

## **Chapter 1**

### **Introduction**

#### **1.01 History of Forest Assessment since Independence**

Considering the crucial role forests play in ecological stability, socio-economic well being and development of a country, the Government of India, in its National Forest Policy, has aimed at having a minimum of one-third of its geographical area under forest and tree cover. In the hills and mountainous regions of the country, this proportion has been targeted at two-thirds.

Information on forest over last five decades can be obtained from three sources, viz; (i) year-wise land use statistics compiled by the Ministry of Agriculture and is based on revenue records (ii) Ministry of Environment & Forests compiles information on forest area based on legal status of land and the source of information is State Forest Departments and (iii) assessment of areas having forest cover using modern technology of remote sensing is another source of information on forest areas.

Table 1.01 shows forest area figure obtained from first two sources. It shows that the recorded forest area of the country in 1951 was 71.80 million ha and it increased to 77 million ha in 1991, showing an increase of about 7%. Forest area as per records of Ministry of Agriculture shows an increase of about 68% in the last five decades but it is mostly because of discrepancies in the revenue records of earlier period. Maximum increase was noticed in the first two decades (i.e. 1951-61 and 1961-71). The difference in the two sources of information is mainly due to the fact that though a lot of area has been notified as recorded forests by the respective State/UT Governments, proper survey and demarcation have not been done and consequently revenue records have not been updated. In number of cases, settlement disputes and encroachment cases have not been settled.

**Table 1.01: Forest area in last five decades**

(in million ha)

<b>Year</b>	<b>Recorded Forests*</b>	<b>Forest area as land use**</b>
1951	71.80 (21.84)	40.48 (14.24)
1961	68.96 (20.98)	54.19 (18.09)
1971	74.83 (22.76)	63.77 (21.03)
1981	75.00 (22.82)	67.47 (22.19)
1991	77.00 (23.42)	67.87 (22.24)

\* Source: Ministry of Environment & Forests

\*\* Source: Ministry of Agriculture

*Figures in parentheses are percent of geographic area/reported area*

Though more than one fifth of India's geographic area is recorded as forest area, it is not known with certainty how much forest area actually bears forest cover. The National Forest Policies (1952 & 1988) aim at having one third of country's land area under forest and tree cover. Therefore, unless one has information on area having forest and tree cover, it can not be said with certainty how much more area needed to be brought under forest and tree cover to achieve the goal set by the National Forest Policy. It is not an easy task to assess forest cover of the country using traditional survey methods. In early eighties, National Remote Sensing Agency (NRSA), Department of Space, took the initiative of assessing forest cover of the country using remote sensing technology. They analyzed satellite data pertaining to the period 1972-75 and 1980-82, and estimated forest cover of the country to be 55.52 million ha for the respective period. As per the assessment made by NRSA, India's forest cover was 16.89% of geographic area in 1972-75 and it came down to 14.10% in 1980-82. Though this assessment had major shortcomings, this was a landmark development in the history of forest survey in India as for the first time use of satellite data for assessment of forest cover in the country was demonstrated.

Almost simultaneously, Forest Survey of India (FSI), an organisation under the Ministry of Environment & Forests, Government of India, which was mandated to take up forest survey of the country using conventional ground inventory, also developed capability of interpreting satellite data for assessment of forest cover. It came up with its first assessment of forest cover in 1987 based on satellite data of 1981-83. Its initial estimate of forest cover of the country was 64.87 million ha (19.70% of the geographic area). A reconciliation exercise between NRSA and FSI led to the final figure of 64.20 million ha (19.52%) of forest cover in India. After this FSI started assessing forest cover situation of the country on a biennial basis and the findings are reported in the State of Forest Reports (SFR), a biennial publication.

The current report, SFR 2003, is the ninth report in this series that started with the publication of SFR 1987. The assessment is principally based on interpretation of satellite data. The techniques of assessment have changed and improved over time due to progress in technology in the fields of remote sensing, data acquisition and processing and improvements in the skills of technical personnel. For the first assessment, reported in SFR 1987, the satellite data was interpreted visually at a scale of 1:1 million. The subsequent assessments till 1999, the assessments were based on visual interpretation of satellite data at a scale of 1:250,000. The last report, SFR 2001, was however based on digital interpretation of satellite data at 1:50,000 scale. An abstract of satellites, sensors and data properties used for various forest cover assessments carried out, so far, is presented in Table 1.02.

