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Acronyms and Abbreviations

CD	-	Compact Disc
CNFA	-	Culturable Non-Forest Area
DBH	-	Diameter at breast height
DIP	-	Digital Image Processing
DF	-	Dense Forest
FAO	-	The Food & Agriculture Organisation of United Nations
FCC	-	False Colour Composite
FSI	-	Forest Survey of India
GA	-	Geographic Area
GCP	-	Ground Control Point
GIS	-	Geographical Information System
GPS	-	Global Positioning System
IRS	-	Indian Remote Sensing (Satellite)
ISRO	-	Indian Space Research Organisation
LISS	-	Linear Imaging and Self-scanning Sensor
MSS	-	Multi Spectral Scanner
MDF	-	Moderate Dense Forest
NDVI	-	Normalised Difference Vegetation Index
NRSA	-	National Remote Sensing Agency
NF	-	Non-Forest
NSSO	-	National Sample Survey Organistion
NWFP	-	Non-Wood Forest Products
OF	-	Open Forest
PAN	-	Pan-Chromatic
PF	-	Protected Forest
SFD	-	State Forest Department
SFR	-	State of Forest Report
SOI	-	Survey of India
TM	-	Thematic Mapper
TOF	-	Trees Outside Forests
UFS	-	Urban Frame Survey
UT	-	Union Territory
VDF	-	Very Dense Forest
Vol.	-	Volume

Executive Summary

Forest Survey of India (FSI) carries out assessment and monitoring of forest cover of the country on a two-year cycle and publishes the findings in the form of 'State of Forest Report' (SFR) on biennial basis. The first SFR was brought out in 1987 and SFR 2003 is the ninth in the series. The forest cover is assessed and monitored by interpreting the latest satellite data procured from National Remote Sensing Agency (NRSA), Hyderabad. The SFRs provide valuable information for policy formulation and planning both at national and state levels. The National Forest Policy (1988) sets out a definite quantitative stipulation for the forest and tree cover for the country and the periodical information provided by SFRs keeps the nation informed of gaps between the actual status and the goals set.

SFR 2003 has been enriched by the incorporation of many new features. The most prominent one is the introduction of one more density class in the classification of forest cover. Upto SFR 2001, any forest cover with a canopy density more than 40% was classified as 'Dense Forest' (DF). There have been suggestions from many quarters that the density class from 40 to 100% was too broad and therefore, SFR 2003 shows the forest cover with a canopy density over 70% as 'Very Dense Forest' (VDF); and that with canopy density between 40 to 70% as 'Moderately Dense Forest' (MDF). The same category has been introduced in mangrove cover assessment too.

Another newly incorporated highly useful feature is the Chapter on the growing stock of wood. The chapter provides information on volumes of growing stock of wood not only in forest areas but also outside it. Sound statistical techniques of stratification, sampling, field inventory and data processing have been used for this estimation which is valuable for planning and management decisions.

SFR 2001 was the first report based on figures of forest cover arrived at using digital image processing (DIP) technique at the scale of interpretation of 1:50,000. Earlier, the forest cover assessment was made using visual interpretation technique and the scale of interpretation was 1:1 million to 1:250,000 and therefore it was not proper to make a valid comparison of results of SFR 2001 with those of earlier SFRs. SFR 2003 provides the direct comparison of forest cover figures with those of SFR 2001 as similar digital methodology and same scale of interpretation have been used in both the assessments. Since the SFR 2001 did not have the class VDF in its figures; change matrices have been made giving the comparison only for the classes described in SFR 2001. The classes VDF and MDF have been clubbed as Dense Forest for this purpose. It may be mentioned that the changes indicated in forest cover may still comprise two components: one, due to actual change on the ground during the intervening period, and two, because of interpretational differences.

As in SFR 2001, in SFR 2003 also, forest cover has been taken as comprising all lands more than one hectare in area, with a tree canopy density of more than 10 per cent, irrespective of land use and ownership. All perennial woody vegetation (including

bamboos, palms, coconut, apple, mango, neem, peepal, etc.) has been treated as tree in this report. Thus, all lands with tree crops, such as agro forestry plantations, fruit orchards, tea and coffee estates with trees, etc. have been included in forest cover.

Another new feature is the introduction of a new methodology based on remote sensing to estimate the tree cover which is below 1 ha and can not discerned using LISS III data used for forest cover assessment. In the new methodology, high resolution PAN data has been used along with LISS III data to stratify the districts into three strata, viz. block plantation, linear plantation and scattered trees. By this method one can identify a tree vegetated land as small as 0.1 ha on the ground. Ground inventory is carried out in desired number of sample plots in each strata and data obtained is processed to generate a notional tree cover at 70 percent canopy density. Thus, as done in last report, a complete picture of forest and tree cover in the country has been provided in the SFR 2003.

The salient features of the SFR 2003 are summarized below:-

i. The forest cover in the country is 678,333 km^2 and constitutes 20.64 percent of its geographical area. Of this, the very dense forest (VDF) constitutes 51,285 km^2, (1.56%) moderately dense forest (MDF) constitutes 339,279 km^2 (10.32%) and open forest constitutes 287,769 km^2 (8.76%). Madhya Pradesh with 76,429 km^2 of forest cover has the maximum forest cover among all the States/UTs, followed by Arunachal Pradesh (68,019 km^2) and Chhattisgarh (55,998 km^2).
ii. There are 123 districts in the country that are categorized as hill districts where the total forest cover is 274,383 km^2 (average forest cover 38.77 % of geographical area).
iii. There are 187 districts in the country categorized as tribal districts. The total forest cover is estimated as 407,298 km^2 (average forest cover 36.91% of geographical area).
iv. In addition, water bodies inside forest cover has also been assessed and found to occupy 17,396 km^2
v. Shifting cultivation prevalent in seven North-Eastern States affects forest cover adversely in this region. The loss of forest cover due to shifting cultivation is also assessed and it is found that between 2001 and 2003 assessments an area of 5,476 km^2 with forest cover has been affected by shifting cultivation. The maximum effect of shifting cultivation has been found in Nagaland (1,332 km2) and minimum in Tripura (384 km^2).
vi. A comparison with the forest cover assessment of 2001 reveals an overall increase of 2,795 km^2 or 0.41 percent in forest cover of the country. There is a decrease in dense forest cover to the tune of 26,245 km^2 (6.30%) and the open forest cover has increased by 29,040 km^2 (11.22 %).
vii. Assessment of forest cover at district level reveals that out of the total 593 districts in the country, 199 districts have less than 5% of their geographic area under forest cover including 59 districts that have less than 1% forest cover. In case of only 146 districts, the forest cover exceeds 33% of their geographical area.
viii. The mangrove cover in the country occupies an area of 4,461 km^2 (0.14 % of geographic area) of which 1,162 km^2 is very dense, 1,657 km^2 is moderately

dense and 1,642 km^2 is open mangrove. A comparison with the 2001 assessment shows a decrease of 41 km^2 in the dense mangrove cover and an increase of 20 km^2 in the open mangrove cover. Overall there is a decrease of 21 km^2 in mangrove cover of the country.

ix. The total tree cover of the country (notional area with 70% canopy density) has been estimated as 99,896 km^2 or about 3.04 percent of the country's geographic area which is 18,424 km^2 more than what was assessed in 2001.

x. The total forest and tree cover of the country so estimated comes out to be 778,229 km^2 constituting 23.68 % of its geographic area against 757,010 km^2 constituting 23.03% of geographic area in 2001 assessment. Thus, there is an increase of forest and tree cover by 21,219 km^2, which is 0.65% of geographical area as compared to 2001 assessment. The per capita forest and tree cover in the country is 0.07 ha.

xi. The total growing stock of wood in the country is estimated to be 6,414 million cubic meter (m.cu.m.) that includes 4,782 m.cu.m. inside forest area and 1,632 m.cu.m. of TOF (Trees Outside Forests).

xii. The average growing stock in the forest per hectare of recorded forest area works out to be 61.72 cu.m.

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)

Year	Recorded Forests*	Forest area as land use**
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 certainity 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 accessment 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^2)

State/UT	1987	1989	1991	1993	1995	1997	1999	2001	
	Forest Cover	Forest Cover	Forest Cover	Forest Cover	Forest Cover	Forest Cover	Forest Cover	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
Grand Total	**640,819**	**638,804**	**639,364**	**639,386**	**638,879**	**633,397**	**637,293**	**675,538**	**757,009**
Percent	**19.49**	**19.43**	**19.45**	**19.45**	**19.43**	**19.27**	**19.39**	**20.55**	**23.03**

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^2 (or 23.57 percent of the country's geographic area) comprising of 399,919 km^2 of Reserved Forest (51.6 percent of total forest area), 238,434 km^2 of Protected Forest (30.8 percent) and 136,187 km^2 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^2)

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
Total	**3,287,263**	**768,436**	**399,919**	**238,434**	**136,387**	**774,740**	**23.57**	**6,304**

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.

CHAPTER 2

FOREST COVER

2.01 Introduction

Assessment of forest cover using satellite data on a two-year cycle has been one of the most important activities of FSI since 1986. The present assessment is the 9th assessment in this series. Forest cover is defined as an area more than 1 ha in extent and having tree canopy density of 10 percent and above. This definition is based on the resolution of digital satellite data (pixel size 23.5m x 23.5m), scale of interpretation (1:50,000) and the technique employed for image processing. No distinction with respect to the type of tree crops (natural or man made) or tree species has been attempted since robust techniques are not available for making such distinction. Moreover, no cognizance of the type of land ownership or land use or legal status of land was taken as geo-referenced maps depicting such information was neither available nor possible to collect at country level. Thus, all species of trees (including bamboos, fruits or palms, etc.) and all types of lands (forest, private, community or institutional) satisfying the basic criteria of canopy density of more than 10 percent have been delineated as forest cover while interpreting satellite data. The minimum area of 1 ha for forest cover has been kept because this is the smallest area that can be delineated on a map at 1:50,000 scale.

2.02 Satellite Data and its Period

The present assessment is based on digital interpretation of satellite data for the entire country. The satellite data was procured from the National Remote Sensing Agency (NRSA), Hyderabad in digital form. For the present assessment, LISS-III sensor data of IRS-1D satellite with a resolution of 23.5 m has been used. Data for nearly all the states pertained to the period from October to December 2002. These are the months when cloud cover is low and the deciduous trees still have leaves to provide satisfactory reflectance for the satellite sensors. It may be mentioned here that one scene of LISS III covers an area of about 20,000 km^2 (140 km x 140 km). Due to considerable overlap (15 to 20 percent) among adjacent scenes, as many as 391 scenes are required to envelope the entire country. Also, at the border of the country or for islands, the whole scene has to be procured though area of interest may be very small part of the scene. While procuring data, only those scenes were selected where cloud cover was less than 10 percent.

2.03 Methodology

Using Digital Image Processing (DIP) software, digital data from satellite available on CDs is downloaded on the Workstation. Radiometric and contrast corrections were applied for removing radiometric defects and for improving visual impact of the False Colour Composites (FCC). Geometric rectification of the data was carried out with the help of scanned SOI toposheets. Based on tone and texture the forest cover areas were delineated. Interpretation of forest cover for the whole country was done at 1:50,000 scale using polyconic projection. Normalized Difference Vegetation Index (NDVI) transformation was also used for density classification of forest cover. Areas of less than one hectare, whether classified as forest within non-forest areas or blanks within

forested areas, were excluded by clustering pixels and merged with the surrounding class. The methodology has been shown schematically in Figure 2.01.

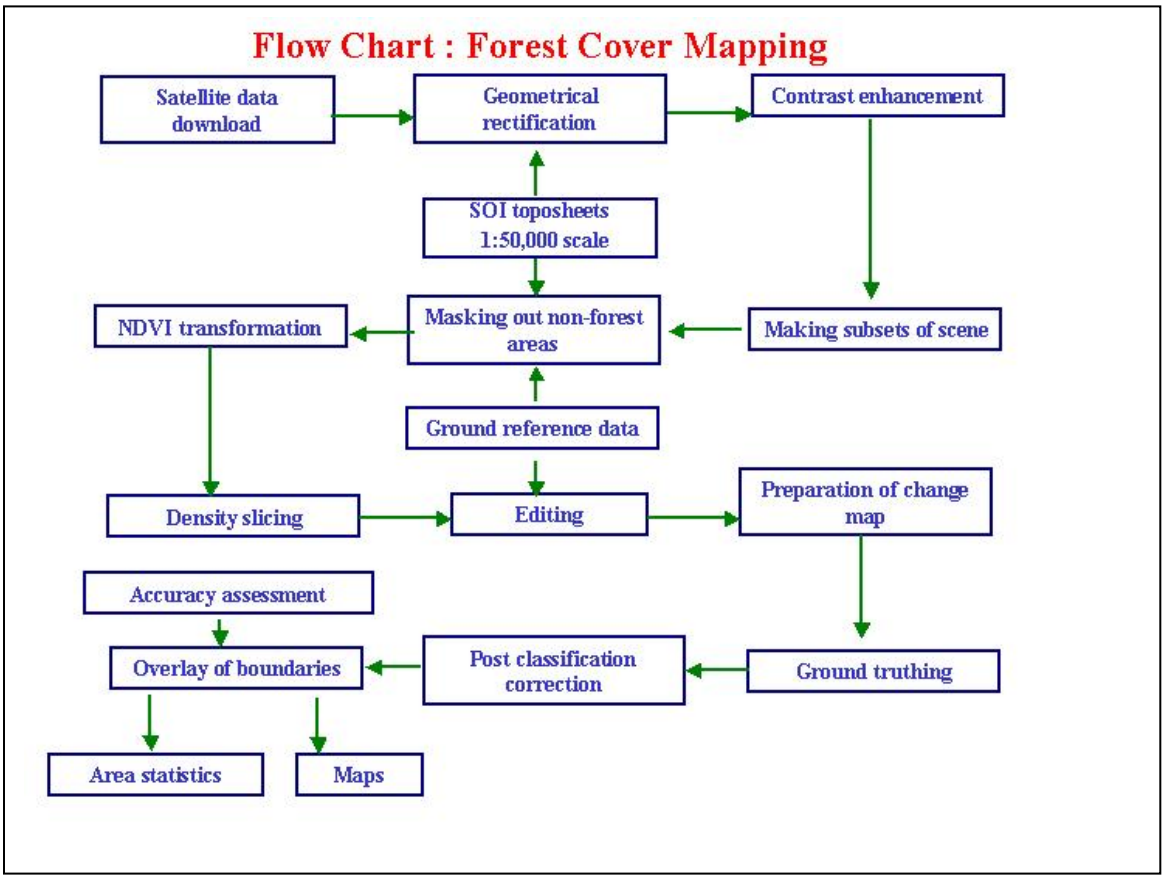


Figure 2.01 Flow Chart Showing Methodology of Forest Cover Mapping

The following categories of land use were delineated based on canopy density:

Forest cover	**Crown density range**
Very Dense Forest (VDF)	> 70 percent
Moderately Dense Forest (MDF)	40-70 percent
Open Forest (OF)	10-40 percent
Non-forest cover	
Scrub	<10 percent
Non-forest	-
Water bodies	-

Very Dense Forest

Moderately Dense Forest

Open Forest

Mangroves

Fig. 2.02 Pictorial illustration of different classes of forests

Highly degraded forest or wastelands with stumped trees having canopy density less than 10 percent were classified as scrubs, a category of non-forest cover. Shadow areas in the scenes were treated separately. Density in shadow area was either based on ground information or was assigned according to the nearest neighbour class of density. Mangrove cover was also delineated due to their unique signature along the coastal areas. Mangroves were further classified into three density classes of forest cover described above. After delineation, mangrove cover was added up with forest cover in the respective density classes. This was then followed by extensive ground verification and all the necessary corrections were subsequently incorporated. Sheet wise mosaic of districts and States/UTs was made using SOI and Census data to compute district wise and State/UT wise forest cover.

2.04 Limitations of Remote Sensing Technology

However, there are still certain limitations with remote sensing technology when used for assessment of forest cover. Some of the major ones are listed below:

- Since resolution of data from LISS-III is 23.5 m, the linear strips of forest cover along roads, canals, bunds and rails of width less than the resolution are generally not captured.
- Young plantations and species having less chlorophyll contents in their crown do not give proper reflectance and as a result are difficult to be interpreted correctly.
- Considerable details on ground may be obscured in areas having clouds and shadows. It is difficult to interpret such areas without the help of collateral data.
- Variation in spectral reflectance during leafless period poses problem in interpretation.
- Gregarious occurrence of bushy vegetation and certain agricultural crops, such as lantana, sugarcane, cotton, etc., often pose problems in delineation of forest cover, as their reflectance is similar to that of tree canopy.

