

**India's proposed
Submission on Forest Reference Levels for REDD+
Result based Payments under UNFCCC**

Report on the Project “Development of Forest Reference Level for REDD+ in India”

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Forest Reference Level for REDD+ in India

1. Introduction

REDD+ refers to reducing emissions from deforestation and forest degradation in developing countries, combined with conservation, sustainable management of forests and enhancement of forest carbon stocks. Abatement of forest-based CO₂ emission is critical to limiting global warming. The UN's Intergovernmental Panel on Climate Change (IPCC) estimated in 2007 that the forest sector and other sectors that impact land use – through deforestation, forest degradation and other changes in forests – contribute approximately 17% of global greenhouse gas (GHG) emissions or approximately 5.8 Gt of carbon dioxide equivalent (CO₂eq), per year. As per the latest Assessment Report 5 (AR 5) of IPCC, the AFOULU sector contributes about 20-24 % of total emission. These emissions are mainly taking place in tropical developing countries.

The Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) adopted at its sixteenth session (COP-16) a milestone decision on Reducing Emissions from Deforestation and Forest Degradation (REDD+). This decision encourages developing countries to develop a “National Forest Reference Emission Level (REL) and/or National Forest Reference Level (RL) or, if appropriate, as an interim measure, sub-national REL and/or RL, in accordance with the national circumstances”. REL and RL serve as benchmark for assessing performance of implementation of REDD+ in a country. A country which undertakes to reduce emissions from deforestation by checking deforestation and forest degradation will be using REL as the benchmark to assess progress of its performance. On the other hand, RL is relevant benchmark when a country undertakes to increase removals by increased carbon sequestration by its forests.

This decision necessitates the development of a National Forest Reference Emission Level (REL)/ Forest Reference Level (RL), adjusting for national circumstances, if required. The Ministry of Environment, Forest and Climate Change has given a project to Forest Survey of India to Development of Forest Reference Level for REDD+ in India in January 2015.

2. National Circumstances

2.1 Forest Governance and Management Regime

India is one of the 12 mega diversity countries having a vast variety of flora and fauna, commanding 7% of world's biodiversity and supporting a variety of forest

types, varying from the alpine forests in the Himalayas thorn forests in the hot deserts, from dry deciduous forests to wet evergreen forests and mangroves. There are 16 forest type groups and 221 forest types in India. Having about 2.5% of the world's geographic area and about 2% of forest area, India at present is supporting 16% of the planet's human population and 18% of the cattle population. The total forest cover of the country is 69.79 mha (21.23% of the geographical area), as per India State of Forest Report, 2013 (SFR 2013). The country has very low per capita forest cover of 0.06 ha. The forest cover in the country is not uniform and varies in different States and regions. Mainly it is concentrated in Himalayas, north eastern states, central India and Western Ghats.

The energy from wood resources is an important parameter to define the social functions performed by the forests. This social function of the forests has been given due consideration, while judging the sustainability of forest resources and preparing management plans. The human population using the fuelwood as main source of cooking is 854 million (Annexure-5). Similarly, grazing and collection of fodder for livestock in forest not only help them to feed but provide a ground for breeding as well. Certain tribal communities keep herds of cattle & sheep. The number of such cattle & sheep are considered as status symbol in their communities. Such communities though do not have their own grazing ground for the cattle, they depend largely on forest. Hence, the dependence of human & cattle population on forests speaks about the social function of forests. As per ISFR 2011, the dependence of biomass consuming livestock on forest is about 37 percent (Annexure-6).

2.2 Governance:

India has a comprehensive policy and legislative framework for guiding forest conservation and management across the country. The subject "Forestry" falls in the concurrent list of Schedule-VII of the Constitution of India, empowering both- State and Central Governments to legislate on the subject. The management and protection of forests is the responsibility of State Governments, whereas the Central Government provides policy framework and guidelines from time to time. The principal aim of National Forest Policy, 1988 (NFP 1988) is to ensure environmental stability and maintenance of ecological balance including atmospheric equilibrium which are vital for sustenance of all life forms- human, animal and plant. The Policy subordinates the derivation of direct economic benefit to this principal aim of respecting environmental concerns. The Indian Forest Act, 1927 provides for law relating to forests, transit of forest produce, duty leviable on timber and other forest produce, and also empowers forest officers with relevant mandate and authority to ensure forest protection. The Forest (Conservation) Act, 1980 regulates diversion of forest land for non forestry purposes. The average annual diversion of forest land after the Act is about 36,560 ha where as prior to Act it was 165,200 ha. Wild Life Protection Act, 1972 is the main legislation guiding conservation, management and development of wildlife and its habitat in the country. Recently, enacted "The Scheduled Tribes and Other Traditional Forest Dwelling Communities (Recognition of Forest Rights) Act, 2006", aims to recognize and vest the forest rights and

occupation in forest land on forest dwelling Scheduled Tribes and other traditional Forest Dwellers, who have been residing in such forests for generations. This legislation has also empowered forest dwelling communities enabling them to manage and conserve forest resources. The NTFP sector has good potential in creating jobs and supplement income of local poor people by way of enhancing the Non Timber Forest Products (NTFP) resource base, by modernizing processing and improving the market access for finished products. The Biological Diversity Act, 2002 also provides framework for biodiversity conservation along-with providing access and benefit sharing among the local communities.

2.3 Forest Management:

The scientific forest management in India dates back to mid 19th century. The first planned working of forest in the country started way back in 1837 in Travancore. Uniform countrywide approach towards the preparation of Working Plans for scientific management of forests was started in 1884. After independence in 1947, a huge thrust on scientific management was given for conservation and development of forests. Basically, Indian forests are managed on the principle of sustainability and conservation. Therefore, the production from recorded forest area is very meagre around 2.0 to 3.0 million tonnes per year (Annexure-2). All management activities are carried as prescribed in concerned working plans. The working plans are written for Recorded Forest Area which has legal connotation of forest (Annexure-4).

Since late seventies, after realizing the importance of conservation of natural forest, India has started tree plantation outside the forest to meet the fuel, fodder and timber demands of people. Community participation was encouraged and many village level committees came into being. Private sector also started tree plantation to produce raw material for wood based industries. Individuals started growing trees in their agricultural field or homesteads. Governmental initiative led to tree plantations along roads, railways, canals and on governmental lands. In urban areas, trees came up in parks, gardens, institutional areas etc. for providing aesthetic and environmental services. Recently India has come out with National Agroforestry Policy 2014 to provide impetus for planting trees. As a result of all above efforts the country is producing 42.8 million m³ industrial wood (Annexure-3) meeting more than eighty percent of demand from industries. Recognizing its importance, National Working Plan Code 2014 (NWPC 2014) recommends conducting TOF inventory in respective forest divisions.

The working plans are prepared as per the existing NWPC 2014 administered by the Ministry of Environment, Forests and Climate Change (MoEF&CC), Government of India, and are usually valid for a 10 year period. The Working Plan Officer prepares the draft working plan which after approval of the State Government is sent to the Regional Office of the MoEF&CC for obtaining approval of the Central Government.

The day to day management of forests is the responsibility of the State Forest Departments of respective State/UT Governments, who are also responsible for the protection, conservation, administration and development of forests.

India has developed a strong network of Protected Areas (PAs) covering 16.12 m ha (as on September, 2011; Forest Sector Report India 2010) of the country's geographical area including National Parks (102), Wildlife Sanctuaries (515), Conservation Reserves (47) and Community Reserves (4), these are the repository of rich flora and fauna of the country. The Wildlife Institute of India (WII) imparts training to the forest officers and scientists in protected area management. Each National Park and Wildlife Sanctuary is managed as per approved management plan.

There are more than 300 million forest dependent people including around 87 million tribals, deriving their livelihood and substantial part of their income from forests. India started Joint Forest Management (JFM), a partnership between local communities and the Forest Department in the nineteen eighties following the "Care and Share" principle. More than 100 thousand JFM Committees involving around 20 million people are managing approximately 22 mha of forest area. JFM has contributed significantly in stabilizing forest and tree cover of the country. There is a great scope for improvement of forest cover by addressing drivers of forest degradation with people's participation and cross-sectoral support.

