Field Guide on
Forest Carbon Measurement

CPF

FGLG INDIA

Field guide on

Forest Carbon Measurement

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Centre for People's Forestry

About Us

Centre for People's Forestry (CPF) is National level Professional NGO, registered as a public trust in 2002, working for the forest dependent and dwelling communities. It is a non-profit, non-political and secular organisation working for the development of people in India, especially the deprived and marginalised sections irrespective of religion, race, caste or creed.

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Contents

Introduction

Forest is an essential component of many village ecosystems. The livelihood of communities residing in the villages adjoining forests is closely linked to the forests. Therefore monitoring the status of forests is an essential component of any natural resource monitoring programme. Details of total forest area, the tenure of the forest, changes in area over time as well as biomass or growing stock in the forest reflect the status of carbon stocks in the forest.

Community forest management in developing countries involves management of natural forests that would otherwise be degraded or deforested and producing carbon emissions. When communities participate in forest management in forests in their vicinity, they generally halt or reduce the rate of deforestation and degradation, and they allow the forest to regenerate, which enhances the forest sink. REDD+ policy would operate on the basis of overall national efforts to slow down loss of carbon from forests. With this mechanism the community managed forests projects could contribute to efforts under the forestry sector to form a country level REDD+ approach. It is probable that individual projects within the country would then be credited by the country's government depending on their mitigation levels in the commitment period. This requires that from the start of the project, monitoring is done to determine the standing stock in both the managed project area and unmanaged forests with similar conditions. At any accounting time the difference between the carbon emissions or removals from the without-project activities and the carbon emissions or removals for with-project activities represent the carbon value to be credited. This includes two processes: reduced degradation and forest enhancement i.e. carbon sequestration.

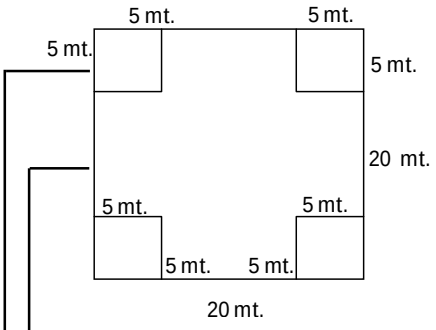
The fundamental requirement for any forestry project to participate in REDD+ policy is therefore to demonstrate its reduced levels of degradation and increased sequestration. Data for this can, in principle, be obtained through comparing a time series of forest inventories.

This field guide provides an approach involving local communities in forest carbon measurement and gives a step-by-step guidance to the procedures and techniques that need to be undertaken at field level. It explains the procedure for field level data collection, analysis to follow in a practical and simple way to estimate forest carbon. The guide aims at creating practical understanding in community forest carbon measurement.

1. Laying the Plot

Divide the forest into 3 or 5 types according to the area.

1. Dense Forest (Thick Forest)
2. Moderately dense forest
3. Degraded forest
4. Shrub forest
5. Open forest



Plot Layout

- Discuss with local community members / Vana Samrakshana Samithi (VSS) members and do the plotting accordingly.
- Number of plots to be made can be decided according to the total area of the forest.

- Plot size can be 20 mt × 20 mt or 50 mt × 50 mt as per the need
- Each plot is to be further divided into 5 mt × 5 mt size plots at the corners of plot.
- After marking the plot(s), make list of tree/shrub in the plot. Note down location of the plot, species local name/scientific name, girth size at breast height (GBH), height of the tree and other remarks (if required). Record all the information in the format as shown in Table -1.

Table - 1: Format to record field level data

S.No	Location	Plot ID	Species Name Local / Scientific)	GBH	Height	Other remarks *(if any)*
1	Sadunugarru	Plot01	Ficus mysorensis	85	21	
2	Buggulamamidi	Plot37	Santalum album	18	4	
3	Karripanasa	Plot11	Mangifera indica	500	15	
4	Sadunugarru	Plot08	Pongamia	4	2.3	
5	Baddemamidi	Plot7	Silver oak	2	2	

- All the vegetation which have the girth size above 10cm; height 1.5 meters or above are to be considered as 'trees'. Below 10cm girth size and height below 1.5 meters are to be considered as 'Shrubs'.
- In each plot, total Carbon Stock is to be estimated in the following pools:


Trees


Shrubs


Litter


Deadwood


Soil

Fig: 1

2. Estimation of Carbon Stock in Trees:

☞ ***Activity:***

- Make the list of identified trees to measure carbon stock. (Follow the criteria as mentioned to demark trees and shrubs).
- Measure Girth size at Breast Height (GBH) in '*centimeters*' of all the identified trees in the plot. Record the reading in note book.
- By using 'Altimeter', measure height o f all the identified trees in the plot. Record the reading in '*meters*'.