**Table 1.02: Satellite Data for Forest Cover Assessments from 1987 to 2003**

Assessment and Year	Data Period	Sensor	Data Form	Spatial Resolution	Spectral Resolution	Scale of Interpretation
I 1987	1981-83	Landsat – MSS	Hard Copy FCC	80 m	4 Bands	1:1million
II 1989	1985-87	Landsat – TM	Hard Copy FCC	30 m	7 Bands	1:250,000
III 1991	1987-89	Landsat – TM	Hard Copy FCC	30 m	7 Bands	1:250,000
IV 1993	1989-91	Landsat – TM	Hard Copy FCC	30 m	7 Bands	1:250,000
V 1995	1991-93	IRS-1B LISS II	Hard Copy FCC & Digital*	36.25 m	4 Bands	1:250,000
VI 1997	1993-95	IRS-1B LISS II	Hard Copy FCC & Digital*	36.25 m	4 Bands	1:250,000
VII 1999	1996-98	IRS-1C/1D LISS III	Hard Copy FCC & Digital**	23.5 m	4 Bands	1:250,000
VIII 2001	2000	IRS-1C/1D LISS III	Digital	23.5 m	4 Bands	1:50,000
IX 2003	2002	IRS-1D LISS III	Digital	23.5 m	4 Bands	1:50,000

\* Digital data used for two states only

\*\* Digital data used for 14 states only

The scale of interpretation puts a limitation (called, cartographic limit) on mapping of any geographical feature. For instance, at 1:250,000 scale, the smallest forest cover that could be delineated was 25 hectare (ha) while at 1:50,000 scale this limit comes down to 1 ha. The implication of cartographic limit was that during eighth assessment (2001), smaller patches of forest and tree canopies (1 to 25 ha in extent), could also be detected and mapped. At the same time, small blanks and gaps inside forested areas could be identified and delineated.

In addition, during the 2001 assessment, the cover on account of all other trees in the country that could not be captured by the satellite data was also estimated. These trees comprise of tree groves and woodlots smaller than 1 ha in area or narrow strips of tree plantations along linear features (e.g., roads, canals, bunds, etc.) or scattered trees on farms, homesteads and urban areas. These were estimated using field inventory methods. Thus, for the first time a complete assessment of forest and tree cover of the country was made during the eighth assessment and reported in SFR 2001. It provided new baseline information on forest and tree cover in the country.

The first seven SFRs (1987 to 1999) gave information of only forest cover while SFR 2001 provided information of forest cover as well as tree cover. The extent of forest and tree cover estimated in all the States and Union Territories (UT) of the country during the previous eight assessments can be seen at a glance in Table 1.03.