3.0 Information on Forest Reference Level:

The process of developing RL draws strength from data and information from FSI's National Forest Monitoring Systems (NFMS) which provide information for Monitoring Reporting and Verification (MRV). The NFMS provides forest-related emissions by sources and removals by sinks. At the same time it will provide results from implemented REDD+ activities and their emissions/removals in national Green House Gas (GHG) inventories. As pointed out above that RL(s) are benchmarks used to assess the performance of REDD+ implementation. The comparison of MRV emission estimates coming from REDD+ implementation with the RL(s) will indicate the performance of REDD+ activity. Therefore, the definitions, methodologies, scope etc followed in MRV and RL are kept same for consistency and comparability (Decision 14/CP.19). The available data and information about forest area, change in area and GHG inventories was analysed and necessary calculations and changes were carried out in order to construct relevant RL.

3.1 Scope: Activity, Pool and Gases

Annex (c) to Decision 12/CP.17 (Guidance on systems for providing information on how safeguards are addressed and respected and modalities relating to forest reference emission levels and forest reference levels as referred to in decision 1/CP.16) which says "Pools and gases, and activities listed in decision 1/CP.16, paragraph 70, which have been included in forest reference emission levels and/or forest reference levels and the reasons for omitting a pool and/or activity from the construction of forest reference emission levels and/or forest reference levels, noting that significant pools and/or activities should not be excluded;"

For construction of FRL, the activity taken is "Sustainable Management of Forest (SMF). By analysing the forest cover assessment between 2000 to 2008, it has been observed that, activities such as deforestation, forest degradation, enhancement of

canopy densities and afforestation (leading to enhancement of carbon stocks) have been observed in significant forest area (a change matrix has been given in Annexure-6 to illustrate the change in area under different category). The new area, which is annually brought under forest as per definition, is slightly more than the area which is harvested and as per definition goes out of forest activity. Similarly, the extent of forest which is experiencing enhancement in canopy densities is slightly more than the extent of forest which is experiencing degradation. It is primarily, output of practicing of sustainable management of forests which is followed all over the country. Moreover in India “All forests are to be managed under the prescriptions of a working plan/scheme which are prepared on the basis of principles of sustainable management of forests; conservation and development of biodiversity; maintenance and enhancement of ecosystem services including carbon sequestration; and the participation of local people in planning and management of forest resources”-(National Working Plan Code, 2014) Due to this reason, the activity Sustainable Management of Forest has been taken as activity for construction of FRL.

Regarding pools to be selected, all the five pools namely Above Ground Biomass, Below Ground Biomass, Dead Wood and Litter and Soil Organic Carbon have been selected for construction of FRL because, India has a time series good quality data through regular National Forest Inventory programme for all the pools. Only CO₂ gas has been taken into account for construction of FRL.

3.2 Definition of forest

The forest definition used for the construction of the RL should be consistence with definition used for GHG inventory (Decision 13/CP.19, Annex, paragraph 2 (g)). The definition of forest in Indian context is the same as used for GHG inventory and given as follows:

“All lands, more than one hectare in area, with a tree canopy density of more than 10 percent irrespective of ownership and legal status. Such lands may not necessarily be a recorded forest area. It also includes orchards, bamboo and palm.”

3.3 Data:

The activity data and emission factors have been derived from NFMS. India is assessing its forest cover since 1987 using remote sensing satellite data. Over the years, many technological advancement have been taken place in the field of remote sensing and mapping. FSI kept pace with rapidly changing technology and improved its assessment over the years. The results are published in successive India State of Forest Report, a biennial publication of FSI, MoEF & CC. The activity data taken for construction of FRL is forest cover assessment since 2000. In addition, inventory of forest resources of the country on a regular basis is another important activity of FSI. It collected data on different parameters from about 17000 sample plots in both forest and TOF every cycle. The inventory data of 2002 to 2008 has been taken for deriving the emission factors.

3.4 Scale:

The activity data used for construction of FRL is based on wall-to-wall mapping using satellite data and emission factors derived from national forest inventory spread over entire country. Accordingly, the FRL has been constructed for the entire country.

3.5 Methodology of construction of FRL:

Country has to submit information and rationale on the development of their RL (Decision 12/CP. 17, II, paragraph 9; Decision 13/CP.19, Annex, paragraph 2 (c)). The **historical method to calculate RL has been considered**. FSI has been monitoring and reporting forest area and has also initiated estimation of forest carbon stocks. FSI has adopted the stock change method for calculating forest carbon stocks, which is appropriate keeping in view the expertise, availability of historical data, and regularity of assessments. Details of methodology is narrated in following paragraphs.

The calculation of GHG inventories require information on extent of an emission/removal category termed as 'Activity data' and emission or removal of GHG per unit of area (emission/removal of CO₂ per ha of forest area) termed as 'Emission factors' as per the 'Good Practices Guidance' (GPG) developed by Intergovernmental Panel on Climate Change (IPCC). The methodology used by FSI for activity data and emission factors has been described in the following paragraphs.

3.5.1 Activity data:

Forest Survey of India (FSI) has a long experience of forest cover mapping using wall to wall satellite data. This activity was started by FSI in 1987 using Landsat (MSS) imagery with 80 m resolution. The technique of interpretation was visual and scale of mapping was 1:1 million. The on screen interpretation was followed by extensive ground trothing. The forests were classified into two canopy classes namely dense forest (crown cover of more than 40%) and open forests (crown cover between 10-40%). Mangroves were delineated as a separate class. Degraded forests having crown cover of less than 10% were classified as scrub (a non-forest category). During the successive assessment, a lot of improvement were took place because of availability of better satellite data and higher mapping scale. However, there was a major methodological improvement since 2000. FSI switched over to digital interpretation of the satellite data with spatial resolution of 23.5 meters with scale of mapping at 1:50,000. As a result, the minimum mappable unit has been reduced to 1.0 ha and it was possible to report forest cover figures in three density classes namely Very Dense Forest (with canopy density of more than 70 %), Moderately Dense Forest (with canopy density between 40 and 70) and Open Forest (with canopy density between 10 and 40 %). Thus the data after the year 2000 is comparable. Table 1 shows the technological advancement in forest cover assessment taken over the years.

Table -1: History of Forest Cover Mapping in India

Data Period (publication)	Sensor	Resolution	Scale	MMU (ha)	Mode of interpretation		
1981-83 (SFR'87)	LANDSAT-MSS	80 m	1:1 million	400 ha	Visual		
1985-87 (SFR'89)	LANDSAT-TM	30 m	1:250,000	25 ha			
1987-89 (SFR'91)	LANDSAT-TM						
1989-91 (SFR'93)	LANDSAT-TM						
1991-93 (SFR'95)	IRS-1B LISS II	36.25 m			1:50,000	1 ha	Visual/ Digital
1993-95 (SFR'97)	IRS-1B LISS II						
1996-98 (SFR'99)	IRS-1C,1D LISS III	23.5 m	1:50,000	1 ha			Digital
2000-01 (SFR'01)	IRS-1C,1D LISS III						
2002-03 (SFR'03)	IRS-1D LISS III						
2004-05 (SFR'05)	IRS-1D LISS III						
2006-07 (ISFR'09)	IRS-P6-LISS III						
2008-09 (ISFR'11)	IRS-P6-LISS III						
2010-12 (ISFR'13)	IRS-P6 & Resourcesat2 LISS III						

The methodology being followed now uses Digital Image Processing software and involves the number of steps : Acquisition of satellite data; Geometric Rectification of raw data; Mosaicing of rectified scenes; Classification of forest cover using NDVI; Interactive method of display is used for assigning threshold values for each class (very dense, moderately dense, open and scrub); Density class of forest cover and colour is accordingly allocated.

Flow chart of methodology of dynamic forest cover mapping using remote sensing is shown in the Fig.1.

