Feasibility Analysis of REDD+
A Case Study in Ghwangkhola Sapaude Babiyabhir Community Forest of Syangja, Nepal

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LETTER OF RECOMMENDATION

This is to certify that works incorporated in this dissertation entitled **"Feasibility Analysis of REDD+, A Case Study in Ghwangkhola Sapaude Babiyabhir Community Forest of Syangja, Nepal**" presented by Mr. Anup K.C. for the partial fulfillment of the requirements for Master's Degree in Environmental Science was under my supervision and guidance. He has worked with sincere interest during entire work period. This dissertation bears the candidates own work to the best of my knowledge. This dissertation has not been published or submitted for any other degree. I therefore, recommend this dissertation for final evaluation and acceptance.

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LETTER OF APPROVAL

The dissertation presented by Mr.Anup K.C. entitled **"Feasibility Analysis of REDD+, A Case Study in Ghwangkhola Sapaude Babiyabhir Community Forest of Syangja, Nepal"** has been accepted for partial fulfillment of the requirements for the completion of Master's degree in Environmental Science.

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ABSTRACT

Climate Change is growing as a hot issue throughout the world. It is necessary to apply mitigation and adaptation strategy for combating climate change. Reducing emissions from deforestation and forest degradation (REDD) is potentially low-cost option for mitigating climate change. The main objective of this study was to determine the carbon stock and cost-benefit analysis (CBA) of community forest (CF) by entering into carbon trading through REDD. For this, the study was carried out in Ghwangkhola Sapaude Babiyabhir CF (GSBCF), Syangja. The CF was established in 2000 with an area of 92 hectares with 195 Community Forest User Group (CFUG) members. The total carbon stocks of forest in 2011 was measured by following the guidelines prepared by MFSC and jointly by ICIMOD, ANSAB and FECOFUN. Information about the socioeconomic condition of the CFUG and cost and benefit associated with Community Forest Management (CFM) was collected from CF Operation Plan, focus group discussion (FGD), key informant survey (KIS) and household (HH) survey. Population of female was more than that of male among the CFUG. More than 52% of total CFUGs had medium economic standard in the village. On an average, 11.61 ropani of land was owned by each household in the village. Average total livestock per household in this CFUG was 5.62. The forest was with *Castonopsis-Scima* lying at an altitude range of 970 to1320 masl. More than 90% of the trees in the forest had diameter less than 20 cm which had high potential of increasing biomass in the future. The biomass in the forest was 164 ton/ha, with yearly increment of 0.95 ton/ha. The total carbon stock of the forest was 122.29 ton/ha, including soil organic carbon and below ground carbon of 45.18 ton/ha and 12.85 ton/ha, respectively. The total Opportunity Cost of the forest was US $ 329. Rich, medium and poor HH were willing to pay 25.97 %, 51.95 %, 22.08 % of total Willingness to Pay (WTP) respectively for the ecological services provided by the forest. The annual total benefit and cost in 2010 was US $ 7300 and 2456, respectively. Benefit Cost Ratio measured directly without discounting and with discounting for 10 years from 2006 to 2015 was 2.97 and 3.91, respectively. The study concludes that the CF had already benefitted from current state of management. If REDD scheme is introduced in the community forest of Nepal, it will provide additional benefit of carbon credit to the CFUG.

Keywords: *GSBCF, Carbon sequestration, REDD, WTP, Opportunity cost, CBA.*

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

˚C/yr	Degree Celsius per year
AGSB	Above ground Sapling biomass
AGTB	Above ground tree biomass
ANSAB	Asian Network for Sustainable Agriculture and Bioresources
BCEFs	Biomass Conversion and expansion factor
BCR	Benefit Cost Ratio
CBA	Cost Benefit Analysis
CDES	Central Department of Environmental Sciences
CDM	Clean Development Mechanism
CER	Certified Emissions Reduction
CF	Community Forest
CFM	Community Forest Management
CFUG	Community Forest User Group
CIFOR	Center for International Forestry Research
CO_2	Carbon dioxide
COP	Conference of Parties
DBH	Diameter at breast height
DFO	District Forest Office/Officer
DoF	Department of Forests
ES	Ecological Services
FAN	Forest Action Nepal
FCPF	Forest Carbon Partnership Facility
FECOFUN	Federation of Community Forestry Users, Nepal
FGD	Focus Group Discussion
g/cm^3	gram per cubic centimetre
GHG	Green House Gases

GIS	Geographic Information Survey
GON	Government of Nepal
GSBCF	Ghwangkhola Sapaude Babiyabhir Community Forest
Gt	Giga tones
Ha	Hectare(s)
HH	Household
i.e.,	that is
ICIMOD	International Center for Integrated Mountain Development
IPCC	Inter-Governmental Panel on Climate Change
Kg	kilogram
LFP	Livelihood and Forestry Program
LHG	Leaf litter, Herbs and Grass
LIBIRD	Local Initiative for Biodiversity, Research and Development
LULUCF	Land Use, Land Use Change and Forestry
m^2	square metre
Masl	Metre above sea level
MFSC	Ministry of Forests and Soil Conservation
MTCO2e	Million metric tons of CO2 equivalent
NPV	Net Present Value
NTFP	Non-Timber Forest Product
OC	Opportunity Cost
OP	Operational Plan of CFUG
PV	Present Value
REDD	Reducing Emissions from Deforestation and Forest Degradation
RPIN	Readiness- Project Idea Note
RPP	Readiness Preparation Proposal
SOC	Soil Organic Carbon

Ton	Metric Ton
Ton/ha	Metric ton per hectares
TUCL	Tribhuvan University Central Library
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Voluntary Carbon Standards
VDC	Village Development Committee
WTP	Willingness to Pay
WWF	World Wide Fund for Nature Conservation

LIST OF NEPALI WORDS USED IN THE REPORT

Bari	Unirrigated land
Bhari	45 kg in the case of fuel wood and 30 kg in the case of fodder
Khet	Irrigated land
NRs	Nepali rupees
Pakha	Sloppy land
Ropani	Unit for Land measurement (20 Ropani =1 ha)

Conversion Rates

1 US$ = 75 NRs (as of April, 2011)

1 cubic feet timber costs US $ 10.67 (N Rs. 800)

1 Bhari Firewood (45 kg) costs US $ 1.33 (N Rs. 100)

1 Bhari Fooder (30 kg) costs US $ 0.33 (N Rs. 25)

1 Bhari leaf litter (15 kg) costs US $ 0.067 (N Rs. 5)

CHAPTER-I
INTRODUCTION

1.1 Background

1.1.1 Climate Change Scenario

Global climate has always been changing naturally, but the changes in the last 50 years are dramatic and scientists attribute the change to human induced factors linked directly to increased levels of carbon dioxide (CO_2) and other green house gases (GHGs). On an average, the global temperature rose by 0.74°C over the last hundred years (1906-2005), with more than half of this rise, 0.44°C, in the last 25 years. Eleven of the twelve years between 1995 and 2006, rank among the twelve warmest years since 1850 (IPCC, 2007). According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007): "Most of the observed increase in global average temperatures since mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations,". Major parts of the Hindu Kush Himalayan area are undergoing warming trends and annual mean temperature is increasing at the rate of 0.01°C/yr or more. In contrast, the Higher Himalayan data from Nepal over the period from 1977-1994 showed an increase in temperature of up to 0.06°C per year, which is greater than the global trend (Shrestha *et al.*1999). Eastern Nepal and eastern Tibet show relatively greater warming trends (greater than 0.02°C per year) (Shrestha and Devkota, 2010). The warming trend was more evident during the winter months (December– February), when it was about 0.015°C per year higher than the annual rate, and at higher altitudes (Singh *et al.* 2011). Warming in the Himalayas is demonstrated by the increased rate of glacial recession and the resultant formation of new glacial lakes in the Higher Himalayas. The number of extreme precipitation events, like heavy rainfall and severe storms appears to have increased, and there is some indication that there has also been an overall increase in precipitation, although the confidence in these estimates is lower than for temperature (Singh *et al.* 2011).

1.1.2 Forest and climate change

Forests are known to play an important role in regulating the global climate. They play a key role in as both sinks and sources of carbon dioxide. The carbon pool in a forest ecosystem can be broadly categorized into biotic (vegetative carbon) and pedologic (soil carbon) components. As tree grow, they sequester carbon in their tissues, and as the amount of tree biomass increases (within a forest or in forest products), the atmospheric CO_2 is mitigated (Shrestha, 2008). Thus forest can capture and retain large amount of carbon over long periods. These stocks are dynamic, depending upon various factors and processes operating in the systems; most significant are land-use changes, soil erosion, and deforestation (IPCC, 2000). Forest is believed to be one of the terrestrial reservoirs storing about 7500 Gt CO_2 (without soils) (Rana, 2008, IPCC, 2001). Soil contains the major part of carbon in terrestrial ecosystems. It has been estimated that deforestation and forest degradation contribute up to 20 percent of global emissions of CO_2 annually. Carbon sequestration in terrestrial ecosystem, especially in soil, is a win–win strategy for developing countries, where land use change and agricultural intensification is most frequent. Moreover, forests are thought to provide a more cost-effective means of reducing global CO_2 emissions than other sectors. The forest has potential to reduce atmospheric concentration of CO_2, which is an important GHG and thus mitigate climate change (Dhakal, 2010). Thus, if incentives could be provided to curb the deforestation and forest degradation in many tropical countries, then forests could have a net positive impact on carbon sequestration and thereby contribute substantially to mitigate climate change (Acharya *et al.* 2009).

1.1.3 Genesis of REDD

According to the Fourth Assessment Report of IPCC Review, 65% of global carbon mitigation potential is located in the tropics and at least 50% of that total could be achieved by REDD (IPCC, 2007). In this context, the prospects of jointly addressing climate, biodiversity, and human livelihood concerns by REDD in developing countries have attracted significant attention within the international environmental community (Rana, 2008). REDD is potentially a low-cost option for mitigating climate change, if acted upon today (Stern, 2007). The Thirteenth Conference of the Parties (COP 13) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2007 laid the foundations for including REDD in developing countries in the post-2012 climate protection regime. The World Bank is already providing support for REDD through the Forest Carbon Partnership Facility (FCPF) with a target funding of US$ 300 million to start REDD policy in developing countries. The fund provides grant support to prepare institutions and to build capacity for REDD related projects like establishing emission reference levels and monitoring systems and for adopting strategies to reduce deforestation. REDD has the potential to achieve significant co-benefits, including alleviating poverty, improving governance, conserving biodiversity and providing other environmental services (Angelsen, 2008).

In the international arena, the meaning of “REDD+” is often expanded to include forest enhancement together with social and biodiversity co-benefits, in addition to avoiding deforestation and forest degradation. REDD++ would incorporate all emissions from different land uses and land use change, including afforestation, grasslands and agricultural lands. However, the complexity of measuring, monitoring and recording carbon emissions and/or stocks in other types of land use would certainly pose additional technical and institutional challenges and increase transaction costs (Acharya *et al.* 2009).

1.1.4 Community Forestry and REDD Options in Nepal

Within the last four decades, CFM has been promoted in Nepal as an important step in common property resource management. To mitigate the growing deforestation and deterioration of the forest all over the country, the government of Nepal made a policy based on the 1976 National Forestry Plan to involve local communities in forest management (Rana, 2008). Till April 1, 2012, there were 17,685 CFUGs with the total CF area of 1,652,654 ha. The total number of households involved was 2,177,858 (DoF, 2012). Nepal’s community forest had been acknowledged in Rio+20 conferences in 2012 as this strategy encourages active participation of local people in managing production and distribution of forest products. In this approach, local users develop their own operation plans, set harvesting rules, set rates and prices for products, and determine how surplus income is spent (UNCSD, 2012). Community managed forests in Nepal are already achieving goals set out at this year’s Rio+20 conference by promoting sustainable use of natural resources and making sure more trees are left standing. However, poverty eradication and social justice will be crucial in the quest for a greener and fairer economy (CIFOR, 2012). Various studies have demonstrated that there is a significant increase in forest condition under CF showing that it is a proven model for controlling deforestation and forest degradation, although in some situations pressure has simply been transferred elsewhere. Branney and Yadav, (1998) recorded a 29% increase in basal area for degraded community forests over 4 years (*cited in* Rana, 2008). LFP, 2009 records a mean 21% biomass increase across community forests of all types and conditions measured over a 14 year period (1.5% yearly) (*cited in* Dhakal, 2010). CF also had co benefits of reducing poverty, addressing social exclusion and creating rural employment. Biological sequestration of CO_2 by CF assists in reducing atmospheric CO_2. This has led the government to try and link CF with the emerging global carbon policy for the post-2012 period. Nepal is trying to prepare a REDD policy with support from the World Bank's FCPF. However, adding value to existing CFM by managing carbon requires new national policies. Nepal participated in FCPF's call for submission of a Readiness-Project Idea Note (R-PIN) in early 2008. Largely based on Nepal's experience with CFM, the R-PIN was selected by the World Bank in July 2008 along with R-PINs from 13 other tropical countries. If REDD programme is implemented in CFs of Nepal; it will provide additional benefit of carbon credit to the local people.

1.1.5 Cost and Benefit related to Community Forest by implementing REDD

1.1.5.1 Opportunity cost

Deforestation, for all its negative impacts, can also bring benefits. Timber can be used for construction, and cleared land can be used for crops or as pasture. Reducing deforestation means foregoing these benefits. Similarly, forest degradation because of selective logging, fuel wood collection, or grazing of animals also brings benefits, and avoiding this degradation foregoes these benefits. The cost of foregone benefits is known as Opportunity cost (OC) and is usually the single most important category of cost a country would incur if it reduces its rate of forest loss to secure REDD payments. Estimating these OC is thus the central problem in estimating the costs of REDD (Pagiola & Benoit, 2009).

