



A Monitoring Report on Forest Carbon Stocks Changes in REDD Project sites

REDD+ Pilot Project

Measurement I- Feb-
March 2010
Measurement II- Feb - April
2011



A Monitoring Report on

Forest Carbon Stocks Changes in REDD Project
Sites (Ludikhola, Kayarkhola and Charnawati)

First measurement: February - March 2010
Second measurement: February – April 2011

(ICIMOD, ANSAB and FECOFUN)

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Project Management Unit - REDD Pilot Project

Abstract

International Centre for Integrated Mountain Development (ICIMOD), Asia Network for Sustainable Agriculture and Bioresources (ANSAB), and Federation of Community Forest Users' Nepal (FECOFUN) are jointly implementing the project "**Design and setting up of a governance and payment system for Nepal's Community Forest Management under Reducing Emissions from Deforestation and Forest Degradation (REDD)**" in 105 community forests of three watersheds of Nepal, namely; Kayarkhola of Chitwan district, Charnawati of Dolakha district and Ludikhola of Gorkha district. The project is in operation since July 2009 with financial support of Norwegian Agency for Development Cooperation (Norad). The watersheds cover an area of 27,000 ha where community forest area alone stands at about 10,266 ha. The first forest carbon stock measurement was undertaken in 2010 and similar measurement was executed in 2011 in February to April. Change in tree biomass was observed in five strata with the highest increment of 7.5 t dm ha^{-1} in Ludikhola dense, however decreased in Kayarkhola sparse by 0.7 t dm ha^{-1} . In case of sapling, highest increment was observed in Ludikhola dense, where biomass increase by $1.93 \text{ t dm ha}^{-1}$ and high decrement was seen in Charnawati sparse by $1.86 \text{ t dm ha}^{-1}$. The difference in herb biomass ranged between -0.15 t ha^{-1} (Kayarkhola dense) to 0.14 t ha^{-1} (Charnawati sparse). Biomass of dry leaf litter has decreased in all strata except in Chitwan sparse and Gorkha sparse. Maximum decrease in case of leaf litter was observed in Charnawati sparse ($2.32 \text{ t dm ha}^{-1}$) followed by Charnawati dense ($0.89 \text{ t dm ha}^{-1}$). At CFUG level, maximum total annual carbon stock increment was observed in Charnawati CFUG of Dolakha (2177.16 t) followed by Ludi Damgade of Ludikhola (1417.59 t) and Bitteri of Charnawati (1304.45 t). Similarly, lowest increment has occurred in Paleko ban of Charnawati watershed (3.56 t) followed by Gahate Baghkhori (8.66 t) and Bhirmuni Devithan (9.09 t). (I think we should revisit yellow marked data. Since per ha carbon is same to all CFUGs there is obvious to increase tC of CFUG with larger area.) This year (2011 Feb- March) project witnessed an increment of 27,392 tons of carbon stock in three watersheds to that of 2,322,659.99 tons in the baseline year (2010 Feb- March). Results show that overall carbon stock has increased in all three project watershed. The annual rate of increment in Kayarkhola is the least (1.38 t/ha) and highest in Ludikhola (5.31 t ha^{-1}). In similar way, carbon stock increased by 2.35 t ha^{-1} in Charnawati watershed. In average, annual per ha carbon stock increment in three watersheds is found to be 2.67 (tC) .

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List of acronyms

AGSB	Above-ground sapling biomass
AGTB	Above-ground tree biomass
ANSAB	Asia Network for Sustainable Agriculture and Bioresources
BGB	Below-ground biomass
CF	Community forest
CFUG	Community forestry users' group
cm (or CM)	Centimeter
CO ₂	Carbondioxide
dbh (or DBH)	Diameter at breast height
DM	Dry matter
FECOFUN	Federation of community forest Users' Nepal
FSC	Forest Stewardship Council
GHG	Green house gas
GIS	Geographic information system
GPS	Global positioning system
ha (or Ha)	Hectare
HGB	Herb and grass biomass
ICIMOD	International Centre for Integrated Mountain Development
IPCC	Intergovernmental Panel on Climate Change
kg (of KG)	Kilogram
LHG	Leaf litter, herb and grass
LLB	Leaf litter biomass
LRP	Local resource person
m (or M)	Meter
Masl	Meter above sea level
NORAD	The Norwegian Agency for Development Cooperation
PISP	Permanent inventory sampling plot
PSP	Pilot sampling plot
REDD	Reducing Emissions from Deforestation and Forest Degradation
SOC	Soil organic carbon
t (or T)	Ton (mega gram, 1000 kg, or metric ton)
tC	ton carbon
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard

1. Introduction

1.1 Background

Asia Network for Sustainable Agriculture and Bioresources (ANSAB), International Centre for Integrated Mountain Development (ICIMOD), and Federation of Community Forest Users' Nepal (FECOFUN) are jointly implementing the project **"Design and setting up of a governance and payment system for Nepal's Community Forest Management under Reducing Emissions from Deforestation and Forest Degradation (REDD)"** in three watershed areas of Nepal, namely, Kayarkhola of Chitwan district, Charnawati of Dolakha district and Ludhikhola of Gorkha district with financial support from the Norwegian Agency for Development Cooperation (Norad). This pilot project aims to demonstrate the feasibility of REDD payment mechanism in Community Forests (CFs) by involving local communities including marginalized groups so that deforestation and forest degradation can be reduced by linking sustainable forest management practices with economic incentives. Further the project focuses on the concerns of indigenous peoples, marginalized people, women, Dalit and local communities dependent on forests by involving them in designing and functioning of a national-level REDD governance and payment mechanism that supports community forestry at grassroots level. The specific objectives of the project include; strengthening the capacity of civil society actors in Nepal to ensure their active participation in the planning and preparation of national REDD-strategies; establishing a Forest Carbon Trust Fund that is sustainable and creditable in the long run; and contributing to the development of REDD strategies that can effectively and efficiently monitor forest carbon flux in community managed forests.

The first year of project focussed on development of biophysical and socio economic baseline information. ANSAB led the baseline information collection procedure for forest carbon stocks and developed baseline report working closely with the Project Management Unit- PMU. The project developed forest measurement guidelines incorporating international accepted methodologies and standards as defined in Intergovernmental Panel on Climate Change (IPCC), Verified Carbon Standards (VCS) and other complementary guidelines including Pearson et al, Sandra Brown and MacDicken and other relevant scientific literatures. The methodologies prescribed in forest carbon measurement guideline were truly applied while conducting forest inventory in the field. Local communities, local resource persons and Watershed REDD Network members were trained and involved during the carbon measurement process viewing to enhance their capacity in measuring forest carbon. With the field data taken in Feb-March 2011, this report summarizes the present stock and changes in forest carbon of five different pools namely above ground (tree, sapling and seedling), herb, litter, soil and below ground. The report further compares the forest carbon with first measurement undertaken in Feb-March 2010. Based on the findings of the carbon measurement this

report further tries to suggest appropriate activities needed to enhance forest carbon stocks.

As previous year, the project employed the stock difference method this year inventory too so as to assess forest carbon that makes reference to traditional forest resource assessments and calculates changes in average carbon stock per unit area as the difference between carbon stock at time 2 and time 1.

1.2 Objectives

Forest carbon measurement in community forests of three watersheds in Norad REDD+ project was basically undertaken to assess change in forest carbon in forests of different ecological set up. Most specifically the measurement was taken to train local communities in forest carbon monitoring and generate forest carbon data for them to make claim for rewards for their efforts in forest conservation and avoiding forest degradation. As mentioned above, during field data collection and analysis local resource persons, Watershed REDD Network members and forest users were involved thereby enhancing their knowledge forest carbon results by efforts of sustainable management of forests. The major objective of this report is to provide an overview of forest carbon stock available in all project watersheds. Specific objectives include:

- To assess the forest carbon at various levels and monitor the carbon stock changes
- To calculate forest carbon of individual community forest and generate forest carbon data for demonstrational payment in project

2. General overview of project sites

This section describes location of the pilot watersheds and their general vegetation/forest characteristics.

2.1 Physiography

The project areas are located in three different watersheds of Nepal covering different ecological ranging from tropical to temperate ecological region. The total area of three watersheds is 27,789 ha. Forest area represents nearly 65% of the total area of watersheds (Land cover analysis report 2010). Of the total forest area in the watersehds, about 60% (10,266.13 ha) is under community forest that is being managed by 105 CFUGs. Table 1 shows the summary of the project area.

Table 1: Physiography and demographic information of project watersheds

SN	Watershed (district)	Total Watershed area [ha]	No of CFUG within WS	Total CF Area [ha]	Households	Population
1	Kayarkhola (Chitwan)	8,002	16	2,381.96	4163	23223
2	Charnawati (Dolakha)	14,037	58	5,996.17	7870	42609
3	Ludikhola (Gorkha)	5,750	31	1,888.00	4110	23685
	Total	27,789	105	10,266.13	16143	89517

Source: Land cover analysis (2010) and socio-economic information from payment claim (2011)

The Kayarkhola Watershed is located in the Chitwan district of the Central Development Region of Nepal. Altitude of this watershed ranges from 245 m to 1944 m, covering area of 8002 hectare. The 16 CFUGs of this watershed cover total 2381.96 hectare of community forest area. The watershed is inhabited by socially and ethnically diverse forest-dependent indigenous communities such as Chepang and Tamang. These ethnic groups are some of the most marginalised ethnic groups in the country.

Charnawati watershed is located in the Dolakha district of the Central Development Region of Nepal. It covers hill and mountain physiography. Altitude ranges from 835 m-3549 m. This watershed is spread over 14,037 hectare. There are 58 CFUGs within this watershed with total forest area of 5996.17 hectare. *Chhetri, Brahmin, newar, tamang, thami* and *dalits* represent the social diversity of this watershed.

Ludikhola watershed lies in the Gorkha district of the Western Development Region of Nepal. It represents the hill physiographic region, altitude ranging from 318 m to 1714 m. This watershed covers an area of 5750 hectare. There are a total of 31 CFUGs within this watershed managing 1888.00 ha forest area. This watershed is characterized by social diversity with presence of *Magar, gurung, tamang, dalit, Brahmin* and *chhetri*.

2.2 Vegetation/forest types

Due to differences in physio-climatic characteristics, watersheds under the present study constitute diverse ecology. Dominant forest types ranges from hill *Shorea robusta* forest through *Schima-Castanopsis* to *Rhododendron*. Even though *Shorea robusta* mixed sub-tropical hill deciduous forest forms major forest type in Kayarkhola (Chitwan) and Ludikhola (Gorkha), representing the lower altitudinal ranges among the three watersheds, associated species varies between these two watersheds. *Lagerestroemia parviflora*, *Mallatus philippinensi* and *Terminelia tomentosa* are dominant associates in Kayarkhola (Chitwan) whereas *Schima wallichii* and *Castanopsis indica* are the most common associates in Ludikhola (Gorkha). On the other hand, even though *Shorea robusta* and *Schima - Castanopsis* forests are present in lower altitudes in Charnawati (Dolakha), the majority is formed by *Rhododendron* forests, extending high up to *Quercus* forest, representing the dominant higher altitudinal coverage by the watershed.

According to broader climatological categorization of forests, forests in Kayarkhola fall under tropical broadleaved, similarly forests in Charnawati belongs to sub tropical to lower temperate (*Quercus*) forests and in Ludikhola the forests are of sub-tropical broad leaved forest mostly with *Shorea robusta* and *Schima wallichii*(sal and chilaune).

2.3 Location, climate and land use

Table 2 presents information on location and climate and Table 3 presents information on land uses of all the project watersheds.

Table 2: Climatological information of watersheds

SN	Watershed	Geographical location		Altitude (m)*	Average temperature (°C)	Average rainfall (mm)
		Latitude (N)	Longitude (E)			
1	Kayarkhola (Chitwan)	27°40'07.79"- 27°46'37.15"	84°33'25.88"- 84°41'48.85"	245- 1944	29-32 (max), 16- 19 (min)***	1436.32***
2	Charnawati (Dolakha)	27°35'16.12"- 27°44'47.92"	85°56'18.41"- 86°03'56.92"	835- 3549	19.9 (max), 8.3 (min)****	2232.1*** *
3	Ludikhola (Gorkha)	27°55'02.85"- 27°59'43.88"	84°33'23.13"- 84°40'41.87"	318- 1714	23.1**	1972- 2000**

Source: *Land cover analysis (2010), **District Profile, Gorkha, ***Department of hydrology and meteorology (1971-1986), ****Meteorological data from Jiri station

According to Table 2, Charanawati watershed appears to cover the higher altitudinal ranges among the watersheds with least average temperature and highest average rainfall.