Altimeter:

Tree height determination requires altimeter readings of both tree top and base levels. The values will be added if they have the opposite sign and subtracted from one another if they have the same sign.

The *altimeter* has five scales – two for the heights graduated to distances, one for the degrees, one for the slope correction and one for the slope percent.

Operation of altimeter is as follows:

- Measure 20/30 m distance from the base of the tree in a direction such that top and bottom are visible.
- Hold the instrument firmly in one hand, support with other hand and sight the top / bottom of the tree through eye (the instrument holding side) with other eye closed.
- After the top / bottom is sighted, close sighting eye, open other eye and observe the needle to stabilize. Click the locking pin gradually without shaking the instrument.
- See the appropriate scale in the altimeter and note down the reading.

- The following cases may be encountered while measuring tree height.

  On a Flat ground: Record the top height and add the height of the eye level.

  Total Height = Top Height + Height of the eye level.

  On a Sloping Ground: Height of the tree top and bottom has to be recorded.

a: If the observer is on the downhill side and below the base of the tree, then subtract the base value from top value.

Total Height = Top Height – Bottom Height.

b: If the observer is on the uphill side and above the base of the tree, then add the base value to the top value.

Total Height = Top Height + Bottom Height.

c: If the observer is on the uphill side and above the base and top of the tree, then subtract the top value from base value.

Total Height = Bottom Height - Top Height.

- Note down the location of plot, plot ID (give a number to each plot. Example: 'Plot-1'), species identified in the plot (local name and scientific name).
- The following readings are to be calculated to estimate carbon stock in trees –

1. Girth size at Breast Height (GBH)
2. Dia at Breast Height (DBH)
3. Bole Volume
4. Bole Biomass
5. Non-bole Biomass
6. Above Ground Biomass (AGB)
7. Below Ground Biomass (BGB)
8. Total Biomass
9. Total Carbon
10. Total Carbon Dioxide

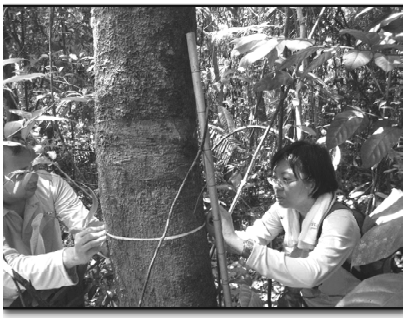


Fig 2: GBH Measurement

⇨ ***Calculations:***

Example: ***Ficus mysorensis***

1. GBH is to be measured with tape (in centimeters)

Requirements for measuring GBH: Measuring tape, paint and brush.

Steps involved in measuring GBH:

Step 1: Make a mark 1.3 meter above ground on tree trunk as a circle.

Step 2: Place the tape along the painted circle, measure and note down the Reading.

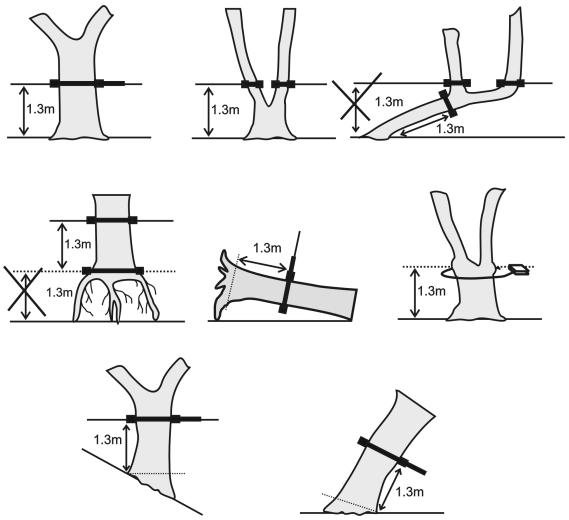


Fig 3 : *Illustration of GBH measurement for different shapes and types of trees*

2. Dia at Breast Height (DBH) can be calculated by using the following formula-

Dia at Breast Height (DBH) = (GBH × 7/22)/100

Example: Species = ***Ficus mysorensis*** ;

GBH = 85cm

DBH of Ficus mysorensis = (85 × 7/22)/100 = 0.27

3. Bole Volume can be calculated by using species specific volume equation[1]. To get the bole volume, take the species specific volume equation from the book '*Volume Equations for Forests of India, Nepal and Bhutan*' and multiply with DBH.