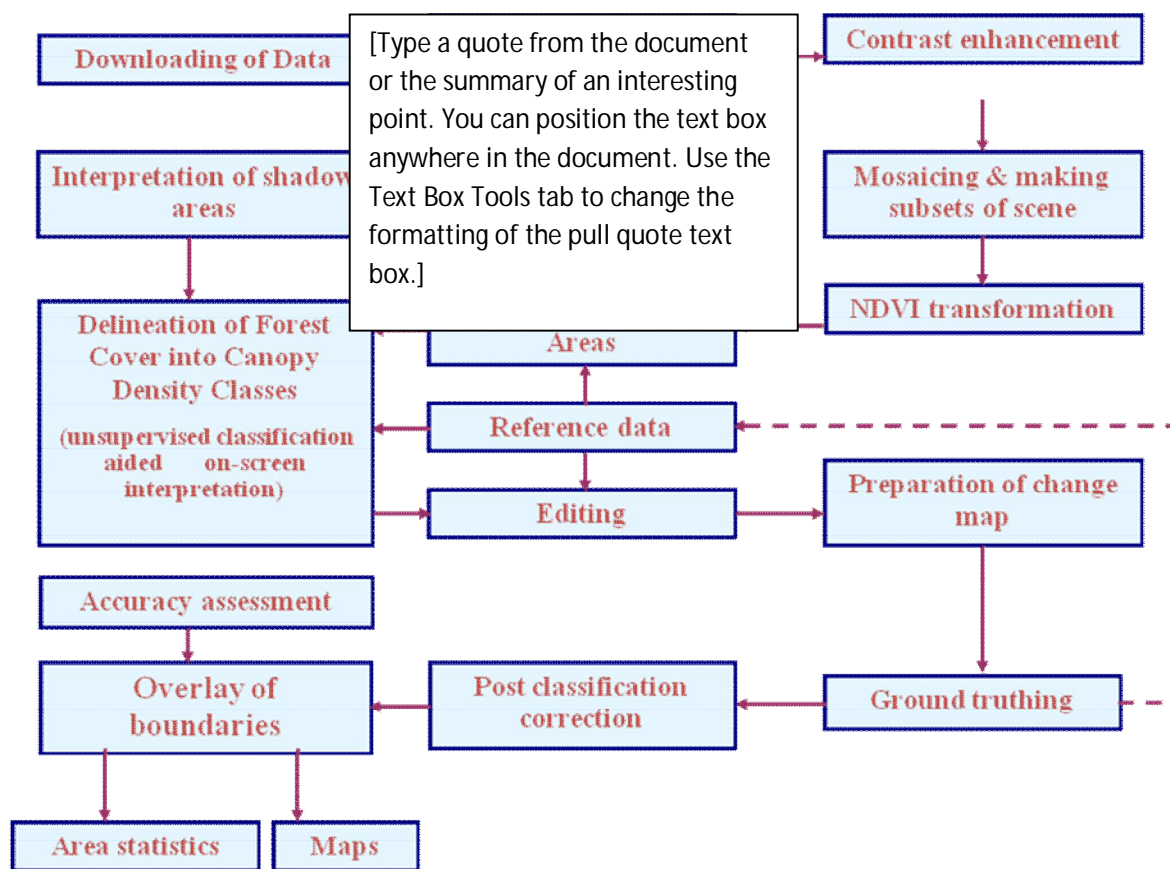


Fig 1: Flow chart of forest cover assessment

The output includes forest cover maps on 1:50,000 scale. These maps show forest cover in four classes- (i) Very Dense forest, having canopy density of more than 70%; (ii) Moderately dense Forests with canopy density 40%-70%; (iii) Open Forests with canopy density between 10-40% and (iv) Scrub which are forest areas having less than 10% canopy density.

A classification is not complete unless its accuracy is assessed. FSI carry out accuracy assessment of classification in the form of error matrix. Classified and ground truth data is compared on about 4000 sample plots to prepare the error matrix. For ground truth, the information of forest inventory and high resolutions satellite data is used. The classification accuracy for various report is above 90 %, which is well within the acceptable limit. For illustration, the error matrix prepared for ISFR 2013 is shown in table 2.

Table 2: Error matrix

Classification Classes	Ground truth (based on field inventory data)						User's Accuracy (Per cent)
	VDF	MDF	OF	Scrub	NF	Total	
VDF	210	22	3	1	1	237	88.81
MDF	17	1,221	60	4	8	1,310	93.21

OF	7	80	1,137	9	16	1,249	91.03
Scrub	1	9	12	192	7	221	86.88
NF	3	37	39	17	1,019	1,115	91.39
Total	238	1,369	1,251	223	1,051	4,132	
Producer's Accuracy (%)	88.24	89.19	90.89	86.10	96.96		
Overall Accuracy	91.46						
Overall Kappa Statistics	0.88						

Source: ISFR 2013

3.5.2 Improvement in Classification of previous cycles:

As pointed out earlier, FSI switched over to digital interpretation of the satellite data (LISS III, multispectral, 23.5m spatial resolution) commencing from the year 2001. It used digital interpretation of satellite data on 1:50,000 scale for mapping and monitoring of forest cover of the country. This has resulted in providing more realistic information on forest cover as areas having forest cover down to 1 ha could be delineated while in earlier assessments, forest cover down to 25 ha could only be delineated. Similarly blanks down to 1 ha within forested areas can be separated. The entire exercise has resulted in new base-line information on forest cover. As perennial woody vegetation (including bamboos, palms, coconut, apple, mango etc.) has been treated as tree and thus all lands with tree crops, such as agro-forestry plantations, fruit orchards, tea and coffee estates with trees etc., have been considered in forest cover provided such patches of trees/forests qualifies the definition of forest.

This has been viewed as great advantage over earlier methodology but threw a number of challenges for interpretation of satellite data as canvas suddenly opened up for number of potential small patches between 1.0 ha to 25 ha. There were numerous locations having mixed nature of classes mainly in agro-forestry, sugarcane crop, cotton crop, young plantation, tea and coffee plantations having shade trees, etc in addition to other technical limitations arising due to satellite data.

It is pertinent to mention here that while carrying out digital classification at 1:50,000 scale in 2001, FSI decided to adopt conservative approach and included those areas in forest cover which satisfied the definition of forest cover and there were, seemingly, very less or no possibility of misclassification.

The errors also arise due to subjectivity involved in certain components of classification. The error in classification also pertains to the areas where the forest cover either went undetected due to snow or cloud cover, hill shadow effect, poor reflectance from trees due to leaf-fall or poor image quality at the time of previous assessment or classified as forest due to poor tonal variation. Despite putting best

efforts discrepancies were observed while working for subsequent cycles which were reported in corresponding 'State of Forest Report'.

The forest cover assessment based on interpretation of 2000, 2004 and 2008 satellite data (sensor LISS III, resolution: 23.5m) had already been carried out as part of FSI's mandated activity and has appeared in the various 'State of Forest reports' (SFRs). The interpretation of satellite data suggesting change in forest cover with respect to previous SFR is checked again while finalising the current SFR. Sometimes, it leads to interpretational changes. To improve the statistics the information of previous SFR are revised. For the exercise of developing RL, These interpretational changes were incorporated in the forest cover maps (FCM) and maps were got revised. **This exercise was conducted for FCMs corresponding to year 2000 (SFR 2001), 2004 (SFR 2005) and 2008 (ISFR 2011).**

Table 3: Forest Cover with Improved area

Cycle of Assessment	Publication	Data Period	Forest Cover (km ²)	Improved Forest Cover (km ²)
I	SFR 1987	1981-83	640819	-
II	SFR 1989	1985-87	612717	-
III	SFR 1991	1987-89	639323	-
IV	SFR 1993	1989-91	638857	-
V	SFR 1995	1991-93	638675	-
VI	SFR 1997	1993-95	633307	-
VII	SFR 1999	1996-98	637288	-
VIII	SFR 2001	2000	653898	675906
IX	SFR 2003	2002	677816	-
X	SFR 2005	2004	690171	690827
XI	ISFR 2009	2006	692394	-
XII	ISFR 2011	2008-09	692027	692693
XIII	ISFR 2013	2010-12	697898	-