Table 3: Land use profiles of the watersheds

Land cover type	Area (ha) of different land use system			Total area (ha) of three watersheds
	Kayarkhola (Chitwan)	Charnawati (Dolakha)	Ludikhola (Gorkha)	
Close to open broadleaved (dense) forest	4119 (51.48%)	4991 (35.56%)	3873 (67.34%)	27,789
Open Broadleaved (sparse) forest	1702 (21.27%)	2501 (17.82%)	996 (17.31%)	
Natural water bodies	31 (0.39%)	1 (0.01%)	9 (0.17%)	
Bare Soil	30 (0.38%)	629 (4.48%)	241 (4.19%)	
Grassland and degraded forest	0.00	204 (1.45%)	0.00	
Clouds	81 (1.02%)	0.00	0.00	
Agriculture Land and built-up areas	2038 (25.47%)	5710 (40.68%)	632 (10.99%)	
Total area	8002 (100%)	14037 (100%)	5750 100%)	

Source: Land cover analysis report (2010)

Table 3 indicates that forest forms major land use in all the watersheds. Within forest categories, the dense forest area is present in larger proportion in all watersheds compared to sparse forest area.

3 Methodology

3.1 Design of sampling and measurement techniques

This section describes the methodologies applied during the forest carbon monitoring and tools used for data analysis. Methodologies suggested in the forest carbon measurement guidelines developed by the project were followed during the forest inventory.

3.1.1 Strategies for stratification

For the purpose of monitoring, stratification that was established in the first year of the project was followed. Forests with more than 70% of canopy coverage were considered dense and less than 70% as sparse strata. Forest stratification was carried out using high resolution remote sensing imagery with the ERDAS image (geo-eye image), Defines Developer and ArcGIS software. Details of the stratification are given in figure 1.

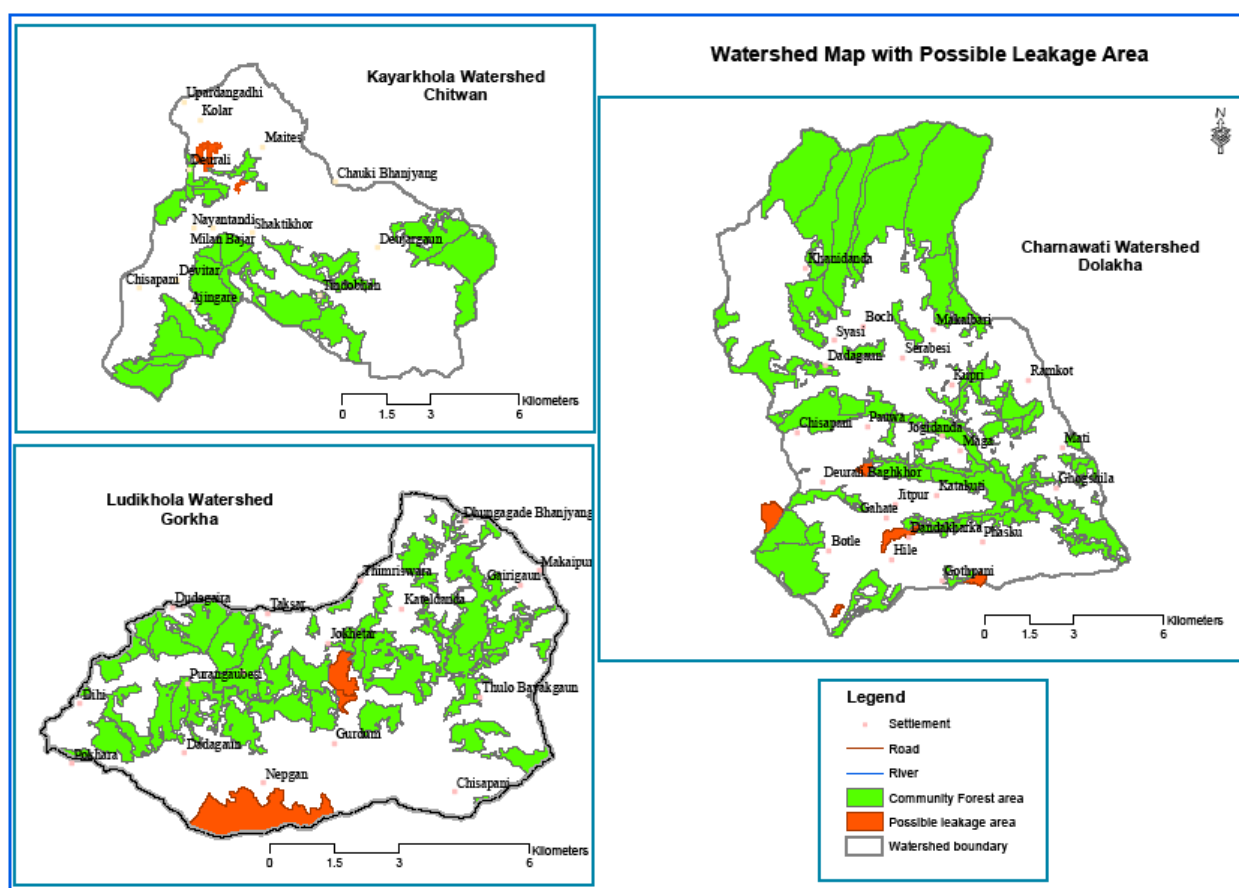


Figure 1: Map showing community forests, leakage belt and permanent plots

Table 4: Area of different forest strata in three watersheds

S N	Watershed/district	Total watershed area [ha]	Total forest area [ha] in watershed	Total CF area [ha]	Categories of forest within CF	
					Dense forest area [ha]	Sparse forest area [ha]
1	Kayarkhola (Chitwan)	8,002	5821	2,381.96	1,902.72	479.19
2	Charnawati (Dolakha)	14,037	7492	5,996.17	3,899.25	2,097.00
3	Ludikhola (Gorkha)	5,750	4869	1,888.00	1,634.64	252.9
Total		27,789	18182	10,266.13	7,436.61	2,829.09

Source: Land cover analysis report (2010)

3.1.2 Permanent plot distribution

The permanent plots that were established during baseline survey were measured for the purpose of monitoring. In year one altogether 570 permanent plots were measured although 481 plots were sufficient for carrying out the forest carbon inventory in three watersheds. Additional plots were established and measured with a view to enhance the output and also to account the outliers that might come during the measurement. However, this year only 566 permanent plots were measured due to difficulty in accessing four plots. Remeasurments was carried out in 180 plots of Kayarkhola, 201 plots in Charnawati and 185 plots in Ludikhola. Four plots were not measured in Charnawati watershed which will be measured next year in case the plots become accessible. Out of these plots 106 plots were distributed in sparse forest strata and 460 in dense strata, detail is given in Table 5.

Table 5: Number of permanent plots for forest carbon inventory in three watersheds

Stratum	Total area under CF [ha]	No. of pilot sample plots (PSP)	Size of PSP [m ²]	Required no. of permanent inventory sampling plot (PISP)	Total plot laid on the ground during baseline year	Number of plot that were measured in 1 st monitoring
Kayarkhola dense	1902.72	13	250	113	154	154
Kayarkhola sparse	479.19	17	250	17	26	26
Charnawati dense	3899.24	10	250	148	164	162
Charnawati sparse	2097.00	10	250	45	41	39
Ludikhola dense	1634.64	32	100	135	144	144
Ludikhola sparse	252.90	9	100	23	41	41
Total	10265.69	91	-	481	570	566

GPS coordinates that were recorded during the first measurement were loaded on the GPS set (GPS Map 60CSx, Garmin) as the centre of the nested plots. With the help of the GPS apparatus, the plot centre was navigated.

3.1.3 Size and shape of sample plots

The monitoring process followed the same procedure as adopted during first year measurement. As illustrated in Figure 2, several sub - plots were established within each plot for specific purposes: inside the plot of 8.92 m radius, a sub-plot of 5.64 m radius was established for saplings, a sub-plot with 1 m radius was established for counting regeneration. However, the sub-

plot with 0.56 m radius was established 5m north from the center point. The position of this sub-plot was changed as leaf litter and herb was collected destructively in the previous year and hence collection within the same point may not give proper result. Slope correction in each permanent plot was done whenever required.

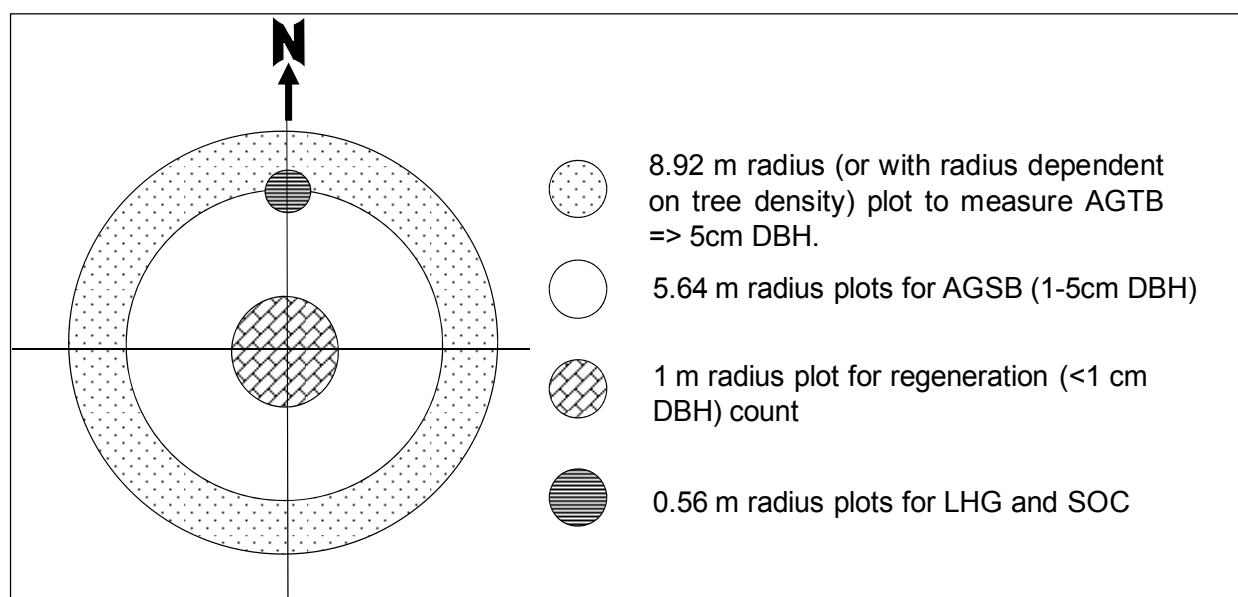


Figure 2: Sampling design for circular plot (default size)

3.1.4 Involvement of local communities in measurement process

As this project intends to increase the capacity of local communities in carrying out forest carbon measurement and monitoring, representatives from community forest user group, watershed REDD network and FECOFUN were actively involved in the whole process of forest carbon measurement. For that purpose, 12 event of refresher training on forest carbon measurement monitoring were organised them (details in table 6). A total of 231 participated in the event. This kind of orientation event enhanced skill as well as improved confidence that ensures consistency while collecting data.

Table 6: Number of local users participated in forest carbon measurement training

District	No. of orientation	Female participants				Male participants				Total participants
		BC	D	IPs	Total	BC	D	IPs	Total	
Kayarkhola	3	2	0	4	6	12	25	0	37	43
Charnawati	6	23	2	10	35	52	0	32	84	119
Ludikhola	3	11	2	10	23	21	7	18	46	69
Grand Total	12	36	4	24	64	85	32	50	167	231

Note: BC: Brahmin, Kshetri; D: Dalit; Ips: Indigenous peoples

Altogether 218 people from communities participated in the monitoring activity and gathered knowledge and skills on forest carbon measurement. Members from REDD watershed Networks¹, Local resource person (LRPs) and CFUGs members (Table 7) took part in the process. Due to the involvement of locals during monitoring, navigation of the permanent plot was easy for the technicians

Table 7: Numbers of forest users involved in forest carbon measurement in the field

Watersheds	Female				Male				Total
	BC	D	IPs	Total	BC	D	IPs	Total	
Kayarkhola	5	1	8	14	13	0	35	48	62
Charnawati	12	4	12	28	33	1	38	72	90
Ludikhola	8	5	0	13	24	16	3	43	56
Grand Total	25	10	20	55	70	17	76	163	218

Source: Annual progress report (2011)

BC = Brahmin kshetri

D= Dalit

IPs= Indigenous peoples

3.1.5 Equipments and materials

All the required equipments and materials were collected before going to field. All instruments and equipment were prepared, checked and calibrated beforehand the field inventory. The field inventory team ensured that every instrument was well functioning to avoid troubles and disturbances during field inventory. Due to the mobility of the monitoring team, complete checklist of instruments was prepared such that no any instruments and equipment gets left behind.

3.1.6 Human resource management

The monitoring team was formed following the practice adopted in the previous year. Because of confidence, inventory cruise team was reduced to 5 - member from that of 8 members team made in last year. Inventory team was oriented well in advance to their field operation to ensure perfect and complete data collection. One forest technician having detail knowledge of carbon measurement methodology was assigned as a crew leader and s/he was further supported by local resource persons, REDD Network Members and CFUG members.. During the orientation, community members were trained on methodologies, tasks of each team member were clarified and detail plan was made.