2.05 Forest Cover: 2003 Assessment

Results of present assessment (2003) of forest cover in the country are summarized in a pie chart in Figure 2.01 and Table 2.01. Forest cover is shown in three density classes viz., very dense forest (VDF) with more than 70% canopy density, moderately dense forests (MDF) with canopy density between 40% and 70% and open forests (OF) with canopy density between 10% and 40%. Scrub and water bodies are also delineated. As mentioned earlier, area under VDF, MDF and OF also includes mangrove cover of the corresponding density class. The total forest cover of the country as per 2003 assessment is 678,333 km² and this constitutes 20.64 percent of the geographic area of the country. Of this, 51,285 km² (1.56 percent) is very dense forest, 339,279 km² (10.32 percent) is moderately dense forest while 287,769 km² (8.76 percent) is open forest cover. The non-forest cover includes scrub and is estimated to cover an area of 40,269 km².

Table 2.01 Status of Forest Cover in India

Class	Area (km^2)	Percent of Geographic Area
Forest Cover		
a) VDF	51,285	1.56
b) MDF	339,279	10.32
c) Open	287,769	8.76
Total Forest Cover*	**678,333**	**20.64**
Non-forest Cover		
Scrub	40,269	1.23
Non-forest**	2,568,661	78.13
Total Geographic Area	**3,287,263**	**100.00**

* Including 4,461 km^2 under mangroves (0.14% of country's geographic area)
** Excludes scrubs and includes water bodies

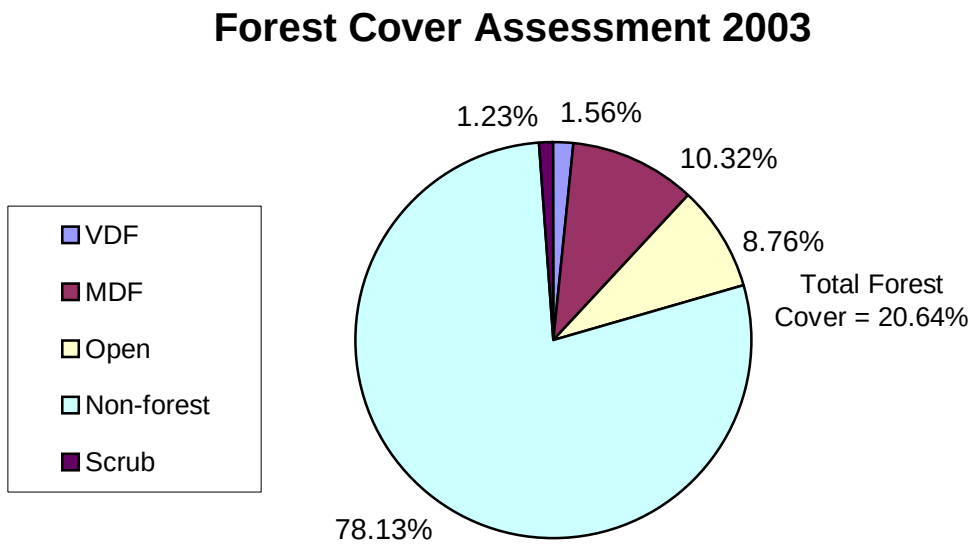


Figure 2.03: Forest Cover

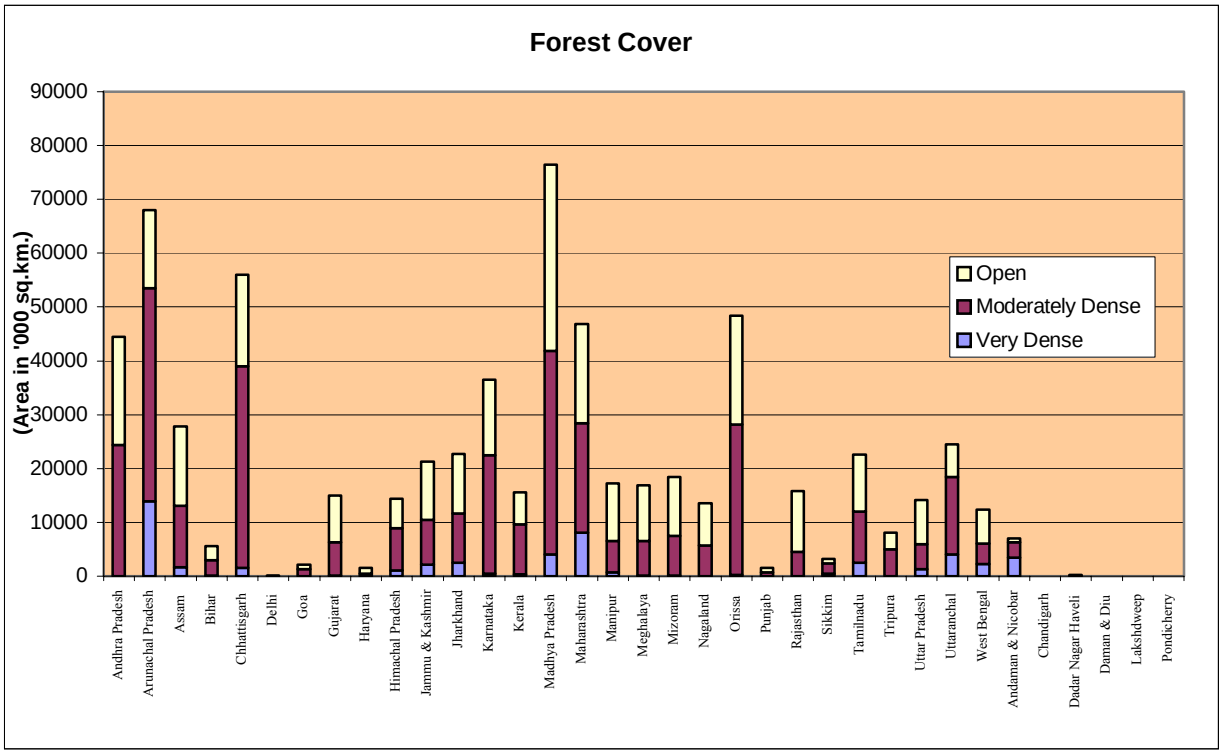


Figure 2.04: Forest Cover in States and UTs

2.06 State/UT wise Forest Cover

The State/UT wise forest cover in the country is shown in Table 2.02 and as bar chart in Figure 2.03. It shows that Madhya Pradesh with 76,429 km² has the maximum area under forest cover, followed by Arunachal Pradesh (68,019 km²) and Chhattisgarh (55,998 km²). Considering proportion of geographic area under forest cover, Mizoram has the maximum percentage (87.42 percent). It is followed by Andaman & Nicobar Islands (84.42 percent), Nagaland (82.09percent) and Arunachal Pradesh (81.22 percent).

Table 2.02 Forest cover in States/UTs in India (Area in km²)

State/UT	Geographic Area	Forest Cover				Percent	Scrub
		VDF	MDF	OF	Total		
Andhra Pradesh	275,069	23	24,356	20,040	44,419	16.15	9,748
Arunachal Pradesh	83,743	13,907	39,604	14,508	68,019	81.22	116
Assam	78,438	1,684	11,358	14,784	27,826	35.48	219
Bihar	94,163	76	2,951	2,531	5,558	5.90	150
Chhattisgarh	135,191	1,540	37,440	17,018	55,998	41.42	88
Delhi	1,483	0	52	118	170	11.47	1
Goa	3,702	0	1,255	901	2,156	58.24	0
Gujarat	196,022	114	6,231	8,601	14,946	7.62	1,743

Haryana	44,212	2	518	997	1,517	3.43	68
Himachal Pradesh	55,673	1,093	7,883	5,377	14,353	25.78	389
Jammu & Kashmir	222,236	2,102	8,395	10,770	21,267	9.57	2,947
Jharkhand	79,714	2,544	9,137	11,035	22,716	28.50	807
Karnataka	191,791	431	22,030	13,988	36,449	19.00	3,141
Kerala	38,863	334	9,294	5,949	15,577	40.08	72
Madhya Pradesh	308,245	4,000	37,843	34,586	76,429	24.79	2,378
Maharashtra	307,713	8,070	20,317	18,478	46,865	15.23	4,175
Manipur	22,327	720	5,818	10,681	17,219	77.12	74
Meghalaya	22,429	168	6,323	10,348	16,839	75.08	169
Mizoram	21,081	84	7,404	10,942	18,430	87.42	274
Nagaland	16,579	57	5,650	7,902	13,609	82.09	231
Orissa	155,707	288	27,882	20,196	48,366	31.06	5,346
Punjab	50,362	0	743	837	1,580	3.14	22
Rajasthan	342,239	14	4,482	11,330	15,826	4.62	4,564
Sikkim	7,096	458	1,904	900	3,262	45.97	360
Tamilnadu	130,058	2,440	9,567	10,636	22,643	17.41	2,040
Tripura	10,486	58	4,988	3,047	8,093	77.18	1
Uttar Pradesh	240,928	1,297	4,699	8,122	14,118	5.86	749
Uttaranchal	53,483	4,002	14,420	6,043	24,465	45.74	320
West Bengal	88,752	2,303	3,742	6,298	12,343	13.91	75
Andaman & Nicobar	8,249	3,475	2,809	680	6,964	84.42	1
Chandigarh	114	1	8	6	15	13.16	1
Dadra & Nagar Haveli	491	0	145	80	225	45.82	-
Daman & Diu	112	0	2	6	8	7.45	-
Lakshdweep	32	0	12	11	23	71.88	-
Pondicherry	480	0	17	23	40	8.33	-
Total	**3,287,263**	**51,285**	**339,279**	**287,769**	**678,333**	**20.64**	**40,269**

2.07 Forest Cover in Hill Districts

The National Forest Policy (1988), aims at having a minimum of one third of geographic area of the country under forest and tree cover and enjoins maintaining two third of the area in hills under forest cover in order to prevent erosion and land degradation and also to ensure maintenance of ecological balance and environmental stability. It is therefore felt desirable to know the extent of forest cover in the hill districts in the country. With this objective FSI started assessing forest cover in the hill districts of the country since 1997.

The classification of hill districts and *talukas* is as adopted by the Planning Commission. A hill *taluka* is one where altitude is above 500 m from the mean sea level. The Planning Commission has applied this criterion for Hill Areas and Western Ghats Development Programmes. Since forest cover assessment is done taking district as a unit, only those districts have been categorised as hill districts where the total area of hill *talukas* exceeds 50 percent of the geographic area of a district. The abstract of forest

cover in hill districts is given in Table 2.03. The hill districts have been marked "H" in the district wise forest cover tables in Chapter 7.

There are 123 districts in the country that can be classified as hill districts on the basis of the criterion explained above. The total forest cover in the hill districts of the country is 274,383 km² constituting 38.77 percent of the geographic area of these districts, against the goal of 66 percent as laid down in the National Forest Policy 1988. Out of total 123 hill districts, only 54 districts have forest cover more than 66 percent. Of the rest, 36 hill districts have forest cover less than 66 percent but more than 33 percent and the remaining 33 districts have even less than 33 percent forest cover (including 10 districts having less than 10 percent forest cover).

Table 2.03: State/UT wise Forest Cover in Hill Districts

(Area in km²)

State/UT	No. of Hill Dist.	Geographic area in Hill Districts	Forest Cover				Percent Forest Cover
			Very Dense Forest	Moderate Dense Forest	Open Forest	Total	
Arunachal Pradesh	13	83,743	13,907	39,604	14,508	68,019	81.22
Assam	3	19,153	943	5,678	6,537	13,158	68.70
Himachal Pradesh	12	55,673	1,093	7,883	5,377	14,353	25.78
Jammu & Kashmir	(a) 14	101,388	1,557	6,326	7,712	15,595	15.38
	(b) *	120,848	545	2,069	3,058	5,672	4.69
Karnataka	6	48,046	379	16,351	5,641	22,371	46.56
Kerala	10	29,572	315	7,428	5,057	12,800	43.28
Maharashtra	7	69,905	307	6,334	5,596	12,237	17.50
Manipur	9	22,327	720	5818	10681	17219	77.12
Meghalaya	7	22,429	168	6,323	10,348	16,839	75.08
Mizoram	8	21,081	84	7404	10942	18430	87.42
Nagaland	8	16,579	57	5,650	7,902	13,609	82.09
Sikkim	4	7,096	458	1,904	900	3,262	45.97
Tamil Nadu	5	22,789	1,121	2,710	2,209	6,040	26.50
Tripura	3	10,486	58	4,988	3,047	8,093	77.18
Uttaranchal	13	53,483	4,002	14,420	6,043	24,465	45.74
West Bengal	1	3,149	472	893	856	2,221	70.53
Total	**123**	**707,747**	**26,186**	**141,783**	**106,414**	**274,383**	**38.77**

***** In area under illegal occupation of Pakistan and China

2.08 Forest Cover in Tribal Districts

Tribals in the country are traditional forest dwellers. Forests play a significant role in the tribal economy, as these are a source of subsistence and livelihood for the tribal communities. It is commonly believed that the tribal communities live in harmony with nature and protect forests. Assessment of forest cover in tribal areas therefore acquires a

special significance. Since the 1997 assessment, FSI is regularly providing information on forest cover in districts identified as tribal districts under the Integrated Tribal Development Programme of the Government of India. In addition, all the districts of Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Dadra & Nagar Haveli and Lakshdweep have also been included in the list of Tribal districts owing to high tribal population. The abstract of forest cover in the tribal districts is given in Table 2.04.

Out of 593 districts in the country, 187 districts have been identified as tribal districts. The present assessment reveals that the total forest cover in these tribal districts is 407,298 km². It constitutes 36.91 percent of the total geographic area of the tribal districts. A comparison of 2003 assessment of forest cover in tribal districts with that of 2001 assessment shows a net increase of 3,211 km^2 since 2001 assessment. The tribal districts are marked "T" in the district wise tables of forest cover in Chapter 7.

The forest cover in the tribal districts constitutes 60.04 percent of the total forest cover of the country whereas the geographic area of 187 tribal districts forms only 33.6 percent of the total geographic area of the country. It demonstrates that tribal districts are generally rich in forest cover, and hence forest resources. Enhanced investments in forestry activities can be used as an instrument for rapid economic development of tribal communities.

Table 2.04: State/UT wise forest cover in Tribal Districts

(Area in km²)

State/UT	No. of Tribal Dist.	Geographic area in Tribal Districts	Forest Cover				Percent Forest Cover
			VDF	MDF	OF	Total	
Andhra Pradesh	8	87,090	15	16,355	8,955	25,325	29.08
Arunachal Pradesh	13	83,743	13,907	39,604	14,508	68,019	81.22
Assam	16	50,137	677	4,625	6,750	12,052	24.04
Chhattisgarh	9	90,134	1,286	26,922	12,100	40,308	44.72
Gujarat	8	48,650	105	3,642	3,223	6,970	14.33
Himachal Pradesh	3	26,764	456	1,510	1,240	3,206	11.98
Jharkhand	8	44,413	1,553	5,815	6,265	13,633	30.70
Karnataka	5	26,597	244	8,415	3,653	12,312	46.29
Kerala	9	27,228	259	7,082	4,828	12,169	44.69
Madhya Pradesh	18	139,448	3,247	21,125	16,725	41,097	29.47
Maharashtra	11	138,272	6,681	11,628	10,447	28,756	20.80
Manipur	9	22,327	720	5,818	10,681	17,219	77.12
Meghalaya	7	22,429	168	6,323	10,348	16,839	75.08
Mizoram	8	21,081	84	7,407	10,942	18,430	87.42
Nagaland	8	16,579	57	5,650	7,902	13,609	82.09
Orissa	12	86,124	287	19,110	13,614	33,011	38.33
Rajasthan	5	38,218	-	2,335	3,937	6,272	16.41
Sikkim	4	7,096	458	1,904	900	3,262	45.97
Tamil Nadu	6	30,720	543	2,558	3,377	6,478	21.09

Tripura	3	10,486	58	4,988	3,047	8,093	77.18
Uttar Pradesh	1	7,680	366	502	446	1,314	17.11
West Bengal	11	69,403	2,286	3,644	5,779	11,709	16.87
Andaman & Nicobar	2	8,249	3,475	2,809	680	6,964	84.42
Dadra & Nagar Haveli	1	491	-	145	80	225	45.82
Daman & Diu	1	72	-	1	2	3	4.17
Lakshdweep	1	32	-	12	11	23	71.88
Total	**187**	**1,103,463**	**36,932**	**209,929**	**160,440**	**407,298**	**36.91**

2.09 Loss of Forest Cover due to Shifting Cultivation in N-E States

Shifting cultivation or Jhum cultivation is an agriculture landuse prevalent mainly in North-Eastern States of India where forest land use is converted to agriculture landuse temporarily and this activity is repeated after certain years. Such practice not only affects forest cover of the area adversely but also reduces its productivity and increase soil erosion.