1.1.5.2 Implementation costs

In addition to OC, there are also costs involved in implementing a REDD program. These are the costs directly associated with the actions leading to reduced deforestation, and hence to reduce emissions. For example, the cost of guarding a forest to prevent illegal logging, relocating timber harvesting activities away from natural forests to degraded land scheduled for reforestation, or intensifying agriculture or cattle ranching. Implementation costs (IC) also comprise the institution and capacity building activities that are necessary to make the REDD programs happen (including the expenses associated with the goods, training, research, and the political, legal and regulatory processes involved, including the consultations and government decision-making processes) (Pagiola & Benoit, 2009).

1.1.5.3 Transaction costs

Over and above opportunity costs and implementation costs, REDD also involves specific transaction costs. These are the costs that are necessary for the parties to a transaction involving a REDD payment (the buyer and seller, or donor and recipient), as well as external parties such as a market regulator or payment system administrator, to establish that the REDD program has indeed achieved a certain amount of emission reductions. The costs are incurred in the process of identifying the REDD program, negotiating the transaction, and monitoring, reporting, and verifying the tons of emission reductions. They are incurred by the implementers of the REDD program and third parties such as verifiers, certifiers, and lawyers (Pagiola & Benoit, 2009).

1.1.5.4 Benefit

Revenues from carbon payments, wood products, non-wood forest products and payments for environmental services other than carbon can provide direct economic benefit to the people. And ecosystem services such as watershed regulation, biodiversity, nutrient cycling, and soil conservation, improved water quality, climate change mitigation, recreational and cultural values provide indirect benefit (Martino, 2009).

1.1.5.5 Willingness to Pay

The Willingness to Pay (WTP) is the means of assigning monetary value to the resources and services flow that are unpriced, or underpriced by the market. It will be used to estimate both use and non-use values, and it is the most widely used method for estimating the non-use values. The WTP is referred to as stated preference method because it asks people directly to state their value rather than inferring values from actual choices (King and Mazzotta, 2003 *cited in* Chand, 2010).

1.1.5.6 Net Present value (NPV)

NPV is perhaps the most straight-forward cost benefit analysis measure. In most projects, the costs and benefits are going to be spread out over time. Since people are not indifferent with respect to the timing of costs and benefits, it is necessary to calculate the present value of all costs and benefits. It is therefore important that the valuation of costs and benefits takes into account the time at which they occur because people generally prefer to receive benefits as early as possible and pay for costs as late as possible. This amount is known as the present value (PV) of the future costs and benefits. The PV is calculated using the method of compound interest and the rate that converts future values into PV (i.e., the discount rate) (CASA, 2007).

Discounting is a procedure that allows computing the present value of financial flows that will take place in the future. Discounting is needed in cost benefit analysis to calculate NPV which is the key criterion for investments. At a more global level, discount rates relate to investment rates: the lower the former, the higher the latter. As such, discounting reflects the balance between present and future well being. The generally preferred approach is to use a real discount rate, i.e., to exclude any inflationary component of market rates. Inflation must be treated consistently across both the applied discount rate and the costs and benefits components of the evaluation (Philbert, 1999) .

1.2 Statement of the Problems

The Clean Development Mechanism (CDM) has been created as a market mechanism that permits participation in carbon market on a voluntary basis. This could be beneficial to non-industrialized countries like Nepal. In the forestry sector, avoiding deforestation is recognized under the regulations of the CDM (Karky, 2008). This means that countries like Nepal that promote CFM and contribute to reducing global emission by biological sequestration of carbon through forest management can claim carbon credits under the CDM. Different study on REDD in Nepal are unable to express all the cost and benefit associated with the present CFM from REDD strategy. There is need for further study that address all cost and benefit of CFM implementing REDD. The problem that this study addresses is whether CFM can be integrated into the market-based mechanism under the new climate change treaty for reducing global emission. It will analyses whether the carbon trading from REDD Strategy will actually benefit the local community.

1.3 Objective of the study

The main objective of this study is to carry out cost-benefit analysis of CFM by entering into carbon trading through REDD. The specific objectives are

1. To assess the socioeconomic status of the studied CFUG.

2. To estimate the amount of carbon sequestered by CF.
3. To assess opportunity cost and WTP associated with present CFM.
4. To estimate all the costs and benefits of CFM along with benefits from carbon trading through REDD and estimate the benefit cost ratio (BCR).

1.4 Rationale of the Study

The scheme of carbon trade through REDD appears an attractive option that offers incremental benefits to the forest users in local income. Among many practices, community forestry is promising example that contributes to avoid deforestation in Nepal.

Application of REDD actions with CF will further offer potential contributions to enhance the livelihood of rural communities. Estimates of the carbon stocks of forests undergoing deforestation, and the subsequent carbon dynamics are uncertain for many developing countries including Nepal (Kanninen *et al.*, 2007 *cited in* Karky, 2008). Up to date information on forest clearing and carbon storage is required to estimate the deforestation and degradation, and to identify the reduced amount of carbon from abated deforestation and degradation (Rana, 2008).

In the above background, this study will help to find accurate measurement of carbon stock in the CF of Nepal. It will also address whether or not the local and indigenous community will actually benefit through implementing REDD scheme in CF. It will also help in determining the rate of carbon credit which will directly benefit the local marginalized and indigenous community.

1.5 Scope of the Study

The scope of the present study is to conduct the research in GSBCFUG in Syangja district of Nepal. The scope of the research includes the field data collection and review of literature and available maps. The other activities carried out during this study were an extensive field visit for survey and field observation. The area of the research covers the cost-benefit analysis of CFM by entering into carbon trading through REDD in one CF. Biomass and carbon stock of the forest was measured by following the guideline prepared by ICIMOD and MFSC. All the socioeconomic information, benefits and cost associated with the community forest was measured with the help of household survey and focus group discussion. Based on the collected data dissertation was prepared.

CHAPTER-II

LITERATURE REVIEW

This chapter reviews the related literatures on biomass and carbon stock estimation of forest, cost benefit analysis and REDD.

2.1 Biomass Estimation of different types of forest

IPCC, (2003) indicate that the highest biomass stock was in tropical rainforests (300 ton/ha) and the lowest in Boreal woodlots (15 ton/ha).

IPCC, (2006) reported that the aboveground biomass in subtropical forest of Asian continental region in natural forest was 100 to 160 ton/ha with the annual increment of 1.5 ton/ha in biomass and in plantation forest was 80 ton/ha with the annual increment of 7 ton/ha in biomass.

CFs have been playing crucial role in increasing forest cover, tree density in public and private land and also sequesters carbon. The community forest user groups (CFUGs) are unaware about the role of CFs on land use changes and carbon sequestration. Land use change analysis between 1988 and 2009 in the selected areas of CFs showed great changes in forest and cultivated lands: increase in forest land and decrease in cultivated land in almost all studied areas. Carbon deposit was found higher in climax than the secondary succession forests due to the presence of big sized trees (Gautam *et al.* 2009).

The latest national forest inventory was taken in 1994. Out of the total area of 14.7 million hectares, 5.8 million ha or 40 percent of total land area was still covered with forests and shrubland. Region wise, terai, hills, siwaliks and mountains had 8.4, 35.3, 22.8 and 33.5 percent of total forest area respectively. The highest rate of deforestation was in Terai (1.65%), followed by Siwaliks and Higher Himalayas. Recent regional level studies have shown that the deforestation rate in the Terai had reduced to 0.6 percent per year. Countrywide, the degradation was about 8 percent per year for whole Nepal. About 22 percent of forests of Nepal were managed by communities and another 15 percent by the state as protected areas. The remaining 63 percent of the forests was legally owned by the state but not effective institutional arrangements were in place to regulate the use, protect the forest, and exclude the non users (Kanel *et al*.2009).

Oli and Shrestha, (2009) estimated that above ground biomass was found to be around 76 ton/ha for Terai forests, 37 ton/ha for the Middle Mountains, and 57 ton/ha as the national average. Since this estimate excludes soil carbon, the estimated total forest carbon stock needs to be properly adjusted.

2.2 Carbon Stock Estimation in different types of forest

IPCC, (2000) had estimated carbon at the global level and had found that 19 % of the carbon in the earth's biosphere was stored in plants and 81 % in the soil. In all forests, tropical, temperate and boreal together, approximately 31 % of the carbon was stored in the biomass and 69 % in the soil. In tropical forests, approximately 50 % of the carbon was stored in the biomass and 50 % in the soil.

Gautam, (2002) reported that the highest total organic carbon was found to be 98 ton/ha in natural forest. The total organic carbon content ranges from 33.2 to 55.5 ton/ha and from 35 to 74.6 ton/ha in annual cropping system and in the plantation orchard, respectively. The SOC was highest (53.2 ton/ha) in naturally grown forest followed by 52.6 ton/ha in vegetable grown field and least in streamside (3.6 ton/ha).

Bhatta, (2004) conducted a study in mixed broad leaved forests of Phulchowki Watershed, Lalitpur. The carbon stock in above ground in natural forest and community forest ranges from 91.89 to 112.79 ton/ha and 55.30 to 67.04 ton/ha, respectively. Similarly, the carbon stock in soil in natural forest and community forest ranges from 195 to 223 ton/ha and 150 to 160 ton/ha, respectively.

Khanal, (2007) conducted a study in Champadevi CF covering an area of 136.2 ha. for calculating carbon and biomass. The total carbon content in the forest was estimated as 24.72 ton/ha. There was a greater biomass of *Quercus floribunda*.

Dahal, (2007) conducted a study in Sunaulo Ghame Danda CF in Kathmandu. The biomass organic carbon in Pine Forest and Mixed Broad Leaf Forest was 116 ±16.39 and 25.95± 8.09 ton/ha, respectively. The soil organic carbon in Pine Forest and Mixed Broad Leaf

Forest was 10.12 ± 1.03 and24.62 ± 1.18 ton/ha, respectively. The carbon sequestration status in Pine Forest and Mixed Broad Leaf Forest was 1 ton/ha/yr and 2.95 ton/ha/yr, respectively. The additional benefit to CFUG by carbon trading was $ 563.15 per annum.

Karky, (2008) conducted a study in three community forest of Manang, Lalitpur & Ilam district in Nepal. From field measurements, it was found that the average carbon pool size of a community managed forest (excluding litter and herbs, shrubs) was 138 ton/ha or 504 ton CO_2/ha including soil organic carbon up to 1m depth in the three sites of Nepal Himalaya. He found that annual incremental rate for carbon sequestration in forest under CFM was found to be between 1.92 & 7.04 ton/ha per year excluding soil organic carbon. He also found that when CFUGs are permitted to use forest resource, the breakeven price for per ton CO_2 is $0.55 for Illam, $3.70 for Lamatar & $2.30 for Manang.

Gurung, (2009) conducted a pilot study in western Terai and had estimated the average forest carbon stock to be around 231 ton/ha. The carbon stock in trees above ground, below ground and in soil organic carbon (SOC) had been estimated to be about 68, 18, and 143 ton/ha, respectively. This clearly indicates that the share of SOC was almost 60 percent of the total forest carbon stock.

Thagunna, (2009) conducted a study in Bailbanda Buffer Zone CF, Kanchanpur.The total carbon stock of CF was 78.46 ton/ha. The benefit from carbon trade was $ 57, 640 at the rate of $ 12.5/ton C.

Aryal, (2010) conducted a study in Toudol Chhap CF, Sipadol, Bhaktapur. The total carbon content of pine forest and mixed broad leaf forest was 167.04 ton/ha and 101.91 ton/ha, respectively.

Bhusal, (2010) conducted a study in Nagmati watershed in Shivapuri National Park. The SOC and total carbon content in the sampled area (14 ha) was found to be 9782.11±25.18 ton/ha corresponding to a total of 167442.26±42076.82 ton carbon content in the Nagmati Watershed (1406 ha). The total carbon content of Shivapuri National Park (5860.8 ha i.e., 40% of total area of park which is forest) excluding soil was 699961.20±175894.32 ton.

Kabindra, (2010) measured the total carbon stock in Pashupati Community Forest, Sarlahi district of Janakpur zone. The total carbon stock was found higher in naturally regenerated forest i.e., 181.83±26.34 ton/ha followed by planted forest with 159.49±31.96 ton/ha. The least amount of total carbon stock of 133.65±37.05 ton/ha was found in Enriched forest.

Mishra, (2010) conducted a study in Chapako CF, Kathmandu. The biomass carbon and SOC of CF was 119.742 ton/ha and 32.29 ton/ha respectively. There was potential of storing and sequestering carbon in the CF.

ICIMOD., ANSAB., FECOFUN, (2010) had done baseline study in 104 community forests of three watershed areas of Nepal; Kayarkhola of Chitwan district, Charnawati of Dolakha district and Ludhikhola of Gorkha district. Analysis of the DBH distributions of all strata follows a left-skewed trend, indicating most of the trees in all the strata were younger and there was potential to enhance forest carbon stock by encouraging tree growth. Forest carbon stock in dense and sparse strata of Kayarkhola, Charnawati and Ludikhola watershed were 296.44 and 256.70 ton/ha; 228.56 and 166.75 ton/ha; 216.26 ton/ha and 162.98 ton/ha, respectively.

2.3 Cost- Benefit Analysis and REDD

Dangi, (2006) conducted cost benefit analysis study in 3 CFs of Makwanpur district located in central part of Nepal. All direct costs and benefits of the CF were calculated. The B/C ratio in Mahila- Srijan CF, Neureni- Chisapani CF and Kalika Hariyali CF was 1.1, 1.77 and 1.14, respectively in 2003/04.

Subedi and Kathuria, (2006) estimated the recreational value of Himalayan Forests by Travel Cost Method (TCM). The basic purpose was to use the cost of travel as surrogate for the Willingness to Pay in different sites in Himalayan forests. Besides actual transportation costs, the travel costs also include tariffs paid at hotels and the opportunity cost of travel time spent on journey, as a proxy for asset value of the recreation site. The analysis and results based on 242 domestic tourists falling in total 49 zones of the 4 sites showed that the value derived from tourism in the Himalayan Forests Rs. 4.06 million (i.e., Rs. 273 per hectare) to Rs. 5.06 million (i.e., 323 per hectare) depending upon which functional form taken. Similarly, the value of Himalayan forests for foreign tourists came out to be US$1.04 (log-linear model) to

1.85 million (linear model). The total tourism value from Himalayan forests was falling between US$ 272 – 526 (Rs 18,490 to Rs 35,797) per hectare.