3.2 Field measurement and analysis

As described in section 3.1.33, nested circular plots with horizontal diameters ranging from 0.56 m to 8.92 m were laid out for quantifying different carbon pools. Details of field measurement techniques and methods for estimating forest carbon stock of different pools are described in the succeeding sections.

¹Watershed REDD Network is a loose network representatives form CFUGs under the respective watershed. It works as a coordinating body among CFUGs at watershed level.

3.2.1 Forest carbon pools

Descriptions of different carbon pools considered under this study are provided in this section. Carbon stock of four carbon pools including above ground (tress, sapling and herbs), below ground, leaf litter and soil organic matters which were measured in Feb- March 2010 was monitored. Detail process of monitoring is described in following paragraphs.

3.2.1.1 Aboveground tree biomass (AGTB)

All the trees which were measured in 2010 were remeasured in year 2011. The DBH (at 1.3m) and height of individual tree greater than or equal to 5 cm DBH were measured in each permanent circular plot with 250 m² area (with 8.92 m horizontal radius) using diameter tape, clinometers and linear tape or vertex-IV/transponder. Each tree which was tagged during first survey was recorded individually, together with its species name. Care was taken to ensure that the diameter tape is put around the stem exactly at the indicated point of measurement.

Table 8: Species ranking on the basis of frequency, wood specific gravity (ρ) [gm cm³] values for the purpose of estimating AGTB [wood specific gravity source from MPFS (1988)]

Stratum	Rank 1 tree species	Rank 2 tree species	Rank 3 tree species	All other species
Chitwan (Kayarkhola) dense	sal (<i>Shorea robusta</i>), 0.88	botdhangero (<i>Lagerstroemia parviflora</i>), 0.85	sindure (Mean of terai/lower slope mixed hardwood forest), 0.72	Mean of terai/lower slope mixed hardwood forest, 0.72
Chitwan (Kayarkhola) sparse	sal (<i>Shorea robusta</i>), 0.88	parijat (Mean of terai/lower slope mixed hardwood forest), 0.72	saj (<i>Terminelia tomentosa</i>), 0.95	Mean of terai/lower slope mixed hardwood forest, 0.72
Dolakha (Charnawati) dense	guras (<i>Rhododendron arboretum</i>), 0.64	angeri (Mean of upper slope mixed hardwood forest), 0.594	khasru (<i>Quercus spp.</i> Mean of upper slope mixed hardwood forest), 0.594	Mean of upper slope mixed hardwood forest, 0.594
Dolakha (Charnawati) sparse	guras (<i>Rhododendron arboretum</i>), 0.64	khote sallo (<i>Pinus roburghii</i>), 0.65	chilaune (<i>Schima wallichii</i>), 0.69	Mean of upper slope mixed hardwood forest, 0.594
Gorkha (Ludikhola) dense	sal (<i>Shorea robusta</i>), 0.88	chilaune (<i>Schima wallichii</i>), 0.69	katus (<i>Catanopsos spp</i>), 0.74	Mean of terai/lower slope mixed hardwood forest, 0.72
Gorkha (Ludikhola) sparse	sal (<i>Shorea robusta</i>), 0.88	chilaune (<i>Schima wallichii</i>), 0.69	bhalayo (Mean of terai/lower slope mixed hardwood forest), 0.72	Mean of terai/lower slope mixed hardwood forest, 0.72

Eq (i) suggested by Chave (2005, p. 93) and used during 2010 analysis was followed for monitoring as well.

$$AGTB = 0.0509 * \rho D^2 H \quad \dots\dots\dots \text{Eq. (i)}$$

Where;

AGTB = aboveground tree biomass [kg];

- ρ = wood specific gravity [kgm^{-3}];
 D = tree diameter at breast height (DBH) [cm]; and
 H = tree height [m].

Even though wood specific gravity (ρ) is a component in Eq (i), but as the wood specific gravity of all the tree species encountered during the field measurements were not readily available, the specific value were only used for three most frequently encountered species in each stratum (if available), for the remaining tree species, a general value was used according to associated forest types (see **Error! Reference source not found.** 8 for detail).

After taking the sum of the entire individual tree biomass (in kg) of a sampling plot and dividing it by the area of a sampling plot (250 m^2), the biomass value was attained in kg m^{-2} . This value was then converted to t ha^{-1} by multiplying it by 10. Since the project areas has both tropical and sub-tropical region, the biomass value was converted into carbon stock by multiplying with default carbon fraction of 0.47 as suggested by IPCC (2006).

3.2.1.2 Aboveground saplings biomass (AGSB)

Nested sub plots of 5.64 m radius were established for measuring saplings. Saplings with diameter $> 1 \text{ cm}$ to $< 5 \text{ cm}$ were measured at 1.3 m above ground level. National allometric biomass equations were used to determine the above ground sapling biomass (AGSB) ($< 5 \text{ cm}$ DBH). These tables are developed by the Department of Forest Research and Survey (DFRS), and the Department of Forest, Tree Improvement and Silviculture Component (TISC), Nepal (Tamrakar 2000). In case of tree species other than given equations in the biomass table, equations were applied according to given associations of species (forest type). The biomass value was derived from stem compartment only. The following regression model [Eq. (ii)] was used for an assortment of species to calculate biomass.

$$\log(\text{AGSB}) = a + b \log(D) \quad \dots\dots\dots \text{Eq. (ii)}$$

where;

- $\log$ = natural log [dimensionless];
 AGSB = aboveground sapling biomass [kg];
 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 1.3m above ground) [cm].

Used variables (i.e. a and b) for all tree species is presented in Annex 1. Biomass stocks were converted to carbon stocks using the IPCC (2006) default carbon fraction of 0.47.

3.2.1.3 Regeneration count

A nested plot of 1 m radius was laid out for evaluating status of regeneration ($< 1 \text{ cm dbh}$). All regenerations in the plot of this size were counted, identified and recorded.

3.2.1.4 Leaf litter, herbs, and grasses (LHG)

One circular sub plot of 1 m^2 (0.56 m radius) was established at 5m north of centre point as leaf litter, herbs and grasses of 1 m^2 plot at center were destructively collected and carbon was measured last year. All the litters (dead leaves, twigs, etc.) and live components (herb and grass) within this sub plot were collected separately in a destructive manner.

Fresh samples were weighed in the field with 0.1 g precision. The conversion factor was used to calculate the biomass of LHG. Conversion factors were calculated from the results obtained from lab report in 2010. Repeated lab test was not conducted this year assuming that the ratio of wet to dry weight will remain same for both the years for the same season. The only change in the plot will be in its green weight of LHGs. Conversion factor for dry leaf litter ranged from 0.702 to 0.954 (Detail is given in table 9).

Table 9: Conversion of factor used for dry leaf litter for various strata

Watershed	Strata	Average wt. of wet litter (t ha ⁻¹)	Average wt. of dry litter biomass (t dm ha ⁻¹)	Conversion factor
Kayarkhola	dense	6.25	5.39	0.86
	sparse	4.14	3.66	0.88
	leakage	2.15	2.05	0.95
Charnawati	dense	8.85	6.93	0.78
	sparse	7.38	5.83	0.79
	leakage	5.99	4.21	0.70
Ludikhola	dense	7.78	6.77	0.87
	sparse	6.07	5.23	0.86
	leakage	7.22	5.11	0.71

Similarly, conversion factors were also calculated for herbs. For this case, conversion factor ranged from 0.27 to 0.69. Please see **Error! Reference source not found.10** for details.

Table 10: Conversion factor used for herbs for various strata

Watershed	Strata	Average green wt. of herbs (t ha ⁻¹)	Average wt. of herbs biomass (t dm ha ⁻¹)	Conversion factor
Kayarkhola	dense	1.73	0.73	0.42
	sparse	1.97	0.92	0.47
	leakage	0.85	0.23	0.27
Charnawati	dense	1.56	0.72	0.46
	sparse	1.28	0.67	0.53
	leakage	0.92	0.63	0.69
Ludikhola	dense	1.49	0.74	0.50
	sparse	0.45	0.28	0.63
	leakage	0.73	0.41	0.57

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

3.2.1.5 Soil organic carbon (SOC)

With the presumption that soil organic carbon doesn't change significantly within period of a year, soil samples were not taken this year measurement. Hence, average value that was calculated in 2010 was used for calculation monitoring. Details are given in table 11.

Table 11: Average soil organic carbon in various strata

Watershed and stratum	Mean [tC ha ⁻¹]
Chitwan (Kayarkhola) dense	109.60
Chitwan (Kayarkhola) sparse	141.85
Dolakha (Charnawati) dense	128.90
Dolakha (Charnawati) sparse	117.48
Gorkha (Ludikhola) dense	97.01
Gorkha (Ludikhola) sparse	95.70

3.2.1.6 Belowground biomass (BGB)

Below ground biomass was calculated by using default root-to-shoot ratio 1:20 value as used in 2010. In this way, 20% of total aboveground biomass was taken as below ground root biomass.

3.3 Forest carbon stock of a stratum:

Total forest carbon stock (tC) of a stratum was calculated by adding all carbon value of repective startum.

$$C(LU) = C(AGTB) + C(AGSB) + C(HG) + C(BB) + C(L) + SOC \quad \text{.....Eq. (vii)}$$

where;

- $C(LU)$ = carbon stock for a land use category [tC ha⁻¹];
- $C(AGTB)$ = carbon stock in aboveground tree biomass [tC ha⁻¹];
- $C(AGSB)$ = carbon in aboveground sapling biomass [tC ha⁻¹];
- $C(HG)$ = carbon in herbs and grass [tC ha⁻¹];
- $C(L)$ = carbon in leaf litter [tC ha⁻¹];
- $C(BB)$ = carbon in belowground biomass [tC ha⁻¹];
- SOC = soil organic carbon [tC ha⁻¹];

The total forest carbon stock is then can be converted to tons of CO₂ equivalent by multiplying by 44/12, or 3.67 (Pearson et al, 2007).

3.4 Leakage monitoring

To ensure that local communities have not deforested or caused degradation in surrounding lands, leakage plots were established during the first year of the project. These plots were monitored to check the carbon flux in surrounding area. 6, 3 and 5 permanent plots in Ludikhola, Kayarkhola and Charnawati were monitored respectively this year. Measurements and analysis of carbon stock measurement were carried out in these plots using similar method as in permanent sample plots.

4 Results and Discussions

Results and analysis of measurement are presented in the subsequent sections. Analysis was done using R-statistical software (R Development Core Team 2009) and MS-excel 2007.

4.1 Aboveground tree biomass (AGTB)

Based on pre-analysis, plots with extreme biomass values were identified and within these plots also individual tree with potential outlier variable values (i.e. DBH and height) were noted. A total of 21,037 trees were measured in 2010 in three watersheds and 43 trees were identified as outliers, out of which measures of 4 trees were corrected during re-measurement in 2011. Hence, there are still 39 trees measured in 2010 remain as outliers (Annex 2). This year, altogether 20,939 trees were measured and 19 trees were identified as outlier. This shows that in total 98 trees were decreased this year and total number of outlier trees measured in 2010 and 2011 became 58 (Annex 2). Each stratum had few plots with outlier tree biomass values. The frequency of outlier plots seems to be highest in Kayarkhola dense in year 2011 followed by Charnawati sparse 2011, Ludikhola dense 2010, Ludikhola sparse 2011 and Charnawati sparse 2010. In order to re-include identified potential outlier trees in the analysis, measurements of these trees need to be reconfirmed from the remeasurements in the field.

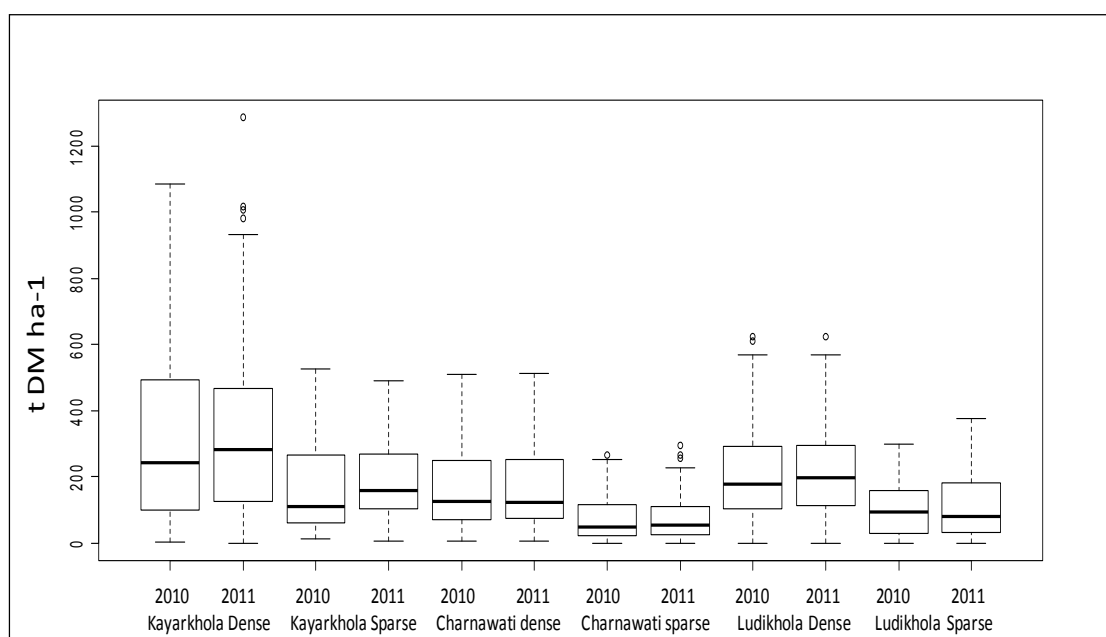


Figure 3: Box and whisker plot of AGTB in different strata showing five number summaries and outliers

Plots in Kayarkhola dense have the most widespread biomass values followed by Ludikhola dense 2010 and Kayarkhola sparse 2010 (Figure 3). Sparse strata in Charnawati and Ludikhola have the least spread AGTB values.

