trend in poor, medium and rich families. But in case of Ludhi Damgade poor people were given special priorities to consume timber from management committee of CFUGs so timber consumption was comparatively higher. Table 4-18 shows the timber consumption per HHs in each selected CFs.

Table 4-18 Timber Consumption per HHs in cub ft in year

Community Forest	Poor	Medium	Rich
Badahare	8.3	15.34	17.7
Birenchok	15.4	20.84	43.3
Lamidanda	10.5	16.68	
Ludhi Damgade	15.4	11.34	33.6
Ram Laxman	9.3	14.5	23
Shikar	11.2	12.4	25.7
Average	11.7	15.2	23.9

4.2.7.6. Forest Products Used

Badahare CF is using more firewood followed by Ram Laxman CF, while in case of fodder Ram Laxman is using highest followed by Badahare. In case of Birenchok and Ludhi Damgade both of them are using less firewood and fodder than other CFs. Timber consumption is highest in Birenchok followed by Ludhi Damgade. Table 4-19 shows forest products used per HHs (t/yr).

Table 4-19 Forest Products Used per HHs t/yr

Community Forest	Timber (t/yr)	Firewood (t/yr)	Fodder (t/yr)
Badahare	0.33	2.88	6.24
Birenchok	0.50	2.11	3.94
Lamidanda	0.33	2.52	5.87
Ludhi Damgade	0.40	2.21	5.05
Ram Laxman	0.32	2.46	7.02
Shikar	0.35	2.34	5.05

4.2.8. Dependency on forest products from spatial aspects:

From spatial aspects (Highway distance and City Centre Distance) (Figure 4-9 and 4-10) no generalization can be made about the resource use pattern. But Birenchok CF which is on the highway and near to the city centre seems to be using less forest products. The use of forest resources seems to depend on the economic status, occupation characteristics and education status and wealth ranking.

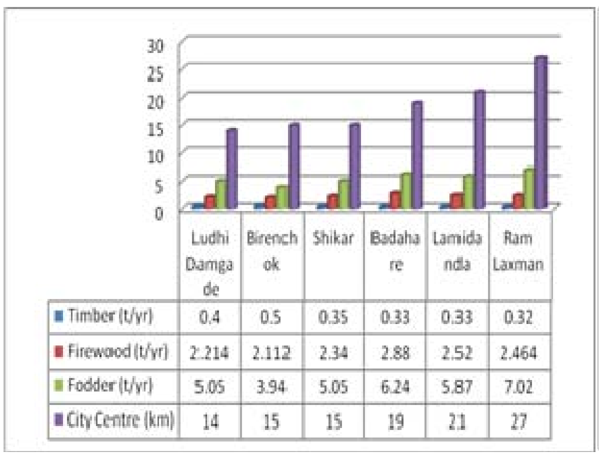

Figure 4-9 Forest Products Used Vs City Centre

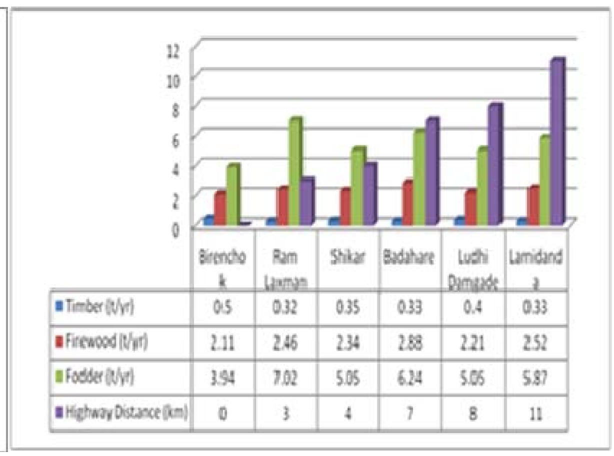

Figure 4-10 Forest Products Used Vs Highway Distance

4.2.9. Forest dependency

The whole process of calculating the forest dependency was shown in Annex 3. The lower the value of CF's dependent shows the highest dependency of CFUGs for their livelihoods. The CFUGs of Badahare, Ram Laxman and Shikar were lower than others. This shows that they are mostly dependent on forest products for their livelihood. Table 4-20 shows the detail of forest dependency for each CFs.

Table 4-20 Forest dependency

CF	Average Ranking	Population Density per ha of CF	CF's dependent
Badahare	2.333	27	0.086
Birenchok	4.75	10.9	0.436
Lamidanda	2.5	6.6	0.379
Ludhi Damgade	4.917	7.2	0.683
Ram Laxman	3.25	19	0.171
Shikar	2.167	21.4	0.101

4.3. Calculating net benefit for Scenario 1 , 2 and 3 of each CF

4.3.1. Management Cost for Scenario 1, 2 and 3 of each CF

The management costs for different scenarios were calculated of each CFs in a year and shown in Table 4-21.The details calculation is shown in Annex 4. The smaller the size of CFs, the lower was the cost and vice versa. These costs are for managing CFs in each Scenario.

Table 4-21 Total management Costs in US$ /yr for each CF

Scenarios	Badahare	Birenchok	Lamidanda	Ludhi Damgade	Ram Laxman	Shikar
First	868	1090	938	2500	729	965
Second	1396	2611	1771	6042	1215	1535
Third	95035	85792	50531	240195	34691	67891

4.3.2. Benefit for Scenario 1, 2 and 3 for each CF

The benefit for different scenarios were calculated for each CFs and shown in the Table 4-22. The benefit from Scenario 1 is shown in Annex 4 which is also benefit from forest products. The calculation process for additional CO_2 for Scenario 2 and 3 are shown in Annex 5.

Table 4-22 Total Benefit in US$ /yr for each CF

Benefit for Scenarios						
Benefit for Scenario First (US$/yr) for CF						
Community Forests	Badahare	Birenchok	Lamidanda	Ludhi Damgade	Ram Laxman	Shikar
Forest Products	93639	83181	48760	234153	33476	66356
Benefit for Scenario Second for CF						
1st Scenario Benefit (US$/yr)	93639	83181	48760	234153	33476	66356
CO_2 (T/yr)	178	576	424	1,865	91	209
Benefit for Scenario Third of CF						
(CO_2) T/yr	178	576	424	1,865	91	209
(CO_2)1 T/yr	638	910	651	2,861	239	513
Total CO_2) T/yr	816	1,485	1,076	4,726	330	723
CO_2 :	Additional CO_2 after consumption of forest products per year in ha by CF (T/yr)					
$(CO_2)_1$:	Additional CO_2 for reducing consumption of extracted Firewood (T/yr)					

4.3.3. Change in cost and benefit when CFs goes Scenario 1 to Scenario 2nd

CF is getting benefit from Scenario 1to Scenario 2 but their benefit varies according to the size of the CF area. The benefit from carbon finance for the forest was calculated by multiplying annual quantity of carbon stock with market value per US$5 t CO_2 as discussed in the method. Even in case of Ram Laxman is not benefiting because of the small area of CF (13.3 ha), it is in loss by US$ -30 under Scenario 2 of REDD. Table 4-23 shows the net benefit for CFs under Scenario 2. Table 4-24 shows the breakeven price of carbon under Scenario 3.

Table 4-23 Net benefit for CFs per HHs to Scenarios 2nd (US$/yr)

CF	Badahare	Birenchok	Lamidanda	Ludhi Damgade	Ram Laxman	Shikar
CF Area (ha)	25.8	83.6	61.6	270.7	13.3	30.4
Cost	528	1521	833	3542	486	570
Benefit	888	2879	2122	9325	456	1046
Net Benefit for CF	360	1358	1289	5783	-30	476
Net Benefit per HHs	2	9	14	13	-1	4

Scenario 3

The breakeven price for per t CO_2 in Scenario 3 was least for Lamidanda, Ludhi Damgade and Birenchok while for rest of the CFs the price was more or even double than what it was to rest of the CFs.
(Breakeven price: The price for per t of CO_2 if the CFs would select scenario 3.

