Tree Cover

Chapter 5

TREE COVER

Tree cover estimate comprises tree patches outside the recorded forest area which are not captured by remote sensing satellite during forest cover assessment. This area is less than the minimum mappable area (1 ha) and comprises block and linear patches having area up to 0.1 ha and scattered trees.

All areas more than 1 ha in extent and having tree canopy density of 10% and above are included under forest cover. However, there are many small patches of trees less than 1.0 ha in extent, such as trees in small scale plantations, woodlots, or scattered trees on farms, homesteads and urban areas, or trees along linear features, such as roads, canals, bunds, etc. not being captured by satellite sensors under forest cover due to technological limitations.

FSI started estimating tree cover in the country in the year 2001 to have a complete picture of the forest and tree cover to compare with the national goal of 33% forest and tree cover.

5.1 Trees Outside Forests and Tree Cover

It is essential to differentiate between Tree Cover and 'Trees Outside Forests' (TOF). TOF refers to all trees growing outside recorded forest area. However, there are tree crops and woodlots outside forest area that are larger than 1 ha in extent and are captured by the resources survey satellite used for forest cover assessment in the present methodology. Such trees are deemed to have been included in the forest cover assessment. The residual trees outside forest cover and less than 1 ha in area and not captured by satellite constitutes the tree cover. Thus, trees included in the tree cover constitute only a part of TOF.

The tree cover estimates are generated from the field inventory for which a separate exercise is conducted by FSI for estimating Trees Outside Forests (TOF) resources for both rural and urban strata. FSI conducts inventory of forest and TOF in 60 randomly selected districts distributed over the 14 physiographic zones of the country in a cycle of 2 years and generates national level estimates of growing stock. The detailed methodology of forest and TOF inventory has been explained in Chapter 6 dealing with the growing stock.

5.2 Methodology of Tree Cover Assessment

Trees outside forest areas are fragmented, scattered and there is no accurate knowledge of their geo-locations. They have a low density and their assessment by conventional methods becomes costly and time-consuming. In 2001, FSI developed a methodology using high resolution satellite imageries (5.8m) for identification and classification of TOF resources. Appropriate sampling is then done and field inventory conducted for assessment of TOF, which is used for estimation of tree cover. Based on this method the first

Fig.5.1: Canal Side Plantation (TOF)

estimate of TOF and tree cover was published in 'SFR 2003', which was based on inventory of 60 districts. There has been improvement in the present estimate because against the inventory data of 60 districts, the data of additional 60 districts inventoried during 2003-2005, i.e.; data of 120 districts has been used to estimate the tree cover of the country.

Assessment of tree cover of a district has two components. One component consists of areas identified from satellite data under block and linear forms. The high resolution satellite imageries map tree blocks (patches between 1 and 0.1 ha) and linear plantations in the rural areas. The actual area covered by such patches is computed from the classified digital map using GIS methods. The second component is the computed area from scattered trees growing in rural and urban strata, which are not mapped/identified even with high-resolution satellite data (5.8m) currently used.

For computing area of tree cover from scattered trees, an exercise was conducted in 2001 to establish relationship between diameter (DBH) and tree crown of different species growing in different physiographic zones. This relation was used to derive the number of trees of a species making 1 ha area with 70% density. The estimated number of trees constituting 1 ha by physiographic zone, species wise and diameter class wise has been given in Appendix-IV (pp. 125-130) of 'SFR 2001.' To estimate the area of tree cover under scattered trees in rural and urban strata, adequate numbers of sample plots are laid and numbers of trees occurring in the sample plots are enumerated by diameter class and species. This helps in estimating the number of trees per ha in scattered and urban strata. Using the number of trees by diameter and species constituting 1 ha area as published, the tree cover under scattered stratum is estimated. The entire Culturable Non-Forest area (CNFA) of the district excluding block and linear patches already assessed is taken for estimating the tree cover under scattered stratum. The area under urban stratum is taken from Census data. The total tree cover for the selected district is obtained by aggregating the area of tree cover under block and linear strata, and computed area from scattered trees in rural and urban strata.

On the basis of tree cover of sampled districts, the tree cover for the physiographic zone is estimated. Adding tree cover estimate for all the physiographic zones provides the estimated tree cover of the country. The present estimate is based on 120 districts comprising 20,228 sample plots and is, therefore, more accurate compared to the estimate given in 'SFR 2003' where results were estimated on the basis of 60 districts comprising 10,145 sample plots.