Referring to **Error! Reference source not found.**, highest tree biomass increment is seen in sparse strata of Ludikhola watershed (8.8 t dm ha^{-1}) followed by Ludikhola dense strata (7.5 t dm ha^{-1}). The highest increase in tree biomass was observed in Ludikhola as it possesses very young forest with better growth. However, the sparse strata of Kayarkhola watershed shows decrease in biomass by 0.7 t ha^{-1} indicating slight degradation.

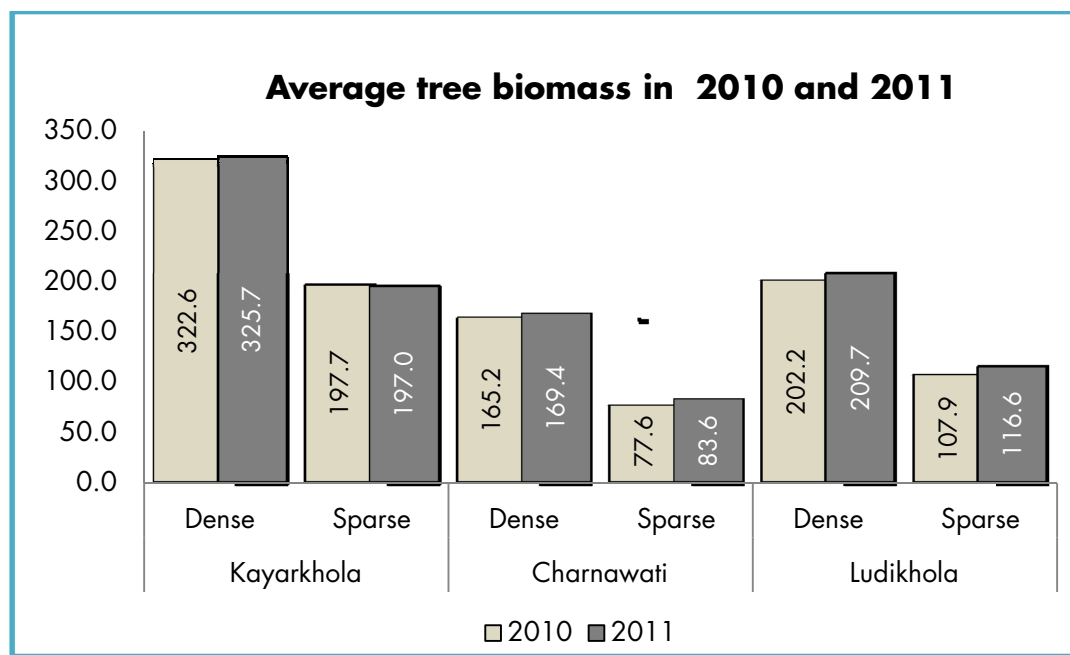


Figure 4: Average tree biomass in 2010 and 2011

As seen in Figure 4, tree biomass, tree density and basal area has increased in four strata. However, in Charnawati dense tree biomass has increased (4.1 t dm ha^{-1}) but at the same time tree density has decreased by $28.1 \text{ trees ha}^{-1}$. Thinning activities carried out by local CFUG is reasons for negative correlation between the value of tree density, and biomass and basal area in Charnawati watershed. Tree biomass has decreased in Kayarkhola sparse (0.7 t dm ha^{-1}) because of forest removal by shifting cultivators in few sample plots.

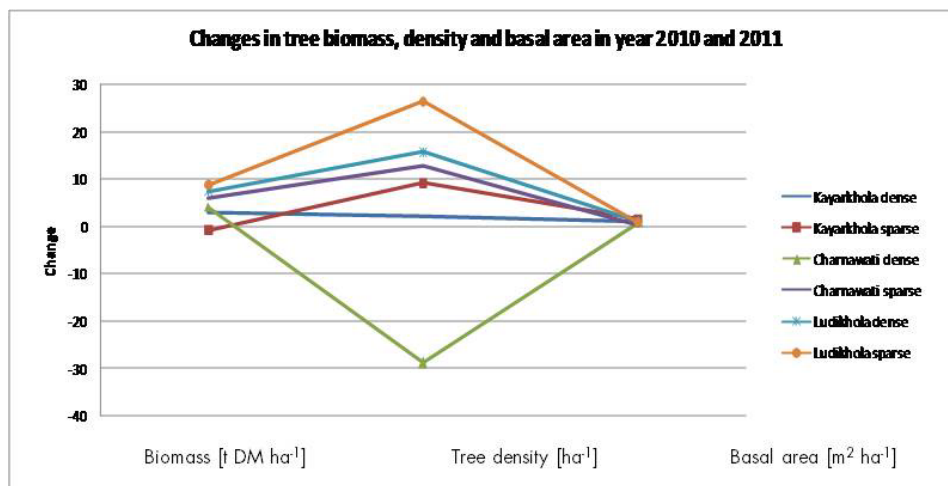


Figure 5: Change in tree biomass, tree density and basal area

However, tree density and basal area in this watershed is found increased by 9.2 tree ha⁻¹ and 1.6 m² ha⁻¹ in average respectively because of sustainable management practice of other CFUGs. Detail table is given in Annex 3.

4.2 Aboveground sapling biomass (AGSB)

Figure 6 suggests Charnawati dense measured in year 2011 has the highest spread of plots in terms of AGBS followed by Ludikhola sparse in year 2011. Both sparse and dense in Kayarkhola recorded the least spread AGTB values. Many outlier plots have been observed in Charnawati Dense in year 2011.

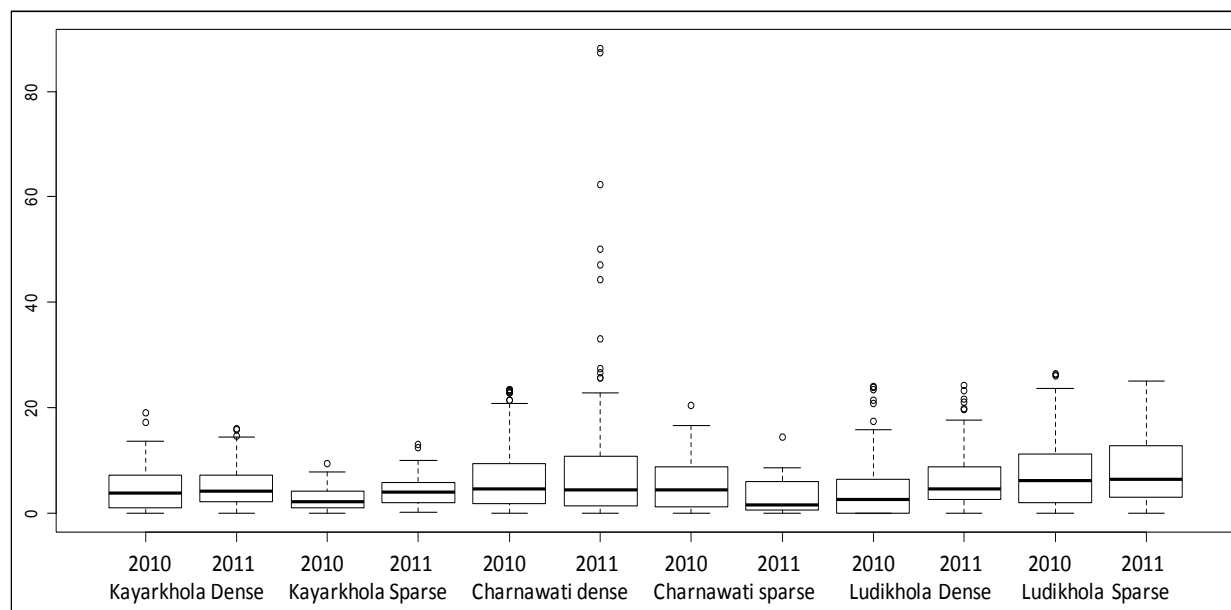


Figure 6: Box and whisker plot of AGBS in different strata showing five number summaries and outliers

As seen table 12, highest increment in sapling biomass, density and basal area has been observed in Ludikhola dense. However, sapling biomass, basal area and density have decreased in Charnawati sparse. Detail is given in Annex 4.

Table 12: Difference in AGSB biomass, density and basal area in two measurements

Strata	Difference in year 2010 and 2011		
	Biomass [t DM ha ⁻¹]	Basal area [m ² ha ⁻¹]	Density [ha ⁻¹]
Kayarkhola dense	0.48	0.07	103.25
Kayarkhola sparse	1.63	0.26	338.46
Charnawati dense	1.86	-0.26	310.75
Charnawati sparse	-1.86	-0.59	-201.50
Ludikhola dense	1.93	0.50	1773.61
Ludikhola sparse	-0.38	-0.08	924.39

4.3 Herb and grass biomass (HGB)

According to Figure 7, all measurements in year 2011 seems to have more outliers than in year 2010. Charnawati sparse 2011 and Charnawati dense 2011 seem to have the higher spread of HGB whereas all strata in 2010 have little spread in terms of HGB values.

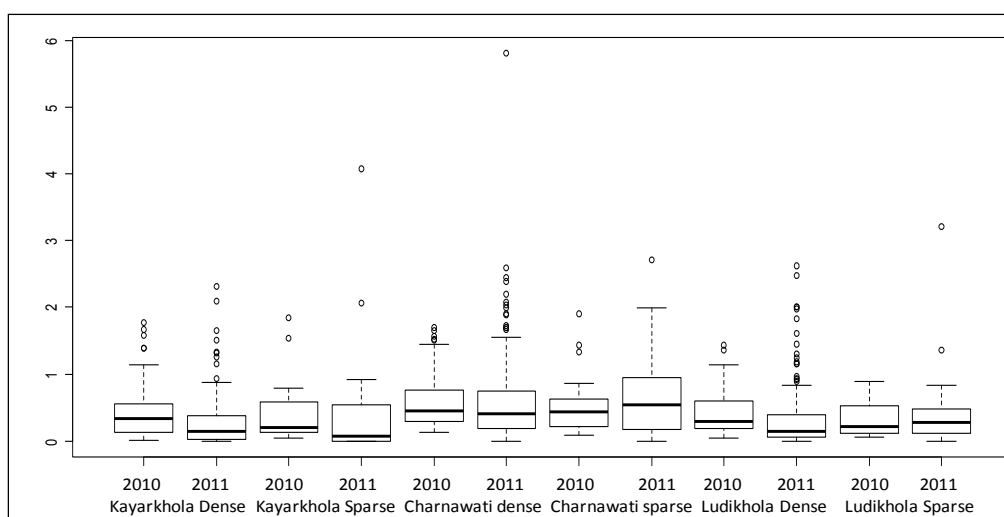


Figure 7: Box and whisker plot of HGB in different strata showing five number summaries and outliers

Graph showing herb biomass in two measurement period reveals that herb biomass has increased in Charnawati Figure 8) but decreased in case of Kayarkhola. However, in Ludikhola, herb biomass has increased in sparse and decreased in dense.