FSI assessed forest cover affected by shifting cultivation in North-Eastern States between the period 2001-2003 and the results are shown in Table 2.05.

Table 2.05 Loss of Forest Cover due to Shifting Cultivation in N-E States

(Area in km^2)

State	Dense Forest	Open Forest	Total
Assam	272	337	609
Arunachal Pradesh	663	262	925
Manipur	125	730	855
Meghalaya	141	543	684
Mizoram	351	336	687
Nagaland	321	1,011	1,332
Tripura	221	163	384
Total	**2,094**	**3,382**	**5,476**

2.10 Extent of water bodies inside forest cover

Food & Agriculture Organisation (FAO) has included oceans, seas, lakes, reservoirs and rivers in the definition of water body. Since forests play an important role in precipitation and conserving water, FSI has made an attempt to assess water bodies inside forest cover. These water bodies include rivers, perennial rivers and streams, lakes, ponds, wetlands, creeks, straits etc. having an area of more than 1 ha. State/UT wise extent of water bodies inside forest cover is given in Table 2.06. It is pertinent to mention here that the forest cover as assessed in this assessment and also in previous assessments, does not include water bodies.

Table 2.06 State/UT wise Extent of Water bodies within Forest cover

(Area in km^2)

S. No.	State	Water bodies	% of Forest cover
1.	Andhra Pradesh	1,496	3.37
2.	Arunachal Pradesh	396	0.58
3.	Assam	359	1.29
4.	Bihar	66	1.19
5.	Chhattisgarh	770	1.37
6.	Delhi	5	2.94
7.	Goa	25	1.16
8.	Gujarat	3,110	20.81
9.	Haryana	22	1.45
10.	Himachal Pradesh	361	2.52
11.	Jammu & Kashmir	380	1.79
12.	Jharkhand	79	0.35
13.	Karnataka	893	2.45
14.	Kerala	299	1.92
15.	Madhya Pradesh	1,324	1.73
16.	Maharashtra	769	1.63
17.	Manipur	35	0.21
18.	Meghalaya	44	0.26
19.	Mizoram	46	0.25
20.	Nagaland	45	0.33
21.	Orissa	1,541	3.19
22.	Punjab	11	0.71
23.	Rajasthan	118	0.74
24.	Sikkim	17	0.52
25.	Tamilnadu	174	0.77
26.	Tripura	43	0.53
27.	Uttar Pradesh	1,184	8.38
28.	Uttaranchal	331	1.35
29.	West Bengal	2,620	21.23
30.	Andaman & Nicobar Islands	819	11.76
31.	Chandigarh	2	10.07
32.	Dadra & Nagar Haveli	12	5.33
33.	Daman & Diu	0	0.00
34.	Lakshadweep	0	0.00
35.	Pondicherry	0	0.00
	Total	**17,396**	**2.56**

2.11 Forest Cover vis-à-vis Forest Area

A common reader may not distinguish between forest cover and forest area whereas these are two different entities. As explained earlier, a land may be recorded as

forest area and under management of forest department but may not have any discernible forest cover. On the other hand, all wooded lands or plantations, delineated as forest cover from satellite data may not be legally recorded as forest area as these could be private plantations or institutional wood lots. Although, majority of forested lands happen to be within legally recorded forest areas, all the changes taking place in the forest cover is not necessarily due to changes in the forests managed by the forest departments. Therefore, it is important from policy and planning point of view to know the extent and quality of forest cover within recorded forest areas and outside it. This information will be important and useful for the concerned forest department, civil administration and others.

With availability of GIS tools, such an exercise would be very convenient if the latest geo-referenced forest maps for the whole country showing the latest boundaries of recorded forest areas were available at 1:50,000 or 1:250,000 scales. In absence of this information and with a view to provide some estimates for the proportion of forest cover within recorded forest areas, FSI took up an in-house exercise. Boundaries of 32 groups of important Reserved Forests (RF) in 27 State/UTs were digitised from Survey of India toposheets. The RFs contiguous to each other or occurring in the same toposheets (of 1:50,000 scale) were grouped together for this exercise. These digitised boundaries were then overlaid on forest cover map of 2003 assessment and forest cover within each RF was assessed.

The selected groups of RFs together covered an area of 17,963 km^2. The area of individual groups of RFs ranged from as large as 2,233.11 km^2 (Simlipal RF in Orissa) to as small as 9.26 km^2 (RFs in Delhi). The total area of selected RFs constituted about 2.2 percent of the total recorded forest area of the country (or about 4.5 percent of total Reserved Forest area of the country). The size of the sample appears reasonable, and together with the fact that the sample was drawn from nearly all forested regions of the country, this exercise can provide an insight into the status of forest cover inside the recorded forests in the country.

The data collected showed that on an average about 81.90 percent of area within RFs had forest cover. For the 32 sampled groups of RFs, the proportion of forest cover ranged from 43.14 percent (in Chamoli district of Uttaranchal where alpine grasslands and snow covered areas are also included in the RFs) to 99.09 percent (in Sikkim). Of these, 14 groups had forest cover of more than 90 percent over its area and 10 groups had between 80-90 percent forest cover. In case of 2 groups the forest cover was even less than 50 percent. It reveals that, on an average, at least 20 percent area within the reserved forests is without forest cover.

CHAPTER 3

CHANGE IN FOREST COVER

3.01 Approach

Forest Survey of India not only assesses forest cover of the country biennially but also monitors the changes in the forest cover during the two-year period. “Change” from one class of land cover to another class is a spatial term, i.e., it can be shown on a map. If we consider only two broad classes of land cover, i.e., forest cover and non-forest and if an area that was non-forest in the earlier assessment is found to have tree vegetation cover in the current assessment, there is said to be a gain in forest cover. On the other hand, an area that was earlier classified as forest but now, due to harvesting of trees or degradation, has been classified as non-forest in the current assessment, signifies loss in forest cover. The difference between sum-total of all such gains and losses is described as “net change” and it is a non-spatial entity and is shown as a statistical number denoted by extent of area of net change.

The net change in forest cover within a region may be nil but it does not mean there has been no change in forest cover in that region. It only implies that total gains in forest cover compensated the total loss therein. Even if there is a net gain in forest cover within a region, there might be areas where losses have occurred and only it can be said that total gains exceeded the total losses in forest cover. Thus, change in forest cover between two assessments can be best understood or explained only on a map showing all kinds of positive and negative changes occurring in different locations during the intervening period. The forest cover change maps for particular area can be obtained from FSI on demand basis.

In this report the net changes in forest cover between 2001 and 2003 assessments in the country, States/UTs and districts have been tabulated. However, describing change through a “change matrix” is the best way of representing change from one class to another and vice versa in a non-spatial or a statistical form. It is table of numbers in a matrix form that shows total changes within different classes. Such matrix for the country has been shown in this chapter while change matrices for individual States and UTs have been given in Chapter 7.

3.02 Net Change in Forest Cover

The net change in forest cover during the period between 2001 and 2003 assessments is estimated by comparing the extent of forest cover recorded in the two assessments. The results are given in Table 3.01. It is found that during this period, there is a net increase of 2,795 km^2 in overall forest cover. It is also found that there has been a net reduction in the dense forest by 26,245 km^2 while the open forest has shown net gain of 29,040 km^2.

Table 3.01: Net Change in forest cover in the country since 2001 assessment

(km^2)

Assessment Year	Dense Forest	Open Forest	Total Forest Cover	Scrub
2001	416,809	258,729	675,538	47,318
2003	390,564	287,769	678,333	40,269
Change	-26,245	29,040	2,795	- 7,049

The change matrix for the whole country is given in Table 3.02.

Table 3.02: Change Matrix for the whole Country

(Area in km^2)

Class	Dense Forest	Open Forest	Scrub	Non-Forest	2001 Assessment
Dense Forest	332,928	55,640	420	27,821	416,809
Open Forest	46,177	194,401	1,366	16,785	258,729
Scrub	749	4,217	34,703	7,649	47,318
Non-Forest	10,710	33,510	3,780	2,516,407	2,564,407
2003 Assessment	390,564	287,769	40,269	2,568,661	
Net Change	-26,245	29,040	-7,049	4,254	

The change matrix for the country reveals that there has been a lot of transformation between classes. For instance, as much as 27,821 km^2 area that was classified as dense forest during 2001 assessment is now without forest cover whereas 10,709 km^2 area earlier classified as non-forest has now come to dense forest category. Similarly, large chunks of land has come into and gone out of open forest category also. Considerable portion of these changes has been due to misclassification or wrong inclusion and omission during the previous assessment that has been corrected now. This is explained in the next paragraph.

3.03 State/UT wise Net Change in Forest Cover

State/UT wise net change in forest cover between 2001 and 2003 assessments is given in Table 3.3.

Table 3.03: State-wise Change in Forest Cover since 2001 Assessment

(Area in km^2)

State/UT	2001 Assessment			2003 Assessment			Change		
	Dense	Open	Total	Dense	Open	Total	Dense	Open	Total
Andhra Pradesh	25,827	18,810	44,637	24,379	20,040	44,419	-1,448	1,230	-218
Arunachal Pradesh	53,932	14,113	68,045	53,511	14,508	68,019	-421	395	-26
Assam	15,830	11,884	27,714	13,042	14,784	27,826	-2,788	2,900	112
Bihar	3,372	2,348	5,720	3,027	2,531	5,558	-345	183	-162
Chhattisgarh	37,880	18,568	56,448	38,980	17,018	55,998	1,100	-1,550	-450
Delhi	38	73	111	52	118	170	14	45	59
Goa	1,785	310	2,095	1,255	901	2,156	-530	591	61
Gujarat	8,673	6,479	15,152	6,345	8,601	14,946	-2,328	2,122	-206
Haryana	1,139	615	1,754	520	997	1,517	-619	382	-237

Himachal Pradesh	10,429	3,931	14,360	8,976	5,377	14,353	-1,453	1,446	-7
Jammu & Kashmir	11,848	9,389	21,237	10,497	10,770	21,267	-1,351	1,381	30
Jharkhand	11,787	10,850	22,637	11,681	11,035	22,716	-106	185	79
Karnataka	26,156	10,835	36,991	22,461	13,988	36,449	-3,695	3,153	-542
Kerala	11,772	3,788	15,560	9,628	5,949	15,577	-2,144	2,161	17
Madhya Pradesh	44,384	32,881	77,265	41,843	34,586	76,429	-2,541	1,705	-836
Maharashtra	30,894	16,588	47,482	28,387	18,478	46,865	-2507	1890	-617
Manipur	5,710	11,216	16,926	6,538	10,681	17,219	828	-535	293
Meghalaya	5,681	9,903	15,584	6,491	10,348	16,839	810	445	1,255
Mizoram	8,936	8,558	17,494	7,488	10,942	18,430	-1,448	2,384	936
Nagaland	5,393	7,952	13,345	5,707	7,902	13,609	314	-50	264
Orissa	27,972	20,866	48,838	28,170	20,196	48,366	198	-670	-472
Punjab	1,549	883	2,432	743	837	1,580	-806	-46	-852
Rajasthan	6,322	10,045	16,367	4,496	11,330	15,826	-1,825	1,285	-540
Sikkim	2,391	802	3,193	2,362	900	3,262	-29	98	69
Tamilnadu	12,499	8,983	21,482	12,007	10,636	22,643	-492	1,653	1,161
Tripura	3,463	3,602	7,065	5,046	3,047	8,093	1,583	-555	1,028
Uttar Pradesh	8,965	4,781	13,746	5,996	8,122	14,118	-2,969	3,341	372
Uttaranchal	19,023	4,915	23,938	18,422	6,043	24,465	-601	1,128	527
West Bengal	6,346	4,347	10,693	6,045	6,298	12,343	-301	1,951	1,650
Andaman & Nicobar	6,593	337	6,930	6,284	680	6,964	-309	343	34
Chandigarh	5	4	9	9	6	15	4	2	6
Dadra & Nagar Haveli	151	68	219	145	80	225	-6	12	6
Daman & Diu	2	4	6	2	6	8	0	2	2
Lakshdweep	27	0	27	12	11	23	-15	11	-4
Pondicherry	35	1	36	17	23	40	-18	22	4
Total	**416,809**	**258,729**	**675,538**	**390,564**	**287,769**	**678,333**	**-26,244**	**29,040**	**2,795**

When analysing satellite data of two periods, the changes in land cover noticed during the interpretation can be due to two main reasons. The first and the most apparent is the actual change in the ground situation. Secondly, some changes may also be noted due to interpretational corrections as a result of progressive ground truthing. After all the remote sensing technology applied for forest cover assessment is still not perfect and has several limitations as indicated in para 2.04 in Chapter 2. When the scale of forest cover assessment was enlarged to 1:50,000 scale during the eighth cycle in 2001, a large number of smaller patches of tree crops down to 1 ha got included in the forest cover. These were mostly surrounded by agricultural crops. It was some times difficult to distinguish them from certain agricultural crops, such as sugarcane or cotton, as these also gave similar kind of reflectance. The ground verification necessary for a large number of small patches is much more extensive and time consuming than required for large forested lands. During 2001 assessment, considering cost and time, this could not be done adequately. Another way to eliminate agricultural crops from getting wrongly interpreted as forest cover is to use and compare satellite data of two seasons during the same year. However, this would also entail huge cost and time. Refinement in forest cover assessment at the national level is a long-term process. The accuracy of reporting improves with every cycle of assessment. The periodic assessments done by FSI can also be seen as a process of correcting certain misclassifications of the past.

Thus, the net changes in forest cover reported in Table 3.03 may be seen in this light. In certain states, such as Punjab, Rajasthan and Haryana (where substantial net loss has been recorded) and Tamilnadu and West Bengal (where large net gain has been shown), the net changes are mostly composed of corrections (wrong inclusion or omission of areas in the previous assessment).

CHAPTER 4

MANGROVE COVER

4.01 Introduction

Mangroves are salt-tolerant forest ecosystems found mainly in tropical and sub-tropical inter-tidal regions of the world. These are trees or shrubs that have the common trait of growing in shallow and muddy salt water or brackish waters, especially along quiet shorelines and in estuaries. Typically they produce tangled masses of arching roots that are exposed during low tides. Mangroves do not appear on sandy beaches and rocky shores. A muddy substratum of varying depth and consistency is necessary for their growth.

Mangrove forests are considered as the most productive and biodiverse wetlands on earth. These provide critical habitat for a diverse marine and terrestrial flora and fauna. Healthy mangrove forests are key to a healthy marine ecology. In fact, mangrove forests fix more carbon dioxide per unit area than phytoplankton in tropical oceans. Yet, these unique coastal tropical forests are among the most threatened habitats in the world. They may be disappearing more quickly than inland tropical rainforests and with little public notice.

Mangroves

4.02 Status of Mangroves In India

Mangroves in India account for about 5 percent of the World's mangrove vegetation and are spread over an area of about 4,500 km^2 along the coastal States/UTs of the country. Sunderbans in West Bengal accounts for a little less than half of the total area under mangroves in India. The Forest Survey of India is assessing the vegetation cover of the country including mangroves using remote sensing since 1983. It published its first assessment of mangroves of India in 1987 and estimated it to be 4,046 km^2 (scale of assessment 1:1 million). Thereafter, mangroves were assessed regularly on a two-year cycle from 1989 to 1999 where scale of assessment was 1:250,000. Assessment for 2001 was done on 1:50,000. State/UT wise mangrove cover as assessed by FSI in different assessments is given in Table 4.01. West Bengal has maximum of mangrove cover in the country, followed by Gujarat and Andaman & Nicobar Islands.