Rana, (2008) studied in Torikhet CF in Dhading district and found that annual mean carbon sequestration rate was 1.40 ton/ha per year. He used discount rate of 12% in his study to calculate NPV of benefit and cost. The average BCR was 2 when restriction was done on removal of forest products for medium economy households without using NPV. By using NPV, the average BCR was 4.57.

Baral *et al.* (2008) had done investigation on the economic contribution of community forestry to rural households in two CFUG of Dolakha district. The surrogated pricing method was used to estimate the value of fodder whereas the market price method was used to estimate the price of timber, fuel wood and non timber forest products (NTFPs). Value of leaf litter was calculated using the opportunity cost method as it does not have any substitute product. In Bhitteripakha CFUG, BCR was the highest (2.58) for poor and the lowest (1.78) for very poor followed by medium class. As medium and very poor had low benefit cost ratio, it means that their return on investment from CF was low compared to rich and poor. BCR in Kalobhir CFUG was 2.36 for rich and 2.03 for very poor.

Gryze and Durschinger, (2009) conducted a study in Dolakha in about 65,000 hectares of land. It was found that over a 30 year period it could generate net cumulative carbon credits of over 5.4 million tons of CO_2. At current trading levels (about four to seven US $ per ton of CO_2, carbon credits could generate significant income each year. On the cost side, the case study identified a high-level overview of the costs involved in bringing the potential Nepal project to market. Start up costs for carbon development, carbon registries and validation, and up front carbon transaction and monitoring costs have been estimated as $410,000, not including the creation and validation of methodology under the Voluntary Carbon Standard (VCS) and project management costs associated with the target interventions. Carbon credits remain only one out of many mechanisms to increase livelihoods in a sustainable way.

REDD was somewhat less competitive with soybean production in Brazil, which had opportunity costs ranging from US$2.5 to US$3.4/ton CO_2. Opportunity cost of cattle ranching ranges from zero for traditional pasture and small scale ranching to US$2/ton CO_2

for ranching on improved pasture. Including incentives to reduce forest degradation in REDD was particularly important for Indonesia, where forest degradation was a larger source of GHG emissions than forest conversion. Opportunity cost range from US$0.49/ton CO_2 for small holder farming in Sumatra up to US$19.6/ton CO_2 for conversion of degraded forest land to palm oil. Opportunity costs range from US$1.65/$CO_2$ for commercial logging in Sumatra to US$3.44/ton CO_2 for unsustainable commercial logging in Southeast Asia and the Pacific (Olsen *et al.* 2009).

Stich, (2009) examined the feasibility of REDD in El Chore Forest Reserve in Bolivia. Estimation of biomass, prediction of deforestation, and calculation of the opportunity cost was done during the study. The reserve had an average biomass of 121.1 million gram biomass/ha with a standard deviation of 15.58. In the absence of intervention, it was predicted that 44% of the forest reserve would be converted to agriculture by 2036. The opportunity cost was modeled using profit predictions of the four main crops (rice, soybean, maize, wheat). The average opportunity cost for a three-year time period ranged from $904/ha in 2006 to $2143/ha in 2036. Using an economic model with an 8% discount rate the average price would need to be $21.17/ton C.

Chand, (2010) conducted a study in Ghodaghodi wetland, a Ramsar site of Nepal, in October 2009 to estimate the economic value of ecosystem services provided by the wetland with its water body of 138 hectare. The economic value of wetland ecosystem services was determined by using Market Price Method and Travel Cost Method. The Willingness to Pay (WTP) of the local people was also elicited to measure the importance of the Ghodaghodi wetland to local people. Within the adjoining Village Development Committees (VDCs) of the Ghodaghodi wetland household survey was carried out among 75 households. For recreational and aesthetic value, 84 visitors were directly surveyed during three days. The consumptive use value was found Rs 1, 84, 31,399 (US $ 248,067), the Willingness to Pay value was found Rs 23, 37,000 (US$ 31,453), the recreational & aesthetic value was found Rs 12, 44,367 (US$ 16,747). The religious and cultural value was found Rs 32,816 (US$ 441.66). The Total Economic Value was found Rs 1, 97, 08,582 (US$ 265,255) per annum.

CHAPTER-III
METHODOLOGY

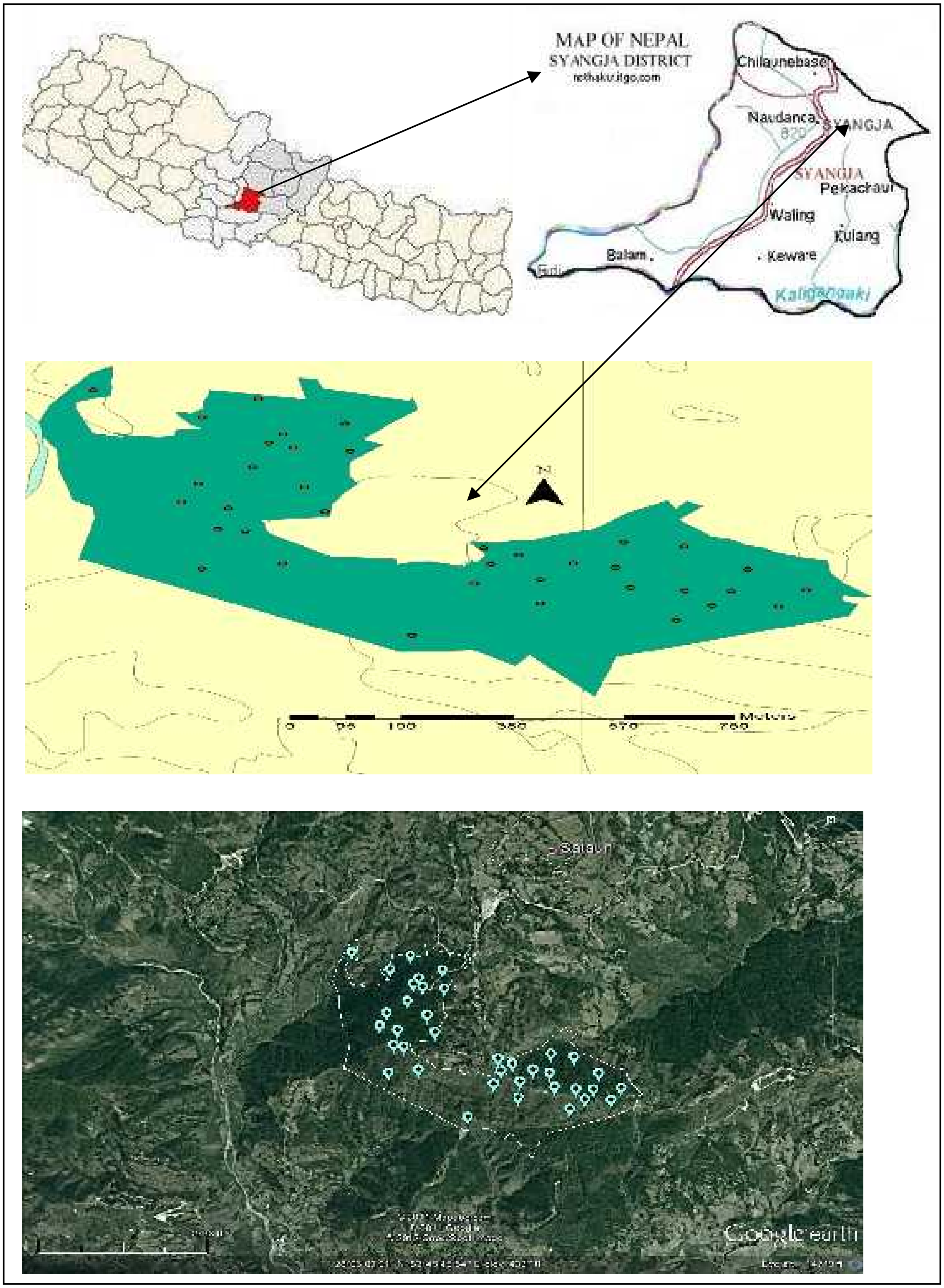
3.1 Study area

The study was undertaken in GSBCF, Putalibazar Municipality-8, Syangja, Nepal (Figure-1). This CFUG was handed over to user group in 2000. It lies at an altitude of 1200 m from sea level and covers an area of 92 hectares. The total number of users is 195. The basic criterion or rationale for the selection of this community forest was due to the availability of growing stock biomass data measured in 2006 during renewal of CF Operational Plan (OP). This data was useful to find out the incremental carbon stock at five years interval.

Description of the Studied CF

CFUG Name:	Gwangkhola Sapaude Babiyabhir CF
Handover Year (Renewed Year):	2000 (2006)
Total forest area (Hectare):	92
Total household involved:	195 (Dalit-6; Janajati-70 and Higher caste-119)
Total Population:	1025
Committee members:	13 (Male-9, Female-4; Dalit-1, Janajati-2, Other-10)
Major caste in group:	Brahmin, Chettri, Magar, Gharti, Kami, Newar
Altitude (mean average sea level):	930-1325 m
Vegetation Type:	Temperate deciduous forest
Major species:	*Castanopsis indica*, *Schima wallichi*,
Block of forest (No.):	3 (Ghwangkhola-46 ha, Sapaude-17ha, Babiyabhir-29ha)

Source: Operation Plan, 2006

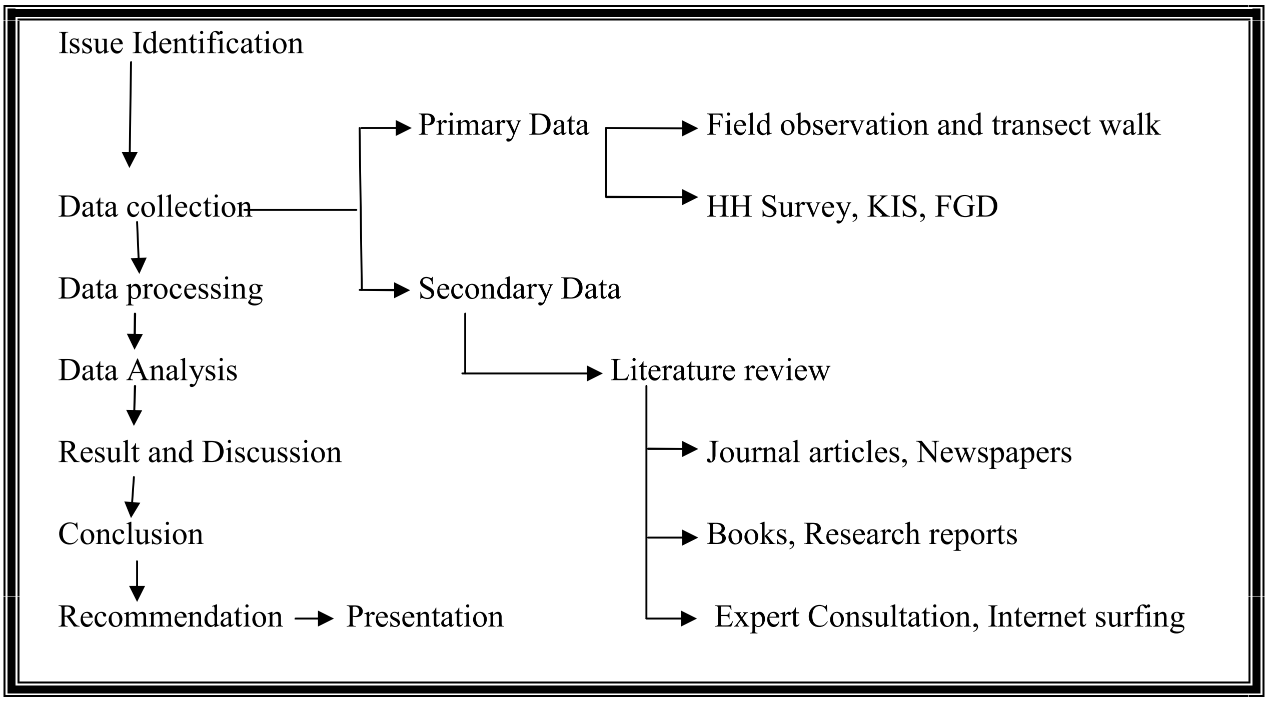


Source: Field Survey 2011, www.googleearth.com and www.google.com

Figure 1: a) Map of Nepal and Syangja district, b) CF with sample plots in GIS map and c) in Google earth

3.2 Research Design

For this research study, REDD related issues in the CF were identified by literature review and expert consultation. The primary data was collected from field observation, HH survey KIS, FGD and transect walk. Secondary data was collected by literature review from journals, books, newspapers, research reports, expert consultation and internet surfing. The collected data were processed with the help of Microsoft excel and GIS. Later on, the data were analysed and results, discussion and conclusion were compiled to form a report.



3.3 Data Collection

3.3.1 Nature and sources of data

Primary as well as secondary data were collected by applying following techniques. Primary data was taken from the measurement of present biomass, HH survey, FGD and KIS. Secondary data was taken from different books, journals, newspapers, research reports and Community Forestry Operational Plan. Also secondary data was collected from International Centre for Integrated Mountain Development (ICIMOD) REDD Cell, Asia Network for Sustainable Agriculture and Bioresources (ANSAB), Federation of Community Forest Users' Nepal (FECOFUN), Ministry of Forest and Soil Conservation (MFSC) REDD-Forestry and Climate Change Cell, World Wide Fund for Nature (WWF), Forest Action Nepal (FAN), TU Central library and CDES library.

3.3.2 Field Study

3.3.2.1 Pilot inventory

Pilot inventory was done from October 5, 2010 to October 20, 2010. During pilot inventory, one FGD was conducted with the CFUG executive committee members about their involvement in biomass measurement of the forest. The boundary of forest was tracked using GPS and block division of the forest was done for sample plot determination. Altogether 40 sample plots of 250 square meters (m^2) each were selected for primary data collection. One hectare out of 92 hectares (1.09%) was selected as a sample for biomass measurement.