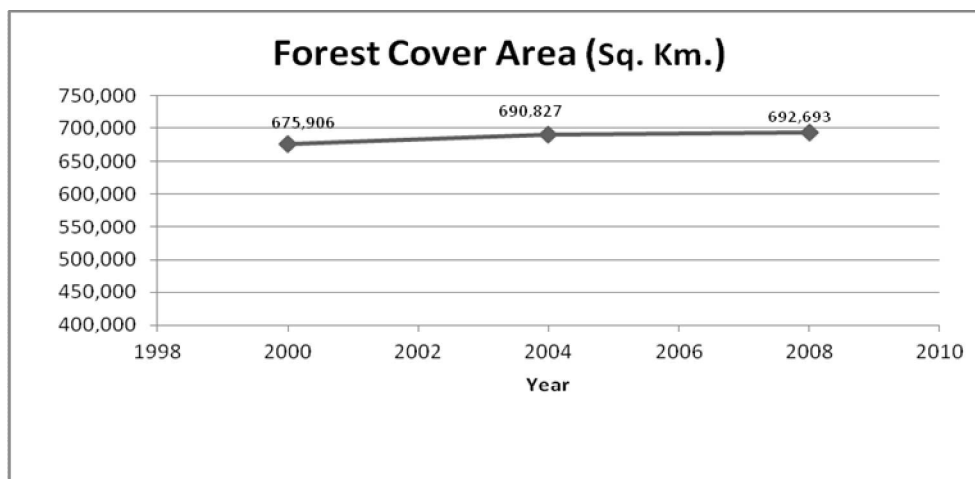


Fig 2: Forest Cover area from 2000 to 2008

3.5.3 Forest Type Mapping (FTM):

Forest type wise extent of forest cover is useful information which provides a basis for characterizing forests in terms of floristic composition and ecological value. In the year 2011, FSI has published “Atlas of forest types of India” mapping forest types as per revised classification of Champion & Seth (1968) on 1:50,000 scale down up to 200 types described in the classification. In the first ever such attempt at the national level, extensive study in GIS framework using the relevant layers like, soil, rainfall, temperature along with the remote sensing data, details from the working plans, thematic maps of FSI, inventory information etc was carried out. The exercise involved extensive and widespread ground truthing covering every part of the country.

The FTM was one time exercise using the satellite data of the 2004 year. This information was not available for data of other years. The methodology for assigning forest types groups to other years’ data was developed. The forest type group has been assigned to the data corresponding to the forest cover of the year 2000, 2004 (interpretational changed area) and 2008.

3.5.4 Stratification of Activity Data:

Stratification is required for any heterogeneous population to gain precision of estimates by dividing it into relatively homogeneous sub-population based on some stratification variable. Since, in this case, carbon stored in the vegetation is principal variable which definitely depends upon canopy density and forest type; these two has been considered as stratification variables. Canopy density wise spatial information is available from the ‘forest cover mapping’. This was supplemented with the forest type wise information generated under the national forest type mapping project carried out by FSI. This gave three canopy density classes and fifteen type group classes – thus resulting forty-five classes in all.

Using this type/density classification, the area statistics (**Activity data**) were generated by a series of steps of intersection and differencing of maps using GIS techniques.

Table 4: Forest type and Forest density wise area for the year 2008

Forest Type Class	VDF	MDF	OF	Total
Tropical Wet Evergreen-North East	997	2815	1132	4944
Tropical Wet Evergreen-Western Ghats	4884	8566	2943	16393
Tropical Semi Evergreen-North East	16090	34072	30960	81122
Tropical Semi Evergreen-Eastern Deccan	36	122	201	359
Tropical Semi Evergreen-Western Ghats	1983	10808	5949	18740
Tropical Moist Deciduous Forests	20459	77033	49056	146548
Littoral & Swamp Forests	1703	2533	2223	6459
Tropical Dry Deciduous Forests	18846	126920	130859	276625
Tropical Thorn Forest	150	2901	8529	11580
Tropical & Subtropical Dry Evergreen Forests	151	582	561	1294

Subtropical Pine/Broadleaved Hill Forests	4098	18942	15905	38945
Montane & Moist Temperate Forest	10237	15828	8977	35042
Sub Alpine & Dry Temperate Forest	3937	8130	6027	18094
Alpine Scrub	426	1024	1280	2730
Plantation/TOF	258	11191	22369	33818
Total	84255	321467	286971	692693

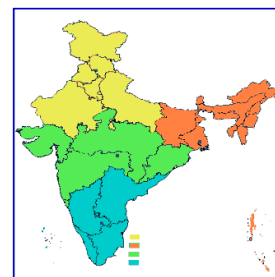
3.5.5 Methodology for Estimating Emission Factors

FSI has been conducting the National Forest Inventory since 2002, following a robust sampling design. Under NFI, data is being collected regularly from sample plots in forest lands distributed across the country in different physiographic and climatic zones. As per the design, data from about 21,000 sample plots (size 0.1 ha) have been collected between years 2002-2008.

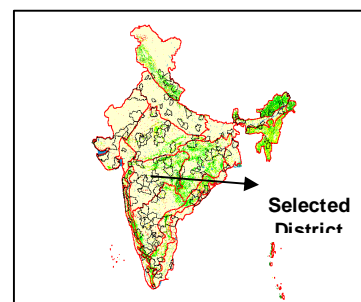
To measure exchange of GHGs between forest eco-system and the atmosphere which is eventually the change in carbon stocks over time, FSI has used Stock-Difference method (inventory based approach or periodic accounting) for estimating various emissions factors as recommended by GPG. FSI has been conducting the National Forest Inventory since 2002, following a robust sampling design. Under NFI, data is being collected regularly from sample plots in forest lands distributed across the country in different physiographic and climatic zones. As per the design, data from about 21,000 sample plots (size 0.1 ha) have been collected between years 2002-2008. The emission factors have been estimated partly by using the NFI data collected during 2002-2008 and partly by conducting a special study during 2008-10. The methodology used has been described as follows:

3.5.6 Above Ground Biomass (AGB) of trees having dbh \geq 10 cm and bamboo

Under the national forest inventory (NFI) programme, FSI has been conducting forest inventory since 2002. The sampling design adopted for national forest inventory is two stages. In the first stage the country is divided into homogeneous strata, based on physiography, climate and vegetation called as physiographic zones and the civil districts form the sampling unit. There are 14 physiographic zones; Western Himalayas, Eastern Himalayas, North east, Northern plains, Eastern Plains, Western Plains, Central highlands, North Deccan, East deccan South deccan, Western ghats, East ghats, West coast and East coast.



A sample of 10 percent districts (approx. 60 districts in the country) distributed over all the physiographic zones in proportion to their size are selected randomly for detailed inventory of forest. In the second stage selected districts are divided into grids of latitude and longitudes which form the second stage sampling unit.



For forest inventory in selected districts plots are systematically laid out in forest area which is indicated on topographic sheets by double dotted line, printed as RF, PF, thick jungle, thick forest etc, shown in green wash and any other area reported as forest area (generally un-classed forest) by the local Divisional Forest Officer.

Fig3.2: Selected districts of a cycle

For each selected district, Survey of India (SOI) toposheets of 1:50,000 scale (size 15'x15' i.e 15 minutes latitudes and 15 minutes longitudes) is divided into 36 grids of 2½'x2½' which is further divided into sub-grids of 1¼'x1¼' forming the basic sampling frame. Two of these sub-grids are then randomly selected to lay out the sample plots. Other forested sub-grids in the districts are selected systematically taking first two sub-grids as random start. The intersection of diagonals of such sub-grids are marked as the centre of the plot at which a square sample plot of 0.1 ha area is laid out to record the measurements. Within sample plot, sub plots of 1m x 1m are laid out at NE and SW corner for collecting data on soil, forest humus. The data on herbs and shrubs including regeneration are collected from four square plots of 1m x 1m and 3m x 3m respectively. These plots are laid out at a distance of 30 meters from the centre of 0.1 ha sample plot in all four directions along diagonals in non-hilly area and along trails in hilly areas. In case of hilly areas the plot are taken randomly 3-10 meters away either side of the trail.