Table 4-24 Breakeven Price for carbon in Scenario 3 (US$/yr)

CF	Badahare	Birenchok	Lamidanda	Ludhi Damgade	Ram Laxman	Shikar
Cost	95035	85792	50531	240195	34691	67891
Total CO_2 (t/yr)	816	1485	1076	4726	330	723
Breakeven Price for t CO_2 (US$/yr)	116	58	47	51	105	94

5. DISCUSSION

5.1. Land Cover Changes for the year 2001 and 2008 in CFs and GF

Community forestry programme is regarded as one of the most successful programme in Nepal (Acharya, 2003; NPC, 2001). The study from Gryze *et al.,* (2009) showed that through the mechanism of community forestry, Nepal has increased its forest cover from previously degraded forestland and even show more forest regeneration. This helps to reduced the emissions of carbon dioxide to the atmosphere or even sequester more atmospheric carbon, compared to forest areas that are not managed by community. As to qualify for payment under REDD mechanism individual Community Forest Management (CFM) project has to prove that its forest management activities resulted in the control of deforestation and degradation activities (Zahabu, 2008).

The classified Maps of CFs and GF showed that the forest cover of the CFs has been improved as compared to GF which is degraded in period 2001-2008. In contrast to CFs, GF staffing and funding levels are inadequate to undertake active forest management and protection. This makes GF a public property for everyone. Forest fire was seen to spread out in GF which is proof in itself of increasing forest degradation and deforestation in Government Managed Forest (GMF). Figure 5-1 shows GFs converted to shrub land in which it is difficult to find good quality forest, while Figure 5-2 shows a forest fire symbol in GMF. The Central Bureau of Statistics in Nepal (1998) estimated that 64% of fires in Nepal are set intentionally by local people. This happened often due to the lack of knowledge of local people, personal interests from poachers clearing land, charcoal traders, encroacher, or the burning for new areas to graze cattle (Gryze*, et al.,* 2009).

The drivers of forest land cover change or degradation in GMF is primarily due to forest dependence of the local people. The distance to community forest also attributed to degradation in nearby GMF. But to solve this problem Government of Nepal has provision to handover the forests to the people residing and depending on the forest products. Therefore, this problem is expected to be solved in future. Apart from this, there are no strict rules and regulations in GMF, thus, the illegal consumption of forest products is high.

Figure 5-3 shows the spatial characteristics of the land cover types in Ludhi Khola. This map shows that there is high population pressure near GMF. This concludes that management of CFs was effective for retaining the forest growth in comparison to GMF.

Figure 5-1 Government Forest in outlook

Figure 5-2 Government Forest in outlook

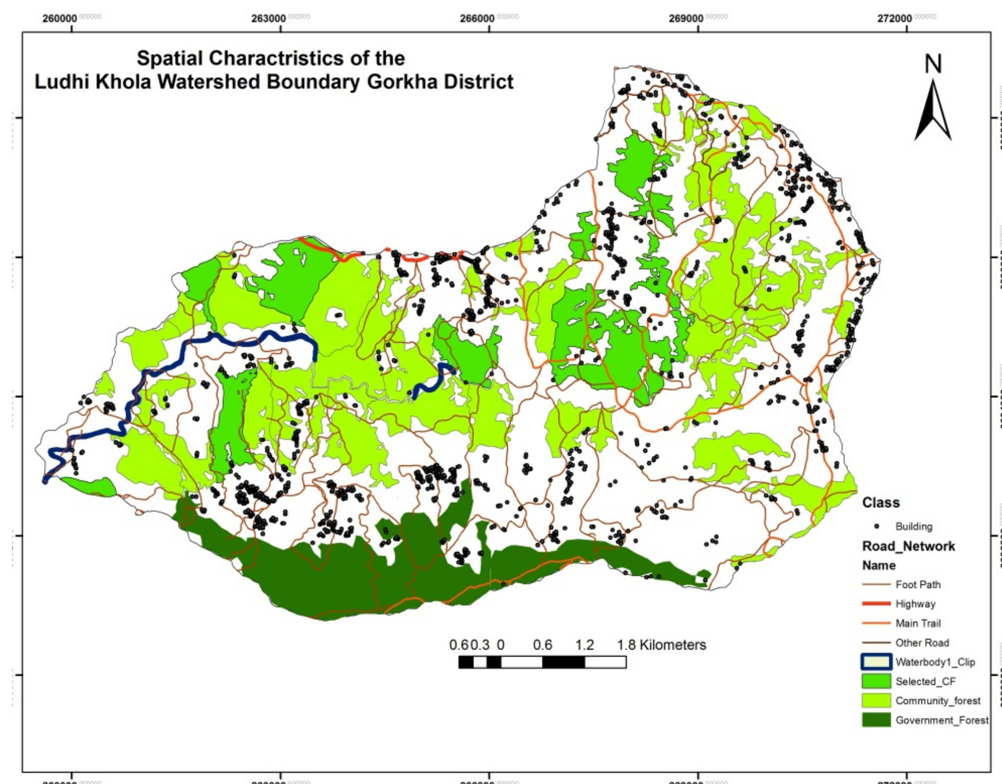

Figure 5-3 Spatial Characteristics of the Ludhi Khola Watershed Boundary Gorkha District

5.2. Forest dependency

Livelihoods comprise of assets (natural, social, human, financial and physical) and activities required for the means of living (Scoones, 1998). But, the study focuses only on the natural assets (the fuel-wood, fodder and timber) collected from the CFUGs. For their living and the socio-economic conditions of

CFUGs (occupation status, education, wealth ranking) and population density per ha of CF are the important factors to determine the forest dependency of CFUGs. Table summarize the selected CFs and their level of dependency on forest.

Table 5-1 Summary of the selected CFs dependency on forest.

CF	Average Ranking	Population Density per ha of CF	CF's dependent
Badahare	2.333	27	0.086
Birenchok	4.75	10.9	0.436
Lamidanda	2.5	6.6	0.379
Ludhi Damgade	4.917	7.2	0.683
Ram Laxman	3.25	19	0.171
Shikar	2.167	21.4	0.101

It is important to understand that the dependency on forests is differ across households for both forest conservation and poverty alleviation program (Fisher, *et al.,* 2002). Labour allocation decisions for forest extraction activities are functions of various socio-economic and demographic variables like: cooking material used, land and livestock holding, caste, average education of family members, occupation characteristics (Adhikari, 2003) are the forest dependence issues in community forest.

The CFs of Badahare, Ram Laxman and Shikar show more dependence on CFs as shown in Table 5-1. In case of Badahare and Ram Laxman CFs, they are using more fodder than other CFs as more than 75% people in these CFs belong to medium class and number of livestock are 3.5/HHs and 3.8/HHs which is higher compared to other CFs. The study from Poudel (2004) shows that in case of medium class people, the number of productive livestock was more and increased their earning by selling livestock. In additional, the majority of local people of this CFs i.e., more than 30% of them are only dependent on agriculture and livestock activities, which make them more dependent on forest based living. Further, more than 90% of local people of Badahare CF and nearly 70% of local people of Ram Laxman CF are only using firewood for their cooking material. Although, the extraction of timber was minimum i.e., 0.33 and 0.32 t/yr for Badahare and Ram Laxman because of their small size of house which doesn't need more wood. In addition, the majority of local people were not in a higher education in these CFUGs, this finding is similar to the finding of from Gunatilake (1998) who found that education level of the family is negatively related to forest dependency e.g., if the family is highly educated then the dependency on forest based livelihood is low and vice versa. The population density per ha of CF for Badahare and Ram Laxman are also higher i.e. 27 and 19 respectively, which is also another additional factor to increase dependency of CFUGs on forest based living from REDD aspects.