**Table 1.03** **Forest and Tree Cover in Different Assessments (1987 to 2001) (km<sup>2</sup>)**

State/UT	1987	1989	1991	1993	1995	1997	1999	2001	
	Forest Cover	Forest & Tree Cover							
Andhra Pradesh	49,573	47,290	47,290	47,256	47,112	43,290	44,229	44,637	53,648
Arunachal Pradesh	64,132	69,002	68,757	68,661	68,621	68,602	68,847	68,045	68,523
Assam	25,160	24,832	24,751	24,508	24,061	23,824	23,688	27,714	29,656
Bihar	28,482	26,668	26,668	26,587	26,561	4,832	4,830	5,720	9,413
Jharkhand	-	-	-	-	-	21,692	21,644	22,637	25,331
Delhi	15	22	22	22	26	26	88	111	151
Goa	1,240	1,255	1,255	1,250	1,250	1,252	1,251	2,095	2,157
Gujarat	11,991	11,921	11,907	12,044	12,320	12,578	12,965	15,152	19,188
Haryana	513	513	513	513	603	604	964	1,754	3,280
Himachal Pradesh	12,480	12,480	12,480	12,502	12,501	12,521	13,082	14,360	14,757
Jammu & Kashmir	20,905	20,449	20,449	20,443	20,433	20,440	20,441	21,237	23,454
Karnataka	32,268	32,104	32,199	32,343	32,382	32,403	32,467	36,991	44,437
Kerala	10,292	10,292	10,292	10,336	10,336	10,334	10,323	15,560	16,706
Madhya Pradesh	130,099	135,541	135,541	135,396	135,164	74,760	75,137	77,265	83,016
Chhattisgarh	-	-	-	-	-	56,435	56,693	56,448	59,983
Maharashtra	45,616	44,044	44,044	43,859	43,843	46,143	46,672	47,482	55,751
Manipur	17,475	17,685	17,685	17,621	17,558	17,418	17,384	16,926	17,021
Meghalaya	16,466	15,645	15,875	15,769	15,714	15,657	15,633	15,584	15,724
Mizoram	19,084	18,170	18,853	18,697	18576	18,775	18,338	17,494	17,589
Nagaland	14,394	14,399	14,321	14,348	14,291	14,221	14,164	13,345	13,415
Orissa	53,253	47,227	47,205	47,145	47,107	46,941	47,033	48,838	53,202
Punjab	943	1,338	1,343	1,343	1,342	1,387	1,412	2,432	4,066
Rajasthan	12,758	12,884	12,889	13,099	13,280	13,353	13,871	16,367	21,653
Sikkim	2,756	3,041	3,041	3,119	3,127	3,129	3,118	3,193	3,207
Tamil Nadu	17,472	16,992	16,992	17,005	17,045	17,064	17,078	21,482	27,536
Tripura	5,953	5,535	5,535	5,538	5,538	5,546	5,745	7,065	7,133
Uttar Pradesh	31,226	33,627	33,609	33,961	33,986	10,751	10,756	13,746	21,291
Uttaranchal	-	-	-	-	-	23,243	23,260	23,938	24,386
West Bengal	8,432	8,015	8,015	8,186	8,276	8,349	8,362	10,693	13,957
A & N Islands	7,601	7,622	7,622	7,624	7,615	7,613	7,606	6,930	7,013
Chandigarh	2	5	5	5	7	7	7	9	11
Dadra & N. Haveli	238	206	206	206	204	204	202	219	246
Daman & Diu	0	0	0	0	0	0	0	6	10
Lakshdweep	0	0	0	0	0	0	0	27	27
Pondicherry	0	0	0	0	0	0	0	36	71
<b>Grand Total</b>	<b>640,819</b>	<b>638,804</b>	<b>639,364</b>	<b>639,386</b>	<b>638,879</b>	<b>633,397</b>	<b>637,293</b>	<b>675,538</b>	<b>757,009</b>
<b>Percent</b>	<b>19.49</b>	<b>19.43</b>	<b>19.45</b>	<b>19.45</b>	<b>19.43</b>	<b>19.27</b>	<b>19.39</b>	<b>20.55</b>	<b>23.03</b>

## 1.02 Forest Cover and Tree Cover

It will be appropriate here to explain what is meant by forest cover and tree cover in this report. The normal perception is that forest cover would include areas covered by the canopy of naturally occurring forests, while man made tree crops and plantations should constitute tree cover. When interpreting satellite imagery for a small area followed by intensive ground verification, it may be possible to distinguish natural forests from plantations. Several articles and research studies dealing with limited areas provide detailed outputs about different land uses and classes of forest cover. However, there is no robust technique available for this that can be applied universally. Moreover,

considering the limited time and manpower resources available with FSI, it is not possible to carry out such an exercise for the whole country. Therefore, FSI has used technology-based definitions for forest cover and tree cover.

All tree canopies that could be delineated and assessed from satellite data (sensor LISS III of IRS satellite 1C/1D) is termed as forest cover. It includes canopy of all forest and tree crops, larger than 1 ha in extent, irrespective of land ownership, land use and type of tree species. With spatial resolution of 23.5 m of sensor LISS III aboard Indian Remote Sensing satellite 1C/1D and using digital image processing technique, land cover could be mapped at a larger scale of 1:50,000. At this scale, forest cover down to 1 ha could now be delineated. However, even with the present capability, countrywide identification and mapping of different tree species is not possible. Also, it is not possible from satellite data to determine what kind of land use is being practised under the tree canopy or who owns the land. Thus forest cover cannot be classified into natural forests, orchards, coffee/tea plantations, public parks, agroforestry plantations, etc.

The area under canopy of all other tree crops not captured by satellite data is termed as tree cover. These were assessed by conducting field inventory. Only trees having diameter of 10 cm or more at breast height were included. A statistically sound stratification and sampling design was developed for assessing tree cover at the national level. The country was stratified into zones constituting such geographic areas that exhibit broad similarity in the factors responsible for tree growth (e.g., altitude, geographic location, soil, precipitation, temperature, soil moisture, etc.) and thus support fairly homogenous tree vegetation. These zones were termed as physiographic zones and the country was stratified into fourteen zones. The data obtained from inventory of trees in sampled rural and urban units was processed and aggregated to estimate number of trees of different diameter classes and species for all physiographic zones. Where actual area under tree crops was not possible to determine (e.g., trees in urban areas or scattered trees in rural areas), relationships between the diameter and crown area of trees for different species were used to convert the number of trees into “notional” area under tree cover.