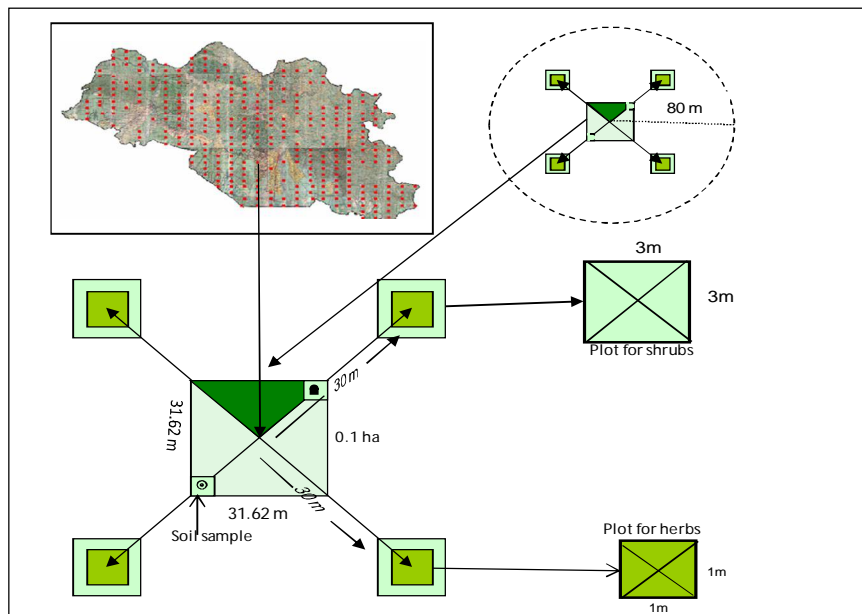


Fig: Layout of the sample plot in plain areas

At each sample plot all trees of diameter 10 cm and above were measured. The woody volume of trees for each sample plot was calculated using volume equations developed by FSI for various species. The volume equation provides above ground woody volume i.e. above ground volume, which includes volume of main stem measured upto 10 cm diameter and volume of all branches having diameter 5 cm or more. As per the design, data from about 21,000 sample plots (size 0.1 ha) had been collected between years 2002-2008. Data of specific gravity and percentage carbon

content of most of the tree species have been obtained from different published literature. For few species, percentage carbon content was ascertained by experimentation and for remaining an average of all other species was used. Standard formulae were used to calculate biomass and carbon content of each tree.

The estimates of bamboo biomass and carbon stocked in this resource are also calculated from NFI data. For estimating volume of the bark, the double bark thickness of trees measured during forest inventory and volume equation of trees have been used. Using species-wise, dbh and bark thickness, bark volume equations were developed and were adjusted for 'bark void factor' which were utilized to estimate bark volume. With the help of the specific gravity of bark, the volume was converted into biomass. Using carbon content percent of wood, carbon stored in bark was estimated and included in the above ground biomass.

3.5.7 Above Ground Biomass of branches, foliage of trees having dbh \geq 10 cm

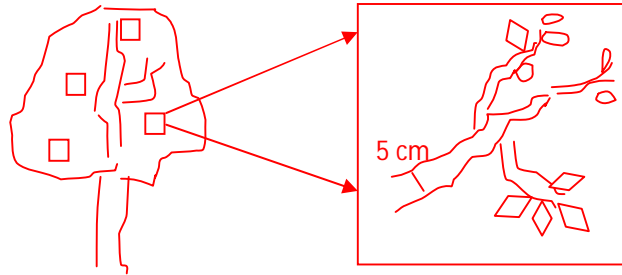
The trees measured under national forest inventory (NFI) give the volume of main stem measured upto 10 cm diameter and volume of all branches having diameter 5 cm or more. It does not give the volume of main stem less than 10 cm in diameter, small branches, foliage, fruits and twigs. Since these components also stock carbon in them, their contribution in carbon stock should be accounted. This can be done by developing biomass equations taking dbh as independent variable and biomass of these components as dependent variable. Once these equations are developed, biomass of each enumerated tree can be estimated for small wood and foliage.

To develop biomass equations of small wood and foliage for each such species other than palm like trees, FSI undertook a special study during 2002-08. The classical approach of developing biomass equation demands for destructive sampling involving felling of trees. In addition, the process is very tedious and therefore a new method which required lopping off, at the most few branches of few trees, was developed. With the analysis of NFI data collected during 2002-08, 20 important species were identified in each physiographic zone and thereafter dbh range was ascertained for each of the species. Dbh of most of the species were ranging from 10 cm to 90 cm. Therefore, it was decided to make dbh classes of 10 cm interval starting from 10-20, 20-30,.....,80-90 and 90+.

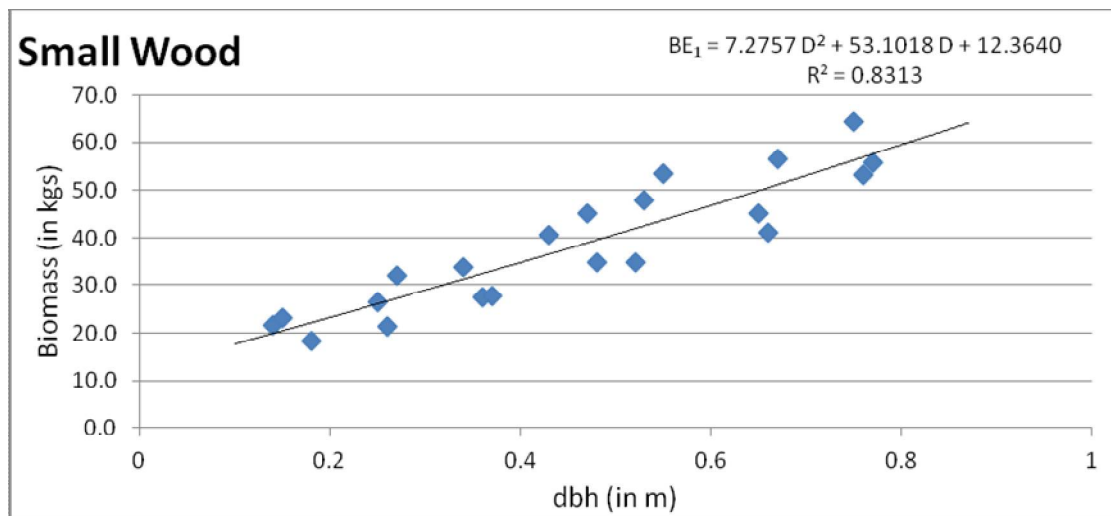
To collect data for this purpose separate format were devised. In each of the diameter class, three normal trees were selected. The normality was defined with respect to that forest. The tree chosen for data collection represent the general condition of that species in that forest. Its dbh, height, crown length, crown width in two direction and shape of the crown is recorded. In addition, canopy blank in that tree was also recorded.

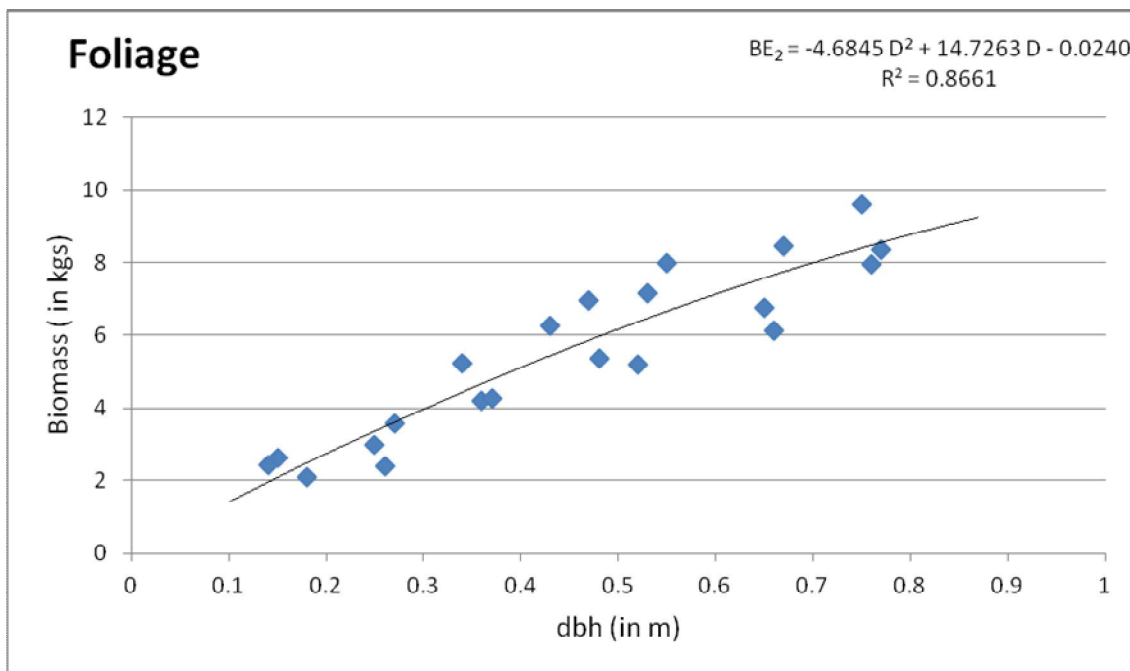
For the purpose of biomass calculation, one normal tree of each diameter class of each species was selected. In the selected tree one square meter window in all the four directions was opened in the crown until woody branches of 5 cm. dia is reached. All such material from window was felled i.e. woody branches up to 5 cm

dia, twigs, leaves, fruits and flowers. Biomass of all these parameters was separately recorded in the prescribed formats. For palm like species two leaves were felled from each tree in each diameter class and their weight and total number of leaves in those trees was counted and recorded for biomass calculation.