The case of Lamidanda and Shikar CFs are very similar from socio-economic aspect because majority of people inhabiting there are poor, i.e., the percentage of people living below poverty are 33% and 41% respectively. Based on the study made in India, (Reddy & Chakravarty, 1999) argued that the poor have less land and are dependent on forests for a greater share of their total income. Therefore, CF is more attractive to the poorest of the poor as it provides highest relative contribution to their livelihood (Khanal, 2001). The poor people were negatively affected (Neupane, 2003; Nightingale, 2003; Timsina & Paudel, 2003) from the REDD project by diminishing their access to vital forest products for both subsistence and commercial uses. The extraction of fodder from CFs per HHS is not as high as Badahare and Ram Laxman CFs. The extraction of firewood was 2.5t/yr. for Lamidanda because for 87% of the population fire-wood is the only energy source for cooking. In case of Shikar only 40% of local people are using firewood as their cooking material, thus the extraction of firewood is only 2.34 t/yr. This amount is slightly higher than in Birenchok CF and Ludhi Damgade CF. Further, the percentage of people getting higher education was very low which also adds in their contribution to forest use. The extraction of timber was 0.35t/yr. and 0.33t/yr. for Shikar and Lamidanda CFs. Though the collected forest product is less than Badahare and Ram Laxman CFs, the percentage of people depending on unskilled work is high in these CFs. Consequently, these unskilled local people were often found to be dependent on forests to carry out market oriented activities such as fuel wood selling, alcohol distilling, timber selling. Though the consumption of forest products is less, the illegal cutting of tree is prominent in these forests. This is not reflected in the data collected as local people who are the users of these CFUGs refused to say about the illegal activities. But still with this similarity seen in these CFs due to their major difference in population density per ha of CF as the population per ha of CF for Lamidanda CF is 6.6 while to that of Shikar is 21.4 from the REDD aspects the dependency of Lamidanda was less while to that of Shikar which was more.

The case of Birenchok and Ludhi Damagade was different from the rest of CFs. Here majority of peoples i.e. 57% and 46% respectively are engaged in skilled work (GoN services, seasonal agriculture, business and getting pension). The situation of Ludhi Damgade is even better as people receiving higher education was 37% followed by that of Birenchok, where 15% of the population was well educated. This education level in the CFUGs helps to develop innovative ideas to carry out sustainable agriculture and livestock activities. In Ludhi Damgade the percentage of rich people was also high i.e. 34%, while in case of Birenchok due their existence on the highway and accessibility to the market, people are engaged in business activities which makes them less dependent on forest, though majority of people belong to medium. The extraction of firewood was 2.21 t/yr and 2.11 t/yr for Ludhi Damgade and Birenchok because only 46% and 38% respectively dependent upon firewood as cooking material. This percentage is very low than other CFs. In case of fodder collection Ludhi Damagade collects 5.05 t/yr of fodder because of their more dependent livestock i.e. 3.2/HHs while for that of Birenchok was 3.94 t/yr of fodder because of less no of livestock dependent upon 1.9/HHs. The extraction of timber was 0.50 t/yr and 0.40 t/yr for Ludhi Damgade and Birenchok CFs greater than other CFs because majority people are rich in Ludhi Damgade. Expansion of market in Birenchok has also added to the high timber extraction. Therefore, in future due to educated people will be the majority thus they are either in rich or working in business or doing skilled work they will use less fodder and firewood and they have more agricultural land, they can be less dependent than other CFs in future. The population density per ha of Birenchok and Ludhi Damgade was 10.9 and 7.2, which is low and makes these CFs less dependence on forest based living.

5.3. Land Cover Changes in selected CFs

These are all CFs that were handed to the community at least a decade ago for their management and utilization. Almost in all CFs expect in Birenchok CF, the forest area had increased between the years 2001 to 2008. Deforestation in developing countries is frequently driven by agriculture, logging, and road expansion (Madeira, 2008). Further the social, economic, political and/or cultural processes in the society also indirectly cause deforestation. Other factors such as soil quality and topography also affect the likelihood of deforestation (Geist & Lambin, 2002).

Unlike the case of Badahare and Ram Laxman i.e. small forest area, high population density in a forest and utilization of more firewood and fodder but still it shows the highest i.e. 9% increment in the forest area. This can be due to limited available resources; people have given more importance of CFs for their livelihood and hence are managing their resources optimally. The improvement of forest area helps local people to collect more fuelwood and fodder (Dev, *et al.,* 2003). The depletion of the forest resources not only affect the availability of basic forest products but also had other adverse impacts on watershed and environment (Easter, *et al.,* 1991), which results in negative impacts on livelihood of forest dependents.

From management perspective, the forest which is managed by indigenous group is well managed. This can be observed in Badahare where, the dominant class are indigenous groups who are applying their indigenous knowledge to protect and manage forest for fulfilling their basic needs which are the primary goals of CF (Gilmour & Fisher, 1991). Indigenous women are the protectors and conservers of natural resources, therefore rich natural resources are found in the area of indigenous peoples (2004). They have made strict rules and regulations for forest protection. They have allocated certain area of forest for grazing purpose. Moreover, these CFs are remotely located, hence not vulnerable to open from market area. The percentage of poor people are low and dominant are from medium class, it can also be the reason behind low rate of deforestation.

Lamidanda CF is of medium in size, has few population density (6.7/ha) and also utilized more firewood after Badahare CF. It shows 8% increment of forest area. The community where majority of people are from poor class and Dalit family are assumed for illegal trading of timber and firewood to carry their livelihood. Still, the increment of forest area is because of its remoteness from both market and from highway. Other additional reasons can be due to low population pressure, the forest resources were not in a vulnerable condition or they were safely utilizing it. Shikar also shows increment in CFs area. It has small area (ha) of forest, high population density (21.4 /ha) and it is located near city centre and located on the side of the highway. The majority of population are from poor class showing the similar characteristics as of Lamidanda. The little increment of forest area can be due to majority of poor people and high population density and it's exposed to market area and city centre due to location.

In case of Birenchok and Ludhi Damgade, population density was less than other CFs (7.2/ha and 10.9/ha) and majority of local people are less dependent upon forest products to carry their occupation. But the forest area decreased by nearly 7% in Birenchok and only 1% increment in Ludhi Damgade. In case of Birenchok the use of fodder and firewood were both minimum compared to others but the use of timber/HHs is highest among all. It is believed that timber production found to be the major culprit causing more negative effect to the forest land of Nepal compared to fuelwood and fodder collection (Dangi, 2009). Thus, it was the only CF that shows decreased of forest area. Its location beside the highway and near to the city centre also accelerated its deforestation rate. Ludhi Damgade is the largest CFs (234 ha) in area, the fodder and firewood collection by local people is low but timber collection was among the highest. It's forest area was increased by 1% which is the second lowest among CFs. Due to large forest area, they are not managing well, still they were near city centre increased illegal firewood and timber collection.

5.4. Cost and benefit under different REDD Scenarios

The carbon stock for 2009 and 2010 were estimated using different techniques. Secondary data was used for estimation of annual carbon sequestration per ha per year. Table 5-2 shows carbon measurement technique for the year 2009 and 2010, while Table 5-3 shows the annual variation in carbon stock in three community managed forests of Nepal Himalayas.