Table 4.01 State/UT wise Mangrove Cover Assessment

(Area in km^2)

Sl. No.	State/UT	Assessment Year							
		1987	**1989**	**1991**	**1993**	**1995**	**1997**	**1999**	**2001**
1.	Andhra Pradesh	495	405	399	378	383	383	397	333
2.	Goa	0	3	3	3	3	5	5	5
3.	Gujarat	427	412	397	419	689	901	1031	911
4.	Karnataka	0	0	0	0	2	3	3	2
5.	Maharashtra	140	114	113	155	155	124	108	118
6.	Orissa	199	192	195	195	195	211	215	219
7.	Tamil Nadu	23	47	47	21	21	21	21	23
8.	West Bengal	2,076	2,109	2,119	2,119	2,119	2,123	2,125	2,081
9.	Andam. & Nicobar	686	973	971	966	966	966	966	789
10.	Pondicherry	0	0	0	0	0	0	0	1
	Total	**4,046**	**4,255**	**4,244**	**4,256**	**4,533**	**4,737**	**4,871**	**4,482**

4.03 Mangrove Cover Assessment 2003

In the present assessment, mangrove cover has also been categorised into very dense mangrove (canopy density of more than 70%), moderately dense mangrove (canopy density between 40-70%) and open mangrove (canopy density between 10-40%). Table 4.02 presents State/UT wise status of mangrove cover as estimated in 2003 assessment.

Table 4.02: State/UT wise Mangrove Cove

(Area in km^2)

Sl. No.	State/UT	Very Dense Mangrove	Moderately Dense Mangrove	Open Mangrove	Total	Change w.r.t. 2001 assessment
1.	Andhra Pradesh	0	15	314	329	-4
2.	Goa	0	10	0	10	+5
3.	Gujarat	0	198	762	960	+49
4.	Karnataka	0	3	0	3	+1
5.	Kerala	0	3	5	8	+8
6.	Maharashtra	8	44	64	116	-2
7.	Orissa	0	160	47	207	-12
8.	Tamil Nadu	0	18	17	35	+12
9.	West Bengal	892	894	334	2120	+39
10.	Andam. & Nicobar	262	312	97	671	-118
11.	Daman & Diu	0	0	1	1	+1
12.	Pondicherry	0	0	1	1	0
	Total	**1162**	**1657**	**1642**	**4461**	**-21**

The current assessment shows that mangrove cover in the country is 4,461 km^2, which is 0.14 percent of the country's total geographic area. The very dense mangrove comprises 1,162 km^2 (26.05 percent of mangrove cover), moderately dense mangrove is

1,657 km^2 (37.14 percent) while open mangrove covers an area of 1,642 km^2 (36.81 percent).

Comparing with 2001 assessment, there has been a marginal net decrease in mangrove cover of the country. Gujarat and West Bengal have shown significant net increase in mangrove cover while a sizeable net reduction has been recorded in Andaman & Nicobar Islands. The increase in Gujarat appears to be the result of large-scale plantations as well as the protection measures taken up by the state. The decrease in Andaman & Nicobar Islands is mainly because of interpretational corrections as some open forest was incorrectly classified as mangrove in the earlier assessment. The mangrove cover in Kerala, consisting of small and scattered patches, has been assessed for the first time.

4.04 District wise mangrove cover

The district wise mangrove cover in each State/UT is given Table 4.03.

Table 4.03: District wise Mangrove Cover

(Area in km^2)

Sl. No.	State/UT and District	Very Dense Mangrove	Moderately Dense Mangrove	Open Mangrove	Total	Change w.r.t. 2001 Assessment
1.	**Andhra Pradesh**					
	East Godavari	0	7	181	188	-6
	Guntur	0	3	44	47	0
	Krishna	0	5	88	93	2
	Prakasham	0	0	1	1	0
	Total	**0**	**15**	**314**	**329**	**-4**
2.	**Goa**					
	North Goa	0	7	0	7	3
	South Goa	0	3	0	3	2
	Total	**0**	**10**	**0**	**10**	**5**
3.	**Gujarat**					
	Ahamdabad	0	2	0	2	0
	Bharuch	0	20	13	33	5
	Bhavnagar	0	10	6	16	0
	Jam Nagar	0	29	112	141	-1
	Kuchchh	0	126	623	749	43
	Navsari	0	0	1	1	-1
	Porbandar	0	1	0	1	0
	Rajkot	0	1	1	2	0
	Surat	0	8	5	13	1
	Valsad	0	1	1	2	2
	Total	**0**	**198**	**762**	**960**	**49**

4.	**Karnataka**					
	Kannad Uttar	0	2	0	2	0
	Udipi	0	1	0	1	1
	Total	**0**	**3**	**0**	**3**	**1**
5.	**Kerala**					
	Ernakulam	0	0	1	1	1
	Cannanore	0	3	4	7	7
	Total	**0**	**3**	**5**	**8**	**8**
6.	**Maharashtra**					
	Mumbai City	0	0	1	1	0
	Mumbai Suburb	0	15	16	31	5
	Raigarh	0	9	29	38	4
	Ratnagire	7	7	0	14	5
	Sindhudurg	1	1	0	2	1
	Thane	0	12	18	30	-17
	Total	**8**	**44**	**64**	**116**	**-2**
7.	**Orissa**					
	Baleshwar	0	0	4	4	1
	Bhadrak	0	17	3	20	1
	Jagatsinghpur	0	1	2	3	-2
	Kendrapara	0	142	38	180	-12
	Total	**0**	**160**	**47**	**207**	**-12**
8.	**Tamil Nadu**					
	Chidambaranar	0	0	2	2	1
	Caddalore	0	5	2	7	0
	Nagapattinam	0	8	9	17	7
	Ramanathapuram	0	1	0	1	0
	Thanjavur	0	4	4	8	4
	Total	**0**	**18**	**17**	**35**	**12**
9.	**West Bengal**					
	Midinipur	6	1	2	9	1
	24 Pargana North	16	10	2	28	1
	24 Pargana South	870	883	330	2083	37
	Total	**892**	**894**	**334**	**2120**	**39**
10.	**Andaman & Nicobar Islands**					
	Andaman	262	286	96	644	-128
	Nicobar	0	26	1	27	10
	Total	**262**	**312**	**97**	**671**	**-118**
11.	**Daman & Diu**					
	Diu	0	0	1	1	1
	Total	**0**	**0**	**1**	**1**	**1**

12.	**Pondicherry**					
	Yanam	0	0	1	1	0
	Total	**0**	**0**	**1**	**1**	**0**
Grand Total		**1162**	**1657**	**1642**	**4461**	**-21**

CHAPTER 5

TREE COVER

5.01 Introduction

Tree cover means the area covered by crown of trees that is too small to be delineated by digital interpretation of remote sensing data at 1:50,000 scale used for forest cover assessment. India's National Forest Policy aims at maintaining 33 percent of country's geographical area under forest and tree cover. FSI has been assessing country's forest cover since the 1980's using data from remote sensing satellites on a two-year cycle but tree cover due to a substantial number of trees not captured by the satellite data was estimated and reported as tree cover for the first time in 2001 assessment. This exercise, with much better inventory data on tree cover, has been continued in the present assessment as well. Thus, a complete picture of forest and tree cover in the country that can be compared with the national goal of 33 percent for forest and tree cover is available.

The present assessment of forest cover, carried out by digital processing of satellite data at 1:50,000 scale, includes forests and tree crops having 10 percent or more canopy density and with an area of more than 1.0 ha. The tree cover comprising of small patches of trees (< 1.0 ha) in plantations and woodlots, or scattered trees on farms, homesteads and urban areas, or trees along linear features, such as roads, canals, bunds, etc. has been estimated by mainly using field inventory methods. However, for estimation of tree cover for SFR 2003, high-resolution satellite data (PAN together with LISS III) has also been used. The tree crops were categorized into three classes, block, linear and scattered, based on their geometric formation. This chapter gives method used and steps involved in assessment of tree cover and presents the results for the country, different physiographic zones and all the States/UTs.

5.02 Trees Outside Forests and Tree Cover

It is important here not to confuse between Tree Cover and "Trees Outside Forests" (TOF). TOF means all tree crops outside recorded forest area. However, there are tree crops and woodlots outside forest area that are larger than 1 ha in extent and can be captured by the satellite data used for forest cover assessment. Such tree canopies are deemed to have been included in the forest cover assessment. The crown cover of residual trees outside forest area constitutes tree cover. Thus, trees included in tree cover constitute only a part of TOF.

Recognising the fact that TOF contributes significantly to socio-economic and ecological status of a country, Food and Agriculture Organisation of United Nations has given prominent place to TOF in its Global Forest Resources Assessment Report. FSI has been conducting inventory of TOF since 1991. Data for estimating tree cover has been extracted from the data of TOF collected by FSI. TOF may lie within rural areas or urban areas and has correspondingly been termed as TOF (Rural) and TOF (Urban). The country was stratified into different zones for assessment of TOF and tree cover.

5.03 Stratification of Country into Physiographic Zones

While estimating any variable, dividing the population into homogenous strata improves accuracy and reduces cost of estimation. The country has to be stratified into geographical zones, for assessment of countrywide TOF and tree cover, within which the tree species, density and growth etc. are more or less comparable. This exercise was carried out for SFR 2001 whereby the country was stratified into 14 physiographic zones. Districts or parts of districts were allocated to one or the other zone. The same 14 strata, with some minor modifications, have been used for the present assessment. A physiographic zone, on the basis of topography, latitude and altitude, besides climatic and soil properties, constitutes geographic areas that exhibit broad similarities in factors responsible for the growth of tree vegetation.

The fourteen physiographic zones are as listed below and as shown in figure 5.01:

1. Western Himalayas (WH)
2. Eastern Himalayas (EH)
3. North East (NE)
4. Northern Plains (NP)
5. Eastern Plains (EP)
6. Western Plains (WP)
7. Central Highlands (CH)
8. North Deccan (ND)
9. East Deccan (ED)
10. South Deccan (SD)
11. Western Ghats (WG)
12. Eastern Ghats (EG)
13. West Coast (WC)
14. East Coast (EC)

The list of districts falling within each physiographic zone, completely or partially, has been given in Annexure-II for information.

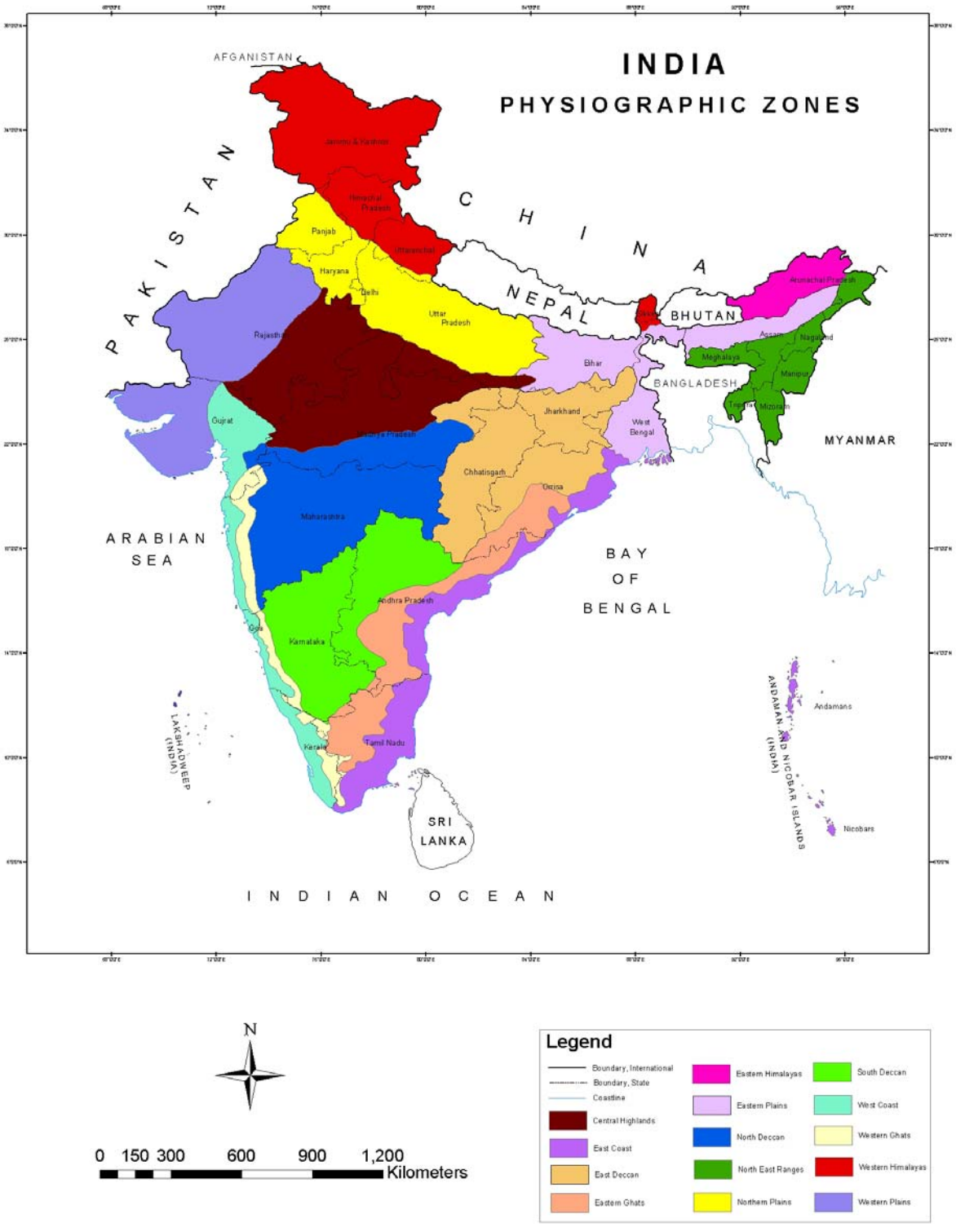


Figure 5.01: Physiographic Zones of India

5.04 Methodology for Assessment of Trees Outside Forest and Tree Cover

Earlier, inventory of TOF was done statewise by taking rural non-forest area of a state as population. The state was stratified according to agro-ecological zones and each zone was further stratified according to districts. Villages within a district were considered as sampling units. The trees were classified into eight categories viz. farm forestry, village woodlots, block plantations, road side, pond side, railway side, canal side and others. Data was processed and tree cover due to TOF was estimated by using ratio estimation method. Using this methodology, FSI had inventoried about 180 districts in different states. In SFR 2001, some of the data thus collected for districts falling within different physiographic zones were used for assessment of tree cover.

Now the approach and the methodology have been modified. Sixty districts (or 10 percent of total districts in the country) are randomly selected, with at least two districts falling within a physiographic zone. TOF (Rural) and TOF (Urban) are estimated separately using different techniques.

Assessment of TOF (Rural): Trees outside the forest have a relatively low density that makes assessment by conventional methods costly and time-consuming. Large area information is needed which can be provided by remote sensing data. Remote sensing data is used to stratify the area on the basis of geometrical formation of tree resources. High-resolution satellite imageries (e.g., IKONOS, QuickBird, etc.) provide information even up to identification of a single tree but these are cost prohibitive. The IRS LISS III data (multi spectral with resolution of 23.5m×23.5m) provides information on vegetation cover and tree canopies for patches larger than one hectare. However, LISS III data alone cannot be used for smaller patches or scattered trees. Using IRS PAN data (monochromatic but with much higher resolution of 5.8m×5.8m) one can identify a tree vegetated land as small as 0.1 ha. Thus in the modified technique, both LISS III and PAN imageries are used for stratification of TOF resources into three classes, namely block plantation (group of trees), linear plantation and scattered trees.