Taking the dry biomass of small wood/foilage as dependent variable and dbh as independent variable biomass equations were developed for each species. For example equations developed for Dalbergia sissoo giving weight in kilograms and dbh in meters is given as follows:

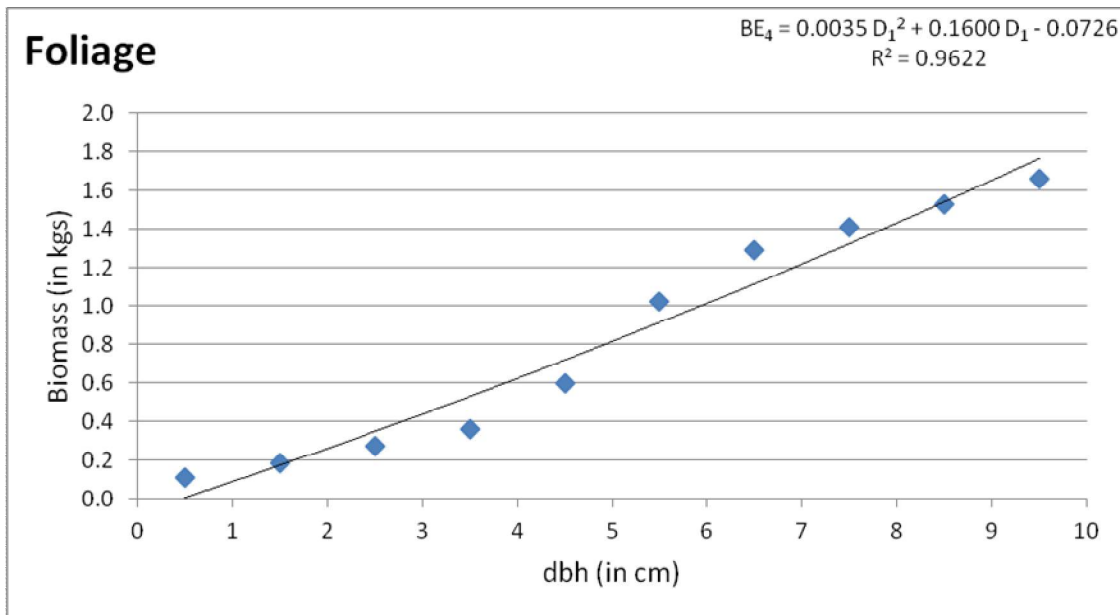
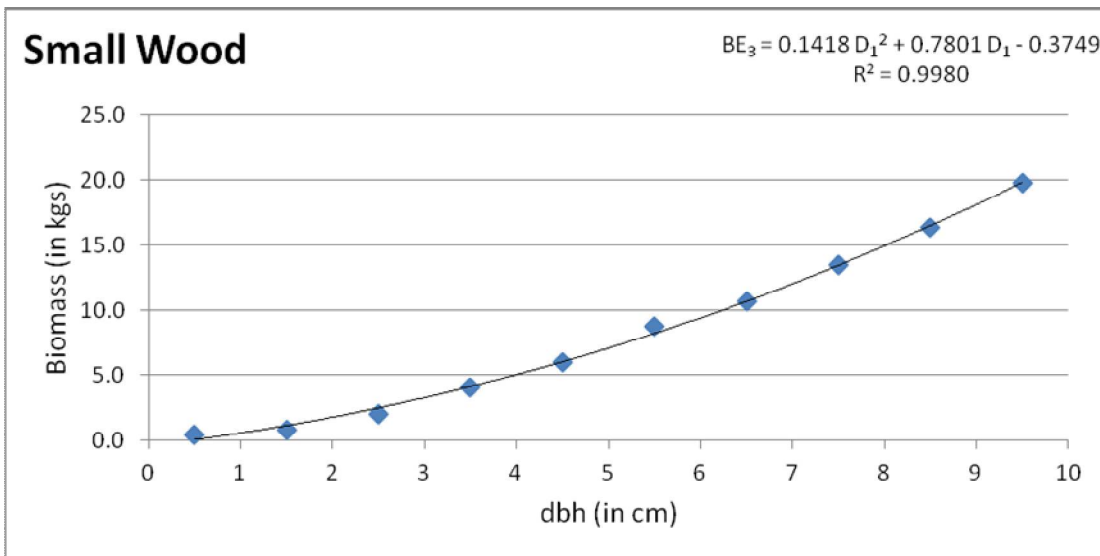




Similarity biomass equations for other species were developed. Using the plot level data of NFI, species wise carbon content, the total biomass and carbon content at plot level was calculated.

3.5.8 Above ground biomass of trees having dbh < 10 cm

During the NFI, all trees having diameter 10 cm and above are taken into account. The trees less than 10 cm in dia are not measured. Since from carbon accounting view, these trees are to be measured, a special study was conducted by FSI to develop biomass equations for such trees. For this purpose, as described above, 20 important tree species were identified for each of 14 strata on the basis of NFI data collected between 2002-08. For each of such species, 3 trees of diameters 1- 9 cm (at 1.37 m. height) were felled. From the felled trees, separate biomass was calculated and recorded for wood, twigs and leaves in the prescribed format. Taking the dry biomass of wood/foilage as dependent variable and dbh as independent variable biomass equations were developed for each species. For example equations developed for *Dalbergia sissoo* giving weight in kilograms and dbh in cms is given as follows:



Similar biomass equations have been developed for other species. Using the plot level regeneration data from NFI i.e. recruits, un-established, established and all trees having dbh between 5 to 10 cm, biomass and carbon content at plot level is calculated.

3.5.9 Above Ground Biomass of Shrubs, Herbs, Climbers, and Biomass of Dead Organic Matter (DOM: Dead Wood and Litter)

For this purpose, the data of forest inventory conducted during 2002-08 was analysed to ascertain the optimum number of plots required for each combination of forest type and forest density. It revealed that about 15 clusters of 2 sample plots for each combination, would suffice for estimating the biomass/carbon factors for these components if 30% permissible error is considered. This survey was conducted in

the districts on randomly selected points which were already inventoried during 2002-2008 and for which forest type and density were known.

For the desired combinations of forest type and forest density, the exact geographical locations (latitude and longitude) of the optimum number of randomly selected sample plots were visited. Using this information, centre of sample point, three concentric plots of size 5mx5m, 3mx3m and 1mx1m were laid out at a distance of 30m away from the centre of sample point in North and South direction. In 5mx5m plot, all dead wood above 5 cm diameter were collected, weighed and recorded. In 3mx3m plot, all woody litter i.e. all branches below 5 cm diameter were collected, weighed and recorded. All shrubs & climbers in 3mx3m plots were uprooted, weighed and recorded in the prescribed format. In 1m x 1m plot, all herbs were uprooted, weighed and recorded. Dry biomass was converted to carbon stock. Thus on the basis of data collected carbon factors were developed for each forest type and density.

3.5.10 Organic matter in soil and forest floor

During forest inventory, the data on forest floor (non-woody litter and humus) and soil carbon is also collected from each sample plot. For collecting data on humus and soil carbon, two sub-plots of size 1mx1m are laid out within the main plot. The forest floor from both the plots was first swept and material so collected was weighed and a portion of same was kept for carbon analysis. Further, at the center of these two sub-plots, a pit of 30cmx30cmx30cm was dug and a composite sample of soil of 200gm was kept for organic carbon analysis. Samples of soil and humus were got analysed from the standard soil labs using Walkley-Black method and were used for the calculation.

3.5.11 Below Ground Biomass

This is the most difficult pool to measure and generally not measured in forest inventory. It is being included using a relationship (usually a root-to-shoot ratio) to aboveground biomass which have been established by various researchers. GPG also provide default ratios for six major global forest types. FSI has selectively used these defaults to arrive at the carbon number.