3.3.2.2 Forest Inventory and Sample Collection

The field work for forest inventory was conducted from April 1, 2011 to April 25, 2011. Biomass measurement was directly done in the field for trees and sapling. For biomass measurement, guidelines prepared by MFSC and guideline prepared jointly by ANSAB, ICIMOD and FECOFUN was followed. The sample of leaf litter, herbs, grasses (LHG) and soil were collected in the field. A total of 40 composite samples of LHG and soil were collected and brought to the laboratory for detailed analysis.

3.3.2.3 Household Survey

The household involved in studied CF were classified into three levels based on their economic status such as rich, medium and poor from FGD with CFUG executive members. More than 50% (100 out of 195) sample was taken for study. The major focus of the HH survey was to collect data about socio economic status of households, forest product collection, household (HH) contribution to forest management, Willingness to Pay (WTP) for ecosystem services (ES) provided by forest and for cost-benefit analysis.

3.3.2.4 Focus Group Discussion

One FGD with the CFUG executive committee members was carried out to find about the contribution and benefits distribution to the general users of CF. Also, the economic stratification of HH was done with the judgement and decision from the committee members in the village during FGD. Due to the lack of economic stratification done by CFOP, CBS and Municipality, economic stratification was done with the presence of these members according to the need and requirement of local community.The economic classification of the HH was done as follows:

If the gross yearly income of the family (collectively from service, agricultural output, business and others) was more than 3.5 lakhs, they were considered as rich. Forty three HH were under this category.

If the gross yearly income of the family (collectively from service, agricultural output, business and others) was less than 3.5 lakhs but were easily sustaining their life without much trouble, they were considered as medium. One hundred and two HH were under this category.

If the family had to depend on daily wage from their work in the village for their survival and had owned very less agricultural field, they were considered as poor. Fifty HH were under this category. But the Living Standard Survey had considered as the family earning less than Rs. 7690 in a year as poor in 1995-96 and Rs, 15,162 in a year in 2003-04for national condition of Nepal.

According to the local people's view, this national condition of CBS does not apply in the context of that community, so economic stratification was done with the CFUG Committee effort.

3.3.2.5 Key Informant Survey (KIS)

To get information about the economic standard of people and for economic classification, KIS was conducted with local political leaders and educated people near CF. Local market price of forest products were discussed with them. Also, information on the contribution and benefit distribution to the general users of CF was gathered from these people.

3.3.3 Laboratory analysis

Soil samples brought to the lab were air dried in dry lab in the beginning. Then, chemical analysis was done to find percentage organic carbon for determining SOC. The LHG sample was kept in hot air oven for 24 hours to remove the moisture for dry biomass calculation.

3.3.4 Sampling technique

Stratified random sampling method was applied to determine the sample plot for biomass estimation in the forest and for household survey. Altogether 40 sample plots of 250 m^2 each were taken for biomass estimation. In three different strata of forest, 19 sample plots were taken in Ghwangkhola block which has moderately dense forest, 10 sample plots were taken in Sapaude block which has dense forest and 11 sample plots were taken in Babiyabhir block which has very sparse trees with pastureland. More than 50% (100 out of 195) sample was taken for HH survey as shown in the table below.

Table 1: Economic stratification of CFUG

Economic class	Total Number of HH	Percentage	Sample Taken
Rich	43	22.05	22
Medium	102	52.31	52
Poor	50	25.64	26
Total	195	100.00	100

3.3.5 Data Collection techniques/instruments

3.3.5.1 Above-ground tree biomass (AGTB)

The diameter at breast height (DBH) (at 1.3 m) and height of individual trees (having diameter more than 5 cm) was measured in each circular plot of 250 m^2 having radius 8.92 m. Diameter tape, clinometers and linear tape were used for this purpose. Each tree was recorded individually, together with its species' name. Trees on the border was included if more than 50% of their basal area falls within the plot and excluded if more than 50% of their basal area falls outside the plot. Trees overhanging into the plot were excluded, but trees with their trunks inside the sampling plot and branches outside were included.

3.3.5.2 Above-ground sapling biomass (AGSB) and regeneration

Sub plots having a 5.64 m radius inside larger plots were established for sapling measurement. Smaller nested sub plots having a 1 m radius inside the larger nested plots was established for assessing regeneration. Saplings with diameters of more than 1 cm to less than 5 cm was measured at 1.3 m above ground level, while saplings smaller than 1 cm in diameter at 1.3 m above ground level was counted as regeneration.

3.3.5.3 Leaf litter, herbs, and grass (LHG)

One circular sub plot of 1 square meter (0.56 m radius) in size was established at the center of each plot. All the litter (dead leaves, twigs, and so forth) within the 1 m^2 sub plots was collected and weighed. Approximately 100 g of evenly mixed sub-samples was brought to the laboratory to determine moisture content, from which total dry mass can then be calculated. Likewise, herbs and grass (all non woody plants) within the plots was collected in polythene bag by clipping all the vegetation down to ground level and brought to the lab.

3.3.5.4 Soil organic carbon

Soil organic carbon was determined through samples collected from the default depth prescribed by the IPCC (2006). Near the center of all plots, a single pit of up to 30 cm in depth was dug to best represent forest types in terms of slope, aspect, vegetation, density and cover. For the purpose of estimating bulk density, individual soil samples of approximately 300 cm^3 was collected with the help of a standardized 300 cm^3 metal soil sampling corer. Similarly, one composite sample was collected mixing soils from all the three layers in order to determine concentrations of organic carbon and then weighed at a precision of 0.1 g. Around 500 g of composite sample was collected from one plot. Composite soil samples were placed into sample bags which were labeled appropriately. All samples were then transported to the laboratory for further analysis.

3.4 Analytical methods

3.4.1 Calculation of Carbon Stock of 2011 Inventory

3.4.1.1 Above-ground tree biomass (AGTB)

The allometric equations (models) in estimating AGTB developed by Chave et al. (2005) was followed. On the basis of climate and forest stand types, eq. (1) for moist forest stand was selected.

$$AGTB=0.0509*\rho D^2 H \ldots\ldots\ldots\ldots\ldots\ldots \text{eq. (1)}$$

Where,

AGTB = above-ground tree biomass [kilogram (kg)];

ρ = wood specific gravity [g/cm^3] was used from guideline prepared by MFSC

D= tree diameter at breast height measured [cm]; and

H = tree height [metre].

After taking the sum of all the individual weights (in kg) of a sampling plot and dividing it by the area of a sampling plot (250 m^2), the biomass stock density was attained in kg m^{-2}. This value was converted to ton/ha by multiplying it by 10. Since the study area was part of the sub-tropical region, the biomass stock density of a sampling plot was converted to carbon stock densities after multiplication with the IPCC, (2006) default carbon fraction of 0.47.

3.4.1.2 Above-ground sapling biomass (AGSB)

To determine the AGSB (DBH less than 5 cm), national allometric biomass tables was used. These tables were developed by the Department of Forest Research and Survey (DFRS) and the Department of Forest, Tree Improvement, and Silviculture Component (TISC) (Tamrakar, 2000). Since the national allometric biomass table did not contain all species present in Nepal, values for related or similar species were used. The biomass values of saplings include foliage, branch, and stem compartments. The following regression model was used to calculate biomass.

$\ln(AGSB) = a + b \ln(D)$…………………………………… eq. (2)

Where,

ln = natural log [dimensionless];

AGSB = above-ground sapling biomass [kilogram];

a = intercept of allometric relationship for saplings [dimensionless];

b = slope allometric relationship for saplings [dimensionless]; and

D = over bark diameter at breast height (measured at 1.3 m above ground) [centimeter].

Biomass stock densities were converted to carbon stock densities using the IPCC, (2006) default carbon fraction of 0.47.

3.4.1.3 Leaf litter, herb, and grass (LHG) biomass

To determine the biomass of LHG, samples were taken from sampling plot of 1 m^2. Fresh samples were weighed in the field with a 0.1 g precision; and a well-mixed sub-sample was then placed in a marked bag. The sub-sample was used to determine an oven-dry-to-wet mass ratio that was used to convert the total wet mass to oven dry mass. A sub-sample was taken to the laboratory and oven dried until constant weight to determine water content. For the forest floor (herbs, grass, and litter), the amount of biomass per unit area is given by:

$$LHG = \frac{Wfield}{A} \times \frac{Wsubsample,dry}{Wsubsample,wet} \times \frac{1}{10000} \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{eq. (3)}$$

Where,

LHG = biomass of leaf litter, herbs, and grass [ton/ha];

Wfield = weight of the fresh field sample of leaf litter, herbs, and grass, destructively sampled within an area of size A [g];

A = size of the area in which leaf litter, herbs, and grass were collected [km^2];

Wsubsample,dry = weight of the oven-dry sub-sample of leaf litter, herbs, and grass taken to the laboratory to determine moisture content [g]; and

Wsubsample,wet = weight of the fresh sub-sample of leaf litter, herbs, and grass taken to the laboratory to determine moisture content [g].

The carbon content in LHG, C (LHG) was calculated by multiplying LHG with the IPCC, (2006) default carbon fraction of 0.47.

3.4.1.4 Soil Organic Carbon

Collected soil samples were analysed in laboratory using special methods and organic carbon percent were calculated. The titration method as developed by Walkely and Black, (1958) was applied for measuring the percentage organic carbon (*cited in* Trivedi and Goel 1984). The soil depth was measured in the field. Bulk density was calculated by dividing weight of the soil by the volume of the soil.

The soil organic carbon was calculated using the method developed by Pearson *et al.* (2007).

Soil Organic Carbon (SOC) = $\% C \times \rho \times d$………………… eq. (4)

%C = Carbon concentration (%)

Where, d = soil depth (cm)

ρ = Bulk density (g/cm^3)

3.4.1.5 Below-ground biomass (BB)

For Below-ground biomass calculation, MacDicken, (1997) root-to-shoot ratio value of 1:5 as used. It means that below-ground biomass was calculated as 20% of above-ground biomass. The carbon content in below ground was calculated by multiplying BB with the IPCC, (2006) default carbon fraction of 0.47.

3.4.1.6 Total carbon stock density

The total carbon stock density was calculated by summing the carbon stock densities of the individual carbon pools of that stratum using the following formula.

Carbon stock density of a stratum:

C Total = C (AGTB) + C (AGSB) + C (BB) + C (LHG) + SOC …… eq. (5)

Where,

C Total = carbon stock density for a land-use category [ton C/ ha],

C (AGTB) = carbon in above-ground tree biomass [ton C/ ha],

C (AGSB) = carbon in above-ground sapling biomass [ton C/ ha],

C (BB) = carbon in below-ground biomass [ton C/ ha],

C (LHG) = carbon in litter, herb & grass [ton C/ ha], and

SOC = soil organic carbon [ton C/ ha]

The total carbon stock was calculated by multiplying the C *Total* with area of forest (92 hectares).

3.4.2 Calculation of Carbon stock of Previous Inventory

Growing stock data in volume from the CF Operation Plan 2006 was used to calculate biomass.

Total biomass = Total Area × Volume × BCEFs × (1+0.2) …… eq. (6) (IPCC, 2006)

Where,

Total biomass was measured in ton,

Total Area = Area of forest; 92 [ha]

Volume = Growing stock volume; 114.594 [m^3]

BCEFs = Biomass conversion and expansion factor for Temperate forest (0.9) (IPCC 2006)

Biomass was converted into carbon by using IPCC, (2006) default carbon fraction of 0.47.

3.4.3 Yearly Incremental Carbon stock

Yearly Incremental carbon stock was calculated as follows:

Yearly Incremental Carbon stock = (Carbon stock in present inventory in 2011 – Carbon stock in 2006 inventory)/5

3.4.4 Economic valuation of the Community Forest

The economic valuation of the community forest was made on the basis of BCR. The BCR was analyzed at different rate of carbon credit. Also, BCR was analyzed including and excluding WTP.

BCR was calculated as follows

1. BCR was calculated as the direct ratio of total benefit (B) and total cost (C) (Without discounting) as BCR = B/C.
2. BCR was calculated with discounting as follows (CASA, 2007)

$$Benefit\ Cost\ Ratio(BCR) = \frac{Present\ Value\ Benefits}{Present\ Value\ Costs}$$

$$Present\ Value\ Benefits = \sum_{n=0}^{N} \frac{Bn}{(1+r)n}$$

$$Present\ Value\ Costs = \sum_{n=0}^{N} \frac{Cn}{(1+r)n}$$

Where,

B = Total Benefit in year 'n' expressed in constant dollars

C = Total Cost in year 'n' expressed in constant dollars

r = Real discount rate (12 %) as taken by Rana, (2008)

n = Evaluation period in years

N = Total number of Years (10 years)

The total benefit includes benefit of forest products, benefit from animal rearing, Willingness to Pay for ecosystem services provided by forest and benefit from carbon credit.

Total Benefit = Benefit of forest products + Benefit from animal rearing + Willingness to Pay for ecosystem services provided by forest + Benefit from carbon credit.

The total cost includes forest management cost, people involvement cost in forest management and opportunity cost.

Total Cost = Peoples' direct involvement cost + Management cost + Opportunity Cost

3.4.4.1 Calculation of Total Benefit from CF

3.4.4.1.1 Benefit of forest products

The benefit of forest products and goods was estimated with direct market pricing method. The direct market pricing method was applied as the local market price of the forest goods. It was determined during FGD and KIS. The entire forest product was easily sellable in the local market. The local market price of the forest goods during the field visit was as follows:

1 cubic feet timber costs US $ 10.67 (N Rs. 800)

1 Bhari Firewood (45 kg) costs US $ 1.33 (N Rs. 100)

1 Bhari Fooder (30 kg) costs US $ 0.33 (N Rs. 25)

1 Bhari leaf litter (15 kg) costs US $ 0.067 (N Rs. 5)

3.4.4.1.2 Willingness to Pay (WTP)

WTP was calculated following the steps recommended by King and Mazzota, (2003) (*cited in* Chand, 2010). Initially, services provided by forest to be valued were identified before the field visit. HH survey method was selected for determining WTP. Sample was randomly selected and questions was asked to the household about their WTP for the better conservation and management of the CF. Finally compilation and analysing of data was done following the statistical techniques.