Table 5-2 Carbon measurement technique for the year 2009 and 2010

Year	2009	2010
Total sample plots	185	62
DBH	Greater than 5 cm	Greater than 10 cm
Area of sample plots	100 m^2 with 5.64 m radius	500 m^2 with 14.56 m radius

So, in this case we take the mean carbon sequestration as 1.88 t C ha-1 year-1, or 6.89 t CO2 ha-1 year. Carbon Stock in Community Forests in Different Geographical Locations in Nepal.

Table 5-3 Annual variation in carbon stock in three community managed forests of Nepal Himalayas

CFUGs	Caron mass (t/ha)			Mean carbon sequestration rate (t C/ha/yr)
	Year 1	Year 2	Year 3	
Illam	57.94	60.75	64.13	3.1
Lamatar	51.19	52.32	54.00	1.41
Manang	30.94	NA	33.19	1.13
Mean carbon sequestration rate across community forests				1.88 (6.89 t CO_2 /ha/yr)

After Banskota (2007)

The study undertaken in near district of Gorkha i.e. Dhading by (Rana, 2008) found annual mean carbon sequestration to be 1.40 t C ha-1 year-1, or 5.14 t CO_2 ha-1 year-1. The quantity includes above and below ground tree carbon, carbon of forest floor materials and of seedlings of less than 5 cm dbh. This result was nearly similar to the secondary data for carbon sequestration rates.

Most literature assessing opportunity costs in relation to REDD refers to the opportunity cost of land. In Nepal's CFM case, even though the CFM is practiced on slopes that are non-arable and have no alternative possible use. There is a high opportunity cost as the forest provides numerous inputs for subsistence mountain livelihood (Karky & Skutsch, 2010) (e.g. fuelwood, fodder, timber, NTFP), which might be foregone under a carbon management regime. It is for these products that local people are conserving their forest now to be taken into account, therefore when considering changes that might be introduced into REDD (Karky & Skutsch, 2010).

Scenario 1: CFUGs derive greater non-monetary benefits in the form of (firewood, firewood and timber) than monetary benefits for managing CFs and these benefits are the economic rationale for them to manage and conserve their forest as it is being currently done.

Scenario 2: When CFUG are permitted to use forest resources and market additional carbon sequestration, at the rate of $ 5 per t CO_2, all CFUGs were found to make profits except Ram Laxman. Though, the benefit varies from each and every CFUGs. Here the size of the area of the CF (ha) and population pressures play their determining role. The larger the size of CF the less the management costs and also more will be benefit resulting more net benefit and the less the population pressure in the CFs the more net benefit per HHs in each CF.

Scenario 3: When CFUGs are not permitted to use the forest products and preserve the CFs from carbon trading proposes, the breakeven price for tonne of CO_2 has calculated for each CFs. The breakeven price for t CO_2 varies between the CFs. As discussed earlier in Second Scenarios the same role is played by size of the CFs (ha) and population pressure but the additional will be the forest products used by the CFUGs. The less forest products used by them the less will be the breakeven price and favours this scenario from REDD prospects.

The study only shows the costs related with community forest management when community members are trained to conduct the survey. The additional benefits from forest management for example biodiversity conservation, water catchment protection, aesthetic and cultural values are not accounted. This is just an immediate costs and benefits to the local communities.

5.5. To assess the best possible REDD scheme for six CFs

REDD is being criticized on several fronts, there is a need for an integral comprehensive concept that incorporates emission reduction, biodiversity conservation and community development for the sustainability in forests and livelihoods rather than narrower goals such as emissions reduction or conservation (Pant, 2011). This study tries to analyse REDD from different perspectives from environmental, social and economic aspects before proposing the possible REDD schemes for these CFs.

5.5.1. Landcover Change (Management) concept:

Each and every CFs except Birenchok is managing their forest well. The result from land cover map shows the Badahare, Lamidanda and Ram Laxman CFUGs are managing their forest well, with 8-10% increment in forest area for the years 2001-2008. In case of Shikar and Ludhi Damgade, the forest area increased slightly by 1-2% in the period 2001-2008. But in Birenchok the forest area has decreased by nearly 7% in the same mentioned period. These are the CFs which are managed from local people after fulfilling their demand from the forest products.

When REDD has to be introduced in the CFs, they need to prove these forests were managed in a sustainable way so they can get benefit from REDD under Scenario 2. Thus, from Scenario 2standpoint, Badahare, Lamidanda and Ram Laxman shows greatest possibility than other CFs. But other CFs due to their little process in forest management or little increment of forest area as in case of Shikar and Ludhi Damgade and even decrease of forest area as in Birenchok the possibility of other scenario will be explored rather than second scenario. From environmental aspects this could help them to preserve their forest.

5.5.2. Livelihood concept:

Badahare, Ram Laxman and Shikar CFs are more dependent on forest products for their livelihoods. While, the CFs likes Ludhi Damgade, Birenchok and Lamidanda are less dependent from the livelihood aspects in the CFs. Birenchok and Lamidanda are more dependent upon timber extraction than fodder and firewood used.

Scenario 2 allows continuation of forest products extraction in addition to carbon trading, this scenario is good for the people who were dependent on forest for their livelihood as in Badahare and Ram Laxman and Shikar CFs.

But due to less forest dependency for their livelihoods as in Ludhi Damgade, Birenchok and Lamidanda third scenario is found to be appropriate. The people in these CFs are expected to be even less dependent on forest products in future.

5.5.3. Net benefit For REDD (Economic) Concept:

This is more based on CFs area, population pressure and forest products used. The net benefit from Scenario 2 varies from each CFs to other. Also, the breakeven price for t CO_2/ha per year is also varies from each and every community forests.

In the Scenario 2 the benefit per HHs will be very low in Badahare and Shikar. In case of Ram Laxman it shows loss due to their small forest area (ha) and high population pressure. But for others Lamidanda, Ludhi Damgade and Birenchok their benefit per HHs is reasonable due to their big forest area (ha) and less population density.

For scenario 3, the breakeven price t CO_2/ha per year was very high in case of Badahare, Shikar and Ram Laxman due to their small forest area (ha), high population pressure and more forest products used from each CFs. But in case of Lamidanda, Ludhi Damgade and Birenchok due to their big forest area (ha), low population density and less forest products used their breakeven price was low which is good from REDD aspects. But from these economic aspects for both scenarios (2 and 3) Lamidanda, Ludhi Damgade and Birenchok seem to be more benefitted than others CFs though Ram Laxman even seems loss also in Scenario 2.

5.5.4. Summary

Scenario 2 is more about continuing the harvesting of the forest resources in additional benefit from carbon revenue for the CFUGs. It is appropriate for the CFs that are managed well, show good increment of forest area, people's livelihood mostly dependent upon forests or people are very poor for whom alternative livelihoods may not exist or where changing livelihood strategies or participating in new programmes may be too risky. In additional CFUGs net benefit must be increased than the traditional Scenario 1.

Scenario 3 is more about preserving the forest not allowing extraction of forest products from the CFs. In other view, preserve the CFs from carbon trading aspects. It is appropriate for the CFs that are not managed well, shows deforestation or little increment of forest area, people's livelihood mostly independent on forests or people are engaged in different occupation rather than forest based economy. In additional, the breakeven price for t CO_2 must be affordable rather than very high.

For Badahare, Ram Laxman and Shikar Scenario 2 is better though the price of t CO_2 must be increased. Their dependency on forests for livelihood and good increment in area as in (Badahare and Ram Laxman) are also support second scenario of REDD. But Shikar CF shows only little increment in forest area, it needs to improve in future for the second scenario to be fulfilled.

But due to less dependence on forest, the least breakeven price for Scenario 3 in case of Birenchok because of deforestation and Ludhi Damgade because of little increment, their forest must be preserved so from all these aspects, third scenario is better option. Due to less dependence on forest and least breakeven price Lamidanda also favours scenario 3.