Example: Species = ***Ficus mysorensis.***

Species specific volume equation for Ficus mysorensis

= 0.03629 + 3.95389 DBH – 0.84421Sqrt DBH^2

Therefore -

Bole Volume = ((0.03629)+(3.95389x0.27) – (0.84421*SQRT(0.27)))^2

= 0.44436

If 'species specific volume' is not defined, use the following 'General volume equation proposed by Brown et al'.

General volume equation 'Brown et al' =

EXP ((-1.996) + ((2.32) × (LN (DBH value))))

[1] 'Species specific volume equation' can be taken from the book '*Volume Equations for Forests of India, Nepal and Bhutan*', published by Forest Survey of India, Ministry of Environment and Forests, Government of India.

Example: *Species* = ***Pongamia pinnata***
DBH Value = 0.1495
= EXP ((–1.996)+((2.32) x(LN (0.1495))))
= 0.00165

4. Bole Biomass can be calculated by using Wood Density Value[2] -

Bole Biomass = Wood Density × Bole Volume

Example: Species = ***Ficus mysorensis.***
Wood Density value = 0.39
Bole Volume = 0.44436
Bole Biomass = 0.39 × 0.44436 = 0.1733

If 'General volume equation' is used for bole volume or if wood density value is not standardized for any species, then consider wood density value as '1(one)'. Then apply the following formula -

Bole Biomass = Bole Volume / 1000

Example: Species = ***Pongamia pinnata.***
Wood Density value = 1
= 1 / 1000 = 0.001

5. Non-Bole Biomass can be calculated by using the following formula -

Non-Bole Biomass = Bole Biomass × 1.6

Example: Species = ***Ficus mysorensis***
Bole Biomass = 0.1733
Non-Bole Biomass = 0.1733 × 1.6 = 0.277281

6. Above Ground Biomass (AGB) can be calculated by using the following formula -

Above Ground Biomass (AGB) = Bole Biomass + Non-Bole Biomass

Example: Species = ***Ficus mysorensis;***
Bole Biomass = 0.1733;
Non-Bole Biomass = 0.277281
Above Ground Biomass = 0.1733 + 0.277281
= 0.450581

[2] Standard Wood density values for tree species from tropical America, Africa, and Asia are defined by FAO. Hence the specific 'wood density values' can be taken from the list. The list is available 'http://www.fao.org/docrep/w4095e/w4095e0c.htm#TopOfPage'.

7. Below Ground Biomass (BGB) can be calculated by using the following formula -

Below Ground Biomass (BGB) = 0.26 × Bole Biomass

Example: Species = ***Ficus mysorensis;***
Bole Biomass = 0.1733
Below Ground Biomass = 0.26 × 0.1733
= 0.04506

8. Total Biomass can be calculated by using the following formula -

Total Biomass = AGB + BGB

Example: Species = ***Ficus mysorensis***
AGB = 0.450581
BGB = 0.04506
= 0.450581+ 0.04506= 0.49564 tonnes

9. Total Carbon can be calculated by using the following formula -

Total Carbon = Biomass / 2

Example: Species = ***Ficus mysorensis***
= 0.49564/2 = 0.24782 tonnes

10. Total Carbon Dioxide can be calculated by using the following formula -

Total Carbon Dioxide = Carbon × 3.6

- Follow the procedure as shown (for 'GBH measurement' to 'Total Biomass') for each tree from each plot in all locations in the sample.
- Sum the total carbon in trees in each location.
- Explorate the total carbon to the sampled area and also to the total tracked forest area to get the total carbon in forest.
- Record all the data (data collected from field and analysed data) as shown in ***Table:2***

3. Estimation of Carbon Stock in 'Shrubs':

☞ ***Activity:***

- Make list of identified shrubs to measure carbon stock. (Follow the criteria as mentioned to demark trees and shrubs)
- Measure Girth size at Breast Height (GBH) in '*centimeters*'. Record the reading in note book.
- Measure shrub height in '*meters*'. Record the reading in note book.
- Location of plot, plot ID, corner number, species identified in each corner (local name and scientific name) to be noted down in note book