3.4.4.1.3 Calculation of Carbon Benefit

The incremental carbon stock was converted to tons of CO_2 equivalent by multiplying it by 44/12, or 3.67 (Pearson *et al.* 2007). Potential incremental benefits from carbon finance for the forest was calculated by multiplying annual quantity of CO_2 stock with market value US$

8 per ton CO_2. World Bank recommended market price per ton CO_2 ranges from 1-15 US $ suggested by Neff *et al.* 2007 (*cited in* Rana, 2008). So, carbon benefit at different rate (US $ 6, 8, 10, 12, 14) was calculated to analyse the BCR.

3.4.4.1.4 Calculation of Benefit from animal rearing

CFUGs were also rearing animal in some part of the forest. So, they were getting benefit from animal rearing. The amount of fodder saved in home in term of Bhari due to animal rearing in the forest was converted into monetary value.

3.4.4.2 Calculation of Cost in CF Activities

3.4.4.2.1 Forest management and monitoring cost

This cost include the money spend by CFUG committee members in managing and monitoring forest. It includes salary of guard, office management cost, forest management cost, physical infrastructure, training, education and others.

3.4.4.2.2 Opportunity Cost

The best alternative of CFM was, use of forest product such as litter. People had opportunity to rear animals in the forest in the past but not now. Due to the handover of forest to CFUG, people were deprived of taking litter from the forest and had to destroy the privately owned land and forest to get these needs. OC was determined by converting this total fodder into monetary value with the help of HH survey.

3.4.4.2.3 People involvement cost in CFM

CFUG committee members and other members had spent a lot of time in planning, management and monitoring activities. They had spent time in meeting and information sharing about CFM. Most of the CFUG members had spent many days in a year for thinning, fencing, cutting and carrying forest products from forest. They used to participate in afforestation activities in the forest. So, the time spent voluntarily for the management of forest was calculated from HH survey and converted into monetary value. As local level rule, 8 hours was calculated as 1 day. The salary of men and women for 1 day was US $ 4 (N Rs. 300) and US $ 2 (N Rs.150) respectively in local level employment.

CHAPTER-IV
RESULTS

4.1 Socioeconomic status of the CFUG

4.1.1 Population Structure

The total population of the CFUG was 1031 as shown in Figure-2. The population of female was 551 which were more than that of male (i.e., 480). CBS in 2001 had considered economically active population from age above 10 years. Among the age group category, majority of people were active population of age between 11 to 49 years, which was 570 out of 1031. There was less number of dependent people below 10 years and above 50 years. There was no exact information about the population of CFUG in the OP. In Central Bureau of Statistics, there was no publishepopulation data in 2010 till the date. So the total population was estimated from the HH sample survey with CFUG during the field visit.

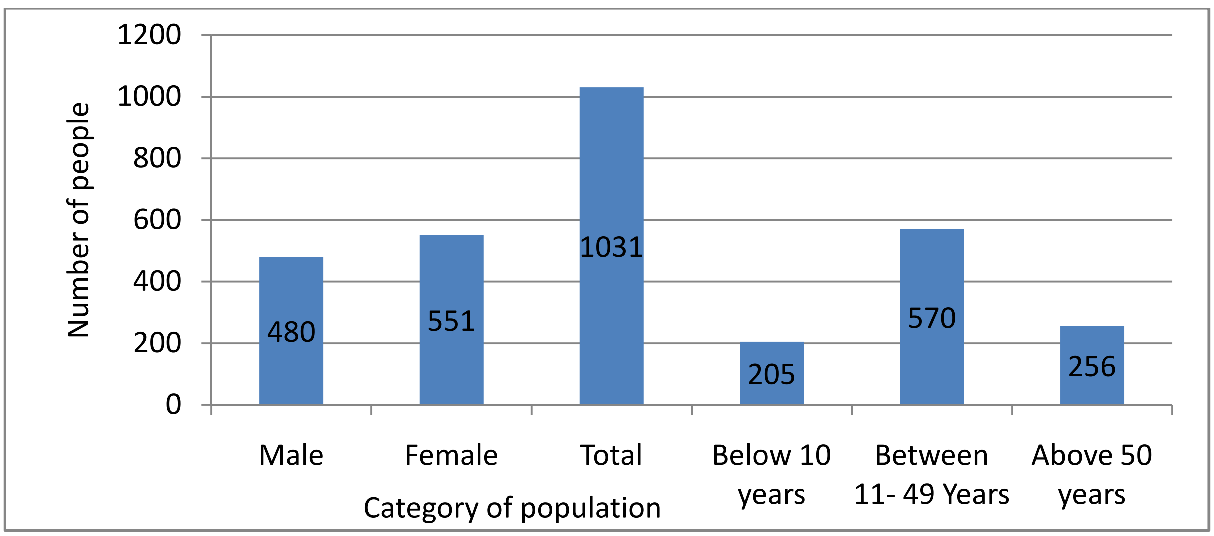


Figure 2: Population structure of studied CFUG in 2011

4.1.2 Economic status of CFUG

As the CF lies in the hilly region of Nepal, agriculture was the main occupation of CFUGs. Out of 195 CFUGs, 43 families were rich, 102 families were medium and 50 families were of poor economic category as shown in Figure-3. The economic classification was done on the basis of their total income from the different sectors of economy such as agriculture, service, business, rent from house, and rent from land and interest rates from the bank during FGD with CFUG executive committee members.

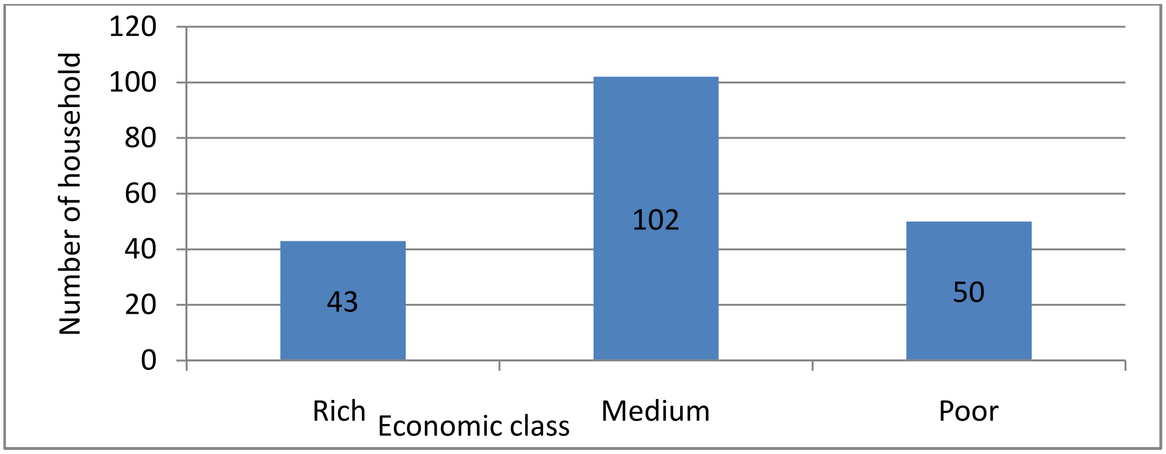


Figure 3: Economic status of studied CFUG in 2011

4.1.3 Land holding status of CFUG

Land owned by the CFUGs was divided into four categories. Information about different categorizes of land was brought during the pilot inventory. Information about the amount of land owned by the CFUGs was collected during HH survey. The total amount of shrubland owned by 195 CFUGs was 785 ropani as shown in Figure-4. Similarly, unirrigated agricultural land, irrigated agricultural land and the private forest was 727, 683 and 69 ropani respectively. Very less private forest was owned by the CFUGs in the given village.

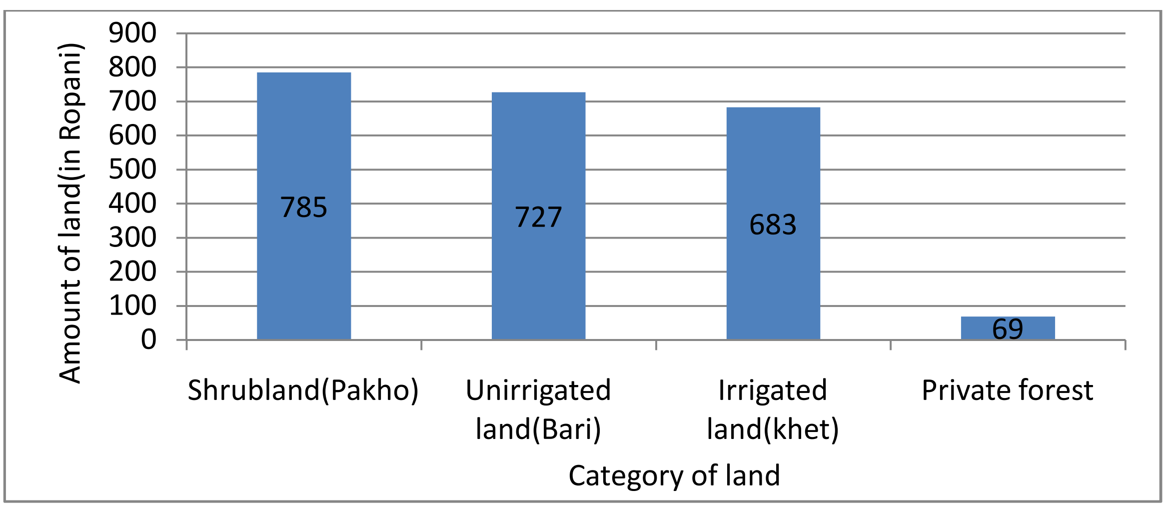


Figure 4: Landholding status of studied CFUG in 2011

4.1.4 Livestock in CFUG

The major livestock domesticated by the CFUGs were buffalo, cow, ox and goat. More people were keeping goat as it was the main source of meat. People were keeping buffalo and cow for milk and milk products and ox for tilling the agricultural field. Altogether, 710 goats were kept by 195 households as shown in Figure-5. Most of the families had kept buffalo (183 out of 195). Many families (113 out of 195) kept ox for tilling the agricultural field.

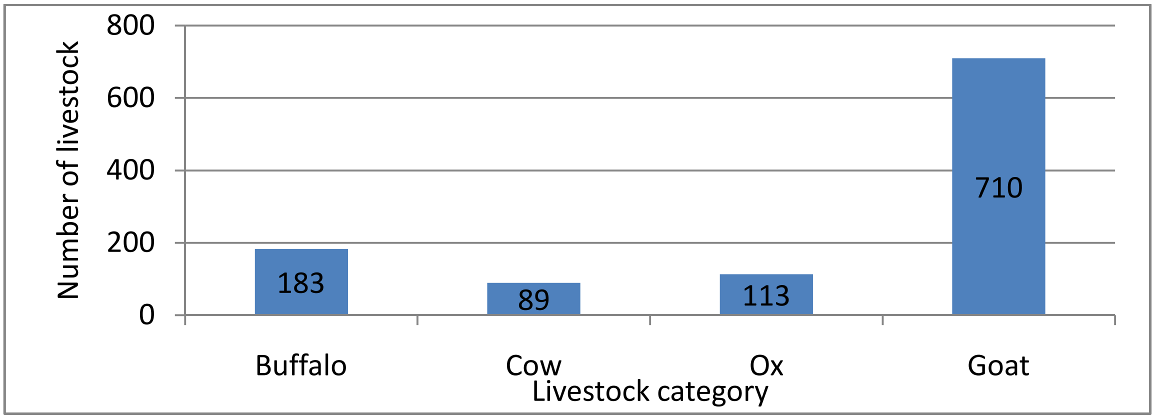


Figure 5: Livestock in studied CFUG in 2011

4.2 Carbon Sequestration by the Community Forest

4.2.1 Vegetation in CF

Regeneration is the sapling with diameter less than 1 cm. It shows the vegetation composition of trees in the forest. They are not included in biomass calculation. The regeneration in the forest is 1384/ha. In the forest, *Castonopsis indica* and *Scima wallichi* had the highest regeneration of 504 and 486 per hectare respectively. Similarly, *Diospyros montana* and *Engelhardtia spicata* had regeneration of 192 and 113 per hectare respectively.

The forest had the sapling of 828 per hectare which is quiet higher in comparison to trees as shown in Figure-6. The tree with DBH class 10-20 had the highest density with 208 trees/ha. But, the density of tree with DBH greater than 50 is 7 trees/ha which is very less. It shows that forest is dominated by newly grown trees after the implementation of CFM.

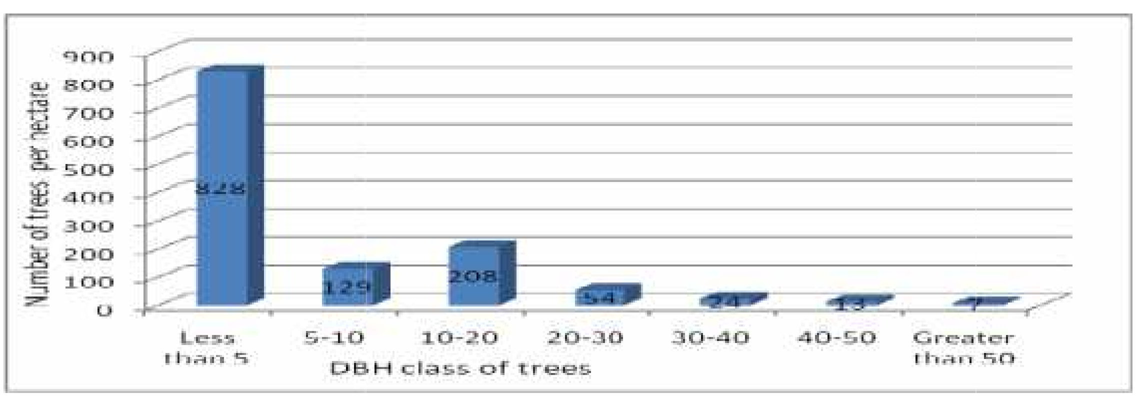


Figure 6: Distribution of DBH Class of trees

4.2.2 Biomass Estimation of Forest for 2011 Inventory

From the current biomass inventory of forest, it was seen that the shoot of the tree contributes as a main source of biomass followed by its roots. Shoot of the tree had biomass of 126.3 ton/ha as shown in Figure-7. Root of plants had biomass of 27.34 ton/ha. Sapling, herbs and litter contribute very less biomass to the forest.