5.3 Accuracy Assessment

As the tree cover assessment is based on field inventory following a suitable sampling design, its accuracy is adjudged by calculating the precision at national and physiographic zone level. The detailed procedure of calculating the precision has been given in Chapter 7. In the present 'SFR', 20,228 sample plots have been used for estimating the tree cover at the national level, which gives a precision of 96.3 percent. At physiographic zones, the precision level varies from 85% to 96%. For large-scale field inventory, the precision level of 85% and above is considered satisfactory.

5.4 Tree Cover in the Country: Physiographic Zone-wise

The total tree cover of the country has been estimated to be 91,663 km^2, which constitutes 2.79 percent of the country's geographic area. The estimates of tree cover for each physiographic zone is given in Table 5.1. It is observed that the tree cover is the maximum in East Deccan (11,293 km^2), followed by Northern Plains (10,747 km^2) and West Coast (8,307 km^2). West Coast has maximum percentage of tree cover (6.85%) with respect to geographical area followed by Western Ghats (5.37%) and East Coast (4.84%). Eastern Himalayas has the lowest tree cover of 255 km^2, as the area is full of forests.

5.5 Tree Cover in the States and Union Territories

Tree cover data of the physiographic zones was processed further to estimate tree cover of each state and union territory. One state may fall in one or many physiographic zones. To estimate the tree cover of the state, CNFA falling in different physiographic zones of the state was calculated. The estimates of tree cover of block, linear, scattered and urban stratums of a physiographic zone of sampled districts was 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 of different physiographic zones, tree cover for the respective state was estimated. However, it may be noted that in some of the States/UTs estimates for tree cover are only indicative in nature and may have lower levels of accuracy since the sample size in such States/UTs is small. The estimates of tree cover in the States and UTs are given in Table 5.2 and in Fig 5.2.

Tree cover constitutes the largest area in Maharashtra (8,978 km^2) followed by Rajasthan (8,379 km^2), Uttar Pradesh (8,203 km^2) and Andhra Pradesh (7,640 km^2). Considering

the percentage of geographic area under tree cover, the highest rank goes to Lakshadweep (13.33%) followed by Pondicherry (8.66%), Daman & Diu (7.76%) Chandigarh (7.61%), Goa (7.24%), Delhi (7.20%), Kerala (6.77%) and Dadra & Nagar Haveli (5.66%)

Table 5.1: Physiographic zone wise tree cover estimates

Sl. No.	Physiographic Zone	Geographic Area	Trees per ha of CNFA	Tree Cover	
				Area (km^2)	% of Geog.Area
1.	Western Himalayas	329,255	21.74	6,950	2.11
2.	Eastern Himalayas	74,618	10.18	255	0.34
3.	North East	133,990	15.28	1,726	1.29
4.	Northern Plains	295,780	13.43	10,747	3.63
5.	Eastern Plains	223,339	11.18	5,447	2.44
6.	Western Plains	319,098	9.86	7,815	2.45
7.	Central Highlands	373,674	9.39	8,124	2.17
8.	North Deccan	355,988	9.41	7,383	2.07
9.	East Deccan	336,289	10.61	11,293	3.36
10.	South Deccan	292,416	10.98	7,656	2.62
11.	Western Ghats	72,381	19.69	3,886	5.37
12.	Eastern Ghats	191,698	11.11	3,967	2.07
13.	West Coast	121,242	20.65	8,307	6.85
14.	East Coast	167,493	17.67	8,106	4.84
	TOTAL	3,287,263	12.14	91,663	2.79

