Chapter

4

TREE COVER

4.1 Introduction

This chapter presents tree cover area of the States/UTs. The information is generated on the basis of sampling based methodology in which high resolution satellite data has been used for stratification followed by field surveys carried out in the sampled districts. Present estimates of the tree cover are based on 178 districts inventoried during the last six years (three cycles) i.e. 2002 to 2008.

Forest cover includes all lands of more than 1.0 ha area, with a tree canopy density of more than 10%. The tree cover includes tree patches outside recorded forest area which are less than 1 ha such as trees on village common lands, farmlands, lands along roads, railways, canals, and in homesteads. To capture such small patches of trees, high resolution satellite data (5.8m) have been used for stratification in the selected districts. It may be noted here that there is no overlap between forest cover and tree cover. These two entities are not only different by their definitions but also by the methods of their assessment. Forest cover is assessed by wall to wall mapping whereas tree cover is estimated by sampling approach.

FSI has been estimating tree cover of the country since 2001. The information on tree cover along with forest cover gives a complete picture of the country to compare with the national goal of 33% area under forest and tree cover.

TOF & tree cover are two different entities but closely related to each other. TOF refers to all trees growing outside recorded forest area irrespective of patch size. All tree patches of TOF which are larger than 1.0 ha are captured by satellite data and are included in the forest cover. The remaining tree patches and scattered trees outside forest cover which are smaller than 1.0 ha, constitute the tree cover. Tree cover, therefore, becomes a subset of TOF.

4.2 Methodology of Tree Cover Estimation

The estimates of tree cover at national level are generated using the data collected during the inventory of TOF. The sampling design used for inventory of TOF is two-stage. In the first stage, the country is stratified into 14 physiographic zones based on physiography, climate, vegetation etc. A sample of 60 districts is then selected in proportion of the area of physiographic zone from the entire country for detailed inventory in a cycle of 2 years. Separate methodologies are used for rural & urban inventory. The detailed methodology has been explained in Chapter 5.

The tree cover has got two components. The first component consists of tree patches of 0.1 ha or more identified through high resolution satellite data

Fig. 4.1: Trees on agricultural land

such as patches under block and linear formations in rural areas. The actual areas of such patches are computed from classified TOF maps of the districts after eliminating the patches which are equal to or larger than 1.0 ha. The second component is the computed area from scattered trees growing in rural and urban areas which are not precisely mapped even with high resolution satellite data (5.8 m). To compute the area under these two strata, the methodology followed till previous assessment was to use crown-diameter relationship developed for different tree species which is an indirect method of estimation of tree cover. However, during the present assessment, the methodology has been refined by using crown diameter of tree species directly for estimating tree cover. This method gives more precise results of tree cover, being direct method of estimation. The methodology is explained in the following paragraphs.

To estimate the area of tree cover under scattered stratum, adequate numbers of sample plots are laid out and crown diameter of each tree is recorded from all such plots. With the help of crown diameter, tree cover of each sample plot is computed, which is then converted into equivalent notional area corresponding to 70% canopy density. Using tree cover area of selected plots and corresponding Culturable Non Forest (CNF) area of district, the district level estimates under scattered stratum are generated.

In the urban areas, the sampling units are Urban Frame Survey (UFS) blocks of varying sizes. The areas of selected UFS blocks are measured with the help of GPS. For estimating tree cover, the crown diameter of each tree falling in the selected UFS block is recorded. With the help of crown diameter, the tree cover of each UFS block is computed following the similar approach as in case of scattered stratum.

The total tree cover for the selected district is obtained by aggregating the areas of tree cover under block, linear, scattered and urban strata.

On the basis of tree cover estimates of sampled districts, the tree cover in each physiographic zone is estimated. Aggregation of tree cover estimates of all the physiographic zones leads to tree cover estimate of the country. The present estimate is based on 30,166 sample plots falling in 178 sampled districts.

The State level estimates of tree cover have been generated using small area estimation technique. Often, sample surveys are designed to provide reliable estimates for larger areas. But if estimates are to be generated for sub-population, then the sample size may not be sufficient for direct estimations. In such a situation, small area technique is used to generate synthetic estimator with better precision. Synthetic estimation has its strength in borrowing information from larger groups for use in small area or sub population under the assumption that the relation of the study character as well as the auxiliary character between larger and smaller areas remains the same. To prepare the State level estimates of tree cover, synthetic estimators were generated using physiographic zone level estimate of tree cover.