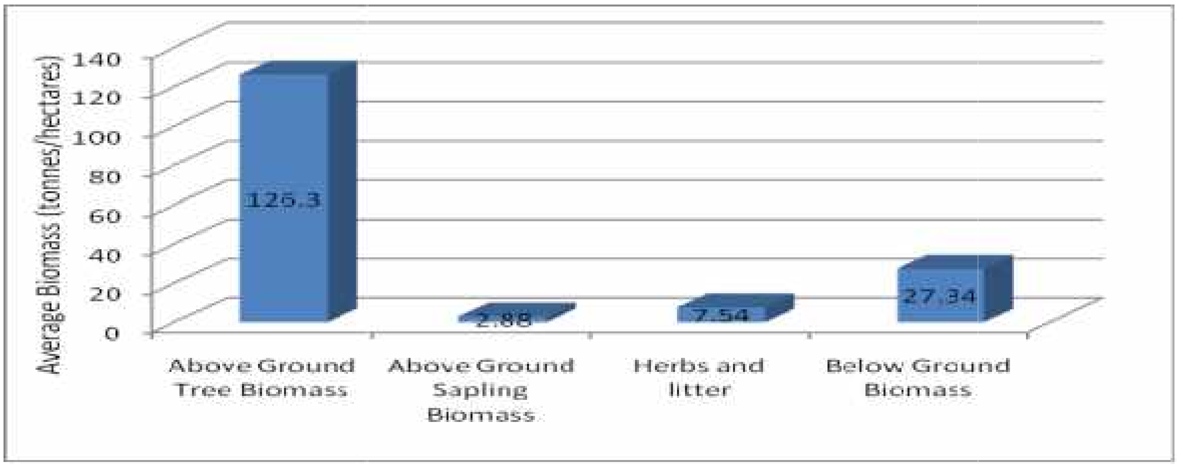


Figure 7: Biomass of the studied CF

From the table-2, it was seen that biomass of the *Scima wallichi* was highest and had 63.40 ton/ha followed by *Castonopsis indica* which had 57.66 ton/ha. Similarly, *Engelhardtia spicata* and other species had biomass of 13.62 and 20.34 ton/ha, respectively.

Table 2: Biomass estimation of different species

Name of the species	Biomass (ton/ha)
Scima wallichi	63.40
Castonopsis indica	57.66
Engelhardtia spicata	13.62
Others	20.34
Total	155.02

4.2.3 Incremental biomass of the Forest in 5 years

Growing stock was measured in 2006 by DFO during the renewal of OP. By the application of biomass expansion factor, the total biomass of 2006 was calculated as 159.34 ton/ ha as shown in Figure-8. The total biomass measured during field visit in 2011 inventory was 164.07 ton/ ha. From the calculation, net incremental biomass in 5 years was 4.73 ton/ ha.

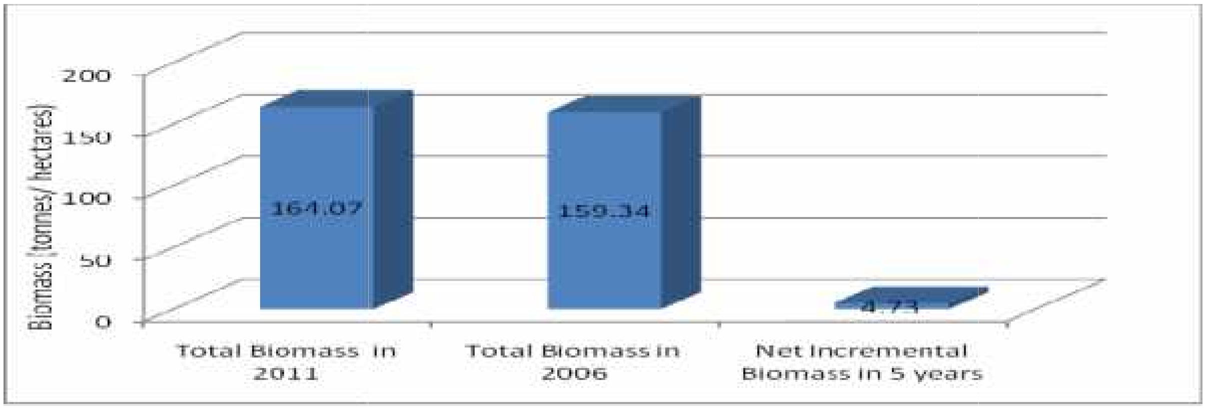


Figure 8: Biomass of the studied CF in 2006, 2011 and 5 years incremental biomass

4.2.4 Carbon stock of Forest in 2011 Inventory

The conversion factor of 0.47 was used to convert biomass into carbon stock. Above ground tree carbon was highest with 59.36 ton/ ha as shown in Figure-9. Soil organic carbon was second highest with 45.18 ton/ ha. The carbon stock in sapling, herbs and litter was low compared to tree and soil carbon. The above ground sapling carbon and carbon in herbs and litter was 1.35 and 3.54 ton/ha respectively.

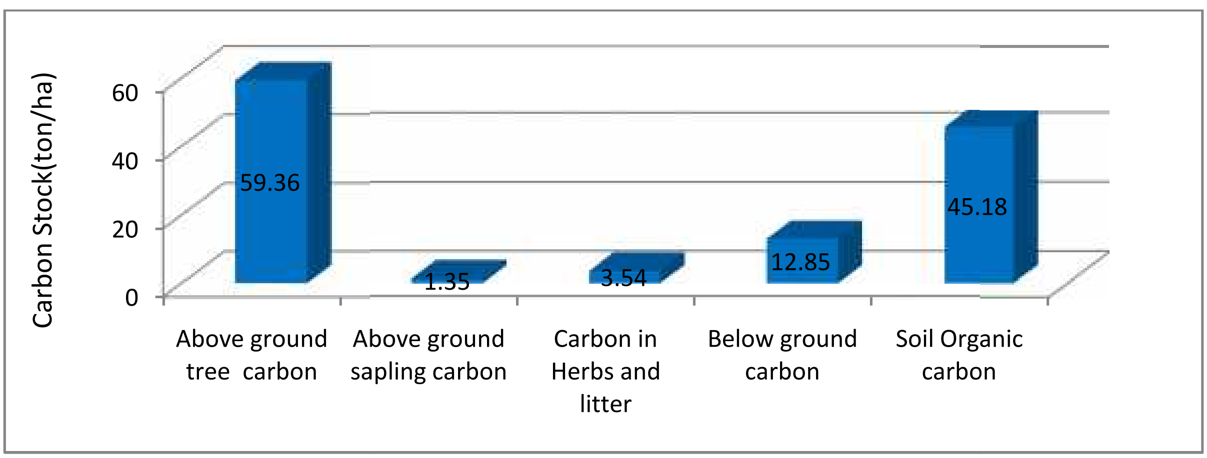


Figure 9: Carbon Stock of studied CF

Table 3: Carbon stock of different species of trees

Name of the species	Carbon stock (ton/ha)
Scima wallichi	29.80
Castonopsis indica	27.10
Engelhardtia spicata	6.40
Others	9.56
Total	72.86

Among the different species of plants found in the forest, *Scima wallichi* and *Castonopsis indica* were dominant and had the carbon stock of 29.80 and 27.10 ton/ha. *Engelhardtia spicata* had the carbon stock of 6.40 ton/ha. Other species had carbon stock of 9.56 ton/ha.

4.3 Willingness to Pay and Opportunity cost of studied CF

For the economic analysis of studied CF, HH were stratified into rich, medium and poor. All the HH were willing to pay for the conservation of forest. Rich, medium and poor HH were willing to pay 25.97 %, 51.95 %, 22.08 % of total WTP respectively for the ES provided by the forest as shown in Table-4. The total opportunity cost of the forest was US $ 329. Opportunity cost was the cost that people were bearing for the ban in animal rearing and litter collection in the forest after CFM. Poor and medium standard household were affected by this cost as it contribute 31.02 % and 51.58 %, respectively of total opportunity cost.

Table 4: Willingness to Pay and Opportunity Cost for different economic class of CFUG

Economic class	No. of houses	% of Total houses	No. of sample taken	Total WTP for ES (US $)	WTP %	Opportunity Cost(US $)	OC %
Rich	44.00	22.56	22.00	364.00	25.97	57.23	17.40
Medium	99.00	50.77	52.00	728.00	51.95	169.65	51.58
Poor	52.00	26.67	26.00	309.40	22.08	102.05	31.02
Total	195.00	100.00	100.00	1401.40	100.00	328.93	100.00

4.4 Cost Benefit Analysis of CF

4.4.1 Cost associated with the studied Community Forest

Cost associated with the CF was peoples' involvement cost in CFM, management and administrative cost and opportunity cost. From the FGD and HH survey, the people involvement cost in thinning, fencing, cutting firewood, fodder and dead trees was found to be the highest. 73% of annual total cost for CFM (US $ 1888) was covered by involvement of people in management as shown in Figure-10. Total cost spends by CFUG committee for administration and management was 10% of total cost of forest.

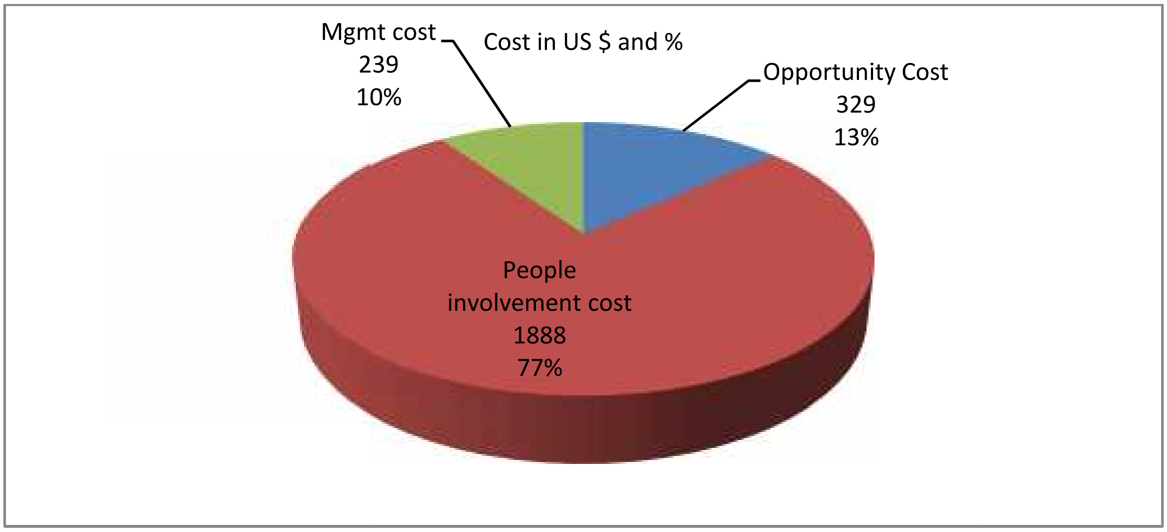


Figure 10: Total Cost of studied Community Forest in 1 year

4.4.2 Benefit associated with the studied Community Forest

Benefit of the forest was divided into four categories. They were benefit from forest products, Willingness to Pay (WTP) for ecological services provided by the forest, carbon credit and benefit from animal rearing. More benefit was received by people in the form of forest products such as fodder, firewood and timber. The annual benefit from forest product in given CF was 64 % of total benefit (US $ 4656). Benefit from carbon credit at the rate of US $ 8 per ton of CO_2 was 16 % of total (US $ 1201). The least benefit was from animal rearing which amount to 1% of total benefit (US $ 42) as shown in Figure-11.

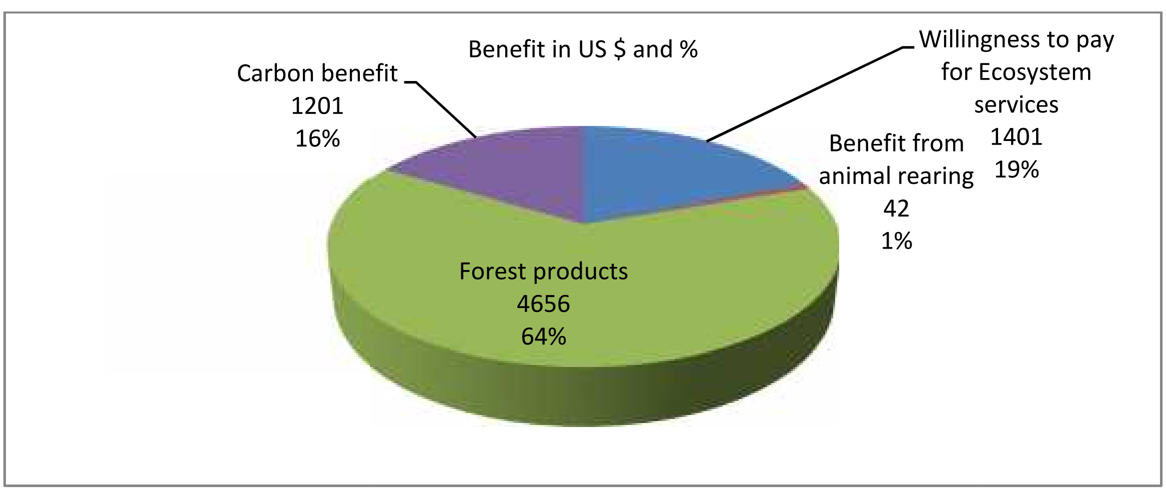


Figure 11: Total Benefit of studied Community Forest in 1 year

4.4.3 Benefit Cost Analysis of Community Forest

Benefit cost ratio was calculated by dividing total benefit by total cost. Real BCR was 1.91 with direct benefit and cost provided by CF to the CFUG. BCR with discounting and CC at the rate of US $ 8 was 2.97 as shown in table-2. If the rate of per ton CO_2 increases, the BCR increases by the increase in total benefit as shown in Table. Benefit Cost Ratio will be 3.34 if the rate of per ton of CO_2 increases to US $ 14.