Raw images of IRS 1C/1D PAN and LISS III data for the period between Oct.-Dec. 2002 are acquired from National Remote Sensing Agency, Hyderabad. Thereafter, the PAN image is geometrically rectified with the help of Survey of India toposheets on 1:50,000 Scale. The LISS III image is then co registered with the rectified PAN images. PAN and LISS III images are fused using appropriate algorithm. Since mapping of TOF areas is the objective, the boundary of forest area is digitized from SOI toposheets and masked out. The remaining fused image is classified into settlement, water bodies, burnt areas, tree cover and agriculture area using appropriate classifier viz. Maximum likelihood. This classification enables the interpreter to distinguish between tree cover and other classes on fused image. This classified image is visually analysed with respect to fused images for editing and refinement for inclusion and omissions. Since a cluster of trees having 0.1 ha area or more is defined as block plantation, pixels are clumped and cluster of pixels having area less than 0.1 ha are eliminated. After editing of the classified image the final classified map is generated which is done by taking the PAN, LISS-III

and the fused images. Incorporating these corrections final classified image is prepared having three classes in TOF areas, namely, Block, Linear and Scattered. From the classified TOF map data pertaining to area under Block, Linear, Scattered and water bodies can be calculated. In addition, such areas, which do not support tree vegetation, like rivers and water bodies, riverbeds, snow covered mountains, etc. which is termed as Culturable Non Forest Area (CNFA) can also be calculated. Such information is very helpful for district level planning. The CNFA area as given in this report is less than what was given in SFR 2001 due to the fact that area under wetlands and rivers/riverbed has been estimated digitally, thereby, giving more precise estimates as compared to SFR 2001 where this information was obtained from a project report "Wetlands of India" conducted by Space Application Centre (ISRO), Ahemdabad where cartographic limitation to estimate the above was 25 ha. In this report the estimate of wetlands and rivers/riverbeds has been estimated using PAN fused with LISS data, wherein one can go down upto 0.1 ha. on the ground, thereby, leading to more precise estimates. Due to this, the area under Unculturable Non Forest Area (wetlands and rivers/riverbeds) has increased as smaller areas could be delineated.

With the help of appropriate sampling design, optimum number of plots can be randomly selected in every stratum. Since the variability in each stratum is expected to be different demanding different sample and plot sizes, pilot studies were conducted to ascertain these so that the variability of the stratum can be properly addressed. In this pilot study, 0.1 ha, 0.2 ha and 0.3 ha plots were considered for Block stratum. Similarly, strip of size 10 m × 75 m, 10 m × 100 m, 10 m × 125 m, 10 m × 150 m, 10 m ×175 m & 10 m × 200 m were considered for Linear stratum. In respect of Scattered stratum, plots of size 0.5 ha, 1.0 ha, 1.5 ha, 2.0 ha, 2.5 ha and 3.0 ha were considered for non hilly districts and 0.25 ha, 0.50 ha, 0.75 ha and 1.00 ha were considered for the hilly districts. Twenty concentric plots in each stratum were randomly selected and data was recorded. After analysis it was concluded that optimum plot size for Block and Linear strata are 0.1 ha and 10 × 125 m strip, respectively for hilly as well as non-hilly districts. In case of Scattered stratum, the optimum size of sample plot was determined as 3.0 ha for non-hilly district and 0.5 ha for hilly district. It was also concluded through pilot study that the sample sizes for Block, Linear and Scattered strata are 35, 50 and 50 respectively for non-hilly districts and 35, 50 and 95 respectively for hilly district.

Desired number of sample points are randomly generated in each stratum separately and the data on pre-decided variables like dbh, crown diameter, species name and category of plantation, etc. are collected on designed formats. Data processing is carried out following appropriate formulae corresponding to the sampling design.

The flow chart of methodology of Tree Cover mapping using remote sensing is shown in Figure-5.02

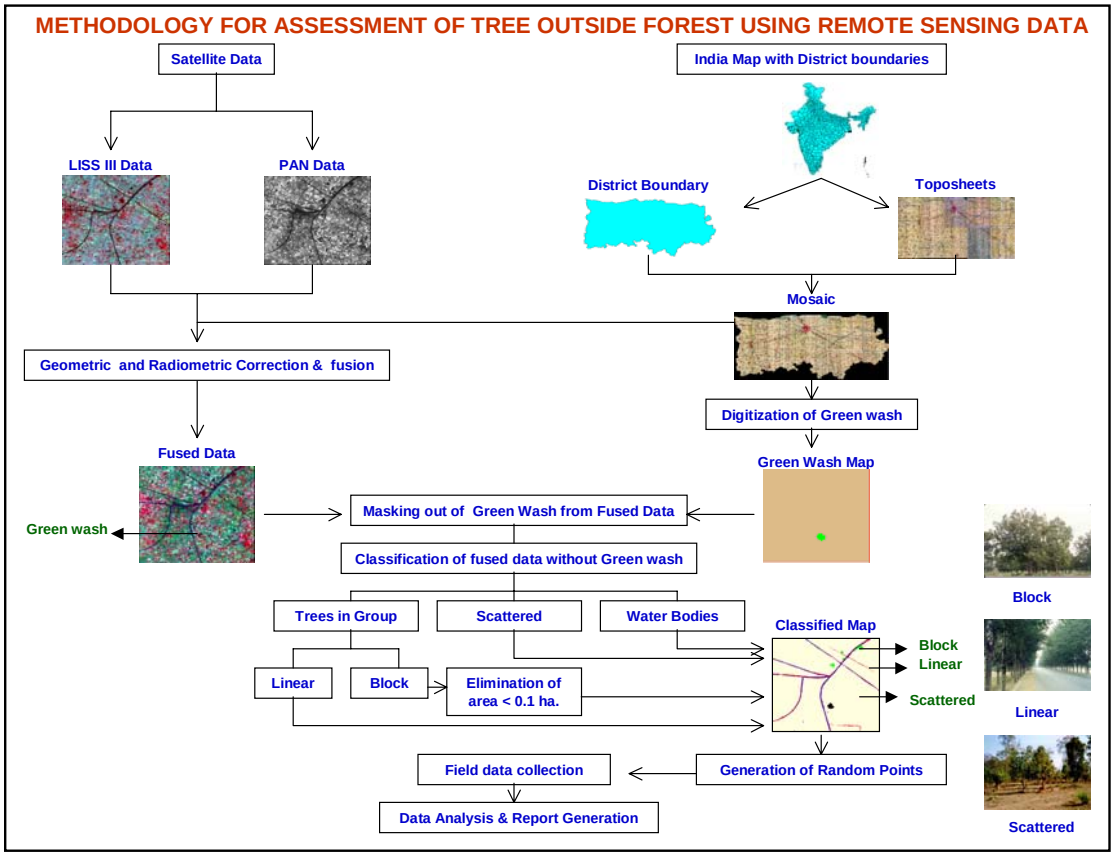


Figure 5.02: Flow chart of methodology of Tree Cover mapping

Assessment of TOF (Urban): The study areas for this survey within the selected districts are the urban centers defined in the corresponding District Census Book. Sampling frame prepared for the urban area is used for survey and inventory. National Sample Survey Organisation (NSSO), an agency under the Ministry of Statistics and Programme Implementation, Government of India, has prepared sampling frame for each urban area. This organization conducts surveys by the name of Urban Frame Survey (UFS). They divide all the urban centers of a district in blocks called UFS blocks. These blocks have clear-cut well defined natural boundaries. These blocks are formed on the basis of 600-800 population or 120-160 households and cover the whole area within the geographical boundary of town including vacant lands.

The district is divided into five categories of town as strata based on population size. UFS blocks are used as sampling units. Frame of such blocks for each district selected for TOF assessment are obtained from the NSSO. The size of the sample for a district, based on pilot studies, was between 20-60 UFS blocks. The sample blocks in each class of town are selected by using random number table. A town class wise sample list of randomly selected blocks in each district are formed and provided to concerned field parties for carrying out complete enumeration of all the trees of 10 cm and above dbh in the prescribed formats having similar parameters as for rural inventory.

However, as mentioned earlier, the data for tree cover assessment is a sub-set of the data collected for TOF and has to be extracted at the time of data processing.

5.05 Aggregation of Sample Data

The data obtained from sampling units have to be aggregated over the corresponding stratum using ratio method of estimation. At this stage care has been taken to see that aggregation of sample data does not result in any overestimation yielding inflated or erroneous values. The non-forest area within a stratum over which the aggregation has to be done may contain certain unculturable lands that cannot support tree vegetation. Such lands include wetlands, riverbeds and perennial snow covered mountains. Also, the extent of area under forest cover outside forest area, consisting of plantations and woodlots more than 1 ha in area, is not to be included for the tree cover assessment. These areas were estimated by using methodology described above from various districts spread over all the physiographic zones. All these areas must be subtracted from the non-forest area. The resultant area gives the "Culturable Non-forest Area" (CNFA) for each physiographic zone. This is the net area over which the sample data of tree cover can be aggregated to obtain the estimates for tree cover.

Physiographic Zone wise and State/UT wise estimates for the components of CNFA are given in Tables 5.01 and 5.02, respectively.

These tables reveal that only 66.6 percent or about two thirds of the total geographic area of the country is culturable non-forest area. The individual components of forest area and unculturable areas as estimated here (with respect to country's geographic area) are the recorded forest area (23.6%), blocks of forest cover (>1 ha) outside forest area (3.4%), wetlands & rivers (1.9%), riverbeds (0.50%) and cold deserts & snow bound areas (4.0%).

Table 5.01 Physiographic Zone wise Culturable Non-forest Area (CNFA)

(Area in km^2)

Physiographic Zone	Geographic Area	Recorded Forest Area	Unculturable Non-forest Area			Blocks of Forest Cover (>1 ha) outside Recorded Forest Area	Culturable Non-forest Area (CNFA)
			Wet-lands & Rivers	Riverbeds	Alpine Pasture & Snow		
	a	B	c	d	e	f	a-(b+c+d+e+f)
Western Himalayas	338,556	98,165	2,078	1,410	132,187	13,986	90,730
Eastern Himalayas	65,317	41,160	681	2,327	862	12,476	7,811
North East Ranges	133,990	78,906	1,104	0	0	21,907	32,073
Nothern Plains	295,780	13,983	4,256	3,172	0	5,586	268,783
Eastern Plains	223,339	31,826	10,098	3,219	0	7,442	170,754
Western Plains	319,098	13,813	16,554	441	0	4,395	283,895
Central Highlands	373,675	82,711	3,479	832	0	2,809	283,844
North Deccan	355,988	86,495	5,090	751	0	2,935	260,717
East Deccan	336,289	128,006	4,498	2,367	0	8,330	193,088
South Deccan	292,416	51,356	3,897	1,230	0	4,154	231,779
Western Ghats	72,381	33,960	1,065	30	0	6,512	30,814

Physiographic Zone	Geographic Area	Recorded Forest Area	Unculturable Non-forest Area			Blocks of Forest Cover (>1 ha) outside Recorded Forest Area	Culturable Non-forest Area (CNFA)
			Wet-lands & Rivers	Riverbeds	Alpine Pasture & Snow		
	a	B	c	d	e	f	a-(b+c+d+e+f)
Eastern Ghats	191,698	75,175	1,435	191	0	3,939	110,958
West Coast	121,242	21,358	5,120	355	0	10,072	84,337
East Coast	167,494	17,826	1,653	904	0	8,026	139,085
TOTAL	**3,287,263**	**774,740**	**61,008**	**17,229**	**133,049**	**112,569**	**2,188,668**

Table 5.02 State/UT wise Culturable Non-forest Area (CNFA)

(Area in km^2)

State/UT	Geographic Area	Recorded Forest Area	Unculturable Non-forest Area			Blocks of Forest Cover (>1 ha) outside Recorded Forest Area	Culturable Non-forest Area (CNFA)
			Wet-lands & Rivers	Riverbeds	Alpine Pasture & Snow		
	a	b	c	d	e	f	a-(b+c+d+e+f)
Andhra Pradesh	275,069	63,821	3,021	971	0	3,172	204,084
Arunachal Pradesh	83,743	51,540	842	2,327	862	15,668	12,504
Assam	78,438	27,018	2,361	630	0	6,114	42,315
Bihar	94,163	6,473	4,529	1,423	0	2,296	79,442
Chhattisgarh	135,191	59,772	1,655	870	0	3,300	69,594
Delhi	1,483	85	19	16	0	85	1,278
Goa	3,702	1,224	127	9	0	931	1,411
Gujarat	196,022	19,113	18,797	369	0	5,817	151,926
Haryana	44,212	1,558	591	478	0	834	40,751
Himachal Pradesh	55,673	37,033	153	102	4,934	1,085	12,366
Jammu & Kashmir	222,236	20,230	1,762	1,196	122,035	11,717	65,296
Jharkhand	79,714	23,605	1,203	611	0	2,740	51,555
Karnataka	191,791	43,084	2,396	710	0	4,921	140,680
Kerala	38,863	11,268	1,251	76	0	4,346	21,922
Madhya Pradesh	308,245	95,221	3,033	695	0	2,834	206,462
Maharashtra	307,713	61,939	5,314	614	0	7,279	232,567
Manipur	22,327	17,418	98	0	0	1,947	2,864
Meghalaya	22,429	9,496	260	0	0	5,130	7,543
Mizoram	21,081	16,717	75	0	0	1,840	2,449
Nagaland	16,579	8,629	160	0	0	3,153	4,637
Orissa	155,707	58,136	1,661	765	0	4,848	90,297
Punjab	50,362	3,084	622	501	0	865	45,290
Rajasthan	342,239	32,488	2,481	715	0	3,398	303,157
Sikkim	7,096	5,841	11	7	842	73	322
Tamil Nadu	130,058	22,877	1,185	470	0	6,675	98,851
Tripura	10,486	6,293	84	0	0	1,663	2,446
Uttar Pradesh	240,928	16,826	3,397	2,247	0	4,068	214,390
Uttaranchal	53,483	34,662	176	125	4,376	1,054	13,090
West Bengal	88,752	11,879	3,711	1,292	0	4,520	67,350
Andaman & Nicobar	8,249	7,171	12	6	0	87	973
Chandigarh	114	34	1	1	0	2	76
Dadra Nagar Haveli	491	204	8	0	0	46	233
Daman & Diu	112	1	4	0	0	11	96

State/UT	Geographic Area	Recorded Forest Area	Unculturable Non-forest Area			Blocks of Forest Cover (>1 ha) outside Recorded Forest Area	Culturable Non-forest Area (CNFA)
			Wet-lands & Rivers	Riverbeds	Alpine Pasture & Snow		
	a	b	c	d	e	f	a-(b+c+d+e+f)
Lakshadweep	32	0	2	0	0	5	25
Pondicherry	480	0	6	3	0	45	426
Total	**3,287,263**	**774,740**	**61,008**	**17,229**	**133,049**	**112,569**	**2,188,668**

5.06 Assessment of Tree Cover

The area under tree cover is a "notional" area. It is an area that is deemed to be covered by the tree canopy of all the trees included in the assessment of tree cover if all these trees are hypothetically brought together to constitute a block of tree land or forest with 70 percent canopy density. The relationship between tree size, species and crown width was used for this computation. The tree cover estimated for all the sample plots in a physiographic zone are aggregated over the CNFA of the zone. This is how tree cover was estimated in SFR 2001. However, in the present assessment, as described earlier, high resolution satellite data has been used to map tree blocks (patches between 0.1 and 1 ha in extent) and linear plantations in the non-forest rural areas. The actual area covered by such patches can be easily computed from the classified digital map using GIS methods. However, in case of urban trees and scattered trees in rural areas, the same method as used in 2001 assessment (notional tree cover at 70 percent canopy density) has been employed.

The total tree cover for a selected district was obtained by aggregation and addition of tree cover under block, linear and scattered strata. The tree cover thus obtained for selected districts within a physiographic zone was used to estimate the tree cover within CNFA for the physiographic zone by using ratio method of estimation. Adding tree cover for all the physiographic zones yielded the estimated tree cover of the country. The total tree cover for the country has been estimated as 99,896 km^2 or 3.04 percent of the country's geographic area.

Tree cover complements forest cover and should not be analysed in isolation. Data on the total number of trees or the area under tree cover alone does not convey much useful information that can be used for policy and planning purposes. A region with lower forest cover is likely to have higher number of trees in CNFA. If a forest area or tree plantation becomes highly degraded and its canopy density falls below 10 percent, it will be a loss to forest cover but may contribute to tree cover. Therefore, it must be noted here that the extent of tree cover assessed here is an appendage to forest cover. However, certain statistics that are of interest are average number of trees per ha within CNFA of a zone or a state. A high number would imply effective steps taken for tree planting by the government, municipalities, farmers and people in general. Another statistics that can be derived is the number of trees per ha of tree cover. A low number means that the trees (included in tree cover) are generally large in size and age, while a high number would indicate that such trees in that region are generally young and small sized.