6. CONCLUSION AND RECOMMENDATION

6.1. Conclusion

Based on the analysis and the result, some conclusions have drawn as answers to research questions.

Related to the research question No 1. What are the changes in Land cover in Community Forest and Government Forest from the year 2001 to 2008 to determine the potentiality of participation in REDD?

During the period 2001-2008, in Government Forest (GF) forestland decreased by 82 ha (20%) and agriculture land increased by 83 ha whereas, in Community Forest (CF) Forestland increased by 4 ha (0.25%) and agriculture land decreased by 5 ha.

Related to the research question No 2. What are the changes in forestland in six Community Forests selected for the study from the year 2001 to 2008 to determine the appropriate scenario in REDD?

During the period, 2001-2008, in Badahare CF the forestland increased by 2 ha (11%), in Birenchok CF the forestland decreased by 5 ha (7%), in Lamidanda CF the forestland increased by 4.5 ha (9%), in Ludhi Damgade CF the forestland increased by 3 ha (1%), in Ram Laxman CF the forestland increased by 1 ha (9%) and in Shikar CF the forestland increased by 1 ha (2%).

Related to the research question No 3. How do the six different CFUGs make a livelihood from the forest?

The six different CFUGs make different livelihood from the forest. Some are more dependent on forest while others are less dependent on forest. The CFs like Badahare, Ram Laxman and Shikar are more dependent on forest, while the CFs like Ludhi Damgade, Birenchok and Lamidanda are less dependent on forest.

Related to the research question No 4. Does distance from the road and city centre affect CFUGs forest products used?

Not really, the road and the city centre don't affect CFUGs forest products used but the CF Birenchok, which is both in a highway and near to the city centre, is using less forest products than other CFs.

Related to the research question No 5. What are the costs and benefits of different defined scenarios for CFUGs?

The costs for scenario 1, scenario 2 and scenario 3 for CFUGs are:

Scenarios	Badahare	Birenchok	Lamidanda	Ludhi Damgade	Ram Laxman	Shikar
1	868	1090	938	2500	729	965
2	1396	2611	1771	6042	1215	1535
3	95035	85792	50531	240195	34691	67891

The benefits of scenario 1, scenario 2 and scenario 3 for CFUGs are:

Benefit for Scenarios						
Benefit for Scenario 1 (US$/yr) for CF						
Community Forests	Badahare	Birenchok	Lamidanda	Ludhi Damgade	Ram Laxman	Shikar
Forest Products	93639	83181	48760	234153	33476	66356
Benefit for Scenario 2 for CF						
1st Scenario Benefit (US$/yr)	93639	83181	48760	234153	33476	66356
CO_2 (T/yr)	178	576	424	1,865	91	209
Benefit for Scenario 3 of CF						
(CO_2) T/yr	178	576	424	1,865	91	209
(CO_2)1 T/yr	638	910	651	2,861	239	513
Total CO_2) T/yr	816	1,485	1,076	4,726	330	723
CO_2 :	Additional CO_2 after consumption of forest products per year in ha by CF (T/yr)					
$(CO_2)_1$:	Additional CO_2 for reducing consumption of extracted Firewood (T/yr)					

Related to the research question No 6. What specific REDD schemes are suited for each of the six CFUGs?
For Badahare, Shikar and Ram Laxman Scenario 2 is the suitable one, for Lamidanda, Ludhi Damgade and Birenchok Scenario 3 is suitable one.

6.2. Recommendation

Based on the conclusion drawn, the following suggestions are offered:

1. To increase benefits, it is recommended to link REDD with other programmes, such as energy sector and forest livelihood programme.

2. The implementation of REDD is very likely to negatively affect the livelihoods of the local people involved in illegal trade of timber and firewood. Therefore, it is also important to take into account the interests of these particular local people whose livelihood will be greatly affected by the policies to be adopted.

3. There is a need for capacity building at the local level to enable to carry out responsible and accurate forest inventories.

LIST OF REFERENCES

Acharya, K. P. (2003). Sustainability of support for community forestry in Nepal. *Forest, Trees and Livelihood 13*(3), 247-260.

Adhikari, B. (2003). What Determines Household Dependency on Community Forests? Empirical Evidence From Nepal. Paper presented at the SANDEES's research and training workshop. Retrieved from http://www.fao.org/DOCREP/ARTICLE/WFC/XII/0044-A1.HTM

Adhikari, B. (2005). Poverty, Property Rights and Collective Action: Understanding the Distributive Aspects of Common property Resource Management. *Environment and Development Economics, 10: 7-31*.

Angelsen, A. (2008). Moving ahead with REDD: issues, options and implications. Bogor, Indonesia: Center for International Forestry Research (CIFOR).

ANSAB. (2009). Draft Standard of Procedure Design and Stting up of a Governance and Payment Systems for Nepal's Community Forestry Manangement Under Reducing Enission from Deforestation and Forest Degradation (REDD).Asia Network for Sustainable Agriculture and Bioresources.

Banskota, K., Karky, B., & Skutsch, M. (2007). Reducing carbon emissions through community-managed forests in the Himalaya. Kathmandu Nepal: International Centre for Integrated Mountain Development (ICIMOD).

Basnet, R. (2009). Carbon Ownership in Community Managed Forests *Journal of Forest and Livelihood, Vol 8, No 1*

Bhatia, A. (Ed.). (1999). Participatory Forest Management: Implications for Policy and Human Resources' Development in the Hindu Kush-Himalayas. Kathmandu: ICIMOD.

Bhusal, Y. (2009). Problems and prospects of REDD in Community Based Forest Management System. *The Greenery - a journal of Environment and Biodiversity 7*(1), 46.

Bleaney, A., Vickers, B., & Peskett, L. (2009). REDD in Nepal: Putting community forestry centre stage ? *Networking for equity in forest climate policy*.

Chhatre, A., & Agrawal, A. (2008). Forest commons and local enforcement. Proceedings of the National Academy of Sciences, 105(36), 13286-13291.

Dangi, R. (2009). Econometric Analysis of the Causes of the Deforestation in Nepal. Ohio University

Dangi, R. B., & Acharya, K. P. (2009). A Quick Review of Potential Benefits and Costs of REDD in Nepal. In K. P. Acharya, R. B. Dangi, D. M. Tripathi, B. R. Bushley, R. R. Bhandary & B. Bhattarai (Eds.), Ready for REDD ? Taking Stock of Experience, Opportunities and Challenges in Nepal. Kathmadu, Nepal: Mass Printing Press.

Dev, O. P., Yadav, N. P., Springate-Baginski, O., & Soussan, J. (2003). Impacts of Community Forestry on Livelihoods in the Middle Hills of Nepal. *Journal of Forest and Livelihood, 3*(1).

DFRS. (1999). Government of Nepal, Department of Forest Research and Survey. from http://www.dfrs.gov.np/

Dhakal, B. (2009). Carbon Liability, Market Price Risk and Social Impact of Reducing Emission from Deforestation and Forest Degradation (REDD) Programme. *Journal of Forest and Livelihood, 8 (1)*.

Dhital, N. (2009). Reducing Emissions from Deforestation and Forest Degradation (REDD) in Nepal: Exploring the Possibilities. *Journal of Forest and Livelihood, 8*(1), 57.

Dudley, R. (2010). A little REDD model to quickly compare possible baseline and policy scenarios for reducing emissions from deforestation and forest degradation. *Mitigation and Adaptation Strategies for Global Change, 15*(1), 53-69.