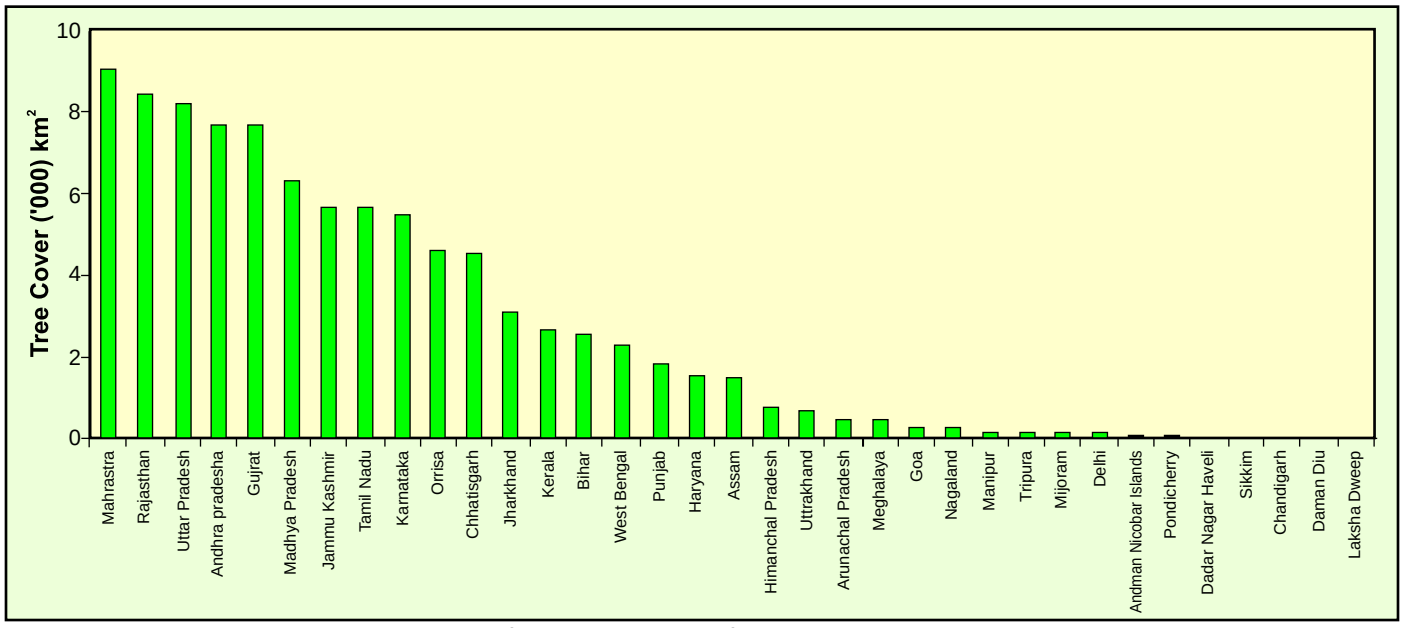

Fig. 5.2: Tree cover in States & UTs

Table 5.2: State/UT wise tree cover estimates

Sl. No.	State/U.T	Geographic Area	Trees per ha of CNFA	Tree Cover	
				Area(km^2)	% of geog. Area
1	Andhra Pradesh	275,069	12.76	7,640	2.78
2	Arunachal Pradesh	83,743	11.07	446	0.53
3	Assam	78,438	11.91	1,484	1.89
4	Bihar	94,163	10.80	2,522	2.68
5	Chhattisgarh	135,191	10.43	4,492	3.32
6	Delhi	1,483	26.44	107	7.20
7	Goa	3,702	25.29	268	7.24
8	Gujarat	196,022	13.41	7,621	3.89
9	Haryana	44,212	13.15	1,565	3.54
10	Himachal Pradesh	55,673	19.02	709	1.27
11	Jammu & Kashmir	222,236	22.54	5,633	2.53
12	Jharkhand	79,714	11.01	3,080	3.86
13	Karnataka	191,791	11.09	5,467	2.85
14	Kerala	38,863	16.50	2,632	6.77
15	Madhya Pradesh	308,245	9.68	6,267	2.03
16	Maharashtra	307,713	11.16	8,978	2.92
17	Manipur	22,327	15.31	142	0.63
18	Meghalaya	22,429	15.32	405	1.80
19	Mizoram	21,081	15.65	122	0.58
20	Nagaland	16,579	15.26	238	1.43
21	Orissa	155,707	12.42	4,589	2.95
22	Punjab	50,362	13.61	1,823	3.62
23	Rajasthan	342,239	9.54	8,379	2.45
24	Sikkim	7,096	22.62	27	0.38
25	Tamil Nadu	130,058	16.40	5,621	4.32
26	Tripura	10,486	15.31	134	1.28
27	Uttar Pradesh	240,928	12.71	8,203	3.40
28	Uttarakhand	53,483	17.38	658	1.23
29	West Bengal	88,752	11.43	2,269	2.56
30	Andaman & Nicobar Islands	8,249	17.16	53	0.65
31	Chandigarh	114	37.11	9	7.61
32	Dadra & Nagar Haveli	491	18.98	28	5.66
33	Daman & Diu	112	13.08	9	7.76
34	Lakshadweep	32	15.20	4	13.33
35	Pondicherry	480	21.80	42	8.66
	Total	3,287,263	12.14	91,663	2.79