Table 5: Total Benefit, Total Cost and BCR in different benefit criteria in 2011

In US $	Real	With WTP	With CC at US $8	With WTP and CC at US $ 6	With WTP and CC at US $ 8	With WTP and CC at US $ 10	With WTP and CC at US $ 12	With WTP and CC at US $ 14
Total Benefit	4698	6099	5899	7000	7300	7601	7901	8201
Total Cost	2456	2456	2456	2456	2456	2456	2456	2456
BCR	1.91	2.48	2.40	2.85	2.97	3.09	3.22	3.34

For benefit cost analysis, NPV at discounted rate of 12% was used for 10 years from 2006 to 2015 for Opportunity cost, People involvement cost, Benefit from animal rearing and carbon credit. For Management cost and Benefit from forest product, real cost and benefit data taken from CFUG committee was used till 2010 and for 2011 to 2015, NPV at discount rate of 12% was used.

The NPV including discounting of 12% of management cost, opportunity cost and people involvement cost was US $ 2733, 3782 and 21703, respectively as shown in Table-6. The NPV including discounting of 12% for benefit from forest products, WTP, benefit from animal rearing and Carbon Credit was US $ 80005, 16104, 483 and 13805, respectively. The BCR of CFM was 3.91 using NPV with discounted rate of 12%.

Table 6: Benefit, Cost and BCR of CFM using NPV at discounted rate of 12%

Annual cost/benefit	**Year**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**NPV**
Cost Associated with CFM	Management Cost	201	196	210	240	223	253	288	327	372	423	2733
	Opportunity Cost	209	234	262	294	329	374	425	483	549	623	3782
	People Involvement Cost	1200	1344	1505	1686	1888	2145	2438	2770	3148	3578	21703
	Total Cost	1610	1774	1977	2220	2440	2773	3151	3580	4069	4624	28218
Benefit Associated with CFM	Benefit from Forest Products	5052	5329	5571	6398	6817	7747	8803	10003	11367	12918	80005
	Willingness To Pay	890	997	1117	1251	1401	1592	1809	2056	2336	2655	16104
	Benefit from Animal rearing	27	30	33	38	42	48	54	62	70	80	483
	Carbon Credit	763	855	957	1072	1201	1365	1551	1762	2003	2276	13805
	Total Benefit	6732	7211	7678	8759	9461	10751	12217	13883	15776	17928	110397
BCR												3.91

CHAPTER-V
DISCUSSION

5.1 Socioeconomic status of the CFUG

Population of female was more (53.44 %) comparing to the population of male (46.56%) in the studied CFUG. But 2001 census records 51.61 % female and 48.39% male in hills of Nepal (CBS, 2003). It was because the adult males were out of their home for their education and service than the female. It shows that there was more involvement of female in conservation and management of forest. People of age between 11-49 years were able to work in the village and help their family in generating income. More than 55 % people were able to sustain their life by involving themselves in their work. It was quiet less than CBS, 2001 census data which was 65.9 % in hills and 63.4 % in Nepal. It shows that more people in the village are able to contribute for sustainable management, conservation and enhancement of CF after REDD implementation.

More than 52% of total CFUGs had medium economic standard in the village. These families were easily fulfilling their life supporting needs such as food, cloth and shelter but were unable to provide all the secondary needs such as education, health and entertainment as their family require in the village. They used to generate income from agriculture and service in the country. About 22% of total CFUGs were rich. They were able to fulfill all the basic needs and secondary needs required by their family in the village. They were either involved in business or their family member works abroad or own more land. More than 25% of the total households were poor and had to work daily on wage for income generation to fulfill their needs. But the Living standard Survey records 40.7% in 1995-96 and 34.5% in 2003-04 in the hill and 42 % in 1995-96 and 31% in 2003-04 in country data of Nepal. They were found involved in working on wage in agriculture, construction work and other heavy manual works in the village. More HH of medium and poor economic standard indicate that the dependency and role of HH in forest was more in the village for forest products extract and conservation.

The CFUGs owned more amount of Shrubland to get fodder for their domestic animals and firewood as a fuel. Each CFUG had more than 4 ropani of land on average as shrubland but had very less private forest (0.35 ropani/ HH). Private forest in the present study was less than that calculated by Rana, (2008) in Dhading district which was 0.80 ropani per HH. On an average there was equal amount of irrigated land (3.5 ropani/ HH) and unirrigated land (3.7 ropani/ HH) for doing agriculture in the given study which was less than that calculated by Rana, (2008). In Rana, (2008) irrigated land was 4.39 ropani/ HH and unirrigated land was 3.99 ropani/ HH. Generally, paddy, maize and wheat was grown in irrigated land and millet, barley and maize was grown in unirrigated land for survival. The agricultural production is sufficient for few months and they depend on market goods for survival. Most of the CFUG can easily manage their daily requirement of fodder, firewood, litter and timber if they are not allowed to harvest forest product in any year for conservation of forest. But for some families, who have very less shrubland and private forest, they depend on community forest for their sustenance of firewood and timber.

Most of the CFUG were involved in agriculture as a source of income generation. To utilize the remaining waste from agriculture other than crops, they were keeping domestic animals for getting different benefits. The average number of goats per household in this study was 3.64 which were more than that observed by Rana, (2008) (i.e., 0.68/HH). Similarly average total livestock per HH in this study was 5.62 which were more than that observed by Rana, (2008) (i.e., 2.2/ HH). The livestock were also used as the source of dung for making compost to use in agricultural field. CFUGs were getting fodder and litter for their livestock mostly from their private land. Fodder from CF was harvested during monsoon season in the month of July and September for livestock. There was shrubland in CF area (about 20 hectares) used permanently for rearing livestock for the CFUG. There is need of more forest and grassland area of forest for animal rearing.

5.2 Carbon Sequestration by the Community Forest

The forest was Castonopsis-Scima forest lying at an altitude range of 970 to 1320 masl. 72 % of the trees in the forest were of *Castonopsis indica* and *Scima wallichi*. Also the sapling and regeneration were dominated by these two species. *Castonopsis indica* had the highest regeneration of 504 per ha in the present study which was much less than that calculated by Bhusal, (2010) in Nagmati watershed (4660 per ha). It shows that these species would dominate the forest in the future. In the steep slope, *Pinus roxburghi* were planted in regular interval. So, this species might dominate the steep slope in the future. High regeneration of trees shows that there was very less grazing and disturbance of human being.

As more than 90% of the trees had DBH less than 20 cm, it shows that the forest was dominated by newly grown trees. The smaller trees would grow and continuously increase the biomass, carbon stock, forest cover and canopy cover in the future. The old trees being less in the forest shows that proper harvesting and thinning was done in the forest at regular interval by CFUG.

More than 77% of the biomass in the forest was contributed by above ground tree biomass. Shrubs, herbs and litter contribute very less biomass to the forest totaling about 7 % of total. The total below ground biomass was about 16%. The biomass in the forest was 164 ton/ha which was less than that reported by IPCC, (2006) in natural forest of Asian region (190 ton/ha). More biomass was contributed by *Scima wallichi* followed by *Catonopsis indica* in the forest showing their dominancy which is common in the hilly forest of Nepal.

By using the biomass value of 2006 and 2011, incremental biomass of 5 years was calculated. The slow incremental biomass might be due to harvesting and selective cutting of old and large trees for firewood and timber. Harvesting of firewood was done for the sustainable supply of cooking fuel by the CFUG. Yearly biomass increment was which was less than that reported by IPCC, (2006) in natural forest of Asian region (8.4 ton/ha). Annual carbon increment was 0.45 ton/ha. It contributes very less for the carbon credit through REDD scheme.

Total carbon stock of the forest in trees, sapling, herbs and litter, below ground carbon and soil organic carbon was calculated. The total carbon stock of the forest was calculated as 122.29 ton/ha, which was less than that calculated by ICIMOD, ANSAB and FECOFUN, (2010) in Kayarkhola, Charnawati and Ludikhola watershed. The carbon stock in dense and sparse strata of Kayarkhola, Charnawati and Ludikhola watershed were 296.44 and 256.70 ton/ha; 228.56 and 166.75 ton/ha; 216.26 and 162.98 ton/ha, respectively. Above ground trees, below ground roots and soil sequestered 48.54%, 10.51% and 36.94% of total carbon respectively. It shows that trees and soil are the main component in the forest for carbon sequestration. Carbon stock of *Scima wallichi* and *Castonopsis indica* was 40.9% and 37.20% of total carbon stock of the forest.

5.3 Willingness to Pay and Opportunity cost of studied CF

Forest had lots of indirect and external benefit to the people other than the direct benefit. People were getting fresh air to breathe, fresh water supply for drinking, HH purpose and irrigation from forest and also it was mitigating climate change and natural disaster like landslide and soil erosion. Rich people were willing to pay money for improving their health by the supply of fresh air and water supply. Medium and low standard people were willing to pay more money because it was saving their agricultural land from landslide and soil erosion.

According to the view of people, second best alternative of CFM was making CF free from strict rules and regulation. Due to strict rules, people were unable to rear animal and take litter from the forest. Animal husbandry was affected by CFM and people were unable to rear more animal due to the lack of fodder. Agriculture was not suitable in the forest. Timber and other forest products harvesting were managed in CF. So, Opportunity cost was lower than other types of cost. Among the three economic classes, poor people were affected most by Opportunity Cost due to their sustenance in forest for animal rearing and litter collection.

5.4 Cost Benefit Analysis of CF

Among the total cost of CF, the cost of people’s contribution for the CFM was high. It was because people are contributing their valuable time in planning, meeting, thinning, selective cutting and planting trees. Also CFUG committee members were contributing more time for better management and sustainable supply of forest products. Management, administration and other secretariat cost was less due to the volunteering help and involvement of local people for CFM. Only one guard was sufficient to observe the overall condition of the forest. Also, cost of fencing was very less. The annual total forest management cost in this study was US $ 239 which was more than that calculated by Baral *et.al* 2008 in Kalobhir CF, Dolakha district (US $ 139).

Very less money was spent in communication, refreshment and building infrastructure by the CFUG committee. Opportunity cost of CF was quiet low. It was due to fewer options in that forest area other than the forest management. Land was in steep slope and it was less viable for cultivating agricultural crops. The only better option of CFM was rearing animals and litter collection for manure production. People were deprived of this benefit due to the establishment of CF. Cost that the people were bearing from these foregone benefits was taken as the opportunity cost which contribute to only 13% of total cost. REDD implementation, monitoring and transaction cost was difficult to calculate due to the lack of REDD scheme implemented in Nepal.

Most of the people involved in CFUG were fully dependent on the CF for firewood and timber. In monsoon season, people were allowed to cut fodder for 1 month after paying very less entry fee. Benefit from forest products was higher due to the use of firewood, fodder, timber, pole and leaf litter by CFUG. All the CFUG were willing to pay some amount for the conservation of forest. Net gain per HH in the current study was US $ 38 which was much less than that studied by Karki, (2008) in CF of Ilam district (US $ 128.12).

The annual benefit from carbon credit through REDD scheme in this study was US $ 1201 at the rate of US $ 8 per ton of CO_2 which was much less than that calculated by Karki, (2008) in CF of Ilam district (At the rate of US $ 5 was US $ 13271). If this benefit is provided to the CF, it will encourage CFUG for further enhancement and conservation of the forest. Only then the local people will get additional benefit from the REDD+ scheme. Animal rearing for self sustaining purpose along with agriculture was the main occupation of the people. Some of the CFUG rear animal in the shrubland of the CF area.

The forest was absorbing 150.1 ton CO_2 yearly. So, there was non-monetary benefit of climate change by mitigating CO_2 emission in the atmosphere. It might benefit people by reducing adverse impact of climate change such as temperature rise, unfavorable weather change and unfavorable precipitation pattern in that area.

BCR including carbon credit at the rate of US $ 8 per ton of CO_2 directly in 2010 was 2.97. The BCR ratio without using discount rate was higher in this study than that calculated by Rana, (2008) which was 2. The BCR using discount rate was 3.91 in 2015 for 10 years analysis from 2006-2015 which was lower in this study than that calculated by Rana, (2008) which was 4.57 for 5 years.

CHAPTER-VI
CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Reducing emissions from deforestation and forest degradation is potentially low-cost option for mitigating climate change. Application of REDD actions with Community forest will further offer potential contributions to enhance the livelihood of rural communities. In this study the biomass and carbon stock was estimated by following the methodology recommended by MFSC Climate Change and REDD Cell and ICIMOD, ANSAB and FECOFUN. Information about the socioeconomic condition of the CFUG and cost and benefit associated with CFM was collected from Community Forest Operation plan, FGD, Questionnaire Survey and KIS.

From the finding of this study, it is concluded that the 55 % of total people in CFUG were of age between 11 to 49 years who were able to be involved in forest conservation and management. More than 52% of total CFUGs had medium economic standard in the village. On an average 11.61 ropani of land was owned by each HH in the village. Average total livestock per HH in this CFUG was 5.62. The forest was *Castonopsis-Scima* forest lying at an altitude range of 970 to1320 masl. More than 90% of the trees in the forest had DBH less than 20cm which had high potential of increasing biomass in the future. The biomass in the forest was 164 ton/ha with yearly increment of 0.95 ton/ha. The total carbon stock of the forest was 122.29 ton/ha including SOC and below ground carbon of 45.18 ton/ha and 12.85 ton/ha, respectively. Rich, medium and poor HH were willing to pay 25.97 %, 51.95 %, 22.08 % of total WTP respectively for the ecological services provided by the forest. The annual total benefit and cost in 2010 was US $ 7300 and 2456 respectively. BCR measured directly without discounting and with discounting was 2.97 and 3.91 respectively.