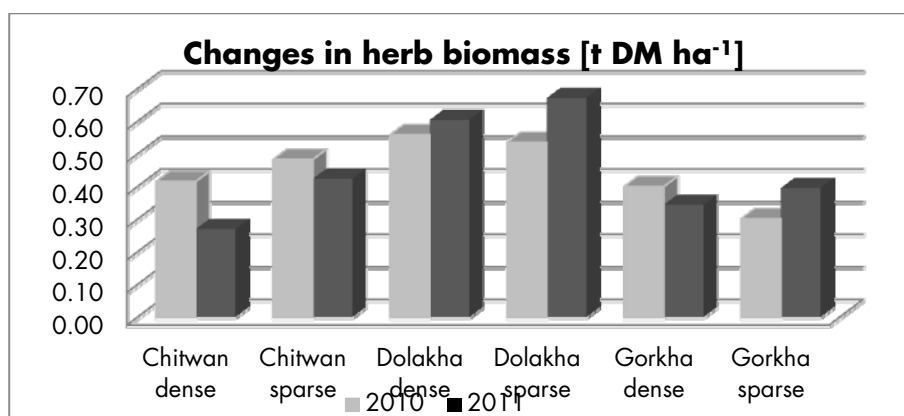


Figure 8: Herb biomass in 2010 and 2011

The difference in herb biomass ranged between -0.15 t ha^{-1} (Kayarkhola dense) to 0.14 t ha^{-1} (Charnawati sparse). Since, these are the changes that have been seen within one year only, result of the measurements in coming years will support to verify the results. For cost efficiency as well as for simplification of monitoring process, conversion values for converting herb biomass into dry biomass should be developed. Or otherwise, fluxes in herb carbon can be ignored considering it to be insignificant. Detail table is presented in Annex 5.

4.4 Leaf litter biomass (LLB)

Similar to other cases, outlier plots have increased in case of LLB in year 2011. However, spread is smaller in year 2011. This shows that LLB has decreased in first monitoring in comparison to baseline survey (figure 9).

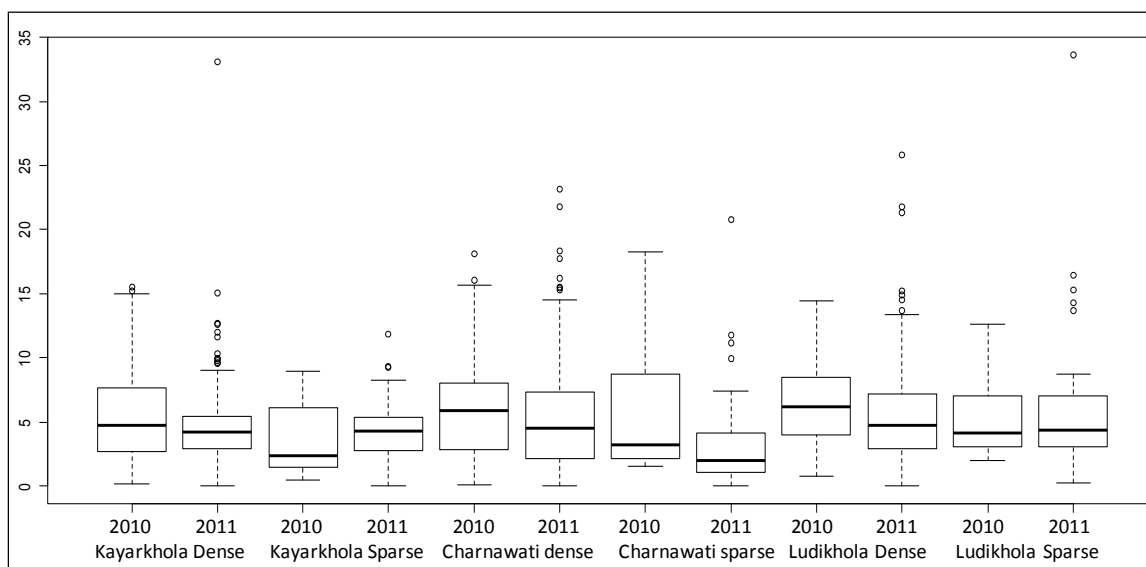


Figure 9: Box and whisker plot of LLB in different strata showing five number summaries and outliers

Referring to Figure 10, biomass of dry leaf litter has decreased in all strata except in Chitwan sparse and Gorkha sparse. Maximum decrease was seen in Charnawati sparse ($2.32 \text{ t dm ha}^{-1}$) followed by Charnawati dense ($0.89 \text{ t dm ha}^{-1}$). Detail analysis table is presented in Annex 6.

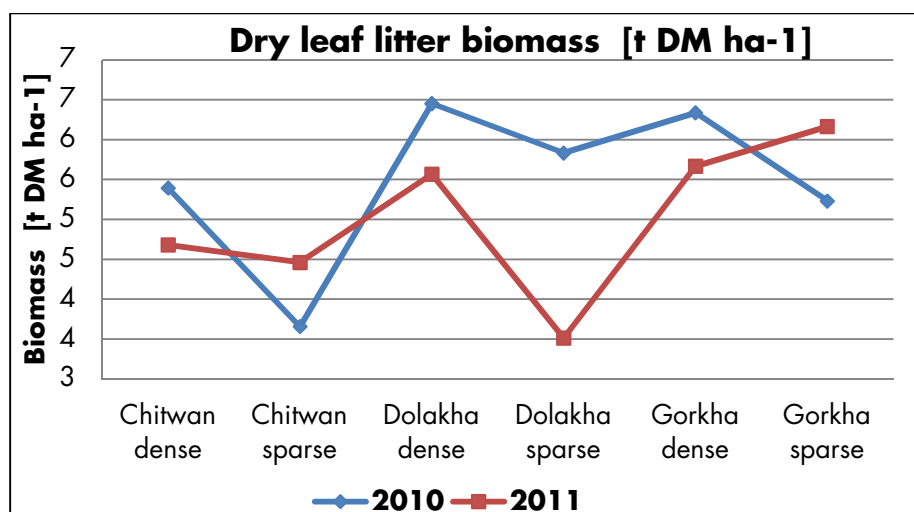


Figure 10: Showing dry leaf litter biomass in 2010 and 2011

4.5 Belowground biomass (BGB)

As mean BGB is considered as 20% of AGTB the trend of BGB is seen similar as in AGTB, i.e. highest in Kayarkhola dense followed by Ludikhola dense and lowest in Charnawati sparse. Summary of BGB is given in Table 13.

Table 13: Changes in below ground biomass in two measurements

Watersheds	Strata	2010	2011	Differences
Kayarkhola	Dense	64.53	65.15	0.62
	Sparse	39.55	39.40	-0.15
Charnawati	Dense	33.05	33.87	0.82
	Sparse	15.53	16.71	1.18
Ludikhola	Dense	40.44	41.95	1.50
	Sparse	21.57	23.32	1.75

4.6 Per ha biomass (t dm ha⁻¹) in different pools in two forest strata of three watersheds

This section summarizes the results of each carbon pool. Table 14 illustrates forest carbon stock changes in different carbon pools of three watersheds in two measurements. A significant increment of tree biomass is recorded in Ludikhola watershed and Kayarkhola watershed in two measurements. In 2011 it has witnessed per ha increment of tree biomass of over 14 t dm in Ludikhola watershed to that of 100.61 per ha t dm in the baseline year 2010. However, negative change in same carbon pool is recorded in Charnawati in 2011 where nearly 2.30 t dm of tree biomass decreased in 2011 than in 2010. Because of decrease in tree biomass, below ground biomass has also been decreased proportionately in Charnawati watershed.

Table 14: Pe ha tree biomass in various pools in three watersheds in two measurements

Forest Carbon Pools	Kayarkhola		Charnawati		Ludikhola	
	2010	2011	2010	2011	2010	2011
Below ground (t dm ha ⁻¹)	3.54	5.00	6.39	5.92	20.12	22.94
Litter(t dm ha ⁻¹)	0.97	2.70	1.98	0.87	2.40	2.04
Herb (t dm ha ⁻¹)	0.11	0.10	0.30	0.47	0.13	0.92
Sapling (t dm ha ⁻¹)	3.00	3.39	2.72	5.69	0.73	0.80
Tree (t dm ha ⁻¹)	17.69	24.98	31.93	29.60	100.61	114.71

Table 15 reveals that forest carbon changes in different carbon pools of two forest strata in three watersheds. In case of above ground tree pool and below ground pool, biomass changes are positive in all strata except in Kayarkhola sparse. Similarly, sapling biomass shows positive changes in all strata except in Ludikhola sparse and Charnawati sparse. In case of litter, negative changes have been observed in four strata viz. Charnawati sparse, Charnawati dense, Ludikhola dense, and Kayarkhola dense. However, litter biomass increased in Ludikhola sparse and Kayarkhola sparse. In case of herb biomass, decrease is observed in both the strata of Kayarkhola and Ludikhola dense and increment has been observed in Charnawati and Ludikhola sparse (table 15).

Table 15: Per ha tC in different pools in three watersheds in two measurements

Watershed/Strata	Year	below ground	soil carbon	litter	herb	sapling	tree	Per ha carbon stock in two measurements
Kayarkhola dense	2010	30.33	109.60	2.54	0.20	2.13	151.64	296.44
	2011	30.62	109.60	2.20	0.13	2.36	153.10	298.01
Kayarkhola sparse	2010	18.59	141.85	1.72	0.23	1.38	92.93	256.70
	2011	18.52	141.85	2.10	0.20	2.15	92.58	257.39
Charnawati dense	2010	15.53	128.90	3.03	0.26	3.17	77.66	228.56
	2011	15.92	128.90	2.62	0.28	4.04	79.60	231.36
Charnawati sparse	2010	7.30	117.48	2.74	0.25	2.49	36.49	166.75
	2011	7.85	117.48	1.65	0.32	1.61	39.27	168.18
Ludikhola dense	2010	19.01	97.01	2.98	0.19	2.03	95.04	216.26
	2011	19.72	97.01	2.66	0.16	2.94	98.58	221.07
Ludikhola sparse	2010	10.14	95.70	2.46	0.14	3.85	50.69	162.98
	2011	10.96	95.70	2.90	0.19	3.67	54.81	168.22

4.7 Carbon stock increment at CF level

Stocks of carbon in each CF in two years are presented in Annex 7. Maximum carbon stock increment was observed in Charnawati CFUG of Dolakha (2177.16 t) followed by Ludi Damgade of Ludikhola (1417.59 t) and Bhitte of Charnawati (1304.45 t). Similarly, lowest increment has occurred in Paleko ban of Charnawati watershed (3.56 t) followed by Gahate Baghkhori (8.66 t) and Bhirmuni Devithan (9.09 t).

4.8 Carbon stocks change in three watersheds

Table 16 provides a summary of carbon stock changes in year 2010 and 2011. A total of 27391.6 ton carbon has increased which is equivalent to 100435.8 tCO₂. The results from table

Table 16: Carbon stock in year 2010 and 2011

Watershed	Total forest area (ha)	Area (ha)	Strata	Forest Carbon 2010 (March-May)		Forest Carbon 2011 (March-April)			
				tC/ha	Carbon stock (tC)	tC/ha	Stratawise tC Stock	Total tC change in two strata	Total tC increased
Kayarkhola	2382	1902.72	D	296.44	564040.24	298.00	567010.56	2970.32	3302.85
		479.19	S	256.70	123006.19	257.39	123338.71	332.53	
Charnawati	5996	3899.25	D	228.56	891222.13	231.35	902090.56	10868.43	14066.75
		2097.00	S	166.75	349672.59	168.27	352870.91	3198.33	
Ludikhola	1888	1634.64	D	216.26	353501.40	221.77	362514.11	9012.71	10021.99
		252.90	S	162.98	41217.44	166.97	42226.713	1009.27	
Total	10266								27391.59

D= Dense and S= Sparse

17 shows that overall carbon stock has increased in all three watersheds. In average, per ha annual increment of carbon stock of three watersheds is 2.67 between 2010 and 2011. The highest rate of increment (5.31 t ha⁻¹) is estimated in Ludikhola watershed whereas the less increment (1.39 t ha⁻¹) in Kayarkhola watershed. In similar way, in Charnawati watershed, annual per ha carbon stock increment was estimated to 2.34 tC.