Easter, K. W., Dixon, J. A., & Hufschmidt, M. M. (1991). *Watershed Resources Management: Studies from Asia and the Pacific*. East-West Center, Honolulu.

Fisher, M., Shively, G., & Buccola, S. (2002). Activity Choice, Labour Allocation, and Forest Use in Malawi. Paper Presented at the Second World Congress of Environment and Resource Economists, Monterey 24-27 June, California, USA.

Foody, G. M. (2002). Status of land cover classification accuracy assessment. *Remote Sensing of Environment, 80*(1), 185-201.

Geist, H. J., & Lambin, E. F. (2002). Proximate Causes and Underlying Driving Forces of Tropical Deforestation. *Bio Science, 52*(2), 143-150.

Gilmour, D. A., & Fisher, R. J. (1991). *Villagers, Forests and Foresters:The Philosophy, Process and Practice of Community Forestry in Nepal*: Sahayogi Pree, Kathmandu.

GoN. (1978). *Panchayat Protected Forest Rules 1978*. Kathmandu, Nepal: Law Book Management Committee,Ministry of Law and Justice, GoN.

GoN. (1993). *Forest Act 1993 (official translation).* Kathmandu, Nepal: Ministry of Forest and Soil Conservation, GoN.

GoN. (2008). *Three Year Interim Plan (2007/08 - 2009/10).*

Gryze, S. D., Durschinger, L., Koontz, A., Pandey, S., & Subedi, B. (2009). *Payment for Ecosystem Services: Developing Forest Carbon Projects in Nepal.*

Gunatilake, H. (1998). The Role of Rural Development in Protecting Tropical Rainforests: Evidence from Sri Lanka. *Journal of Environmental Management 53*, 273-292.

Hansen, J., Sato, M., Ruedy, R., Lo, K., Lea, D. W., & Medina-Elizade, M. (2006). Global temperature change. *Proceedings of the National Academy of Sciences, 103*(39), 14288-14293.

ICIMOD, ANSAB, & FECOFUN. (2010). *Forest Carbon Stock in REDD+ Pilot Project Sites: Year One Measurement and Measurement & Analysis.*

IPCC. (2001). *Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change*

IPCC. (2007). *Working group II Contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report. Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability. Summary for Policymakers.*

Jackson, J. K. (1994). Community forestry in Nepal: Achievement and Challenges. *Forest and Livelihood 4*(1).

Kanel, K. R. (2006). Current Status of Community Forestry in Nepal. *Thailand: Regional Community Forestry Training Center for Asia and the Pacific Bangkok.*

Kanel, K. R., & Kandel, B. R. (2004). Community Forestry in Nepal: Achievements and Challenges. *Journal of Forest and Livelihood, 4*(1), 55.

Kant, S. (2004). Economics of sustainable forest management *Forest Policy and Economics, 6*(3-4), 197- 203.

Karky, B. S. (2008). *The Economics of Reducing Emissions from Community Management Forests in Nepal Himalaya.* University of Twente, Enschede.

Karky, B. S., Margaret Skutsch, & Kamal Banskota. (2009). Implications for community forest policy under the proposed REDD policy. In K. P. Acharya, R. B. Dangi, D. M. Tripathi, B. R. Bushley, R. R. Bhandary & B. Bhattarai (Eds.), *Ready for REDD ? Taking Stock of Experience, Opportunities and Challenges in Nepal.* Kathmandu, Nepal: Nepal Foresters Association.

Karky, B. S., & Skutsch, M. (2010). The cost of carbon abatement through community forest management in Nepal Himalaya. [doi: DOI: 10.1016/j.ecolecon.2009.10.004]. *Ecological Economics, 69*(3), 666-672.

Katuwal, H., & Bohara, A. K. (2009). Biogas: A promising renewable technology and its impact on rural households in Nepal. [doi: DOI: 10.1016/j.rser.2009.05.002]. *Renewable and Sustainable Energy Reviews, 13*(9), 2668-2674.

Khanal, K. (2001). *Economic Evaluation of Community Forestry in Nepal and its Equity Distribution Effect.* The Royal Veterinary and Agricultural University, Denmark.

King, R. S., Richardson, C. J., Urban, D. L., & Romanowicz, E. A. (2004). Spatial Dependency of Vegetation–Environment Linkages in an Anthropogenically Influenced Wetland Ecosystem. *Ecosystems, 7*(1), 75-97.

Kirschbaum, M. U. F. To sink or burn? A discussion of the potential contributions of forests to greenhouse gas balances through storing carbon or providing biofuels. [doi: DOI: 10.1016/S0961-9534(02)00171-X]. *Biomass and Bioenergy, 24*(4-5), 297-310.

Kirschbaum, M. U. F. (2003). To sink or burn? A discussion of the potential contributions of forests to greenhouse gas balances through storing carbon or providing biofuels. *Biomass and Bioenergy, 24*(4-5), 297-310.

Klooster, D., & Masera, O. (2000). Community forest management in Mexico: carbon mitigation and biodiversity conservation through rural development. [doi: DOI: 10.1016/S0959-3780(00)00033-9]. *Global Environmental Change, 10*(4), 259-272.

Kuemmerle, T., Radeloff, V. C., Perzanowski, K., & Hostert, P. (2006). Cross-border comparison of land cover and landscape pattern in Eastern Europe using a hybrid classification technique. [doi: DOI: 10.1016/j.rse.2006.04.015]. *Remote Sensing of Environment, 103*(4), 449-464.

Lamichhane, B. R., & Awasthi, K. D. (2009). Changing Climate in a Mountain Sub-watershed in Nepal. *Journal of Forest and Livelihood, 8*(1).

Madeira, E. C. M. (2008). *Policies to Reduce Emissions from Deforestation and Degradation (redd) in Developing Countries:An examination of the issues facing the incorporation of REDD into market-based climate policies*. Washington, DC 20036-1400.

Manandhar, U. (2009). REDD, REDD+ and Co-Benefits In K. P. Acharya, R. B. Dangi, D. M. Tripathi, B. R. Bushley, R. R. Bhandary & B. Bhattarai (Eds.), Ready for REDD ? Taking Stock of Experience, Opportunities and Challenges in Nepal. Kathmandu: Mass Printing Press.

Neef, T., Eichler, L., Deche, I., & Fense, J. (2007). Update on Markets for Forestry Offsets, *The FORMA project, CATIE. No. 67. 27 p. ISBN 978-9977-57-436-3*.

Neupane, H. (2003). Contested impact of community forestry on equity: some evidences from Nepal. *Journal of Forest and Livelihood, 34*(4), 525-540.

Nightingale, A. (2003). Nature-society and development: social, cultural and ecological change in Nepal. *Geoforum, 34*(4), 525-540.

NPC. (2001). Mid-term Evaluation of the Ninth Five Year Plan, National Planning Commission. Kathmandu, Nepal.

Ojha, H. R. (2009). Climate Change, Forestry and Carbon Financing in Nepal: Editorial Introduction. *Journal of Forest and Livelihood 8 (1).*

Operation Plan for CFUGs. (2007/08 to 2017/18).

Pant, P. (2011). Carbon, Conservation, Communities Under Sustainability (C3S) Paradigm for Forests. In W. Leal Filho (Ed.), The Economic, Social and Political Elements of Climate Change (pp. 543-553): Springer Berlin Heidelberg.

Peskett, L., Luttrell, C., & Brown, D. (2006). Can payments for avoided deforestation to tackle climate change also benet the poor?

Pokharel, B., & Byrne, S. (2009). Climate Change Mitigation and Adaptation Strategies in Nepal's Forest Sector: How can Rural Communities Benefit ?

Poudel, B. C. (2004). Community forest management and its contribution to sustainable rural livelihoods in Nepal. Tribhuvan University Kathmanudu, Kathmandu, Nepal.