It concludes that the CF had already benefitted in the current state. If REDD scheme is implemented, it will provide additional benefit to the local people in the future. It would help to enhance the economic standard and livelihood of the vulnerable and indigenous people and encourage them for sustainable management of forest resource.

6.2 Recommendations

Based on this present study, different issues related to forest management, cost and benefit of CF and REDD were identified. Based on these findings, some of the recommendations for this Gwangkhola Sapaude Babiyabhir Community Forest are as follows:

- The annual incremental carbon of the forest was only 0.95 ton/ha. So, forest products should be harvested in sustainable manner without disturbing the young trees to grow and increase its biomass. Only old and dead trees should be cut down to fulfill the demand of firewood.
- About 20% of the forest was shrubland. So, appropriate seedlings of trees should be planted in these areas to increase the density of trees.
- Majority of the people among the CFUG are capable to help in conservation and management activities. So, they should be utilized regularly in plantation, fencing and selective thinning of forest.
- CFUG are already benefitted by CFM, applying REDD scheme from international level would help this CF in further conservation and management of forest.
- Using this forest inventory data of 2011 as a baseline, it is recommended to carry out forest inventory in the future for appropriate annual cost- benefit analysis.
- The methodology and output of the research can be used by REDD policy makers to form appropriate policy towards REDD strategy and students to do research in this topic in other community forest.

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ANNEXES

Annex 1: Questionnaire for CFUG Household Survey

Date of interview-

A. Socio economic information

1. Name of respondent: 2. Age:

3. Sex: a. Male b. Female 4. Caste: Bramin/Chetri/Others

5. Your position in committee: Committee key member (Chairperson, VC, Secretary, Treasury, member) /General member

6. Education: Illiterate/ Normal Literate /below SLC /SLC-Graduate /above Graduation

7. Family size –Total________ (male ________ Female______________)

Age group	Below 10	11-49 years	Above 50
Number of family members			

8. Land holding-Ropani (*1 ropani= 0.05 ha*)

Upland (Pakho)	Irrigated Land (khet)	Private Forest	Total Land

9. When did you involve in the CFUG?

a. From the time CFUG handed over b. After few years of CFUG handed over/Year

10. Which fuel types you use in your home for cooking and heating?

Fuel Type	Quantity used(monthly		Cost (in Rs.)	Time taken for fuel collection
	Before CFM	Last year		
Firewood				
Kerosene				
LPG Gas				
Electricity				
Biogas				
Others				

For benefit from forest product analysis/ Leakage analysis/Opportunity Cost

11. How often are you allowed to collect products from CF? Monthly/Yearly, Specify it.

12. Is it free of cost? Or you have to pay for the entry. Free …. /Pay…..

If you have to pay, how much in a year? Rs.______

13. How much are you allowed to collect in each time of your entry from your demand?

Products	Quantity supplied				Quantity consumed /demanded (last year)
	Before CFM (In1997)		After CFM (last year)		
	NF	PF	CF	PF	
Timber					
Pole					
Firewood					
Fooder					
NTFP					
Litter					

CF= Community Forest, NF= National Forest, PF=Private forest

For Monitoring and management cost

14. a. Have you participated in management of CF last year? Yes…… No…….

14. b. Have you contributed money for management activity last year? Yes…… No…….

Management activity	Time and Duration(in days)	Money in Rs.
Fencing		
Planting		
Thining		
Harvesting		
Meetings		
Others		

15. Fee or levy that you paid last year-NRs………

Willingness to Pay for ecological services

16. What ecological services you are benefitted directly from CF other than forest products? For ex. Water for Drinking/Irrigation, Conservation of house/ land from natural disasters, scenic beauty, greenery, fresh air, etc.

17. a. Suppose the CF is to disappear tomorrow and the persons like you have a chance to save this particular area. What is the maximum amount that you will be willing to pay every year through a tax surcharge to improve the landscape around this forest?

b. Would you like to pay NRs.500.00 through tax to improve the forest? Yes …No….

c. If yes, the bid amount would be increased until the respondents answer "no".

The maximum Willingness to Pay is elicited….

d. If no, the bid amount would be decreased until the respondents answer "no".

The maximum Willingness to Pay is elicited…

Annex 2: Questionnaire for CFUG committee interview

1. General Information

Name of Group: Address: Forest Handover year: Management Plan revision year: Total Forest area: Major tree species:

Total households……a. Dalit…..b. Janajati ……c. Non-Dalit and Janajati……

Total Population-….. Committee Members….. Male…… Female……. Dalit/Janajati ….

2. Annual income sources

S.N	Income Sources	2006	2007	2008	2009	2010
1	Fee from membership renew					
2	Identity Card					
3	Fee for forest thining					
4	Forest product sale					
5	Punishment					
6	Bank interest					

3. Annual expenditures and Livelihood Activities conducted by CFUGs

S.N	Expenditure Sources	2006	2007	2008	2009	2010
1	Salary for guard					
2	Office management cost					
3	Forest management cost					
4	Physical Infrastructure					
5	Training and Education					
6	Others					

3. Forest Product removal from the CF

S.N	Forest Products	2006	2007	2008	2009	2010
1	Timber					

2	Pole					
3	Firewood					
4	Fooder					
5	Leaf litter					

5. Does the harvested product meet the household needs? a. Yes b. No

6. If no...How do you meet the forest products requirements?

a. Use of alternative source b. Harvest from the nearest forest c. PF d. Agriculture residue e. Others

7. Historical forest destruction event due to Fire, Flood and Storm (from 10 years back)

8. Damage amount of forest due to Fire, Flood and landslide (in ropani)

9. Protection measures adopted to reduce destruction through Fire, Flood, Landslides, etc.

10. Benefit Sharing Mechanism in CFUG a. Equality b. Equity c. Other approaches

Annex 3: GPS data sheet for boundary plot and sample plot determination

SN	Way Point No.	Longitude	Latitude	Altitude
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

Annex 4: Checklist for biomass data collection

Sample plot no.: GPS Waypoint no.: GPS Point:

Altitude: Date: Time:

For trees, dead wood, logs (>5cm DBH)

SN	Name of species	A	β	Distance	DBH

For sapling (<5cm DBH)　　　　　　　　For Regeneration (<1cm DBH)

Name of species	DBH		Species	No.

For litter, herb, grass(0.56m radius)-Collect all these, measure total weight and take 100 gm sample in a bag.　　　　　Total weight:

For soil analysis: With the help of soil corer, take full volume of soil, measure its weight and keep in bag.　　　　　Weight of fresh soil:

Annex 5: Vegetation Parameters of the Forest

Name of the species	Regeneration/ha & %		Density/ha	% of trees	Sapling/ha
Castonopsis indica	504	36.42	15	36.63	304
Scima wallichi	486	35.12	160	27.65	304
Diospyros montana	192	13.87	120	2.99	41
Engelhardtia spicata	113	8.16	13	20.05	87
Others	89	6.43	87	12.68	67
Total	1384	100	40	100	817

Annex 6: Annual expenditure of GSBCF

Expenditure(in NRs)	2006	2007	2008	2009	2010
Salary of guard	12000	12000	14400	18000	18000
Office management Cost	400	500	650	700	900
Forest management cost	1500	2200	2500	4000	4200
Physical infrastructure	235	500	700	1000	1080
Training and Education	500	800	900	850	1200
Others	400	450	600	700	850
Total	15035	16450	19750	25250	26230

Annex 7: Benefit from forest products of GSBCF

Benefit of forest (NRs)	2006	2007	2008	2009	2010
Timber	32000	36000	44800	52000	60000
Pole	0	1600	2000	2800	4000
Firewood	165000	168000	171000	208800	222000
Fooder	177750	189000	195750	211500	219375

Leaf litter	4125	5025	4275	4700	5850
Total	378875	399625	417825	479800	511225

Annex 8: Land holding status of CFUG

Land Category	Total Land (Ropani)	Average land/HH
Shrubland(Pakho)	785	4.03
Unirrigated land(Bari)	727	3.73
Irrigated land(khet)	683	3.50
Private forest	69	0.35
Total	2264	11.61

Annex 9: Livestock holding status of CFUG

Livestock	Total No.	Average/HH
Buffalo	183	0.94
Cow	89	0.46
Ox	113	0.58
Goat	710	3.64
Total		5.62

Annex 10: List of Executive Committee Members participating in FGD

S. N	Post	Name	Villege/Tole
1	Chairperson	Padam Bdr. Shah	Thakurithar
2	Vice-Chairperson	Nar Bdr. K.C.	Maidan
3	Joint-Secretary	Min Bdr. K.C.	Thakurithar
4	Treasurer	Yam Bdr. K.C.	Fulbari
5	Member	Krishna Puri	Chapbot
6	“	Juna G.T.	Khora
7	“	Hari Prasad Dhakal	Jukepani
8	“	Neeru Karki	Sewadi
9	“	Bindu Shahi	Shoraghar

Annex 11: List of participants in KIS

S .No	Name of Participants	Village/Tole
1	Kamal Paudel	Archaur
2	Tika Poudel	Archaur
3	Laxmi Paudel	Archaur
4	Renuka Paudel	Archaur
5	Keshar Shah	Chapabot
6	Krishna Puri	Chapabot
7	Buddi Sara Darji	Chapabot
8	Sita K.C.	Chaura
9	Ram Maya B.K.	Chaura
10	Surendra Chhetri	Dharapani
11	Bikki Thapa	Dharapani
12	Sunil A. C.	Dharapani
13	Ganga Kumari K.C	Fulbari

14	Dirpa Dhakal	Fulbari
15	Deepa Dhakal	Fulbari
16	Indra Kumari K. C.	Fulbari
17	Laxmi Dhakal	Fulbari
18	Dhruba Dhakal	Fulbari
19	Dandapani Dhakal	Fulbari
20	Surendra K.C.	Fulbari
21	Mitha K. C.	Fulbari
22	Yam Bd. K.C.	Fulbari
23	Hari Prasad Dhakal	Jukepani
24	Bishnu K.C.	Khatrithar
25	Kopila Khatri	Khatrithar
26	Dipin A.C.	Khatrithar
27	Karna Bdr K.C	Khatrithar
28	Sita K.C.	Khatrithar
29	Binita K.C.	Khatrithar
30	Juna G.T.	Khora
31	Srijana Mahat	Mahatgau
32	Arjun Mahat	Mahatgau
33	Ram Kumar Mahat	Mahatgau
34	Sapana Mahat	Mahatgau
35	Jhyapa Mahat	Mahatgau
36	Dhaka Kumara Poudel	Maidan
37	Thamman Singh Rana	Maidan
38	Aananda Poudel	Maidan
39	Aapsara Shah	Maidan
40	Tota Kumari G.C.	Maidan
41	Maya Rana	Maidan
42	Hari K.C.	Maidan
43	Nar Bdr. K.C.	Maidan
44	Tikaram Poudel	Maidan
45	Lekhnath Dhakal	Ratmata
46	Hum nath Dhakal	Ratmata
47	Suraj Dhakal	Ratmata
48	Bhola Dhakal	Ratmata
49	Bhuwani Prasad Dhakal	Ratmata
50	Ram Prasad Dhakal	Ratmata
51	Hrisi Ram Dhakal	Ratmata
52	Bhabi Acharya	Ratmata
53	Bimala Poudel	Senchauri
54	Surya Bdr. K.C.	Sewadi
55	Ser Bahadur K.C.	Sewadi
56	Dil Bahadur K.C.	Sewadi
57	Nir Maya Karki	Sewadi
58	Kishan Karki	Sewadi

59	Dinesh Khadka	Sewadi
60	Ram K.C.	Sewadi
61	Harka bahadur K.C.	Sewadi
62	Bal Bdr. Khadka	Sewadi
63	Kishan K.C.	Sewadi
64	Hum Bdr. K.C.	Sewadi
65	Sam Bdr. Shrestha	Shoraghar
66	Netra Man Shrestha	Shoraghar
67	Hari Prasad Dhakal	Shoraghar
68	Dipin Dhakal	Shoraghar
69	Dipesh Poudel	Shoraghar
70	Maina Rana	Shoraghar
71	Karan Magar	Shoraghar
72	Dipin G. C.	Sohraghar
73	Tanka Dhakal	Sohraghar
74	Sher Bahadur Rana	Sohraghar
75	Bijaya Kumar	Sohraghar
76	Nanda Kumara Shrestha	Sohraghar
77	Sesh Raj Dhakal	Sohraghar
78	Amrit Shrestha	Sohraghar
79	Hum Bahadur Rana	Sohraghar
80	Putali Shahi	Sohraghar
81	Biwash Shahi	Sohraghar
82	Megh Bdr. Shah	Thakurithar
83	Ek Bdr. Shah	Thakurithar
84	Padam Bdr Shah	Thakurithar
85	Saroj Shah	Thakurithar
86	Dhiraj Shah	Thakurithar
87	Ujjwal Shah	Thakurithar
88	Bishnu G. C.	Thakurithar
89	Shuva Kumari Shah	Thakurithar
90	Nar Kumari Shah	Thakurithar
91	Saraswati Shahi	Thakurithar
92	Jiten Shahi	Thakurithar
93	Bikash Shahi	Thakurithar
94	Hem K. C.	Thakurithar
95	Megh Bahadur Shah	Thakurithar
96	Mamata Shahi	Thakurithar
97	Laxman Shah	Thakurithar
98	Rajendra Shahi	Thakurithar
99	Gambar Bdr. Mahat	Ukali
100	Sunita G. C.	Ukali

Annex 12: Photo Snaps

Researcher taking the boundary of forest in GPS

Researchers taking the boundary of the plot

Researcher measuring angle of tree by a Clinometer

Researcher measuring diameter of tree by a DB tape

Researcher taking the soil sample

Researcher measuring dry litter, herbs and grass

Researcher taking reading in a diary

Researcher introducing and moderating the FGD

Chairman of the CFUG sharing his view during FGD

Researcher involved in KIS

Researchers measuring carbon of soil in the lab

Researcher doing literature review in central library