Table 17: Stratawise per ha forest carbon stocks of three watersheds in two measurements

Watershed/Strata	CF area (ha)	Carbon increment [tC ha-1]				Weighted mean annual increment per ha tC
		tC/ha (2010)	tC/ha (2011)	Annual increment tC/ha	Weighted mean annual increment of per ha tC	
Kayarkhola- dense	1902.72	296.44	298.00	1.56	1.39	2.67
Kayarkhola- sparse	479.19	256.70	257.39	0.69		
Charnawati- dense	3899.25	228.56	231.35	2.79	2.34	
Charnawati- sparse	2097.00	166.75	168.27	1.52		
Ludikhola- dense	1634.64	216.26	221.77	5.51	5.31	
Ludikhola- sparse	252.90	162.98	166.97	3.99		
Total CF area (Ha)	10266					

4.9 Changes of carbon stock in leakage belt

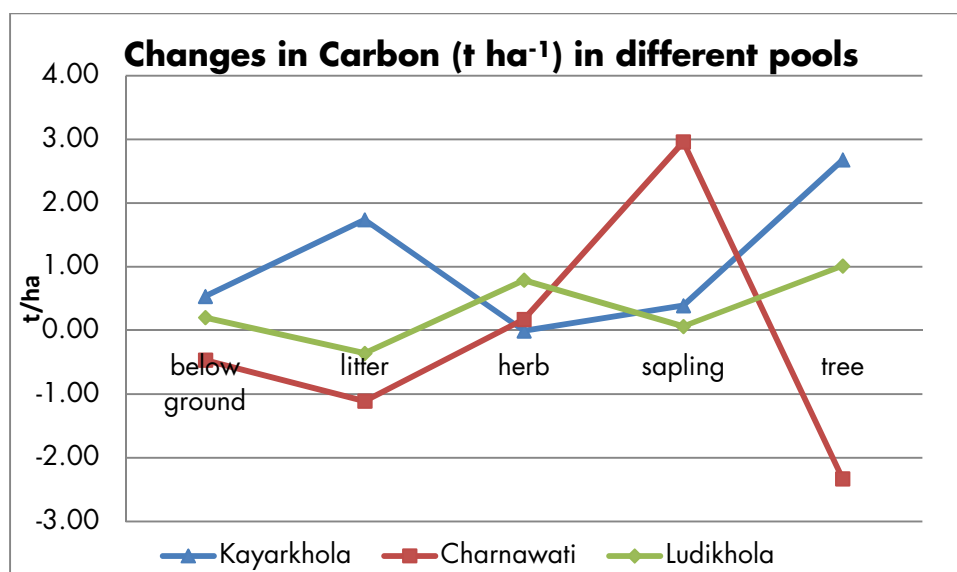


Figure 11: Changes in carbon stock (tC/ha) in leakage belt in different carbon pools

The total Carbon stock in leakage belt has increased in Kayarkhola (5.34 t ha⁻¹) and Ludikhola (1.71 t ha⁻¹) and decreased in Charnawati (0.77 t ha⁻¹). In case of Charnawati the below ground, litter and tree carbon pool were decreased, while in herb and litter pools the carbon stock were increased in the 2011. Similarly in Kayarkhola and Ludikhola the herb and litter pools the total carbon stock was decreased and in the rest of the pools the carbon stock was increased for the year 2011 (Table 18).

Table 18: Tone per ha carbon stock in various pools in leakage belt in three watersheds

Forest Carbon Pools	Kayarkhola		Charnawati		Ludikhola	
	2010	2011	2010	2011	2010	2011
Below ground (t dm ha ⁻¹)	3.54	4.07	6.39	5.92	20.12	22.94
Litter(t dm ha ⁻¹)	0.97	2.70	1.98	0.87	2.40	2.04
Herb (t dm ha ⁻¹)	0.11	0.10	0.30	0.47	0.13	0.92
Sapling (t dm ha ⁻¹)	3.00	3.39	2.72	5.69	0.73	0.80
Tree (t dm ha ⁻¹)	17.69	20.37	31.93	29.60	100.61	101.62

5 Data use and future prospects

Forest carbon data from this monitoring were thus used by CFUGs as evidences in reward claim. Few CFUGs have used data for revising community forest group constitution and forest operational plan. Following observation are made based on the findings of the carbon monitoring on which basis future prospects were also recommended.

- Identified outlier trees from pre-analysis (as presented in Annex 2) need special attention during next measurements. During remeasurements, the attempt should make sure that the outliers are the result of measurement or other human errors.
- Human and instrumental errors are prominent during the field measurements which were not detectable in first year but were observed in year two. Error in case of community forests was compensating and insignificant as it compensated among each other. But error in leakage belt was significant because of lesser number of plots (three in Kayarkhola, five in Charnawati and six in Ludikhola). This provided little opportunity for error to be distributed. Thus, the number of plots in leakage belt should be increased to get more significant results. For removing human and instrumental error more cross checking is required.
- Major changes are seen in above ground tree pool, below ground pool and sapling. Changes in other pools are minimal. So, it would be better if conversion factor for leaf litter, and herb could be developed. This will reduce significant cost that community will have to pay for lab analysis and its data collection.
- Regarding soil organic carbon changes detailed and long term research is required.
- If the changes (increment) are not much significant in leaf litter, herb and soil organic carbon, it can be discarded in analysis thus making analysis simple and easy for communities. Discarding the increment in these pools will underestimate saleable carbon credits thus making it more credible to be sold in market.
- So far, forest carbon measurement is focused on community forest. It is however suggested that forest carbon should be measured at other management regimes including government managed and religious forest. It gives a complete picture of forest carbon potentiality.

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Annexes

Annex 1: Species parameters details used to estimate sapling biomass (Tamrakar, 2000)

Scientific name	Local name	Intercept (a)	Slope (b)	R square
<i>Alnus nepalensis</i>	Utis	-2.348	2.102	0.978
<i>Casearia graveolens</i>	Barkamle	-1.627	1.520	0.990
<i>Castanopsis indica</i>	Katus	-0.710	1.720	0.970
<i>Engelhardia spicata</i>	Mauwa	-2.142	1.938	0.987
<i>Eurya acuminata</i>	Jhigune	-1.743	1.797	0.981
<i>Ficus neriifolia</i>	Dudilo	-0.986	1.750	-
<i>Ficus semicordata</i>	Khanyo	-1.370	2.010	0.940
<i>Fraxinus floribunda</i>	Lakuri	-2.130	2.082	0.971
<i>Litsea monoptala</i>	Kutmero	-1.880	2.260	0.940
<i>Lyonia ovalifolia</i>	Angari	-2.833	2.010	0.990
<i>Maesa macrophylla</i>	Bhokate	-1.769	1.650	0.766
<i>Melastoma melabathricum</i>	Chulese	3.670	1.050	0.980
<i>Myrica esculenta</i>	Kafal	-2.535	1.403	0.848
<i>Myrsine capitellata</i>	Setokath	-1.859	1.932	0.979
<i>Phyllanthus embilica</i>	Amala	-2.046	1.889	0.968
<i>Pinus roxburghii</i>	Sallo	-3.985	2.744	0.990
<i>Pinus wallichiana</i>	ghoge sallo	-1.816	1.816	0.990
<i>Pyrus pahia</i>	Mayal	-1.863	1.814	0.953
<i>Quercus spp.</i>	Baj	-0.532	0.988	0.786
<i>Quercus spp.</i>	Khasru	2.763	1.166	0.999
<i>Rhododendron spp.</i>	Laligurans	-2.533	1.393	0.698
<i>Rhus wallichii</i>	Bhalayo	-1.954	1.899	0.956
<i>Schima wallichii</i>	Chilaune	-2.220	2.520	0.980
<i>Shorea robusta</i>	Sal	-2.608	2.996	0.982
<i>Wendlandia coriacea</i>	Tilke	-1.280	1.432	0.999
all other species	Mixed species	-0.280	1.510	0.930

Annex 2: Details of outlier trees.

Measurement year	District	Strata	Plot number	Tree number	Species	DBH	height
2010	Chitwan	sparse	5	10	Ashana	95.4	28.1
2010	Chitwan	sparse	10	15	Harra	52.7	26.2
2010	Chitwan	sparse	10	21	sal	59	32.9
2011	Chitwan	dense	93	11	sal	92	6.7
2010	Chitwan	dense	128	13	sal	72	24.0
2010	Chitwan	dense	140	1	sal	79.7	25.1
2010	Chitwan	dense	140	14	sal	94.5	17.6
2010	Chitwan	dense	140	15	chilaune	113.3	23.8
2011	Chitwan	dense	156	12	Bakhare	21	9.7
2010	Chitwan	dense	190	2	sal	67.4	30.9
2011	Chitwan	dense	207	11	sal	84	56.4
2011	Chitwan	dense	232	8	sal	91.8	7.8
2010	Dolakha	dense	2	22	thingre salla	79	19.4
2010	Dolakha	dense	5	19	thingre salla	103.5	34.6
2010	Dolakha	dense	13	12	thingre salla	123.8	27.0
2011	Dolakha	dense	14	18	Kamali	98.6	12.3
2010	Dolakha	dense	15	4	gobresallo	47.8	39.9
2010	Dolakha	dense	15	37	gobresallo	46	34.3
2011	Dolakha	dense	15	47	gobresallo	49.3	48.3
2010	Dolakha	dense	17	1	hasru	120.1	25.9
2010	Dolakha	dense	29	3	thingre salla	72	23.6
2010	Dolakha	dense	29	32	gobresallo	68	26.3
2010	Dolakha	dense	38	30	thingre salla	104	18.3
2011	Dolakha	dense	40	6	gobresallo	81.7	25.0
2011	Dolakha	dense	47	23	Angari	46.1	66.6
2011	Dolakha	dense	69	22	gobresallo	106	31.3
2011	Dolakha	dense	72	9	hasru	92.5	19.0
2011	Dolakha	dense	72	13	hasru	68.4	14.7
2010	Dolakha	dense	90	8	thingre salla	71	34.4
2011	Dolakha	dense	90	13	thingre salla	76.1	33.8
2011	Dolakha	dense	100	10	Angari	6	54.2
2010	Dolakha	dense	103	6	gobresallo	118.5	36.4
2011	Dolakha	dense	139	9	Guras	76.5	35.0
2011	Dolakha	dense	213	29	Payu	9.2	51.2
2011	Dolakha	sparse	223	19	hasru	35.3	25.9
2010	Dolakha	sparse	223	27	thingre salla	86.3	21.4

Measurement year	District	Strata	Plot number	Tree number	Species	DBH	height
2010	Dolakha	sparse	232	6	Khote sallo	83.2	35.3
2010	Dolakha	sparse	235	4	mauwa	32.4	45.7
2010	Dolakha	sparse	235	23	chilaune	25.7	38.8
2010	Dolakha	sparse	247	1	Khote sallo	42.4	23.8
2010	Dolakha	sparse	247	10	Khote sallo	31.4	24.9
2010	Dolakha	sparse	247	11	Khote sallo	39	30.0
2010	Dolakha	sparse	247	14	Khote sallo	36.4	30.3
2010	Dolakha	sparse	248	7	khasru	84.6	18.4
2011	Dolakha	leakage	1002	18	Kharani	99	8.7
2010	Gorkha	sparse	20	43	sal	39	16.1
2010	Gorkha	sparse	20	58	sal	47.7	24.7
2010	Gorkha	sparse	21	6	sal	80	32.1
2010	Gorkha	sparse	31	1	sal	57.8	21.6
2010	Gorkha	sparse	31	22	sal	39.7	20.7
2010	Gorkha	sparse	37	3	sal	68.7	17.8
2010	Gorkha	dense	64	23	sal	65.3	30.5
2011	Gorkha	dense	68	11	sal	18	53.0
2010	Gorkha	dense	103	10	sal	51.2	25.2
2010	Gorkha	dense	104	10	sal	59.4	32.1
2010	Gorkha	dense	141	6	sal	50.4	25.1
2010	Gorkha	dense	142	2	sal	74	28.1
2011	Gorkha	dense	180	23	baar	135	27.0

Annex 3: Summary statistics of sampling of trees in different strata

strata	Variable unit	Year	Number of plots	Mean	std deviation	half width of confidence interval	max	min	median	sampling precision
Kayarkhola Dense	Biomass [t DM ha ⁻¹]	2010	154	322.6	267.7	42.6	1084.7	1.2	242.4	6.7
		2011	154	325.7	250.6	39.9	1286.5	0.5	282.0	6.2
	Tree density [ha ⁻¹]	2010	154	1092.2	740.8	117.9	4160.0	120.0	960.0	5.5
		2011	154	1094.3	753.0	119.9	3720.0	80.0	880.0	5.5
	Basal area [m ² ha ⁻¹]	2010	154	31.2	18.5	2.9	90.9	0.7	27.4	4.8
		2011	154	32.2	16.9	2.7	79.4	0.5	29.9	4.2
Kayarkhola Sparse	Biomass [t DM ha ⁻¹]	2010	26	197.7	173.9	70.2	526.6	12.0	110.5	17.2
		2011	26	197.0	139.0	56.2	490.6	7.0	158.6	13.8
	Tree density [ha ⁻¹]	2010	26	903.1	669.6	270.5	3120.0	240.0	700.0	14.5
		2011	26	912.3	691.8	279.4	3120.0	240.0	740.0	14.9
	Basal area [m ² ha ⁻¹]	2010	26	23.2	13.7	5.5	58.6	5.2	19.3	11.6
		2011	26	24.8	12.2	4.9	52.8	4.8	23.7	9.7
Charnawati Dense	Biomass [t DM ha ⁻¹]	2010	164	165.2	122.0	18.8	508.4	4.8	126.8	5.8
		2011	162	169.4	124.4	19.3	512.0	4.9	123.1	5.8
	Tree density [ha ⁻¹]	2010	164	1600.5	1013.6	156.3	4720.0	160.0	1320.0	4.9
		2011	162	1571.9	949.5	147.3	4680.0	160.0	1380.0	4.7
	Basal area [m ² ha ⁻¹]	2010	164	33.8	19.3	3.0	122.0	3.0	30.2	4.4
		2011	162	34.7	18.2	2.8	86.1	3.7	31.4	4.1
Charnawati Sparse	Biomass [t DM ha ⁻¹]	2010	41	77.6	70.6	22.3	266.2	0.0	48.1	14.2
		2011	39	83.6	76.8	24.9	293.4	0.0	55.6	14.7
	Tree density [ha ⁻¹]	2010	41	1110.2	854.2	269.6	3560.0	0.0	720.0	12.0
		2011	39	1123.1	833.5	270.2	3640.0	0.0	880.0	11.9
	Basal area [m ² ha ⁻¹]	2010	41	20.1	15.9	5.0	60.7	0.0	15.0	12.4
		2011	39	20.4	15.9	5.2	63.2	0.0	14.8	12.5
Ludikhola Dense	Biomass [t DM ha ⁻¹]	2010	144	202.2	137.0	22.6	622.0	0.4	177.4	5.6
		2011	144	209.7	130.8	21.5	624.6	0.5	196.6	5.2
	Tree density [ha ⁻¹]	2010	144	1898.3	1033.3	170.2	6360.0	120.0	1680.0	4.5
		2011	144	1914.2	1050.6	173.1	6520.0	120.0	1740.0	4.6
	Basal area [m ² ha ⁻¹]	2010	144	27.3	12.8	2.1	64.6	0.3	26.5	3.9
		2011	144	28.4	13.1	2.2	79.8	0.3	27.7	3.9
Ludikhola Sparse	Biomass [t DM ha ⁻¹]	2010	41	107.9	84.7	26.7	298.3	0.0	93.0	12.3
		2011	41	116.6	99.1	31.3	375.2	0.0	82.0	13.3
	Tree density [ha ⁻¹]	2010	41	1363.9	873.4	275.7	4280.0	0.0	1160.0	10.0
		2011	41	1390.2	896.7	283.0	4280.0	0.0	1200.0	10.1
	Basal area [m ² ha ⁻¹]	2010	41	17.7	10.2	3.2	39.5	0.0	18.7	9.0
		2011	41	18.6	11.6	3.7	53.8	0.0	18.1	9.8