4.3 Precision of Tree Cover Estimates

As the tree cover estimates are based on sampling following a standard design, its precision is determined by the standard error at different levels. The detailed procedure of calculating the precision has been given in Chapter 6. The tree cover at national level has been estimated with standard error (SE) of 2.54%. At physiographic zones, the SE varies from 3.21% to 19.61%.

4.4 Tree Cover in the Physiographic Zones

The extent of tree cover of the country has been estimated to be 92,769 km^2, which is 2.82 % of the country's geographical area. The estimates of tree cover for each physiographic zone is given in Table 4.4.1. It is observed that the tree cover is maximum in East Deccan (11,157 km^2), followed by Northern Plains (9,473 km^2) and West Coast (9,427 km^2). West Coast has the maximum percentage of tree cover (7.78%) with respect to geographical area followed by Western Ghats (5.32%) and East Coast (3.88%). Eastern Himalayas has the lowest tree cover of 324 km^2, as the area is largely under forest cover.

4.5 Tree Cover in the States and Union Territories

Tree cover data of the physiographic zones

Table 4.4.1: Physiographic zone wise tree cover estimates

S. No.	Physiographic Zone	Geographical Area (G.A.) (km^2)	Tree Cover	
			Area (km^2)	% of G.A.
1.	Western Himalayas	329,255	8,091	2.46
2.	Eastern Himalayas	74,618	324	0.43
3.	North East	133,990	2,243	1.67
4.	Northern Plains	295,780	9,473	3.20
5.	Eastern Plains	223,339	5,444	2.44
6.	Western Plains	319,098	7,497	2.35
7.	Central Highlands	373,675	9,150	2.45
8.	North Deccan	355,988	7,559	2.12
9.	East Deccan	336,289	11,157	3.32
10.	South Deccan	292,416	8,002	2.74
11.	Western Ghats	72,381	3,847	5.32
12.	Eastern Ghats	191,698	4,051	2.11
13.	West Coast	121,242	9,427	7.78
14.	East Coast	167,494	6,504	3.88
	Total	**3,287,263**	**92,769**	**2.82**

was processed further using small area estimation technique as described earlier to estimate tree cover of each State and Union Territory. One State may fall in one or more physiographic zones. To estimate the tree cover of the State, CNF area falling in different physiographic zones of different States/UTs was calculated. The estimates of tree cover of block, linear, scattered and urban strata of sampled districts were used to estimate the total tree cover of that physiographic zone using CNF area. The same exercise was repeated for different physiographic zones falling in that state. Adding tree cover estimates of different physiographic zones, tree cover for the respective States were estimated. It may be

Table 4.5.1: State/UT wise tree cover estimates

S. No.	State/UT	Geographical Area (G.A.) (km^2)	Tree Cover	
			Area (km^2)	% of G.A.
1	Andhra Pradesh	275,069	7,191	2.61
2	Arunachal Pradesh	83,743	592	0.71
3	Assam	78,438	1,590	2.03
4	Bihar	94,163	2,495	2.65
5	Chhattisgarh	135,191	4,027	2.98
6	Delhi	1,483	123	8.29
7	Goa	3,702	286	7.73
8	Gujarat	196,022	8,390	4.28
9	Haryana	44,212	1,409	3.19
10	Himachal Pradesh	55,673	638	1.15
11	Jammu & Kashmir	222,236	6,764	3.04
12	Jharkhand	79,714	3,032	3.80
13	Karnataka	191,791	5,683	2.96
14	Kerala	38,863	2,801	7.21

continued

S.No.	State/UT	Geographical Area (G.A.) (km^2)	Tree Cover	
			Area (km^2)	% of G.A.
15	Madhya Pradesh	308,245	6,871	2.23
16	Maharashtra	307,713	9,466	3.08
17	Manipur	22,327	197	0.88
18	Meghalaya	22,429	542	2.42
19	Mizoram	21,081	172	0.82
20	Nagaland	16,579	300	1.81
21	Orissa	155,707	4,435	2.85
22	Punjab	50,362	1,699	3.37
23	Rajasthan	342,239	8,274	2.42
24	Sikkim	7,096	20	0.28
25	Tamil Nadu	130,058	4,968	3.82
26	Tripura	10,486	171	1.63
27	Uttar Pradesh	240,928	7,381	3.06
28	Uttarakhand	53,483	665	1.24
29	West Bengal	88,752	2,458	2.77
30	Andaman & Nicobar Islands	8,249	44	0.53
31	Chandigarh	114	11	9.65
32	Dadra & Nagar Haveli	491	27	5.50
33	Daman & Diu	112	9	8.04
34	Lakshadweep	32	4	12.50
35	Puducherry	480	34	7.08
	Total	**3,287,263**	**92,769**	**2.82**

noted that in some of the States/UTs, estimates for tree cover are only indicative in nature and may have lower levels of precision since the sample size in such States/UTs is small. The estimates of tree cover in the States and UTs are given in Table 4.5.1 and in Fig 4.2.