3.5.12 Synthesizing Data for National Carbon Estimation

GIS techniques were used to intersect forest type map and forest cover map with three density classes which has resulted in creation of 45 strata (forest type and canopy density intersections) one corresponding to each year. Further the geographical location of each sample plot of NFI was duly recorded with GPS during field inventory. These locations helped in creating a GIS compatible point layer of the forest inventory plots. This NFI point layer map was overlaid on the above map having 45 forest type - canopy density strata. The NFI points falling in each stratum were identified. For each stratum, the plot wise information on all the parameters of each carbon pool, were aggregated to have generalized factor for that stratum.

Biomass and carbon factors were specifically developed for each stratum like, shrubs, herbs, climbers, dead wood and woody litter. Multiplying activity data with these factors, different parameter wise total carbon for all the 45 strata were arrived at. This information was arranged into five carbon pools. Adding pool wise carbon contents, national carbon estimates were arrived at two point of time. The difference between pool wise carbon estimates gave the net removal of carbon.

4. Proposed Reference Level

Historical emission estimates are developed based on method narrated above using the modified time series activity data of the year 1994, 2000, 2004 and 2008. Since the classification based on digital satellite data of 1994 was reconstructed without ground truthing the accuracy of classification could not be assessed. Moreover, the NFI in India started from 2002 and the field data for emission factors pertains to 2004-12 which may be considered unrealistic for 1994.

Further, during late 1990's and early 2000's number of new Acts and policies were introduced to safeguard ecological security and interest of common man viz Biological Biodiversity Act, 2002, Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, National Environment Policy, 2006, Agro-forestry policy etc. Many of these have significant bearing on the management of forest. Considering all above facts it was decided that the historic period of 2000 to 2008 should be considered for construction of forest reference level. The activity data and carbon stock in different pools used for construction of FRL has been given in table 5.

Table: 5: activity data and pool wise carbon stock used for FRL

Data Year	Forest Cover Area (sq.km)	AGB (m.tonnes)	BGB (m.tonnes)	DOM (wood) (m. tonnes)	DOM(Litter) (m.tonnes)	SOC (m. tonnes)	Total Carbon (m. tonnes)
2000	675906	2168.2	670.0	26.1	124.7	3847.5	6836.4
2004	690827	2309.7	760.3	25.2	119.0	3706.0	6920.3
2008	692693	2216.2	687.5	28.5	128.4	3884.3	6944.9

From table 5, the annual carbon stock has been worked out for the year 2000, 2004 and 2008. Based on annual carbon stock, historical average of annual carbon stock has been calculated. The same has been given in table 6.

Table: 6

Year	Carbon stock	Hist-Av (2000-2008)
2000	19.8	13.6
2004	21.0	13.6
2008	6.2	13.6

From table, annual CO2 equivalent has been worked out for the year 2000, 2004 and 2008. The historical CO2 equivalent for the period 2000 to 2008 has been calculated and given in table 7.

Table: 7

Year	CO2 equivalent	Hist-Av (2000-2008)
2000	72.7	49.7
2004	76.8	49.7
2008	22.6	49.7

Based upon above data, India's proposed Forest Reference Level
-49.70 million CO₂ Equivalent

5. Transparent, complete, consistent and accurate, information

As per the good practice guidance for carbon accounting, the data used for constructing of FRL should be transparent, complete, consistent and accurate. India has followed these principles while constructing the FRL which are described as follows:

5.1 Transparent

This requires sufficient and clear documentation of the accounting process to be available so that credibility and reliability of estimates can be assessed. FSI has been carrying out forest cover mapping since 1987 using the satellite data. The data used for the purpose of FRL is LISS-III data of Resourcesat-I. All the classified maps of forest cover for different period are available with FSI. Similarly, the data of National Forest Inventory is available in the data base The methodology and results are published in the form of 'State of Forest Report (SFR)' biennially. All these report are available on FSI's website (www.fsi.nic.in). Other information like methodology and concerned data which has been used for constructing RL are annexed with corresponding source of data. **(should we annexe carbon factors?)**

5.2 Complete

Accounting should be inclusive of all relevant categories of sources and sinks and gases, as limited accounting may lead to misleading results. All carbon pools should be measured as precisely as possible. India has been reporting carbon numbers in all the five pools for GHG inventory. Accordingly, all the pools have been taken into account for preparation of reference level.

5.3 Consistent

Accounting estimates for different years, gases and categories should reflect real differences in carbon rather than differences in methods. Since the technology, methodology and data is changing over the period, for the consistency purposes the old information is revised and brought out upto the level of latest level. This fact has been already mentioned in subsequent SFRs based on which revised activity data has been constructed. For FRL construction, the same methodologies and data sets have been used as was used for reporting the GHG inventory under the National communications. Thus, there is a consistency between the FRL and GHG inventory.

5.4 Comparable

FSI has been following the same satellite data and same methodology since 2000 for assessment of forest cover. The NFI design has also been modified and same for the entire historic period. As such, the results given for different year during 2000 to 2008 are comparable.

5.5 Accurate

Accuracy is how close estimates are to the true value; accurate measurements lack bias and systematic error. Precision is the level of agreement between repeated measurements; precise measurements have lower random error. To give confidence in the estimate, both accuracy and precision are desirable. For this purpose FSI has Quality control and quality assurance schemes at different levels. For estimating the carbon stock, FSI has used most of the data/ estimates and information generated by FSI itself, which have high and known reliability level. For example, the forest cover assessment recently completed has accuracy of more than 91% and for national level estimate of growing stock has sampling error of less than 3% only. Similarly litter and soil organic carbon have estimated with high precision. For missing components of biomass, a separate study was undertaken and results of the study are highly precise.

Timber Production from Recorded Forest Area in India during 2005-10**(000' m³)**

States/UTs	2005-06	2006-07	2007-08	2008-09	2009-10	Total	Average
Andhra Pradesh	111.38	293.11	191.85	88.64	116.05	801.03	160.21
Arunachal Pradesh	40.66	40.50	30.78	35.05	31.37	178.35	35.67
Assam	11.97	27.49	13.63	13.93	7.33	74.35	14.87
Bihar	15.62	7.23	7.23	6.87	5.99	42.94	8.59
Chhattisgarh	113.61	176.45	209.32	173.49	199.32	872.20	174.44
Gujarat	25.05	29.10	48.81	42.51	32.44	177.90	35.58
Goa	0.45	0.42	0.51	0.17	0.18	1.73	0.35
Haryana	151.16	165.73	140.76	166.66	164.12	788.42	157.68
Himachal Pradesh	356.91	220.82	246.97	227.98	272.00	1324.68	264.94
Jammu & Kashmir	86.40	80.85	68.49	71.55	61.32	368.61	73.72
Jharkhand	3.38	0.56	10.76	11.62	4.67	30.99	6.20
Karnataka	77.53	65.69	44.84	44.91	45.28	278.24	55.65
Kerala	43.41	26.79	48.65	50.60	50.60	220.05	44.01
Madhya Pradesh	345.45	313.42	372.06	336.95	143.74	1511.62	302.32
Maharashtra	88.05	119.12	132.61	141.00	125.47	606.26	121.25
Manipur	9.07	9.11	8.58	2.67	6.41	35.85	7.17
Meghalaya	0.08	0.98	1.02	0.88	0.52	3.49	0.70
Mizoram	2.32	4.41	11.62	11.71	3.13	33.19	6.64
Nagaland	25.00	25.00	25.00	25.00	25.00	125.00	25.00
Odisha	19.03	22.61	21.84	27.80	20.79	112.07	22.41
Punjab	134.63	129.06	72.33	69.76	79.58	485.36	97.07
Rajasthan	37.90	35.40	38.50	36.30	36.30	184.40	36.88
Sikkim	0.09	0.05	0.03	0.07	0.05	0.30	0.06
Tamil Nadu	4.90	5.50	4.78	4.01	4.12	23.31	4.66
Tripura	2.10	2.10	2.10	2.10	2.10	10.50	2.10
Uttar Pradesh	218.73	200.58	310.67	300.08	313.13	1343.20	268.64
Uttarakhand	331.32	283.08	310.58	271.62	242.62	1439.22	287.84
West Bengal	85.99	114.59	231.58	151.12	183.40	766.68	153.34
Union Territories							
A & N Islands	6.91	5.29	9.28	8.97	8.06	38.50	7.70
Total	2349.10	2405.04	2615.18	2324.02	2185.09	11878.44	2375.69

Source: Forest Sector Report India 2010, ICFRE, MoEF&CC, Government of India.