Annex 4: Summary statistics of sampling of saplings in different strata

strata	Variable unit	Year	Number of plots	Mean	Std dev	Half width of confidence interval	Max.	Min.	Median	Sampling precision
Kayarkhola Dense	Biomass [t DM ha ⁻¹]	2010	154	4.5	3.9	0.6	19.0	0.0	3.7	6.9
		2011	154	5.0	3.7	0.6	16.1	0.0	4.2	5.9
	Tree density [ha ⁻¹]	2010	154	1685.1	1494.6	237.9	6200	0.0	1300	7.1
		2011	154	1788.3	1389.3	221.2	6200	0.0	1400	6.3
	Basal area [m ² ha ⁻¹]	2010	154	1.1	0.9	0.2	4.6	0.0	0.8	7.2
		2011	154	1.1	0.9	0.1	4.0	0.0	1.0	6.2
Kayarkhola Sparse	Biomass [t DM ha ⁻¹]	2010	26	2.9	2.7	1.1	9.5	0.0	2.2	17.7
		2011	26	4.6	3.4	1.4	13.1	0.1	3.9	14.5
	Tree density [ha ⁻¹]	2010	26	1184.6	1261.0	509.3	5800	0.0	800.0	20.9
		2011	26	1523.1	1027.3	415.0	4000	0.0	1250	13.2
	Basal area [m ² ha ⁻¹]	2010	26	0.7	0.6	0.3	2.3	0.0	0.5	17.7
		2011	26	1.0	0.8	0.3	3.2	0.0	0.8	15.8
Charnawati Dense	Biomass [t DM ha ⁻¹]	2010	164	6.7	6.5	1.0	23.5	0.0	4.6	7.6
		2011	162	8.6	13.2	2.1	88.2	0.0	4.4	12.1
	Tree density [ha ⁻¹]	2010	164	2070.7	1999.5	308.3	13900	0.0	1500	7.5
		2011	162	2381.5	2397.6	372.0	11400	0.0	1700	7.9
	Basal area [m ² ha ⁻¹]	2010	164	1.5	1.3	0.2	5.1	0.0	1.1	6.9
		2011	162	1.2	1.2	0.2	7.0	0.0	0.9	7.8
Charnawati Sparse	Biomass [t DM ha ⁻¹]	2010	41	5.3	4.9	1.5	20.5	0.0	4.4	14.5
		2011	39	3.4	3.6	1.2	14.3	0.0	1.6	16.6
	Tree density [ha ⁻¹]	2010	41	1670.7	1677.1	529.4	6700	0.0	1100	15.7
		2011	39	1469.2	1453.0	471.0	5100	0.0	900	15.8
	Basal area [m ² ha ⁻¹]	2010	41	1.4	1.4	0.4	5.4	0.0	1.1	15.6
		2011	39	0.8	0.8	0.2	3.1	0.0	0.6	15.9
Ludikhola Dense	Biomass [t DM ha ⁻¹]	2010	144	4.3	5.4	0.9	24.1	0.0	2.6	10.4
		2011	144	6.3	5.1	0.8	24.2	0.0	4.7	6.8
	Tree density [ha ⁻¹]	2010	144	1497.2	1948.6	321.0	11500	0.0	950	10.8
		2011	144	3270.8	2416.6	398.1	13000	0.0	2500	6.2
	Basal area [m ² ha ⁻¹]	2010	144	1.2	1.5	0.2	7.4	0.0	0.7	10.4
		2011	144	1.7	1.3	0.2	7.5	0.0	1.3	6.7
Ludikhola Sparse	Biomass [t DM ha ⁻¹]	2010	41	8.2	8.0	2.5	26.4	0.0	6.2	15.2
		2011	41	7.8	6.2	2.0	25.0	0.0	6.4	12.4
	Tree density [ha ⁻¹]	2010	41	3073.2	3691.8	1165.3	18600.0	0.0	2200	18.8
		2011	41	3997.6	3153.4	995.3	16200.0	0.0	3400	12.3
	Basal area [m ² ha ⁻¹]	2010	41	2.0	2.0	0.6	7.1	0.0	1.5	15.0
		2011	41	1.9	1.5	0.5	5.8	0.0	1.6	11.9

Annex 5: Per ha Dry Matter value of f herbs and grass in different strata

Strata	Year	Number of plots	Mean	Standard deviation	Half width of confidence interval	Maximum	Minimum	Median	Sampling precision
Chitwan dense	2010	99	0.42	0.37	0.07	1.77	0.01	0.33	9.04
	2011	154	0.27	0.39	0.06	2.31	0.00	0.15	11.50
Chitwan sparse	2010	15	0.48	0.54	0.30	1.84	0.05	0.20	28.91
	2011	26	0.42	0.88	0.35	4.08	0.00	0.06	40.48
Dolakha dense	2010	120	0.56	0.37	0.07	1.71	0.12	0.46	6.01
	2011	162	0.61	0.71	0.11	5.81	0.00	0.41	9.20
Dolakha sparse	2010	26	0.54	0.44	0.18	1.90	0.08	0.43	15.99
	2011	39	0.67	0.64	0.21	2.70	0.00	0.54	15.27
Gorkha dense	2010	82	0.40	0.32	0.07	1.44	0.04	0.28	8.78
	2011	143	0.34	0.51	0.08	2.62	0.00	0.15	12.28
Gorkha sparse	2010	34	0.30	0.23	0.08	0.89	0.06	0.21	13.28
	2011	42	0.40	0.53	0.17	3.21	0.00	0.28	20.73

Annex 6: Summary statistics of leaf litter biomass sampling in different strata

Strata	Year	Number of plots	Mean	Standard deviation	Half width of confidence interval	Maximum	Minimum	Median	Sampling precision
Chitwan dense	2010	80	5.39	3.69	0.82	15.52	0.19	4.77	7.66
	2011	154	4.68	3.52	0.56	33.13	0.00	4.18	6.07
Chitwan sparse	2010	13	3.66	2.94	1.77	8.96	0.42	2.40	22.26
	2011	26	4.46	2.87	1.16	11.87	0.00	4.29	12.60
Dolakha dense	2010	88	6.45	4.05	0.86	18.09	0.06	5.89	6.69
	2011	162	5.57	4.57	0.71	23.20	0.00	4.52	6.44
Dolakha sparse	2010	9	5.83	5.48	4.22	18.26	1.54	3.19	31.34
	2011	39	3.51	4.13	1.34	20.83	0.00	2.02	18.81
Gorkha dense	2010	98	6.34	3.41	0.68	14.46	0.79	6.21	5.44
	2011	143	5.67	4.21	0.70	25.83	0.00	4.71	6.21
Gorkha dense	2010	19	5.23	2.80	1.35	12.62	2.00	4.10	12.28
	2011	42	6.17	5.72	1.78	33.66	0.21	4.39	14.32

Annex 7: CF level summary of carbon stock

SN	Watershed	CF name	Total CF area [ha]	Area in dense [ha]	Area in sparse [ha]	Total carbon stock in dense strata [tC]		Total carbon stock in sparse strata [tC]		Total carbon in CF [tC]		Difference in total carbon [tC]
						2010	2011	2010	2011	2010	2011	
1	Kayarkhola	Nibuwatar	329.18	315.21	13.97	93440.51	93932.58	3586.04	3595.74	97026.55	97528.32	501.77
2	Kayarkhola	Chitramkami nchuli	314.02	233.05	80.96	69085.09	69448.90	20782.11	20838.29	89867.20	90287.19	419.99
3	Kayarkhola	Deujar	278.87	184.06	94.82	54562.55	54849.88	24339.92	24405.72	78902.47	79255.60	353.13
4	Kayarkhola	Devidhunga	189.10	152.03	36.07	45067.77	45304.94	9259.17	9284.06	54326.94	54589.00	262.06
5	Kayarkhola	Chelibeti	64.80	59.61	6.17	17670.79	17763.78	1583.84	1588.10	19254.63	19351.88	97.25
6	Kayarkhola	Kalika	213.77	206.15	7.57	61110.88	61432.70	1943.19	1948.44	63054.07	63381.14	327.07
7	Kayarkhola	Indreni	172.17	155.57	16.61	46117.00	46359.86	4263.72	4275.25	50380.72	50635.11	254.39
8	Kayarkhola	Batauli	155.77	91.29	64.49	27061.91	27204.42	16554.33	16599.08	43616.24	43803.50	187.26
9	Kayarkhola	Dharapani	147.16	142.19	4.96	42150.65	42372.62	1273.21	1276.65	43423.86	43649.27	225.41
10	Kayarkhola	Janapragati	118.84	97.18	21.66	28807.93	28959.64	5560.04	5575.07	34367.97	34534.71	166.74
11	Kayarkhola	Pragati	115.48	70.78	44.70	20981.95	21092.44	11474.31	11505.33	32456.26	32597.77	141.51
12	Kayarkhola	Kankali	91.60	78.48	13.12	23264.53	23387.04	3367.85	3376.96	26632.38	26764.00	131.62
13	Kayarkhola	Samfrang	63.90	26.84	37.06	7956.42	7998.32	9513.16	9538.87	17469.58	17537.19	67.62
14	Kayarkhola	Satkanya	58.28	55.95	2.33	16585.76	16673.10	598.10	599.72	17183.86	17272.82	88.96
15	Kayarkhola	Jharana	34.53	23.47	11.07	6957.42	6994.06	2841.63	2849.31	9799.05	9843.37	44.32
16	Kayarkhola	Jamuna	34.53	10.86	23.67	3219.33	3236.28	6076.00	6092.42	9295.32	9328.70	33.38
17	Ludikhola	Ludi Damgade	270.71	221.44	49.28	47887.82	49108.75	8031.61	8228.28	55919.44	57337.03	1417.59
18	Ludikhola	Ghaledanda Ranakhola	181.66	146.56	35.09	31694.54	32502.61	5718.94	5858.98	37413.48	38361.59	948.11
19	Ludikhola	Gangate Bahunechaur	173.62	156.79	16.83	33906.84	34771.32	2742.94	2810.11	36649.78	37581.42	931.64
20	Ludikhola	Bhalukhola	107.59	106.48	1.10	23026.98	23614.07	179.28	183.67	23206.26	23797.74	591.48
21	Ludikhola	Kuwadi	92.27	83.75	8.52	18111.48	18573.24	1388.58	1422.58	19500.06	19995.82	495.76
22	Ludikhola	Taksartari	89.31	83.08	6.23	17966.58	18424.65	1015.36	1040.22	18981.94	19464.87	482.93
23	Ludikhola	Birienchok	83.57	69.88	13.69	15112.00	15497.29	2231.19	2285.82	17343.18	17783.11	439.92
24	Ludikhola	Thokane	76.18	73.54	2.65	15903.50	16308.97	431.89	442.47	16335.39	16751.44	416.04