Table - 2: Format for consolidation of data (field data & calculated data)

Location	Plot ID	Species Name	GBH in cm	Height in cm	DBH in cm	Bole Vol cubic m spp. Specific	Wood density	Bole biomass in tonnes	Non bole biomass in tonnes	AGB in tonnes	BGB in tonnes	Total biomass tonnes
Baddemamidi	Plot7	Pongamia pinnata	23	7	0.07318	0.00032	1	0.001	0.0016	0.0026	0.00026	0.00286
Baddemamidi	Plot8	Eucalyptus tereticornis	40	11	0.12727	0.06013	0.51	0.0307	0.049069	0.07973	0.00797	0.08771
Sadunugarru	Plot01	Ficus mysorensis	85	21	0.27045	0.44436	0.39	0.1733	0.277281	0.45058	0.04506	0.49564
Sadunugarru	Plot27	Santalum album	19	4	0.06045	0.00020	1	0.001	0.0016	0.0026	0.00026	0.00286
Karripanasa	Plot06	Cassia fistula	20	6	0.06363	0.07263	0.69	0.0501	0.08017	0.13029	0.01303	0.14332
Karripanasa	Plot011	Mangifera indica	40	4	0.12727	0.00114	1	0.001	0.0016	0.0026	0.00026	0.00286
Raimamidi	Plot34	Ficus indica	50	5	0.15909	0.10797	0.39	0.0421	0.06737	0.10948	0.01095	0.12043
Samasenumamidi	Plot64	Terminalia alata	26	5	0.082727	0.00042	1	0.001	0.0016	0.0026	0.00026	0.00286
Jarribalaku	Plot63	Ficus tomentosa	18	5	0.05727	0.00369	0.39	0.0014	0.00230	0.00373	0.00037	0.00411
Lanke	Plot51	Artocarpus heterophyllus	159	11	0.50590	1.58385	0.58	0.9186	1.46981	2.38844	0.62099	3.00943

To estimate carbon stock in shrubs, the following readings are to be calculated -

1. Girth size at Breast Height (GBH)
2. Dia at Breast Height (DBH)
3. Height of the shrub
4. Bole Volume
5. Bole Biomass

⇨ ***Calculations:***

1. GBH is to be measured with tape (in centimeters)

2. Dia at Breast Height (DBH) can be calculated by using following formula- Dia at Breast Height (DBH) = ((GBH × 7/22)/100)/2

Example:	Species	=	***Sapindus mukorossi (Soapnut)***
	GBH	=	6cm
		=	((6×7/22)/100)/2 = 0.009545

3. Height of the shrub is to be measured in '*meters*' by using 'Altimeter'

Example:	Species	=	***Sapindus mukorossi (Soapnut)***
	Height	=	2 mts

4. Bole Volume can be calculated by using following equation -

Bole Volume = ((22/7) × (DBH^2) × Height)

Example:	Species	=	***Sapindus mukorossi (Soapnut)***
	DBH	=	0.009545
		=	((22/7) × (0.009545^2) × 2 = 0.0005727

5. Bole Biomass can be calculated by using following equation -

Bole Biomass = Bole Volume × 0.5

Example:	Species	=	***Sapindus mukorossi (Soapnut);***
	Bole Volume	=	0.0005727
		=	0.0005727 × 0.5 = 0.000286364

- Calculate biomass in shrubs from each plot and each location of the sampled area.
- Sum the total biomass in each location.
- Multiply the total biomass (location wise) with area of the plot (total area of the corners) to get the biomass in tonnes per hectare per location.
- Minus 60% of the value from total biomass value, as moisture content in shrubs.

- The average value of all locations (after deducting 60% moisture value) is the biomass in shrubs in (of all locations) total plots in the sampled area.
- Multiply the average value with sampled area and then proportionate to the total forest area to get total biomass in tonnes in the forest area tracked.
- Total biomass in tonnes divided by '2' is the total carbon in shrubs in the forest.