Thus, it may be noted while going through State of Forest Reports that “forest cover” implies “forest and tree cover (satellite)” and “tree cover” means “other forest and tree cover (inventory)”. It may also be noted that assessments done at different scales cannot be compared directly to determine and map changes in forest cover. For this reason, SFR 1987 (scale 1:1 million) and SFR 2001 (scale 1:50,000) cannot be judged directly against other SFRs (scale 1:250,000). Since the scale used in the present assessment (1:50,000) is same as that used in SFR 2001, these can be compared directly to map changes in forest cover during the intervening period.

### **1.03 Forest and Forest Area**

Forest is generally described as a tract of land having plant community largely consisting of trees and other woody vegetation. However, there is no universally accepted technical definition of forest. Food and Agriculture Organisation of United Nations (FAO) defines forest as land having a tree canopy cover of more than 10 percent over an

area of more than 0.5 ha with forestry as the principal land use. In India, a piece of land is recognized as forest if it is legally proclaimed to be forest area under a forest law (e.g., Indian Forest Act of 1927) and it is recorded/notified as forest in government records. In the present report, the legal definitions of “forest” and “forest area” (also termed as “recorded forest area”) have been used.

It is possible that a part or the whole of such forest area, at any point in time, may not have trees on it but still all the provisions of the forest law under which it is notified will be applicable to it. However, while assessing forest cover using satellite data, such blanks or gaps will be classified as non-forest. The primary responsibility of managing, protecting and conserving forests within recorded forest areas lies with the corresponding State or UT Forest Departments.

The recorded forest area is further categorized into “Reserved Forest”, “Protected Forest” and “Unclassed Forest”. Reserved Forest is an area notified under the provisions of India Forest Act or the State Forest Acts having full degree of protection. All activities are prohibited unless permitted within a Reserved Forest. Protected Forest is also notified under the provisions of India Forest Act or the State Forest Acts but has only a limited degree of protection. In Protected Forests all activities are permitted unless prohibited. Unclassed Forest is an area recorded as forest but not included in reserved or protected forest category. Ownership status of such forests varies from forest to forest and state to state.

As per the latest reports received from the State/UT Forest Departments, the recorded forest area in the country is 774,740 km<sup>2</sup> (or 23.57 percent of the country’s geographic area) comprising of 399,919 km<sup>2</sup> of Reserved Forest (51.6 percent of total forest area), 238,434 km<sup>2</sup> of Protected Forest (30.8 percent) and 136,187 km<sup>2</sup> of Unclassed Forest (17.6 percent). The State/UT wise distribution of recorded forest area in the country is given in Table 1.04. The Table also indicates State/UT wise total recorded forest area reported in SFR 2001 and changes therein.

**Table 1.04 Recorded Forest Area in States and UTs**

(Area in km<sup>2</sup>)

State/UT	Geographic Area (GA)	Total Forest Area as in SFR 2001	Recorded Forest Area at Present					
			RF	PF	UF	Total Forest Area	% of GA	Change w.r.t. SFR 2001
Andhra Pradesh	275,069	63,814	50,479	12,365	977	63,821	23.20	7
Arunachal Pradesh	83,743	51,540	10,178	9,536	31,826	51,540	61.55	0
Assam	78,438	27,018	18,060	0	8,958	27,018	34.45	0
Bihar	94,163	6,078	693	5,779	1	6,473	6.87	395
Chhattisgarh	135,191	59,285	25,782	24,036	9,954	59,772	44.21	487
Delhi	1,483	85	78	7	0	85	5.73	0
Goa	3,702	1,224	237	822	165	1,224	33.06	0
Gujarat	196,022	18,999	14,155	395	4,563	19,113	9.75	114
Haryana	44,212	1,551	249	1,158	151	1,558	3.52	7
Himachal Pradesh	55,673	37,033	1,896	33,043	2,094	37,033	66.52	0