SN	Watershed	CF name	Total CF area [ha]	Area in dense [ha]	Area in sparse [ha]	Total carbon stock in dense strata [tC]		Total carbon stock in sparse strata [tC]		Total carbon in CF [tC]		Difference in total carbon [tC]
						2010	2011	2010	2011	2010	2011	
		Bhanjyang										
25	Ludikhola	Baghepani	68.16	67.55	0.60	14608.12	14980.56	97.79	100.18	14705.91	15080.75	374.84
26	Ludikhola	Lamidanda	61.59	58.98	2.61	12754.80	13079.99	425.38	435.79	13180.18	13515.79	335.61
27	Ludikhola	Siraute	60.34	56.20	4.14	12153.61	12463.47	674.73	691.26	12828.34	13154.73	326.38
28	Ludikhola	Kyamundanda	58.72	56.60	2.12	12240.11	12552.18	345.52	353.98	12585.63	12906.16	320.53
29	Ludikhola	Mahalaxmi	63.96	38.05	25.92	8228.56	8438.35	4224.42	4327.86	12452.98	12766.21	313.23
30	Ludikhola	Shikhar Bhanjyang	55.49	55.40	0.10	11980.61	12286.06	16.30	16.70	11996.90	12302.76	305.85
31	Ludikhola	Sandan Bisauni	50.62	48.65	1.98	10520.88	10789.11	322.70	330.60	10843.57	11119.71	276.14
32	Ludikhola	Kharko Pakho Bekhpari	51.15	44.35	6.80	9590.97	9835.50	1108.26	1135.40	10699.23	10970.90	271.66
33	Ludikhola	Chisapani	50.04	45.15	4.88	9763.98	10012.92	795.34	814.81	10559.32	10827.73	268.41
34	Ludikhola	Shikhar	50.84	42.47	8.38	9184.41	9418.57	1365.77	1399.21	10550.18	10817.78	267.60
35	Ludikhola	Kharkandep akha	47.82	45.82	2.00	9908.87	10161.50	325.96	333.94	10234.83	10495.44	260.61
36	Ludikhola	Goldanda	45.99	45.63	0.36	9867.78	10119.37	58.67	60.11	9926.45	10179.47	253.02
37	Ludikhola	Shikhar Danda	30.36	16.28	14.09	3520.65	3610.42	2296.38	2352.61	5817.03	5963.02	145.99
38	Ludikhola	Badahare	25.78	10.69	15.09	2311.78	2370.72	2459.36	2519.58	4771.14	4890.30	119.16
39	Ludikhola	Punche	18.13	15.44	2.69	3339.00	3424.13	438.41	449.15	3777.41	3873.28	95.86
40	Ludikhola	Ludi	17.44	5.75	11.69	1243.47	1275.18	1905.23	1951.88	3148.70	3227.06	78.36
41	Ludikhola	Ram Laxman	13.25	12.78	0.47	2763.76	2834.22	76.60	78.48	2840.36	2912.70	72.34
42	Ludikhola	Laxmi Mahila	8.72	8.09	0.63	1749.51	1794.12	102.68	105.19	1852.19	1899.31	47.12
43	Ludikhola	Patal Chanpe Mahila	8.16	7.44	0.72	1608.95	1649.97	117.35	120.22	1726.29	1770.19	43.89
44	Ludikhola	Anapswanra	9.14	4.21	4.93	910.44	933.65	803.49	823.16	1713.93	1756.81	42.89

SN	Watershed	CF name	Total CF area [ha]	Area in dense [ha]	Area in sparse [ha]	Total carbon stock in dense strata [tC]		Total carbon stock in sparse strata [tC]		Total carbon in CF [tC]		Difference in total carbon [tC]
						2010	2011	2010	2011	2010	2011	
		Bhawanipakha										
45	Ludikhola	Sitalu Pakha	5.69	4.12	1.57	890.98	913.69	255.88	262.14	1146.85	1175.84	28.98
46	Ludikhola	Bhangeristan Ghantari	5.24	3.15	2.09	681.21	698.58	340.63	348.97	1021.83	1047.54	25.71
47	Ludikhola	MajhiKhola Simredanda	6.00	0.33	5.67	71.36	73.18	924.09	946.72	995.46	1019.90	24.45
48	Charnawati	Amalekharka CF	6.60	1.51	5.09	345.13	349.34	848.75	856.49	1193.88	1205.83	11.95
49	Charnawati	Barkhe dadapari	35.40	11.61	23.78	2653.61	2685.97	3965.29	4001.46	6618.90	6687.43	68.53
50	Charnawati	Bhakare	104.43	76.26	28.17	17430.19	17642.75	4697.31	4740.17	22127.50	22382.92	255.41
51	Charnawati	Bhasmepakha	10.93	6.16	4.77	1407.95	1425.12	795.39	802.65	2203.34	2227.76	24.43
52	Charnawati	Bhirmuni Devithan	5.98	0.00	5.98	0.00	0.00	997.16	1006.25	997.16	1006.25	9.10
53	Charnawati	Bhitteri	542.64	377.67	164.97	86321.27	87373.95	27508.55	27759.50	113829.82	115133.46	1303.64
54	Charnawati	Bhumethan Shivajung	46.67	16.71	29.97	3819.28	3865.86	4997.46	5043.05	8816.74	8908.91	92.17
55	Charnawati	Bichaur	47.71	7.29	40.42	1666.22	1686.54	6739.99	6801.47	8406.21	8488.01	81.81
56	Charnawati	Botlesetidevi	172.10	113.69	58.42	25985.29	26302.18	9741.47	9830.33	35726.76	36132.51	405.76
57	Charnawati	Budabhimse n	41.97	9.12	32.85	2084.49	2109.91	5477.70	5527.67	7562.19	7637.58	75.39
58	Charnawati	Charnawati	819.35	733.67	85.67	167689.59	169734.55	14285.37	14415.69	181974.96	184150.25	2175.29
59	Charnawati	Charnawati 1	55.12	43.12	11.99	9855.62	9975.81	1999.32	2017.56	11854.94	11993.37	138.43
60	Charnawati	Chhitakunda	51.51	0.00	51.51	0.00	0.00	8589.23	8667.59	8589.23	8667.59	78.36
61	Charnawati	Chuchhedhunga	8.90	0.00	8.90	0.00	0.00	1484.06	1497.60	1484.06	1497.60	13.54
62	Charnawati	Chyanedada	64.86	33.07	31.79	7558.57	7650.74	5300.94	5349.30	12859.51	13000.05	140.54

SN	Watershed	CF name	Total CF area [ha]	Area in dense [ha]	Area in sparse [ha]	Total carbon stock in dense strata [tC]		Total carbon stock in sparse strata [tC]		Total carbon in CF [tC]		Difference in total carbon [tC]
						2010	2011	2010	2011	2010	2011	
63	Charnawati	Chyanse Bhagawati	30.32	23.82	6.50	5444.36	5510.76	1083.87	1093.76	6528.23	6604.51	76.28
64	Charnawati	Devithan	43.94	14.36	29.58	3282.16	3322.19	4932.43	4977.43	8214.59	8299.61	85.02
65	Charnawati	Dhade	29.17	0.17	29.01	38.86	39.33	4837.38	4881.51	4876.24	4920.84	44.60
66	Charnawati	Dhande Singhdevi	343.69	229.51	114.18	52457.42	53097.14	19039.38	19213.07	71496.80	72310.21	813.41
67	Charnawati	Dimal	38.20	34.66	3.54	7921.98	8018.59	590.29	595.68	8512.27	8614.27	101.99
68	Charnawati	Eklepakha	197.33	157.83	39.58	36074.05	36513.97	6599.92	6660.13	42673.97	43174.10	500.13
69	Charnawati	Gahate baghkhori	5.54	0.19	5.35	43.43	43.96	892.11	900.24	935.53	944.20	8.67
70	Charnawati	Gairi jungle	131.08	125.98	5.11	28794.33	29145.47	852.09	859.86	29646.41	30005.33	358.92
71	Charnawati	Golmeshor	215.18	100.95	114.23	23073.40	23354.78	19047.72	19221.48	42121.12	42576.26	455.14
72	Charnawati	Gothpani	23.50	17.40	6.09	3976.99	4025.49	1015.50	1024.76	4992.49	5050.25	57.76
73	Charnawati	Jugedarkha	125.60	101.50	24.10	23199.11	23482.03	4018.65	4055.31	27217.76	27537.33	319.57
74	Charnawati	Jyamire	70.01	58.38	11.64	13343.49	13506.21	1940.96	1958.66	15284.45	15464.88	180.43
75	Charnawati	Kalchhe	21.49	16.34	5.14	3734.71	3780.26	857.09	864.91	4591.80	4645.17	53.36
76	Charnawati	Kamalamai	71.81	15.31	56.50	3499.29	3541.97	9421.31	9507.26	12920.60	13049.22	128.62
77	Charnawati	Kopila	96.07	88.24	7.83	20168.37	20414.32	1305.64	1317.55	21474.01	21731.88	257.86
78	Charnawati	Kuprisalleri	42.03	1.61	40.42	367.99	372.47	6739.99	6801.47	7107.97	7173.95	65.97
79	Charnawati	Laliguras	35.53	10.33	25.20	2361.05	2389.85	4202.07	4240.40	6563.12	6630.25	67.13
80	Charnawati	Lodini	50.67	46.64	4.03	10660.16	10790.16	672.00	678.13	11332.16	11468.29	136.13
81	Charnawati	Mahabhir	50.26	48.00	2.26	10971.01	11104.80	376.85	380.29	11347.86	11485.09	137.23
82	Charnawati	Mahankal Sahele	39.38	26.69	12.69	6100.34	6174.73	2116.04	2135.35	8216.38	8310.08	93.70
83	Charnawati	Maitan harisiddi	28.35	3.51	24.85	802.26	812.04	4143.71	4181.51	4945.96	4993.55	47.59
84	Charnawati	Majhkharka Lisepani	174.18	145.73	28.44	33308.44	33714.64	4742.34	4785.60	38050.78	38500.23	449.46
85	Charnawati	Mathani	28.28	22.52	5.77	5147.23	5210.00	962.14	970.92	6109.37	6180.92	71.55
86	Charnawati	Napkeyanm	152.46	82.56	69.90	18870.14	19100.26	11655.74	11762.07	30525.88	30862.33	336.45

SN	Watershed	CF name	Total CF area [ha]	Area in dense [ha]	Area in sparse [ha]	Total carbon stock in dense strata [tC]		Total carbon stock in sparse strata [tC]		Total carbon in CF [tC]		Difference in total carbon [tC]
						2010	2011	2010	2011	2010	2011	
		ara										
87	Charnawati	Palung Mahila	10.28	0.32	9.96	73.14	74.03	1660.82	1675.97	1733.96	1750.00	16.04
88	Charnawati	Pauwa	58.64	41.92	16.72	9581.35	9698.19	2788.04	2813.47	12369.39	12511.67	142.28
89	Charnawati	Pokhari	23.60	18.00	5.60	4114.13	4164.30	933.79	942.31	5047.92	5106.61	58.69
90	Charnawati	Ramite	13.60	13.17	0.43	3010.17	3046.88	71.70	72.36	3081.87	3119.24	37.36
91	Charnawati	Salleri	92.27	26.69	65.58	6100.34	6174.73	10935.39	11035.15	17035.73	17209.88	174.15
92	Charnawati	Sanobothle	35.06	18.27	16.79	4175.84	4226.76	2799.71	2825.25	6975.55	7052.02	76.47
93	Charnawati	Setidevi Dadar	421.71	192.63	229.08	44028.03	44564.95	38198.82	38547.29	82226.85	83112.24	885.39
94	Charnawati	Shankadevi	305.26	247.40	57.86	56546.41	57235.99	9648.09	9736.10	66194.49	66972.09	777.60
95	Charnawati	Simpani	64.40	8.05	56.35	1839.93	1862.37	9396.30	9482.01	11236.23	11344.38	108.16
96	Charnawati	Simsugure	33.35	3.87	29.47	884.54	895.32	4914.09	4958.92	5798.63	5854.24	55.62
97	Charnawati	Sitakunda	141.31	15.72	125.59	3593.01	3636.82	20941.98	21133.03	24534.99	24769.85	234.86
98	Charnawati	Srijana	264.20	209.90	54.29	47975.31	48560.37	9052.79	9135.38	57028.10	57695.74	667.64
99	Charnawati	Sundarimai	12.98	4.51	8.47	1030.82	1043.39	1412.36	1425.25	2443.18	2468.64	25.46
100	Charnawati	Thansa deurali	124.37	59.08	65.29	13503.48	13668.16	10887.03	10986.35	24390.51	24654.51	263.99
101	Charnawati	Tharlange	203.97	183.92	20.05	42037.25	42549.89	3343.31	3373.81	45380.56	45923.71	543.14
102	Charnawati	Thumkadada	40.78	20.56	20.22	4699.25	4756.56	3371.66	3402.42	8070.91	8158.98	88.07
103	Charnawati	Thutemane	23.60	8.63	14.97	1972.50	1996.55	2496.23	2519.00	4468.73	4515.55	46.83
104	Charnawati	Timure tinsalle	67.10	23.49	43.62	5368.94	5434.41	7273.58	7339.94	12642.52	12774.35	131.83
105	Charnawati	Palekoban	1.49	1.03	0.45	235.42	238.29	75.04	75.72	310.46	314.01	3.56