Table - 3: Data of NeelamputtuVSS

Location	Biomass in t	Biomass in tonne/ hectare	Biomass in tonne/ hectare (Less 60% moisture)
Baddemamidi	0.013929364	1.39	0.557174545
Buggulamamidi	0.004146534	0.41	0.165861373
Dabbagaravu	0.006774155	0.68	0.270966214
Gondhigarru	0.00247271	0.25	0.098908409
Gummalamamidi	0.018470614	1.85	0.738824545
Jantiremamidi	0.010169449	1.02	0.406777955
Jarribalaku	0.002704774	0.27	0.108190966
Karripanasa	0.005496392	0.55	0.219855682
Lanke	0.012764938	1.28	0.5105975
Muntamamidi	0.000608344	0.06	0.02433375
Raimamidi	0.050088595	5.01	2.003543786
Sadunugarru	0.047270111	4.73	1.890804427
Samasenu mamidi	0.009200983	0.92	0.368039318
Average shrub biomass in t/ha			**0.5664522**

4. Estimation of Carbon Stock in 'Litter':

☞ ***Activity:***

- Location of plot, plot ID, corner number to be noted down in note book.
- Collect litter from each plot and weigh the same immediately and after drying it, record both the readings in note book.
- To estimate carbon stock in 'litter', the following readings are to be calculated -
  1. Fresh weight in grams
  2. Dry weight in grams
  3. Difference in weight (before and after dry)
  4. Moisture content
  5. Dry weight percentage
  6. Variance in weight
  7. Biomass in litter (in tonnes)

⇨ Calculations:

Table - 4: Data of NeelamputtuVSS

Plot No.	Corner No.	Wet Weight	Dry Weight	Dry Weight_1 in gms	Dry Weight in gms_1	Dry Weight	Moisture content	Dry%	Variance%
10	C1	900	805	670	660	610	290	67.78	32.22
	C2	1000	950	790	785	705	295	70.50	29.50
	C3	800	645	500	493	430	370	53.75	46.25
	C4	700	580	395	384	310	390	44.29	55.71

1. Fresh weight is to be measured by using standard balance.
2. Dry weight is to be measured after 48 hours of collecting the litter. Repeatedly weigh the dry litter until the static unit is reached. Record both fresh and dry weight. Also record the difference in weight.
3. Moisture content can be calculated by using the following formula -

   Moisture = Wet weight – Dry weight

   Example: (from the readings of corner 1 in **Table :4**) = 900-610 = 290 gms
4. Dry percentage can be calculated by using following formula –

   Dry percentage = (Dry weight / Wet weight) × 100

   Example: (from the readings of corner 1 in **Table :4**) = (610/900) × 100 = 68%
5. Variance in weight can be calculated by using following formula –

   Variance in weight = 100 – Dry percentage

   Example: (from the readings of corner 1 in **Table :4**) = 100-68 = 32%
6. Biomass in litter can be calculated by using the following formula-

   Biomass in litter = Dry weight of litter (in all plots) / 1000000

   Example: (from the readings of plot 10)

   Total Dry weight = 2055 gms

   Biomass in litter = 2055/1000000 = 0.00206 tonnes

- Calculate biomass in litter from each plot and each location of the sampled area.
- Sum the total biomass in each location.
- Multiply the total biomass (location wise) with area of the plot (total area of the corners) to get the biomass in tonnes per hectare.
- The average biomass value of all locations is the biomass in litter in the total plots of sampled area.
- Multiply the average value with sampled area and then proportionate to the total forest area to get total biomass in tonnes in the forest area tracked.
- Total biomass in tonnes divided by '2' is the total carbon in litter in the forest.

Table -5: Data of Neelamputtu VSS

Location	Biomass in t	Biomass in Tonne/ha
Baddemamidi	0.002055	0.21
Dabbagaravu	0.001955	0.20
Gondhigarru	0.001015	0.10
Gummalamamidi	0.00172	0.17
Jantiremamidi	0.00242	0.24
Raimamidi	0.00191	0.19
Sadunugarru	0.00333	0.33
Average litter content of the forest in t/ha		0.21

5. Estimation of Carbon Stock in 'Deadwood':

☞ ***Activity:***

- Location of plot, plot ID to be noted down in note book.
- Note down list of the deadwood, species name (local and scientific) in each corner of the plot.
- To estimate carbon stock in 'deadwood', following readings are to be calculated -
  1. Girth in centimeters
  2. Height in meters
  3. Dia at Breast Height (DBH)
  4. Bole Volume
  5. Biomass in tonnes