Tree cover in the country has been estimated to be 92,769 km^2 in 2007, which is 2.82% of the geographical area. Tree cover estimate of the country as per the SFR 2005 was 91,663 km^2 (2.80%). Tree cover constitutes the largest area in Maharashtra (9,466 km^2) followed by Gujarat (8,390 km^2), Rajasthan (8,274 km^2) and Uttar Pradesh (7,381 km^2). Considering the percentage of geographical area under tree cover, the highest rank goes to Lakshadweep (12.50%) followed by Chandigarh (9.65%), Delhi (8.29%), Daman & Diu (8.04%), Goa (7.73%) and Kerala (7.21%).

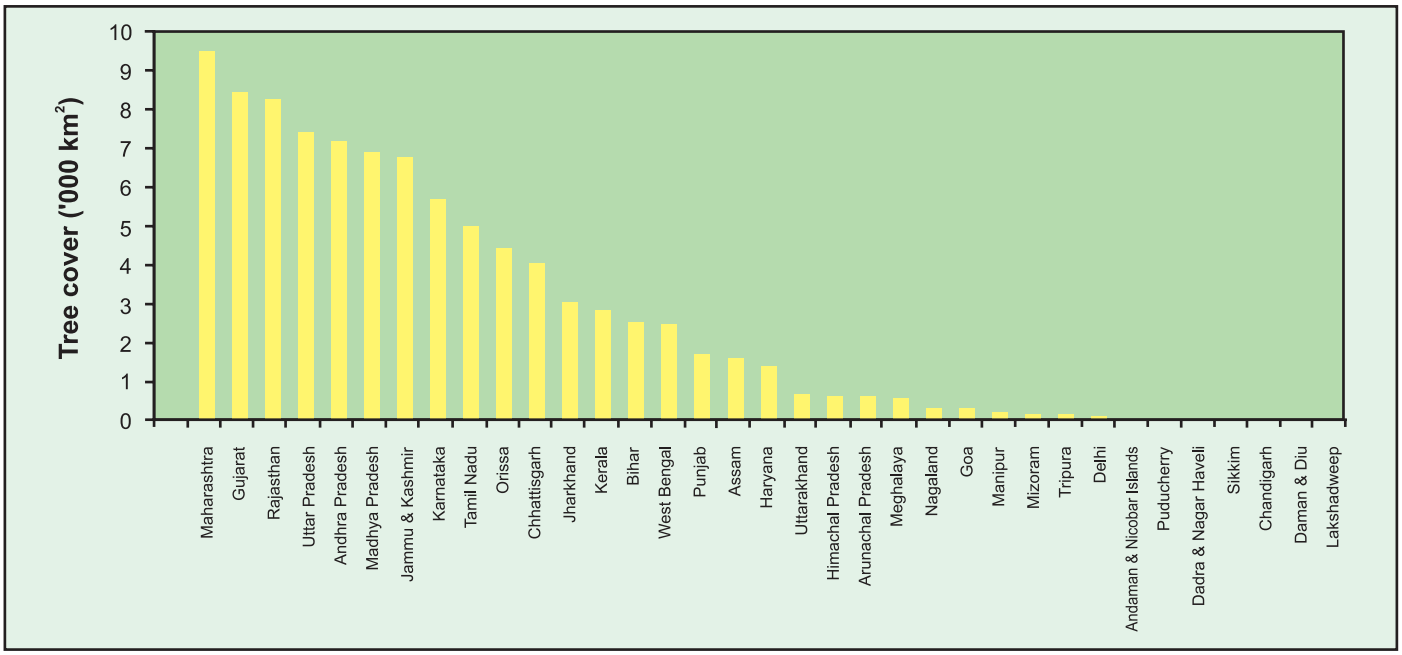

Fig. 4.2: Tree cover in States & UTs