**Table: State/UT wise Potential Production of timber from TOF
(Million m³)**

S.No.	States	Growing Stock of tree spp. used as timber	Annual potential production of timber
1	Andhra Pradesh	115.683	1.939
2	Arunachal Pradesh	74.516	0.762
3	Assam	41.336	1.355
4	Bihar	47.195	1.209
5	Chhattisgarh	70.069	1.826
6	Delhi	1.040	Negligible*
7	Goa	3.895	0.019
8	Gujarat	117.993	3.099
9	Haryana	15.268	1.975
10	Himachal Pradesh	21.146	0.939
11	Jammu & Kashmir	147.745	0.830
12	Jharkhand	51.308	1.327
13	Karnataka	101.773	2.023
14	Kerala	49.059	1.628
15	Madhya Pradesh	85.106	3.168
16	Maharashtra	147.029	3.519
17	Manipur	10.691	0.220
18	Nagaland	9.392	0.289
19	Meghalaya	20.964	0.421
20	Mizoram	12.681	0.342
21	Orissa	73.624	1.418
22	Punjab	19.305	2.650
23	Rajasthan	81.560	3.463
24	Sikkim	2.017	0.025
25	Tamil Nadu	70.328	0.834
26	Tripura	7.391	0.256
27	Uttar Pradesh	81.683	5.082
28	Uttarakhand	20.917	0.697
29	West Bengal	45.693	1.436
30	Andaman & Nicobar	0.666	0.007
31	Chandigarh	0.084	Negligible
32	Dadar Nagar Haveli	0.833	0.014
33	Daman & Diu	0.108	Negligible
34	Lakshadweep	0.049	Negligible
35	Pondicherry	0.320	0.010
	Total	1548.427	42.774

*- Less than 0.005 million cum has been considered as 'negligible'.

Source: ISFR 2011, FSI Dehradun

Recorded Forest Area

In India, however, legal connotation of forest is, mainly employed. An area of land recorded as forest in revenue records or proclaimed to be forest under a forest law or Act is described as forest. Thus, “forest area” is an area recorded as forest in the government records. Often this term is also written as “recorded forest area”. This should, however, not be confused with forest cover which is based on the capability of remote sensing satellite sensor and has nothing to do with the legality of land use or land ownership.

The recorded forest area is categorized into “Reserved Forest”, “Protected Forest” and “Unclassed Forest”. These are defined below:

Reserved Forest: An area notified under the provisions of India Forest Act or the State Forest Acts having full degree of protection. In Reserved Forests all activities are prohibited unless permitted.

Protected Forest: An area notified under the provisions of India Forest Act or the State Forest Acts having limited degree of protection. In Protected Forests all activities are permitted unless prohibited.

Unclassed Forest: An area recorded as forest but not included in reserved or protected forest category. Ownership status of such forests varies from state to state.

Table: Recorded Forest Area since 1987

Sl No	Year	Area (sq.km)	Percentage of geographic area (sq.km)
1	1987	751,846	22.87
2	1989	751,346	22.85
3	1991	770,078	23.43
4	1993	770,078	23.43
5	1995	765,210	23.28
6	1997	765,210	23.28
7	1999	765,253	23.28
8	2001	768,436	23.38
9	2003	774,740	23.57
10	2005	769,626	23.41
11	2009	769,512	23.41
12	2011	769,538	23.41
13	2013	771,821	23.48

Table: Annual Fuelwood Consumption

Sl.No.	State	No of Persons using Fuel Wood (millions)	No of Persons using Fuel Wood from Forest (million)	Quantity of Fuel Wood used (million tonnes)	Quantity of Fuel Wood used from Forest (million tonnes)	Percentage (6 w.r.t. 5)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Andhra Pradesh	64.992	7.573	24.293	2.966	12.21
2	Arunachal Pradesh	0.882	0.698	0.402	0.325	80.93
3	Assam	23.373	5.812	11.421	2.494	21.83
4	Bihar	65.816	3.115	11.475	0.465	4.05
5	Chhattisgarh	20.078	7.818	4.366	1.378	31.56
6	Gujarat	40.092	7.497	9.731	2.225	22.87
7	Haryana	8.092	0.012	1.494	0.003	0.17
8	Himachal Pradesh	5.912	5.646	1.214	1.163	95.80
9	J & K	8.375	4.540	1.394	1.015	72.80
10	Jharkhand	21.733	9.984	4.844	2.849	58.81
11	Karnataka	44.681	9.584	20.967	5.776	27.55
12	Kerala	29.504	4.429	14.543	2.183	15.01
13	Madhya Pradesh	51.007	24.839	13.665	7.191	52.63
14	Maharashtra	68.904	31.845	9.508	4.527	47.61
15	Orissa	33.029	11.110	8.894	2.971	33.40
16	Punjab	13.628	0.136	3.348	0.029	0.87
17	Rajasthan	57.992	11.414	18.782	3.698	19.69
18	Tamil Nadu	42.405	7.429	12.387	2.601	21.00
19	Uttar Pradesh	175.096	10.495	19.063	1.294	6.79
20	Uttarakhand	7.289	6.060	2.566	2.139	83.38
21	West Bengal	51.202	18.574	14.158	6.361	44.92
22	North Eastern States	9.383	6.588	5.274	3.822	72.48
23	UTs	10.412	4.432	2.633	1.272	48.32
	Grand Total	853.879	199.631	216.421	58.747	27.14

Source: ISFR 2011

Table: Adult Cattle Unit Dependent on Forests

S.No	States	Total Adult Cattle Unit	Total Adult Cattle Unit dependent on forests	Total Adult Cattle Unit completely dependent on forests	% of (5) with (3)
1	Andhra Pradesh	34.84	14.58	7.57	21.73
2	Arunachal Pradesh	0.89	0.85	0.73	82.57
3	Assam	11.96	4.89	3.56	29.81
4	Bihar	23.57	0.90	0.66	2.78
5	Chhattisgarh	12.60	9.24	5.98	47.48
6	Gujarat	21.02	4.17	3.28	15.60
7	Haryana	9.58	0.0005	0.002	0.02
8	Himachal Pradesh	3.79	3.73	2.73	72.18
9	J & K	6.10	1.25	0.60	9.90
10	Jharkhand	12.50	2.13	1.17	8.85
11	Karnataka	18.97	8.63	2.99	15.77
12	Kerala	2.08	0.74	0.15	7.01
13	Madhya Pradesh	36.94	18.79	13.18	35.68
14	Maharashtra	27.53	23.95	16.56	60.15
15	Orissa	15.96	6.40	5.60	35.09
16	Punjab	8.61	0	0	NA
17	Rajasthan	32.32	12.23	7.19	22.24
18	Tamil Nadu	16.48	2.94	2.07	12.55
19	Uttar Pradesh	54.20	9.73	3.02	5.58
20	Uttarakhand	4.28	4.17	2.66	62.16
21	West Bengal	23.30	8.35	5.12	21.96
22	Other NE States	3.36	2.07	1.26	37.42
23	UTs	0.90	0.75	0.37	40.47
	Total	381.78	140.48	86.39	22.63

Source: ISFR 2011

The change matrix is generally prepared to analyse the dynamics of changes from one land class to other classes observed across the country between two epoch of time. The change matrixes indicating the change in the extent of forest cover classes between 2000 and 2004 is given below in Table 4.

Table 4: Forest cover change matrix between 2004 and 2008.

INDIA						
CLASS	Forest cover in 2008 (km ²)					Forest cover in 2004(km ²)
	VDF	MDF	OF	Scrub	Non Forest	
VDF	78211	4077	694	9	797	83788
MDF	4219	289397	16965	352	9048	319981
OF	616	19615	244826	1721	20280	287058
Scrub	3	741	2270	33205	5004	41223
Non Forest	690	8509	21859	6971	2517184	2555213
Forest cover in 2008 (km ²)	83739	322339	286614	42258	2552313	3287263
Net change	-49	2358	-444	1035	-2900	
Degradation	Deforestation		Enhancement		Afforestation	

The above matrix suggests the extant (activity data) of deforestation, forest degradation, enhancement in canopy density and new area under forest land cover. At the same time, diagonal elements of forest category relates to particular activity of 'conservation of forest carbon stock' of REDD+. It also provides the annual changes in area of these categories which relates to three activities of REDD+ as given in the following Table 5.

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