Fig 4: Deadwood

➪ ***Calculations:***

1. Girth in centimeters to be measured at centre point of deadwood.

   Example: Silver oak Girth in centimeters = 32 cms

2. Height of deadwood to be measured in '*meters*'.

   Example: Silver oak Height = 5 meters

3. Dia at Breast Height (DBH) can be calculated by using following formula -

   Dia at Breast Height = ((GBH × 7/22)/100)

Example: Silver oak GBH = 32 cms

Dia at Breast Height = ((32 × 7/22)/100)

= 0.10182

4. Bole Volume can be calculated by using following formula -

Bole Volume = ((22/7) × (DBH^2) × Height)

Example: Silver oak DBH = 0.10182

Bole Volume = ((22/7) × (0.10182^2) × 5 = 0.16290

5. Biomass in tonnes can be calculated by using following formula-

Biomass = Bole Volume × 0.5

Example: Silver oak; Bole Volume = 0.16290

Biomass = 0.16290 × 0.5 = 0.08145

- Calculate biomass in deadwood from each location of the sampled area.
- Sum the total biomass in each location.
- The average biomass value of all locations is the biomass in litter in the total plots of sampled area.
- Multiply the average value with sampled area and then explorate to the total forest area to get total biomass in tonnes in the forest area tracked.
- Total biomass in tonnes divided by '2' is the total carbon in deadwood in the forest.

Table -6: Data of Neelamputtu VSS

Location	**Total Biomass in Tonnes**
Baddemamidi	0.012727273
Jantiremamidi	0.032653409
Karripanasa	0.010034659
Raimamidi	0.003977273
Sadunugarru	0.041335795
Samasenu mamidi	0.002784091
Average dead wood biomass in t/ha	**0.017**

6. Estimation of Carbon Stock in 'Soil':

☞ ***Activity:***

- Identify suitable location for soil sample in each plot.
- Dig soil with the help of scoop, make 'V' shape in 30 cm depth and collect the sample from each plot.
- Keep the sample soil on a plain glass or paper in a round shape and divide into 4 equal parts as shown in **Fig: 5**. Take the 1st and 4th part and again divide it into 4 equal parts, now take 2nd and 3rd part of the sample. Repeat same exercise until the total sieved dry sample reaches 200 gr.
- Seal the sample in a tight moisture resist pouch and send it to scientific lab for the estimation of 'Soil Organic Carbon' (SOC).

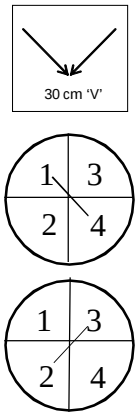


Fig: 5

Estimation of bulk density in soil sample:

- Weigh the empty bottle (of the bulk density kit) and record the value as '**W1'**. (ensure that the bottle should not contain moisture/water)
- Fill the sieved soil up to the mark on the bottle. Weight the bottle with soil and record the value as '**W2'**.
- Empty the bottle and fill with water up to the mark. Transfer the water to measuring jar and record the reading as '**V'**.

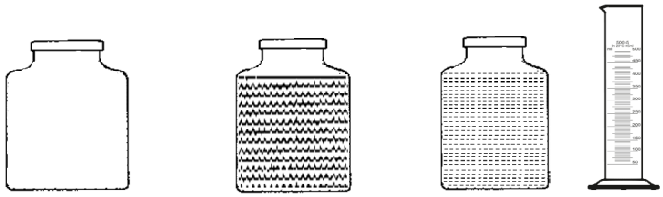


Fig 6: Bulk density kit

Estimation of total carbon in soil sample:

- To estimate the soil carbon in tonne per hectare area, the following readings are to be calculated -
  1. Area in square centimeter (sq.cm)
  2. Bulk density in gm/cm3
  3. Bulk density in t/m3
  4. Soil Organic Carbon in %
  5. m3 of soil in a hectare area
  6. Organic Carbon in t/m3

7. Organic Carbon in t/hectare
8. Average Organic Carbon (in each forest type) in t/hectare
9. Total Forest (in Hectares)
10. Total Organic Carbon in the forest (for each type of Forest)

➪ ***Calculations:***

1. Area in square centimeter (sq.cm) to be calculated according to the size of the plot. If 20x20 plot, the total area in sq.cm is 400, if it is 50 × 50 the area is 2500sq.cm
2. Bulk density in gm / cm3 to be calculated by using the following formula -