Prentice, Farquhar, G. D., Fasham, M. J. R., Goulden, M. L., Heimann, M., Jaramillo, V. J.*, et al.* (2001). The Carbon Cycle and Atmospheric Carbon Dioxide.

Rana, E. B. (2008). *"REDD"*- an Option for Carbon Finance and its Impact on Livelihoods of Forest Users in Nepal. A Case Study from a Community Forest in Dhading, Nepal. Technische Universität München, Germany, German.

Reddy, S. R. C., & Chakravarty, S. P. (1999). Towards Participatory Economic Analysis by Forest User Groups in Nepal. Portland house, Stag place, London, UK: ODI.

Richards, M., Davies, J., & Yaron, G. (2004). Stakeholder Incentives in Participatory Forest Management: A Manual for Economic Analysis: , ITDG Publishing, London, 2003, ISBN: 1853395595, 238 pp. [doi: DOI: 10.1016/j.ecolecon.2004.03.006]. *Ecological Economics, 50*(1-2), 160-161.

Richards, M., Kanel, K., Maharjan, M., & Davies, J. (1999). Towards Participatory Economic Analysis by Forest User Groups in Nepal,ODI in collabration with the Nepal-UK Communtiy Forestry Programme.

Scoones, I. (1998). Sustainable Rural Livelihoods - A framework for Analysis. IDS Working Paper 72: Institute of Development Studies (IDS), UK.

Stern, N. (2007). The economics of climate change The Stern Review: Cambridge University Press.

Skutsch, M., & Murdiyarso, D. (2006). Lessons Learned. In D. Murdiyarso & M. Skutsch (Eds.), *Community Forest Management as a Carbon Mitigation Option*.

Tempfli, K. e., Huurneman, G. C. e., Bakker, W. H. e., Janssen, L. L. F. e., Bakker, W. H., Feringa, W. F.*, et al.* (2009). *Principles of remote sensing : an introductory textbook* (Fourth edition ed.). Enschede: ITC.

Timsina, N., & Paudel, N. S. (2003). State versus community: a confusing policy discourse in Nepal's forest management. *Journal of Forest and Livelihood, 2*(2), 8-16.

UNFCCC. (2007a). The Bali Roadmap and the way forward.

UNFCCC. (2007b). Reducing Emissions from Deforestation in Developing Countries: Approaches to Stimulate *Actions.from http://unfccc.int/files/meetings/cop_13/application/pdf/cp_redd.pdf*.

Wollenberg, E., & Springate-Baginski, O. (2009). Incentives + How can REDD improve well-being in forest communities? *CIFOR, 21*.

Wollenberg, E., & Springate-Baginski, O. (2010). Introcuction. In O. Springate-Baginski & E. Wollenberg (Eds.), *REDD, forest governance and rural livelihoods: the emerging agenda.* Indonesia: CIFOR.

Zahabu, E. (2008). Sinks and Sources: A Strategy to involve Forest Communities in Tanzania in Global Climate Policy. University of Twente, Enschede.

Zheng, M., Cai, Q., & Wang, Z. (2005). Effect of prior probabilities on maximum likelihood classifier. [Paper presented at the Geoscience and Remote Sensing Symposium (IGARASS 05)].

ANNEXES

Annex 1 Questionnaires for HHs survey

ID: **GPS Coordinate:**
Address: **Name of the CFUGs:**

Family Types:

Age Groups: 0 -10:
10-20:
20-50:
Above 50:

Ethnicity: **Size:** **Highest literacy rate:**

Executive/Member of any Institutional Organizations:

House
Size: **Age:** **Brick Material:**
Roofing Material: **River:** **Sanitation:**
Electricity: **Communication:** **TV**
Car / Any vehicles:

Resources

River Resources:
Name of River: Address: Distance:
Use: Irrigation Canal:

Agricultural Resources:
Cost:
Fertilizer:
Seeds
Labour
Equipment (Tracker: Diesel: Complier)
Irrigation facilities

Landholding capacity (ha) **Address:** **Distance:**
Agricultural/Paddy Land (ha)
Bari Land /Upland (ha)
Forests (ha)
Total Quantity of Cash crop/yr
Total Quantity of Non-Cash Crop/yr
Quantity of Crops used/yr
Quantity of Crops sold/yr
Market price:
Income from Agricultural:

Forest Resources:

Forest Resources:	Quantity used	Gov/CF	Name	Address	Distance	Market Price	Used for HHs	Sold by HHs
Timber/yr								
Fodder/yr								
NTFPs /yr								
Firewood /yr								
Any other products								

Cost for paying as a CF member:
Cost for paying timber/fodder/firewood/NTFPs for HHs used:
Cost for paying timber/fodder/firewood/NTFPs for sold by HHs:

Livestock:
Name of total cattle:
Cattle used for HHs/yr:
Cattle sold /yr:
Market price:
Income from Cattle/yr:

Cooking stove used:
a. Only firewood b. Firewood + Biogas c. Firewood + LPG Gas

3) What is your perception about the availability of forest products of CF management?

4. What is the trend of your both forest
Community Forest Area Decreasing / Increasing:
Government Forest Area Decreasing / Increasing:

5) How is the condition of CFs and GF in the year 2001? (Particular for forest guards/ forest exports)

Annex 2 Focus Group Discussion

The costs for managing the CF in different Scenarios

Scenario 1	Scenario 2	Scenario 3
Labour cost	Labour cost	Labour cost
Management cost	Management cost	Management cost
Protection cost	Protection cost	Protection cost
	Carbon measurement cost	Carbon measurement cost
	Making Carbon Report	Making Carbon Report
	Miscellaneous costs	Miscellaneous costs
		Costs for over extracted forest products

1. What costs will be included in labour cost for CF in Scenarios 1st, 2nd and 3rd ?
Scenario 1st
Scenario 2
Scenario 3

2. The annual expenditure for labour cost in Scenarios 1st, 2nd and 3rd CF ?
Expenditure for Scenario 1
Expenditure for Scenario 2
Expenditure for Scenario 3

3. What costs will be included in Management cost for CF in Scenario 1st, 2nd and 3rd ?
Scenario 1
Scenario 2
Scenario 3

4. The annual expenditure for Management cost in Scenario 1st, 2nd and 3rd for CF ?
Expenditure for Scenario 1
Expenditure for Scenario 2
Expenditure for Scenario 3

5. What costs will be included in Protection cost for CF in Scenario 1st, 2nd and 3rd ?
Scenario 1
Scenario 2
Scenario 3

6. The annual expenditure for Protection cost in Scenario 1st, 2nd and 3rd for CF?
Expenditure for Scenario 1
Expenditure for Scenario 2
Expenditure for Scenario 3

7. The annual cost for Carbon Measurement for CF in Scenario 2 ?

8. The annual cost for making carbon report for Scenario 2 ?

9. The cost for over extracted forest products for Scenario 3 ?
Foregone fodder: Foregone Firewood Foregone Timber:

Annex 3 Dependency of CFUGs

Forest Products used Ranking

Community Forest	Timber	Firewood	Fodder	Ranking
Badahare	4	1	2	2.333
Birenchok	1	6	5	4.000
Lamidanda	4	2	3	3.000
Ludhi Damgade	2	5	4	3.667
Ram Laxman	5	3	1	3.000
Shikar	3	4	4	3.667

Occupation Status Ranking

Community Forests	A	B	C	D	Total	Ranking
Badahare	36	64	75	7	45.5	2
Birenchok	8	54	171	8	60.25	6
Lamidanda	7	66	75	35	45.75	3
Ludhi Damgade	23	46	138	8	53.75	5
Ram Laxman	33	44	108	9	48.5	4
Shikar	23	54	60	30	41.75	1