5.07 Tree Cover in the Country: Physiographic Zone wise

The estimates of tree cover for each physiographic zone is given in Table 5.03. It is noted that the density of trees in the CNFA is maximum in Western Ghats (21.6 trees/ha) followed by West Coast (20.8 trees/ha), East Coast (18.4 trees/ha) and Western Himalyas (17.9 trees/ha). It may be seen against the national average that is 12.25 trees per ha of CNFA.

Table 5.03: Physiographic Zone wise Tree Cover Estimates

Physiographic Zone	Geog. Area (GA) (km^2)	CNFA (km^2)	CNFA as % of GA	Trees per ha of CNFA	Number of Trees ('000)	Tree Cover		
						Area (km^2)	% of Geog. Area	% of CNFA
Western Himalayas	338,556	90,730	26.80	17.9	162,446	4,901	1.45	5.40
Eastern Himalayas	65,317	7,811	11.96	9.1	7,136	149	0.23	1.90
North East Ranges	133,990	32,073	23.94	13.6	43,644	1,511	1.13	4.71
Northern Plains	295,780	268,783	90.87	12.8	342,813	9,746	3.30	3.63
Eastern Plains	223,339	170,754	76.46	14.3	244,420	3,014	1.35	1.77
Western Plains	319,098	283,895	88.97	6.9	196,142	7,964	2.50	2.81
Central Highlands	373,675	283,844	75.96	9.9	280,405	8,694	2.33	3.06
North Deccan	355,988	260,717	73.24	10.8	280,940	7,542	2.12	2.89
East Deccan	336,289	193,088	57.42	10.4	200,393	18,742	5.57	9.71
South Deccan	292,416	231,779	79.26	12.2	282,151	8,691	2.97	3.75
Western Ghats	72,381	30,814	42.57	21.6	66,515	4,631	6.40	15.03
Eastern Ghats	191,698	110,958	57.88	12.8	142,239	6,727	3.51	6.06
West Coast	121,242	84,337	69.56	20.8	175,505	9,569	7.89	11.35
East Coast	167,494	139,085	83.04	18.4	255,398	8,015	4.79	5.76
TOTAL	**3,287,263**	**2,188,668**	**66.58**	**12.25**	**2,680,147**	**99,896**	**3.04**	**4.56**

5.08 Tree Cover in the States and Union Territories

Tree cover data was processed further to provide information of tree cover for each state and union territory. One state may fall in one or many physiographic zones; accordingly estimation procedures were used to develop state level estimates. As such, area of different physiographic zones within one state is considered as separate strata. CNFA corresponding to the State/UT has been ascertained in a similar fashion as in case of physiographic zone. CNFA corresponding to different physiographic zones falling within a State/UT was also computed. Using estimates of tree cover of different physiographic zones, estimates of tree cover for the respective state was calculated. However, it may be noted that the State/UT wise estimates for tree cover are only indicative in nature and may have lower levels of accuracy since the sample size was calculated only to provide estimates at the physiographic zone level.

The estimates of tree cover in the States and UTs are given in Table 5.04 and in Fig. 5.03.

Table 5.04: State/UT wise Tree Cover Estimates

State/UT	Geog. Area (km^2)	CNFA (km^2)	Trees per ha	Number of Trees ('000)	Tree Cover		
					Area (km^2)	% of GA	% of CNFA
Andhra Pradesh	275,069	204,084	16.9	345,355	12,120	4.41	5.94
Arunachal Pradesh	83,743	12,504	10.8	13,470	363	0.43	2.90
Assam	78,438	42,315	14.1	59,473	935	1.19	2.21
Bihar	94,163	79,442	13.8	109,971	1,620	1.72	2.04
Chhattisgarh	135,191	69,594	10.2	71,326	6,723	4.97	9.66
Delhi	1,483	1,278	24.9	3,176	98	6.61	7.67
Goa	3,702	1,411	15.2	2,137	136	3.67	9.62
Gujarat	196,022	151,926	14.1	213,829	10,586	5.40	6.97
Haryana	44,212	40,751	12.3	50,055	1,415	3.20	3.47
Himachal Pradesh	55,673	12,366	15.5	19,127	491	0.88	3.97
Jammu & Kashmir	222,236	65,296	18.7	122,309	3,826	1.72	5.86
Jharkhand	79,714	51,555	10.4	53,858	5,012	6.29	9.72
Karnataka	191,791	140,680	11.6	162,718	5,371	2.80	3.82
Kerala	38,863	21,922	13.6	29,904	1,903	4.90	8.68
Madhya Pradesh	308,245	206,462	10.2	211,456	7,250	2.35	3.51
Maharashtra	307,713	232,567	11.5	267,733	9,320	3.03	4.01
Manipur	22,327	2,864	13.6	3,901	136	0.61	4.73
Meghalaya	22,429	7,543	13.6	10,241	352	1.57	4.67
Mizoram	21,081	2,449	14.0	3,440	130	0.62	5.31
Nagaland	16,579	4,637	13.6	6,297	217	1.31	4.67
Orissa	155,707	90,297	11.0	98,919	6,381	4.10	7.07
Punjab	50,362	45,290	12.6	57,285	1,608	3.19	3.55
Rajasthan	342,239	303,157	8.0	241,255	8,638	2.52	2.85
Sikkim	7,096	322	20.3	653	22	0.31	6.77
Tamil Nadu	130,058	98,851	13.7	135,131	4,991	3.84	5.05
Tripura	10,486	2,446	13.6	3,336	116	1.11	4.76
Uttar Pradesh	240,928	214,390	12.3	263,875	7,715	3.20	3.60
Uttaranchal	53,483	13,090	15.4	20,164	571	1.07	4.36
West Bengal	88,752	67,350	14.4	96,888	1,731	1.95	2.57
Andaman & Nicobar	8,249	973	12.1	1,178	33	0.40	3.42
Chandigarh	114	76	33.6	257	8	7.09	10.53
Dadra Nagar Haveli	491	233	21.0	489	35	7.10	15.02
Daman & Diu	112	96	10.6	102	6	5.23	6.10
Lakshadweep	32	25	13.7	35	2	7.24	9.01
Pondicherry	480	426	18.8	804	35	7.19	8.09
Total	**3,287,263**	**2,188,668**	**12.25**	**2,680,147**	**99,896**	**3.04**	**4.56**

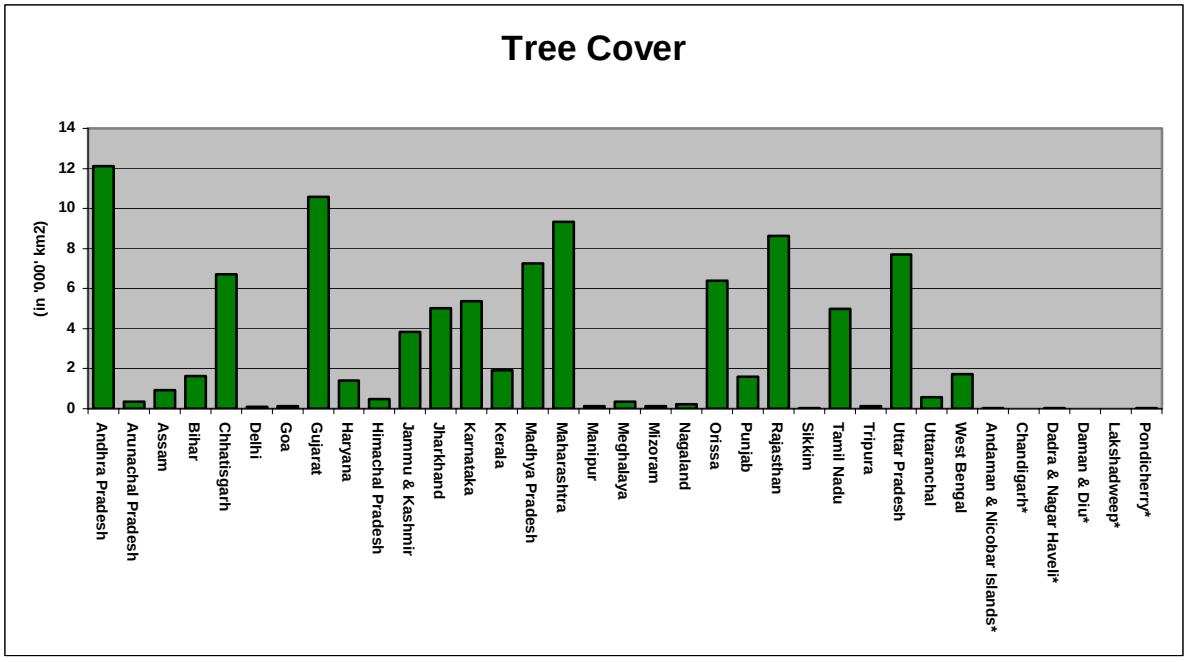


Fig. 5.03 Tree cover in States & UTs

The States/UTs with high density of trees within CNFA are Chandigarh, Delhi, Dadra & Nagar Haveli and Sikkim. The ones with low density are Rajasthan, Chhattisgarh, Madhya Pradesh and Jharkhand.

Tree cover constitutes largest area in Andhra Pradesh (12,120 km^2) followed by Gujarat (10,586 km^2), Maharashtra (9,320 km^2) and Rajasthan (8,638 km^2). Considering the percent of geographic area of the State/UT under tree cover, the highest rank goes to Lakshdweep (7.24 percent) followed by Pondicherry (7.19 percent), Dadra & Nagar Haveli (7.10 percent), Chandigarh, (7.09 percent), Delhi (6.61 percent), Jharkhand (6.29 percent) and Gujarat, (5.40 percent).

Considering the percentage of tree cover with respect to CNFA, which indicates the actual potential different States/UTs have for increasing area under tree cover, it is found that Lakshdweep, Dadra & Nagar Haveli, Pondicherry, Chandigarh, Jharkhand, Orissa, Kerala, Goa, Delhi and Chhatisgarh cover between 7-15 percent of their CNFA's. Analysing these figures in combination with the extent of forest cover outside recorded forest areas in different States/UTs, the concerned governments can determine where and how much scope is there to enhance tree-growing activities.

CHAPTER 6

GROWING STOCK

6.01 Introduction

Forest managers, planners and policy makers need information about availability of wood from important tree species growing inside and outside forest areas. Detailed information on distribution of timber species, volume, biomass, number of stems, regeneration status, population structure, etc. within different zones and regions of the country is highly useful for effective planning. FSI has been generating such information through systematic and intensive field surveys. In 1995, FSI published the findings in the form of a book "Extent, Composition, Density, Growing Stock and Annual Increment of India's Forests". It provided information about growing stock in the forested regions of the country. This information was based on satellite data, thematic maps (based on aerial photographs) and forest inventory data from different parts of the country over a period of 25-30 years. FSI has now expanded this activity to provide periodic information at national and regional levels on growing stock of wood existing within and outside forest areas.

6.02 Methodology

This assessment is done within each of the 14 physiographic zones in which the country has been stratified (described in Chapter 5). A sample of 10 percent districts (or 60 districts in the country) spread over all the physiographic zones is taken for detailed inventory during a cycle of two years. Inventory of forest and TOF is done to generate the required information. These estimates will be further improved in the subsequent cycles of assessment as another set of 10 percent districts are sampled and surveyed, and so on. The methodology employed for forest inventory and inventory of TOF is described in the following paragraphs.

Forest Inventory: In the selected districts the following areas are treated as forest:

1) All those areas indicated on toposheets by double dotted line, the legend for forest area;
2) All those areas shown in green wash on the toposheets;
3) All such areas on the toposheet in which words such as thick jungle, thick forest, dense jungle, open forest with bamboos etc. are printed;
4) Apart from above categories any other area reported to be a forest area by the local Divisional Forest Officers (generally unclassed forests).

Within each strata (physiographic zones), districts are considered first sampling units and grids of size 1 ¼′ × 1 ¼′ as secondary sampling units. SOI toposheets of 1:50,000 scale is divided into 36 grids of 2 ½′ × 2 ½′. Further, each grid is divided into 4 sub-grids of 1 ¼′ × 1 ¼′ forming the basic sampling units. Two of these sub-grids are randomly selected and corresponding sub-grids in all the 2 ½′ × 2 ½′ grids are selected to form the sample. The intersection of diagonals of such sub-grids are marked as center of

plot on the map at which a sample plot of 0.1 ha area is laid out for collection of field inventory data in prescribed formats.

The data on legal status, land use, forest stratum, topography, crop composition, bamboo, regeneration, biotic pressure, species name and their diameter at breast height (dbh) and height etc. falling in forest area only are recorded. The information thus generated is analysed to obtain growing stock and other parameters of the forest.

Methodology for Trees Outside Forests (Rural & Urban): The methodology used for sampling and inventory of TOF within different strata of Block, Linear and Scattered has already been described in para 5.04 of chapter 5. The inventory data on trees inside the sample plot is collected and recorded in the same way as done inside forest areas. However, data on regeneration status etc. is not recorded, as it was not felt important for TOF areas.

6.03 Volume Equations

Volume equations have been developed for all prominent tree species occurring in different physiographic zones. These are local volume equations since a single volume equation cannot be applicable to all physiographic zones. Therefore, for a particular species, separate volume equations were generated for all the physiographic zones. These are used to convert the tree inventory data into volumes of growing stock of wood.

These volume equations have been listed in Annexure – III.

6.04 Data Processing

After collection of field data, it is sent to respective Zonal Offices of FSI, where it is first checked manually for detecting anomalies in enumeration. Thereafter, the data is fed into computer utilizing 'data entry modules', which were designed separately for forest, TOF (Rural) and TOF (Urban) inventories. After checking the consistency of the data, volume corresponding to each tree was calculated using the volume equations for each important species.

For forest inventory, the plots of a selected district were classified according to legal status, i.e. how many of them fall in recorded forest and how many in non-forest. On the basis of this information and that about the recorded forests, the 'area factor', i.e., how much area is represented by the sample plot, is calculated. Thereafter, plots of a particular legal status are classified according to land use classes (viz. very dense forest (70% and above canopy density), moderately dense forest (40-70%), open forest (10-40%), scrub, plantations, water bodies, habitation, agriculture with trees, agriculture without trees and barren land. This classification is grouped under three classes, namely, vegetated area (very dense, moderately dense, open, plantation), less vegetated area (agriculture, habitation, agriculture with and without trees) and area not supporting vegetation (water bodies and barren land). All the areas under these classes were calculated using 'area factor'. The plots corresponding to vegetated area were classified according to forest stratum. Forest strata are created on the basis of different dominant species, appearing with its associates in a particular physiographic zone, giving rise to different population structure and wood volume.

On the basis of this, growing stock (species wise volume and number of trees) of the sample plot is calculated for a particular forest stratum of the selected district. Using the ratio method of estimation, forest stratum wise growing stock is estimated and after adding growing stock of all strata the growing stock of selected district is estimated. Similar process is followed for other classes of forest also. This process is repeated for all the selected districts within a physiographic zone. To estimate the growing stock at physiographic zone level, formulae of two-stage sampling were followed for each forest stratum and then these were added to get physiographic level estimates of growing stock. Finally, summing of growing stock for all the physiographic zones would yield the estimated growing stock inside forests for the whole country.

In case of TOF inventory, the area of coverage for a selected district was estimated using the information of forest inventory, urban area and information generated through remote sensing as indicated earlier. For TOF (Rural) growing stock of plots falling in TOF (Rural) areas were calculated. For each of the stratum, i.e., block, linear and scattered, the estimate of growing stock was estimated using ratio method of estimation. Adding growing stock of all strata, led to the estimated yield of the growing stock of the selected district. Using the similar process, as in case of forest inventory, physiographic zone level estimates and countrywide estimates of growing stock were generated. For TOF (Urban), the method of estimation is the same as for TOF (Rural) except that it has five strata (of towns) instead of three.

6.05 Results

Two basic results were generated from the countrywide inventory and subsequent data processing done using the above methodology. These are: (i) growing stock within forest areas and (ii) growing stock of TOF, for each physiographic zone. This information was used to generate indicative estimates of growing stock inside and outside forest areas for each State/UT. The simple sum of both these sets of growing stocks provided estimates of total growing stock in the country, zones and States/UTs.

The physiographic zone wise growing stock within forest and in TOF along with the total growing stock is presented in Table 6.01. The indicative estimates for the same for the States/UTs are presented in Table 6.02.