Jammu & Kashmir	222,236	20,230	2551	17,643	36	20,230	9.10	0
Jharkhand	79,714	23,605	4,387	19,185	33	23,605	29.61	0
Karnataka	191,791	38,724	29,550	3,585	9,949	43,084	22.46	4,360
Kerala	38,863	11,221	11,098	170	0	11,268	28.99	47
Madhya Pradesh	308,245	95,221	58,734	35,587	900	95,221	30.89	0
Maharashtra	307,713	61,939	49,217	8,196	4,526	61,939	20.17	0
Manipur	22,327	17,418	1,467	4,171	11,780	17,418	78.01	0
Meghalaya	22,429	9,496	1,112	12	8,372	9,496	42.34	0
Mizoram	21,081	15,935	7,909	3,568	5,240	16,717	79.30	782
Nagaland	16,579	8,629	308	508	7,813	8,629	52.05	0
Orissa	155,707	58,135	26,329	15,525	16,282	58,136	37.34	1
Punjab	50,362	3,059	44	1,137	1,903	3,084	6.12	25
Rajasthan	342,239	32,494	11,860	17,652	2,976	32,488	9.49	-6
Sikkim	7,096	5,765	5,452	389	0	5,841	82.31	76
Tamilnadu	130,058	22871	19,388	2,183	1,306	22,877	17.59	6
Tripura	10,486	6,293	3,588	664	2,041	6,293	60.01	0
Uttar Pradesh	240,928	16,826	11,078	2,425	3,323	16,826	6.98	0
Uttaranchal	53,483	34,662	23,827	10,673	162	34,662	64.81	0
West Bengal	88,752	11,879	7,054	3,772	1,053	11,879	13.38	0
Andaman & Nicobar	8,249	7,171	2,929	4,242	0	7,171	86.93	0
Chandigarh	114	32	31	0	3	34	29.82	2
Dadra & Nagar Haveli	491	203	199	5	0	204	41.55	1
Daman & Diu	112	1	0	1	0	1	0.89	0
Lakshdweep	32	0	0	0	0	0	0.00	0
Pondicherry	480	0	0	0	0	0	0.00	0
<b>Total</b>	<b>3,287,263</b>	<b>768,436</b>	<b>399,919</b>	<b>238,434</b>	<b>136,387</b>	<b>774,740</b>	<b>23.57</b>	<b>6,304</b>

Source: Forest Departments of States and Union Territories

## 1.04 New Features in this Report

(i) Additional class of forest cover: In all the previous eight State of Forest Reports, forest cover was classified into two broad categories: Dense Forest and Open Forest. Dense Forest included all lands with a forest cover of trees with a canopy density over 40 percent while Open Forest showed all lands with a forest cover of trees with a canopy density between 10 and 40 percent. Many well meaning readers felt that the class “Dense Forest” was too wide and it encompassed a large range of crop density. Even significant changes in canopy density within this class would thus go unreported. In the present SFR, the earlier category of “Dense Forest” has been sub-divided into two classes: “Very Dense Forest” (where canopy density is above 70 percent) and “Moderately Dense Forest” (where canopy density lies between 40 and 70 percent). Now with maps showing three classes of forest cover (instead of only two till now), it will be possible to monitor changes in forest quality more closely.

(ii) Information on growing stock of wood inside and outside forest areas: FSI has so far been generating information only on area under forest and tree cover in the country. However, for sound planning and management decisions in forestry sector,

information (spatial as well as non-spatial) is also required on volumes of growing stock of wood, preferably species wise and diameter class wise. Since, in the recent times, timber/wood produced from areas outside forests constitutes a substantial proportion of total wood coming to market, the information of growing stock will be complete and useful only if growing stock existing both inside and outside forests is reported. This additional information for the whole country, based on statistically sound techniques of stratification, sampling, field inventory and data processing, has been included in this report.

## **1.05 About this Report**

SFR 2003 comprises of seven chapters and a number of annexures. This introductory chapter gives historical information, highlights important features of the report, describes various concepts and explains several important terms used in this report. A reader should clearly understand what these terms imply if he or she wishes to fully appreciate the information provided in this report. A “Glossary of Important Terms” appended as Annexure-I may also be referred to. Chapter 2 on “Forest Cover” describes methodology and results of forest cover assessment. Chapter 3 gives estimates of “Changes in Forest Cover” with respect to 2001 Assessment. Chapter 4 is devoted to “Mangrove Cover”. Chapter 5 on “Tree Cover” describes the methodology and quantitative estimates of tree cover. Chapter 6 gives information on “Growing Stock of Wood inside and outside Forests Area”. The last chapter on “Forest and Tree Cover” provides forest cover maps, forest and tree cover data and other important statistical information for the country, states and union territories. It also gives district wise data on forest cover and changes therein for each State and UT.