A = Agriculture + Livestock=1; B = Agriculture + Livestock + Remittance=2;
C= Agriculture + Livestock + skilled work =3; D = Agriculture + Livestock + unskilled work = 1

Education Ranking

Community Forests	% of Higher Education	Ranking
Badahare	4	1
Birenchok	15	4
Lamidanda	7	3
Ludhi Damgade	37	5
Ram Laxman	7	3
Shikar	5	2

Wealth Ranking

Community Forests	Rich	Medium	Poor	Total	Ranking
Badahare	36	160	8	68.0	4
Birenchok	36	170	4	70.0	5
Lamidanda	0	134	33	55.7	1
Ludi Damgade	93	126	6	75.0	6
Ram Laxman	33	156	11	66.7	3
Shikar	96	54	41	63.7	2

Rich=3; Medium =2; Poor =1

CF	Average Ranking	population Density per ha of CF	CF's Dependent
Badahare	2.333	27	0.086
Birenchok	4.75	10.9	0.436
Lamidanda	2.5	6.6	0.379
Ludhi Damgade	4.917	7.2	0.683
Ram Laxman	3.25	19	0.171
Shikar	2.167	21.4	0.101

Annex 4 Costs for different Scenarios (1, 2 and 3)

The total costs for managing CFs under different scenarios (1, 2 and 3)

Cost for Scenario One						
Community Forests	Badahare	Birenchok	Lami Danda	Ludhi Damgade	Ram Laxman	Shikar
A. Labour cost	0	0	0	0	0	0
B. Management Cost						
a. Office maintenance charge	10,000	18,000	15,000	20,000	5,000	15,000
b. Organizing meeting, training, seminar	10,000	18,000	10,000	20,000	5,000	12,000
c. Making operational Plan	10,000	10,000	10,000	10,000	10,000	10,000
C. Forest Protection cost						
a. Annual salary for forest guard	32,500	32,500	32,500	130,000	32,500	32,500
Total cost NRs.	62500	78500	67500	180000	52500	69500
Total Cost in US$/yr for CF	868	1090	938	2500	729	965
Cost for Scenario Two						
A. Labour cost	0	0	0	0	0	0
B. Management Cost						
a. Office maintenance charge	15,000	25,000	15,000	35,000	10,000	20,000
b. Organizing meeting, training, seminar	13,000	20,000	10,000	30,000	10,000	18,000
c. Making operational Plan	10,000	10,000	10,000	10,000	10,000	10,000
C. Forest Protection cost						
a. Annual salary for forest guard	32,500	65,000	32,500	260,000	32,500	32,500
b. Maintenance of Forest Fire control	5000	10,000	10,000	15,000	5000	5000
D. Carbon measurements costs	5,000	8,000	10,000	20,000	5,000	5,000
E. Making carbon Report	15,000	30,000	25,000	50,000	10,000	15,000
F. Miscellaneous costs	5,000	20,000	15,000	15,000	5,000	5,000
Total costs NRs.	100,500	188,000	127,500	435,000	87,500	110,500
Total Cost in US$/yr for CF	1396	2611	1771	6042	1215	1535
Cost for Scenario Three						
Cost from Scenario Two	1396	2611	1771	6042	1215	1535
Cost for over extracted forest products	87348	59806	33663	187579	30083	58567
Total Costs in US$/yr for CF	88744	62417	35434	193621	31298	60102

Annex 5 Benefits from Forest Products

Benefit from Forest Products					
A. Benefit from Fodder					
CF	Fodder (t/yr) per HHs	Benefit (NRs/yr) per HHs	Total HHs	Benefit (US$/yr)	
Badahare	6.24	10400	160	23111	
Birenchok	3.94	6567	158	14410	
Lamidanda	5.87	9783	90	12229	
Ludhi Damgade	5.05	8417	450	52604	
Ram Laxman	7.02	11700	60	9750	
Shikar	5.05	8417	130	15197	
1 US$= NRs. 72; 30 kg of fodder = NRs. 50					
B. Benefit from Firewood					
CF	Firewood (t/yr) per HHs	Benefit (NRs/yr) per HHs	Total HHs	Benefit (US$/yr)	
Badahare	2.88	21696	160	48213	
Birenchok	2.112	15910	158	34914	
Lamidanda	2.52	18984	90	23730	
Ludhi Damgade	2.214	16679	450	104243	
Ram Laxman	2.464	18562	60	15468	
Shikar	2.34	17628	130	31828	
1 US$ = NRs. 72; 30 kg of firewood = NRs. 226					
Benefit from Timber					
CF	Timber (cub. ft/yr) per HHs	Benefit (NRs/yr) per HHs	Total HHs	Benefit (US$/yr)	
Badahare	15.1	10042	160	22314	
Birenchok	23.2	15428	158	33856	
Lamidanda	15.4	10241	90	12801	
Ludhi Damgade	18.6	12369	450	77306	
Ram Laxman	14.9	9909	60	8257	
Shikar	16.1	10707	130	19331	
1 US$=NRS. 72; 1 cub ft = NRs. 665					
Total Benefit from Firewood + Fodder + Timber for CFs in US$ per year					
CF	Benefit from Firewood	Benefit from Fodder	Benefit from Timber	Total Benefit	Benefit /HHs
Badahare	48213	23111	22314	93639	585
Birenchok	34914	14410	33856	83181	526
Lamidanda	23730	12229	12801	48760	542
Ludhi Damgade	104243	52604	77306	234153	520
Ram Laxman	15468	9750	8257	33476	558
Shikar	31828	15197	19331	66356	510

Annex 6 Additional CO_2 for scenario 3

Additional CO_2 for Scenario 3							
	Scenario 2		Scenario 3				
CF	Area (ha)	CO_2 (T/yr)	Firewood	HHs	$(CO_2)1$ (T/yr)	CO_2 (T/yr)	Total CO_2 (T/yr)
Badahare	25.78	178	2.88	160	461	178	638
Birenchok	83.58	576	2.112	158	334	576	910
Lamidanda	61.59	424	2.52	90	227	424	651
Ludhi Damgade	270.71	1865	2.214	450	996	1865	2861
Ram Laxman	13.25	91	2.464	60	148	91	239
Shikar	30.36	209	2.34	130	304	209	513
Increment rate of 6.89 t CO_2/ha/yr							
CO_2 =Additional CO_2 after consumption of forest products per year in ha by CF							
Firewood = Firewood that are extracted (T/yr) by CFs							
$(CO_2)1$= Additional CO_2 by reducing consumption of extracted Firewood							
1 kg of firewood gives 1.8333 kg of CO_2							

Annex 7 Energy Consumption for cooking

CF	Only Firewood	Biogas + Firewood	LPG Gas + Firewood	Total
Badahare	92	4	4	100
Birenchok	38	27	35	100
Lamidanda	87	0	13	100
Ludhi Damgade	46	31	23	100
Ram Laxman	67	22	11	100
Shikar	40	28	32	100
Average	58	21	21	100

Annex 8 Livestock status in each CF

Livestock	Badahare	Birenchok	Lamidanda	Ludhi Damgade	Ram Laxman	Shikar
Cows	1.8	0.5	0.8	0.22	0.55	0.45
Oxen	1.16	0.7	1.53	1.17	1.88	1.13
Buffaloes	0.8	0.54	0.4	1.45	1.22	0.59
Goats	4.52	3.73	3.93	5.02	5.67	3.18
Pigs	0.28	0.46	0.1333	0.05	0	0.27
Local Hens	1.32	3.61	2.266	0.26	0	0.5
Boiler Hens	18.24	50.46	0	0	0	0