Table 6.01: Physiographic Zone wise Growing Stock

Physiographic Zone	Areas of Phy. Zone (km^2)	Recorded Forest Area (km^2)	CNFA *plus* Forest Cover Outside Forests (km^2)	Volume of Growing Stock (m. cum)		
				In Forest	In TOF	Total
West. Himalayas	338556	98165	104715	1,044.665	115.215	1,159.880
Eastern Himalayas	65317	41160	20287	478.869	70.485	549.354
North East Ranges	133990	78906	53981	438.455	48.311	486.766
Nothern Plains	295780	13983	274370	181.259	103.727	284.986
Eastern Plains	223339	31826	178196	309.166	81.088	390.254
Western Plains	319098	13813	288291	4.496	100.158	104.654
Central Highlands	373675	82711	286651	100.496	140.637	241.133
North Deccan	355988	86495	263652	285.692	87.299	372.991
East Deccan	336289	128006	201418	542.242	177.342	719.584

Physiographic Zone	Areas of Phy. Zone (km^2)	Recorded Forest Area (km^2)	CNFA *plus* Forest Cover Outside Forests (km^2)	Volume of Growing Stock (m. cum)		
				In Forest	In TOF	Total
South Deccan	292416	51356	235933	281.137	179.675	460.812
Western Ghats	72381	33960	37326	458.469	97.588	556.057
Eastern Ghats	191698	75175	114897	461.727	114.540	576.267
West Coast	121242	21358	94410	90.620	169.823	260.443
East Coast	167494	17826	147110	104.120	146.451	250.571
TOTAL	**3287263**	**774740**	**2301237**	**4,781.414**	**1632.338**	**6,413.752**

Table 6.02: State/UT wise Growing Stock

State/UT	Geographic Area (km^2)	Recorded Forest Area (km^2)	CNFA *plus* Forest Cover Outside Forests (km^2)	Volume of Growing Stock (m. cum)		
				In Forest	In TOF	Total
Andhra Pradesh	275069	63821	207256	372.497	179.031	551.528
Arunachal Pradesh	83743	51540	28172	555.433	77.601	633.034
Assam	78438	27018	48429	251.571	25.151	276.722
Bihar	94163	6473	81738	20.468	32.915	53.383
Chhatisgarh	135191	59772	72894	245.446	63.165	308.611
Delhi	1483	85	1363	1.445	1.055	2.500
Goa	3702	1224	2342	5.102	6.669	11.771
Gujarat	196022	19113	157744	83.797	140.403	224.200
Haryana	44212	1558	41585	2.370	15.363	17.733
Himachal Pradesh	55673	37033	13452	339.421	12.417	351.838
Jammu & Kashmir	222236	20230	77013	246.856	88.773	335.629
Jharkhand	79714	23605	54295	96.932	48.231	145.163
Karnataka	191791	43084	145601	356.796	131.061	487.857
Kerala	38863	11268	26267	129.772	51.778	181.550
Madhya Pradesh	308245	95221	209296	216.998	99.818	316.816
Maharashtra	307713	61939	239846	216.652	144.617	361.269
Manipur	22327	17418	4811	111.072	4.279	115.351
Meghalaya	22429	9496	12673	73.611	11.347	84.958
Mizoram	21081	16717	4289	59.710	3.740	63.450
Nagaland	16579	8629	7790	55.026	6.972	61.998
Orissa	155707	58136	95144	291.367	90.598	381.965
Punjab	50362	3084	46155	11.081	17.906	28.987
Rajasthan	342239	32488	306554	31.960	121.917	153.877
Sikkim	7096	5841	394	33.123	0.495	33.618
Tamil Nadu	130058	22877	105526	183.563	107.712	291.275
Tripura	10486	6293	4109	13.515	3.650	17.165
Uttar Pradesh	240928	16826	218458	164.275	87.089	251.364
Uttaranchal	53483	34662	14145	429.598	12.040	441.638
West Bengal	88752	11879	71870	126.071	44.024	170.095
Andaman & Nicobar	8249	7171	1060	51.611	1.064	52.675
Chandigarh	114	34	78	0.578	0.071	0.649
Dadra & Nagar Haveli	491	204	279	3.695	0.722	4.417

State/UT	Geographic Area (km^2)	Recorded Forest Area (km^2)	CNFA *plus* Forest Cover Outside Forests (km^2)	Volume of Growing Stock (m. cum)		
				In Forest	In TOF	Total
Daman & Diu	112	1	107	0.002	0.135	0.137
Lakshadweep	32	0	30	0.000	0.052	0.052
Pondicherry	480	0	472	0.000	0.477	0.477
Total	**3287263**	**774740**	**2301237**	**4781.414**	**1632.338**	**6413.752**

The total growing stock of wood in the country is estimated to be 6,414 million cubic meter (m. cum) comprising of 4,782 m. cum inside forest area and 1,632 m. cum outside recorded forest area (TOF). The average growing stock in the forest per hectare of forest area works out to be 61.72 cum. Maximum growing stock in forest area is found in Arunachal Pradesh followed by Uttaranchal and Andhra Pradesh. Similarly, maximum growing stock in TOF is observed in Andhra Pradesh followed by Maharashtra and Gujarat. As far as total growing stock (in both forest area and TOF) is concerned, Arunachal Pradesh leads and is followed by Andhra Pradesh and Karnataka.

CHAPTER 7

FOREST AND TREE COVER IN INDIA

In the present assessment, forest cover as well as tree cover has been estimated at the national level. This will provide the reader as complete information on forest and tree cover situation in the country as possible. The methodologies of forest cover and tree cover assessments have already been described in Chapters 2 and 5, respectively. In this chapter, basic area related statistics on forest resources in each State and Union Territory is provided along with their forest cover maps. District wise information on forest cover, dense and open forest, and scrub has been given for each State and UT. Several data, provided in earlier chapters, have been reproduced here for ready reference and to present comprehensive information for each State and UT.

The statistics for human population, including figures for proportion of rural and urban population, have been taken from Census Report of 2001; proportion of tribal population from Census Report of 1991*; livestock population (in cattle units) from Livestock Census of 1992**; geographical area of States/UTs and districts from Survey of India. Their percentages with respect to the country's figures have also been given. The statistics on recorded forest area has been supplied by the forest departments of respective States and Union Territories.

The recorded forest area, along with its break up into different categories, has been shown statistically as well as diagrammatically for each State and UT. Their percentages with respect to geographical area of the concerned State/UT and country's recorded forest area have also been produced. The information on forest cover, dense and open, in respect of each State/UT has been reproduced here. The forest cover is also depicted as pie chart for each State/UT. Statistics of tree cover along with its percentage with respect to geographic area for each State/UT has also been reproduced. The combined forest and tree cover, its percentage with respect to geographic area of the State/UT and country's total forest and tree cover, have been presented. The per capita forest and tree cover for each State/UT has also been given.

In order to make retrieval of data and numbers convenient, most of these statistics have been presented in boxes and tabular form. Effort has been made to provide only such forestry data that has been generated by FSI. Secondary information or forestry data not directly generated by FSI has been avoided as these can be obtained from other sources. A countrywide overview of the forest and tree cover status, number of districts falling in different groups according to forest cover percentages and relative ranking of 35 States/UTs with respect to different criteria has been presented in the last section.

The wealth of statistics provided in this report can be used for many different kinds of analysis. Together with forest cover maps at desired scale up to 1:50,000 scale, which can be supplied by FSI on demand, these data can be employed for further academic research and studies.

* For data on tribal population, the State of Jammu & Kashmir was excluded from the census during 1991.

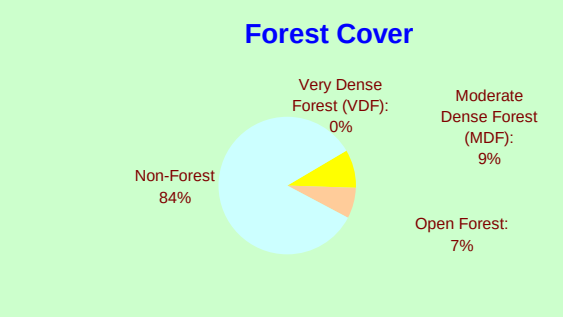
** N. A. indicates non-availability of data

7.01 ANDHRA PRADESH

Geographic Area	2,75,069 km^2 (8.4% of country)
Population	75.73 million (7.4% of country)
Urban	20.50 million (27.1%)
Rural	55.22 million (72.9%)
Average Population Density	275 persons per km^2
Tribal Population	6.30%
Livestock Population	32.91 million (7.0% of country)
No.of Districts	23
No. of Hill Districts	0
No. of Tribal Districts	8

Recorded Forest Area	
Reserved Forest (RF):	50,479 km^2
Protected Forest (PF):	12,365 km^2
Unclassed Forest (UF):	977 km^2
Total:	63,821 km^2
Of State's Geographic Area	23.2%
Of Country's Forest Area	8.24%

Forest Cover:	Andhra Pradesh
Very Dense Forest (VDF):	23 km^2
Moderate Dense Forest (MDF):	24,356 km^2
Open Forest (OF):	20,040 km^2
Total:	44,419 km^2
Of State's Geographic Area:	16.15%
Of Country's Forest Cover:	1.35%



Tree Cover	
Culturable Non-Forest Area (CNFA):	204,084 km^2
No. of trees per ha of CNFA:	16.9
Tree Cover:	12,120 km^2
Of State's Geographic Area:	*4.41%*
Of CNFA:	*5.94%*

Forest & Tree Cover	
Total Forest & Tree Cover:	56,539 km^2
Of State's Geographic Area:	*20.55%*
Of Country's Forest & Tree Cover:	*7.27%*
Per capita Forest & Tree Cover:	0.07 ha

FOREST COVER MAP OF ANDHRA PRADESH

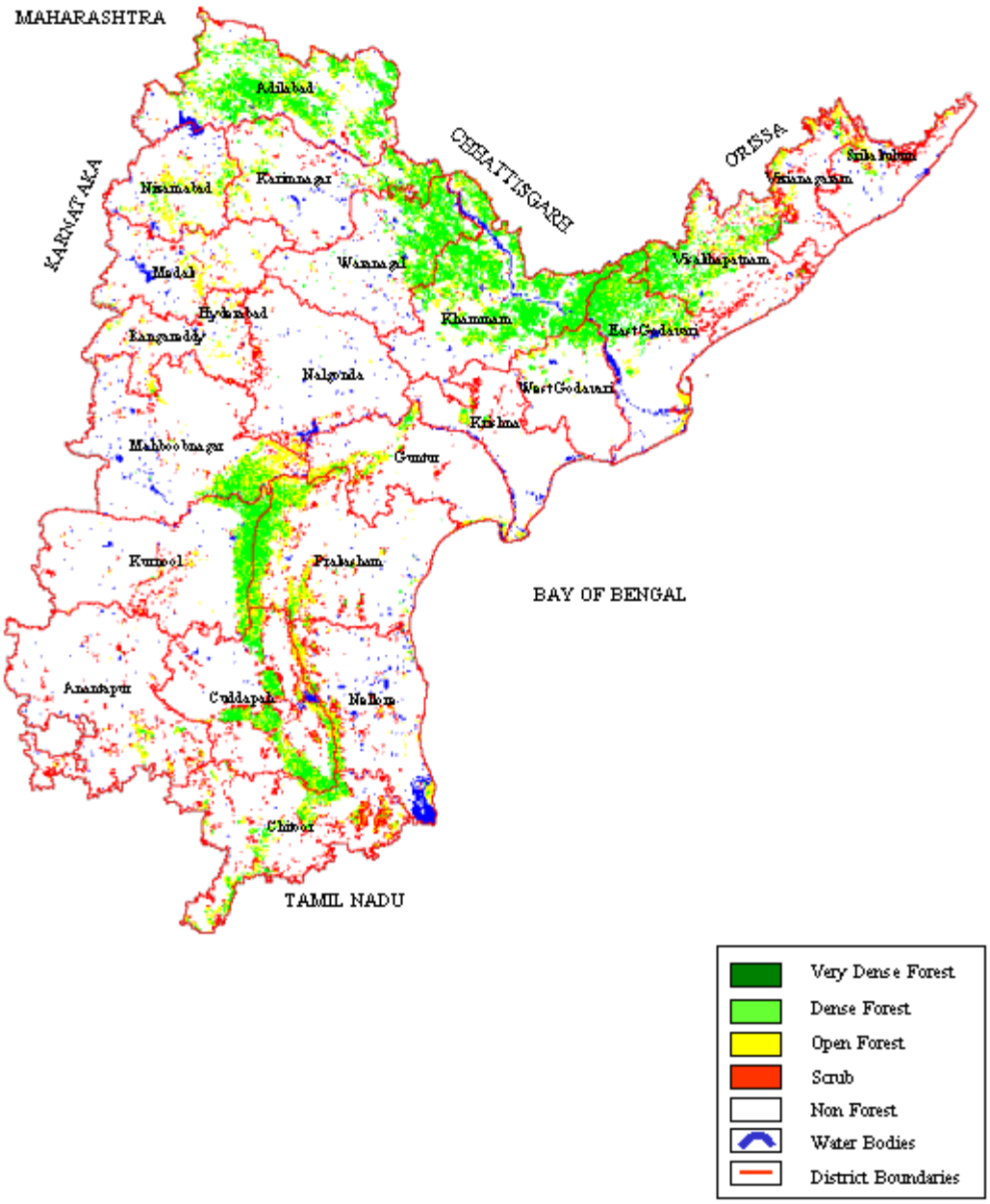


Fig. 7.01

Table 7.01a: District-wise Forest Cover (Andhra Pradesh)

Number of Districts: 23 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Adilabad[T]	16,128	11	3,667	2,440	6,118	37.93	67
Anantapur	19,130	0	73	340	413	2.16	-98
Chittoor	15,151	1	826	1,367	2,194	14.48	86
Cuddapah	15,359	4	1,864	1,507	3,375	21.97	27
East Godawari[T]	10,807	1	2,339	1,156	3,496	32.35	-14
Guntur	11,391	0	198	673	871	7.65	-126
Hyderabad Rangareddy	7710	0	36	356	392	5.08	11
Karimnagar	11,823	0	865	784	1,649	13.95	21
Khammam[T]	16,029	3	5,144	2,033	7,180	44.79	-2
Krishna	8,727	0	50	201	251	2.88	-23
Kurnool	17,658	1	1,469	676	2,146	12.15	16
Mahboobnagar	18,432	0	748	1,203	1,951	10.58	-80
Medak	9,700	0	40	534	574	5.92	6
Nalgonda	14,240	0	18	136	154	1.08	-40
Nellore	13,076	0	214	675	889	6.80	-49
Nizamabad	7,956	0	237	894	1,131	14.22	7
Prakasham	17,626	2	1,363	1,739	3,104	17.61	100
Srikakulam[T]	5,837	0	100	321	421	7.21	-26
Vizianagaram[T]	6,539	0	145	578	723	11.06	-19
Vishakapatnam[T]	11,161	0	2,002	1,376	3,378	30.27	42
Warangal[T]	12,847	0	2,345	757	3,102	24.15	-126
West Godawari[T]	7,742	0	613	294	907	11.72	2
Total	**275069**	**23**	**24,356**	**20,040**	**44,419**	16.15	**-218**

Table 7.01b : Forest cover change matrix of Andhra Pradesh

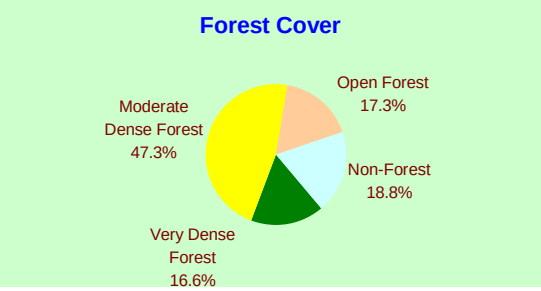
2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	23,898	532	15	1,382	25,827
Open forest	313	18,088	250	159	18,810
Scrub	5	417	9,305	180	9,907
Non-forest	163	1,003	178	219,181	220,525
Total 2003	24,379	20,040	9,748	220,902	275,069
Net change	-1,448	1,230	-159	377	

7.02 ARUNACHAL PRADESH

Geographic Area	83,743 km^2 (2.5% of country)
Population	1.09 million (0.1% of country)
Urban	0.22 million (20.4%)
Rural	0.86 million (79.6%)
Average Population Density	13 persons per km^2
Tribal Population	63.70%
Livestock Population	0.8 million (0.2% of country)
No.of Districts	13
No. of Hill Districts	13
No. of Tribal Districts	13