   Bulk density = (W2-W1) / V
3. Bulk density in t/m3: Note: When the bulk dentistry value is converted into t/m3, the value is numerically same. Hence for calculations of Organic Carbon, the bulk density in gm/cm3 can be directly used as bulk density in t/m3.
4. Soil Organic Carbon in %: This value is to be collected from the scientific lab, where the sample is submitted
5. m3 of soil in a hectare area: Sine the standard depth for the soil sample is 30cm, the same can be multiplied with 100 to get the m3 of soil in a hectare area.
6. Organic Carbon in t/m3 to be calculate by using the following formula-

   O.C in t/m3 = (Bulk density in gm/cm3 × Soil Organic Carbon)/100
7. Organic Carbon in t/hectare to be calculated by using the following formula -

   O.C in t/hectare = m3 of soil in a hectare area × Organic Carbon in t/m3
8. Average Organic Carbon (in each forest type) in t/hectare: Take the average value of the 'Organic Carbon in t/hectare' for each type of forest.
9. Total Forest (in Hectares): This value is the forest in hectares from the total track of the forest.
10. Total Organic Carbon in the forest = Total forest area (of all the forest type) × Average Organic Carbon in t/hectare (in the sample).

EXAMPLE

CARBON STOCK ESTIMATION IN NEELAMPATTU VSS, VISAKHAPATNAM - A PARTICIPATORY APPROACH

CPF has organized estimation of carbon stock in Neelampattu Vana Samrakshana Samiti (VSS) forest by involving VSS members of the Neelampattu village in Visakhapatnam district.

Quick facts of the estimation exercise:

- VSS forest extent: 200 hectares
- Sample size:10% of the forest extent (20 ha)
- Establishment of VSS : 1997
- Number of households: 80
- Population: Male =169: Female = 210
- Period of data collection: February to July, 2010

Methodology

- Ten VSS members were identified in the general body meeting of VSS and training conducted for this purpose. Theory and technical sessions were organized to train them on procedures for sampling and data collection. They were also explained the purpose of the data collection and its relevance.
- Further, CPF team associated with community in data collection at specific intervals with regular monitoring and validation of collected data.
- The estimation of carbon stock was then done for the sample (20 ha) and extrapolated to the total VSS forest.
- The methodology adopted for estimating the carbon stock is drawn from the IPCC 2003 and 2006 guidelines. Primary data was collected from a 10% sample of the total VSS forest using quadrate method. Data was collected for a total of four carbon pools - above ground biomass (trees), soil, litter and deadwood. Below ground biomass (roots) was estimated using IPCC conversion factor. Other conversion factors such as volume of bole and non bole biomass, biomass density and carbon content in wood was adopted mostly from IPCC and relevant peer-reviewed literature.

Laying of quadrats for data collection

Estimating height of trees using altimeter

Collecting litter samples

Table -7: **Results**

Carbon Pools	Biomass in tonnes	Biomass carbon in tonnes
Tree	3258	1629
Shrubs	113.2	57
Dead Wood	3.4	1.7
Litter	41.1	20.5
Total Biomass carbon in tonnes/200 ha	**3416**	**1708.3**
The total Soil Organic Carbon of Neelampattu VSS		**5532 tonnes**

The 'net carbon stock' of Neelampattu VSS = Total Biomass carbon + Total Soil Organic Carbon

That is = 1708 tonnes + 5532 tonnes = 7240 tonnes for 200 ha

Table -8: **Proportional Abundance (%)**

S. No.	Species Name	Vernacular	Proportional Abundance (%)
1	Eucalyptus tereticornis	Nilagiri (Eucalyptus)	20.78
2	Grevillea robusta	Silvary (Silver oak)	18.16
3	Santalum album	Gandham (Sandal wood)	15.15
4	Mangifera indica	Mamidi (Mango)	9.30
5	Syzygium cumini	Neredu (Black plum)	7.08
6	Pongamia pinnata	Kanuga (Pongamia)	3.49
7	Rottera tinctora (Scarlet croton)	Kumkumachettu	2.02
8	Terminalia alata	Nalla Maddi (Indian laurel)	1.90
9	Artocarpus heterophyllus	Panasa (Jackfruit)	1.66
10	Cylissus pinnatus	Kagi (Indian beech)	1.14
11	Other 96 species		19.33

Forest area

Collecting soil samples

Biodiversity indices for Neelampattu VSS forest

- ✓ Total number of different species recorded: 106
- ✓ Total number of individuals (of all species) recorded: 3321

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