Recorded Forest Area	
Reserved Forest (RF):	10,178 km^2
Protected Forest (PF):	9,536 km^2
Unclassed Forest (UF):	31,826 km^2
Total:	51,540 km^2
Of State's Geographic Area	61.55%
Of Country's Forest Area	6.65%

Forest Cover:	
Very Dense Forest (VDF):	13,907 km^2
Moderate Dense Forest (MDF):	39,604 km^2
Open Forest:	14,508 km^2
Total:	68,019 km^2
Of State's Geographic Area:	81.22%
Of Country's Forest Cover:	2.07%



Tree Cover	
Culturable Non-Forest Area (CNFA):	12,504 km^2
No. of trees per ha of CNFA:	10.8
Tree Cover:	363 km^2
Of State's Geographic Area	*0.43%*
Of CNFA:	*2.90%*

Forest & Tree Cover	
Total Forest & Tree Cover:	68,382 km^2
Of State's Geographic Area:	*81.66%*
Of Country's Forest & Tree Cover:	*8. 79%*
Per capita Forest & Tree Cover:	6.27 ha

FOREST COVER MAP OF ARUNACHAL PRADESH

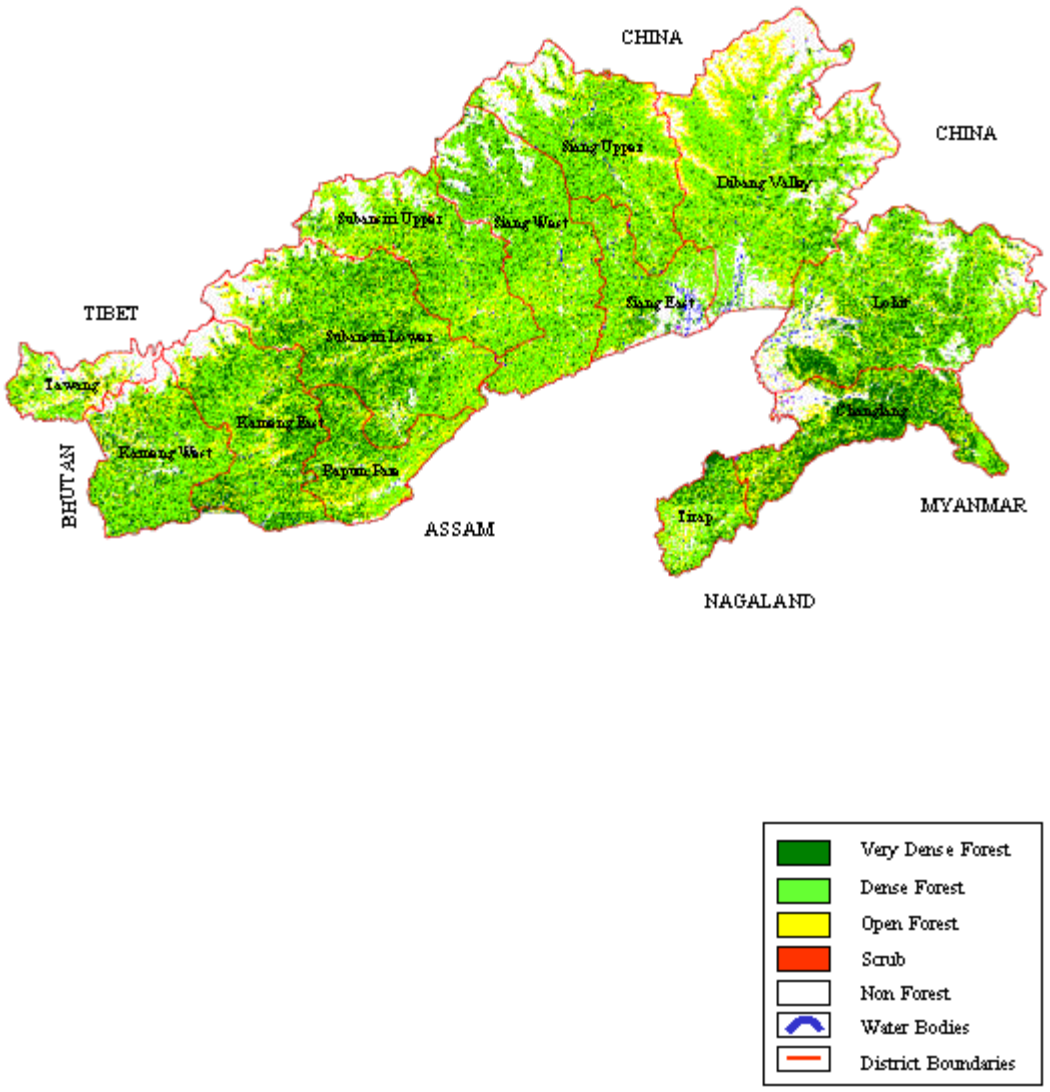


Fig. 7.02

Table 7.02a: District-wise Forest Cover (Arunachal Pradesh)

Number of Districts: 13 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Changlang[TH]	4,662	1,879	1,539	888	4,306	92.36	-46
Dibang Valley[TH]	13,029	851	5,836	2,736	9,423	72.32	12
Kameng East[TH]	11,556	2,583	5,548	2,107	10,238	88.59	4
Kameng West[TH]							
Lohit[TH]	11,402	1,955	4,224	1,615	7,794	68.36	34
Papum Pare[TH]	3,462	754	1,699	834	3,287	94.95	7
Siang East[TH]	3,655	448	1,944	480	2,872	78.58	9
Siang Upper[TH]	7,050	736	3,676	1,198	5,610	79.57	11
Siang West[TH]	7,813	997	4,884	946	6,827	87.38	-69
Subansiri Lower[TH]	9,548	2,286	4,745	1,704	8,735	91.49	-53
Subansiri Upper[TH]	7,032	849	3,803	1,155	5,807	82.58	67
Tawang[TH]	2,172	110	664	453	1,227	56.49	12
Tirap[TH]	2,362	459	1,042	392	1,893	80.14	-14
Total	**83,743**	**13,907**	**39,604**	**14,508**	**68,019**	**81.22**	**-26**

Table 7.02b : Forest cover change matrix of Arunachal Pradesh

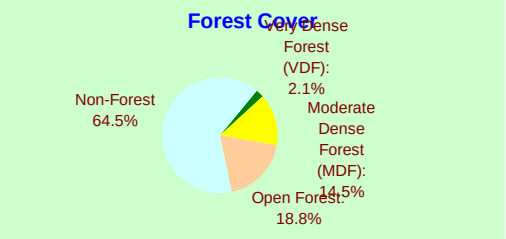
2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	51,261	1,907	0	764	53,932
Open forest	2,172	11,524	0	417	14,113
Scrub	0	0	111	30	141
Non-forest	78	1,077	5	14,397	15,557
Total 2003	53,511	14,508	116	15,608	83,743
Net change	-421	395	-25	51	

7.03. ASSAM

Geographic Area	78,438 km^2 (2.4% of country)
Population	26.64 million (2.6% of country)
Urban	3.38 million (12.7%)
Rural	23.24 million (87.3%)
Average Population Density	340 persons per km^2
Tribal Population	12.80%
Livestock Population	16.06 million (3.4% of country)
No.of Districts	23
No. of Hill Districts	3
No. of Tribal Districts	16

Recorded Forest Area	
Reserved Forest (RF):	18,060 km^2
Protected Forest (PF):	0
Unclassed Forest (UF):	8,958 km^2
Total:	27,018 km^2
Of State's Geographic Area	34.45%
Of Country's Forest Area	3.49%

Forest Cover:	
Very Dense Forest (VDF):	1,684 km^2
Moderate Dense Forest (MDF):	11,358 km^2
Open Forest:	14,784 km^2
Total:	27,826 km^2
Of State's Geographic Area:	35.48%
Of Country's Forest Cover:	0.85%



Tree Cover	
Culturable Non-Forest Area (CNFA):	42,315 km^2
No. of trees per ha of CNFA:	14.1
Tree Cover:	935 km^2
Of State's Geographic Area:	*1.19%*
Of CNFA:	*2.21%*

Forest & Tree Cover	
Total Forest & Tree Cover:	28,761 km^2
Of State's Geographic Area:	*36.67%*
Of Country's Forest & Tree Cover:	*3.70%*
Per capita Forest & Tree Cover:	0.11 ha

FOREST COVER MAP OF ASSAM

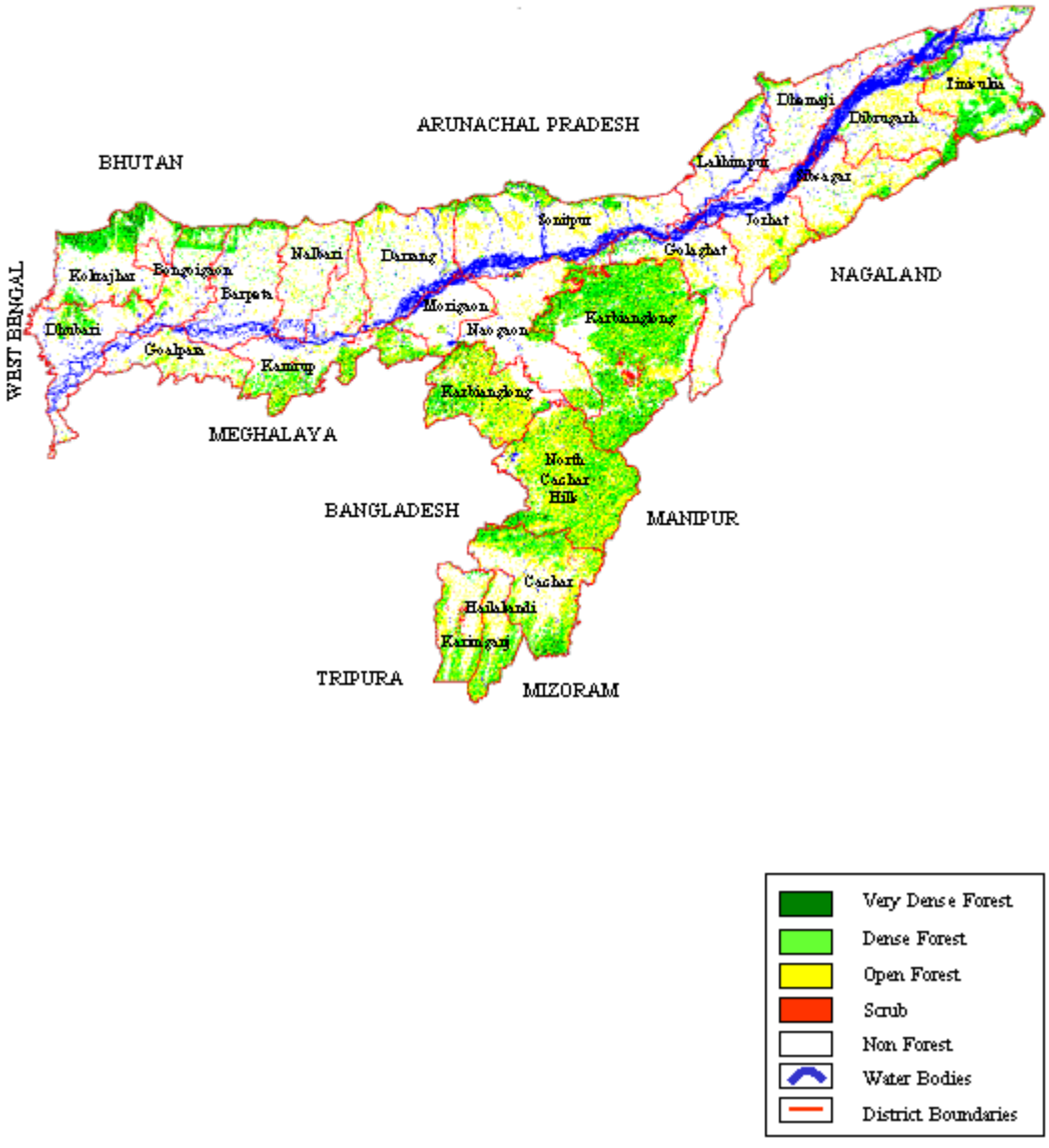


Fig. 7.03

Table 7.03a: District-wise Forest Cover (Assam)

Number of Districts: 23 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Barpeta[T]	3,245	35	183	183	401	12.36	-337
Bongoigoan	2,510	33	267	212	512	20.40	-119
Cachar[T]	3,786	91	872	1,263	2,226	58.80	177
Darrang[T]	3,481	17	121	375	513	14.74	41
Dhemaji[T]	3,237	7	140	152	299	9.24	66
Dhubari[T]	2,798	20	197	198	415	14.83	-103
Dibrugarh[T]	3,381	26	184	538	748	22.12	9
Goalpara[T]	1,824	0	69	263	332	18.20	9
Golaghat	3,502	15	113	369	497	14.19	45
Hailakandi	1,327	14	339	421	774	58.33	98
Jorhat[T]	2,851	0	90	481	571	20.03	9
Kamrup[T]	4,345	69	609	754	1,432	32.96	3
Karbianglong[H]	10,434	684	3,876	3,447	8,007	76.74	35
Karimganj	1,809	2	336	495	833	46.05	208
Kokrajhar[T]	3,169	207	709	267	1,183	37.33	-181
Lakhimpur[T]	2,277	4	112	154	270	11.86	14
Morigaon[T]	1,704	8	39	81	128	7.51	24
North Cachar Hills[H]	4,888	187	1,504	2,645	4,336	88.71	78
Naogaon[H]	3,831	72	298	445	815	21.27	21
Nalbari[T]	2,257	4	66	210	280	12.41	13
Sibsagar[T]	2,668	15	133	534	682	25.56	33
Sonitpur[T]	5,324	71	334	636	1,041	19.55	-13
Tinshukia[T]	3,790	103	767	661	1,531	40.40	-18
Total	**78,438**	**1,684**	**11,358**	**14,784**	**27,826**	35.48	**112**

Table 7.03b : Forest cover change matrix of Assam

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	12,283	1502	10	2,035	15,830
Open forest	631	10,603	8	642	11,884
Scrub	15	58	131	20	224
Non-forest	113	2,621	70	47,696	50,500
Total 2003	13,042	14,784	219	50,393	78,438
Net change	-2,788	2,900	-5	-107	

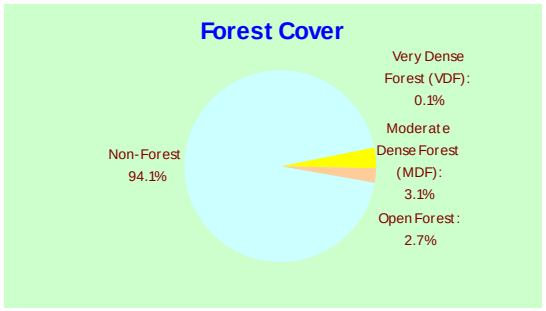
7.04. BIHAR

Geographic Area	94,163 km^2 (2.9% of country)
Population	82.88 million (8.1% of country)
Urban	8.67 million (10.5%)
Rural	7.41 million (89.5%)
Average Population Density	880 persons per km^2
Tribal Population	0.80%
Livestock Population	47.93 million (10.2% of country)*
No.of Districts	37
No. of Hill Districts	0
No. of Tribal Districts	0

*includes Jharkhand Livestock population.

Recorded Forest Area	
Reserved Forest (RF):	693 km^2
Protected Forest (PF):	5,779 km^2
Unclassed Forest (UF):	1 km^2
Total:	6,473 km^2
Of State's Geographic Area	6.87%
Of Country's Forest Area	0.84%

Forest Cover	
Very Dense Forest (VDF):	76 km^2
Moderate Dense Forest (MDF):	2,951 km^2
Open Forest:	2,531 km^2
Total:	5,558 km^2
Of State's Geographic Area:	5.9%
Of Country's Forest Cover:	0.17%



Tree Cover	
Culturable Non-Forest Area (CNFA):	79,442 km^2
No. of trees per ha of CNFA:	13.8
Tree Cover:	1,620 km^2
Of State's Geographic Area:	*1.72%*
Of CNFA:	*2.04%*

Forest & Tree Cover	
Total Forest & Tree Cover:	7,178 km^2
Of State's Geographic Area:	*7.62%*
Of Country's Forest & Tree Cover:	*0.92%*
Per capita Forest & Tree Cover:	0.01 ha

FOREST COVER MAP OF BIHAR

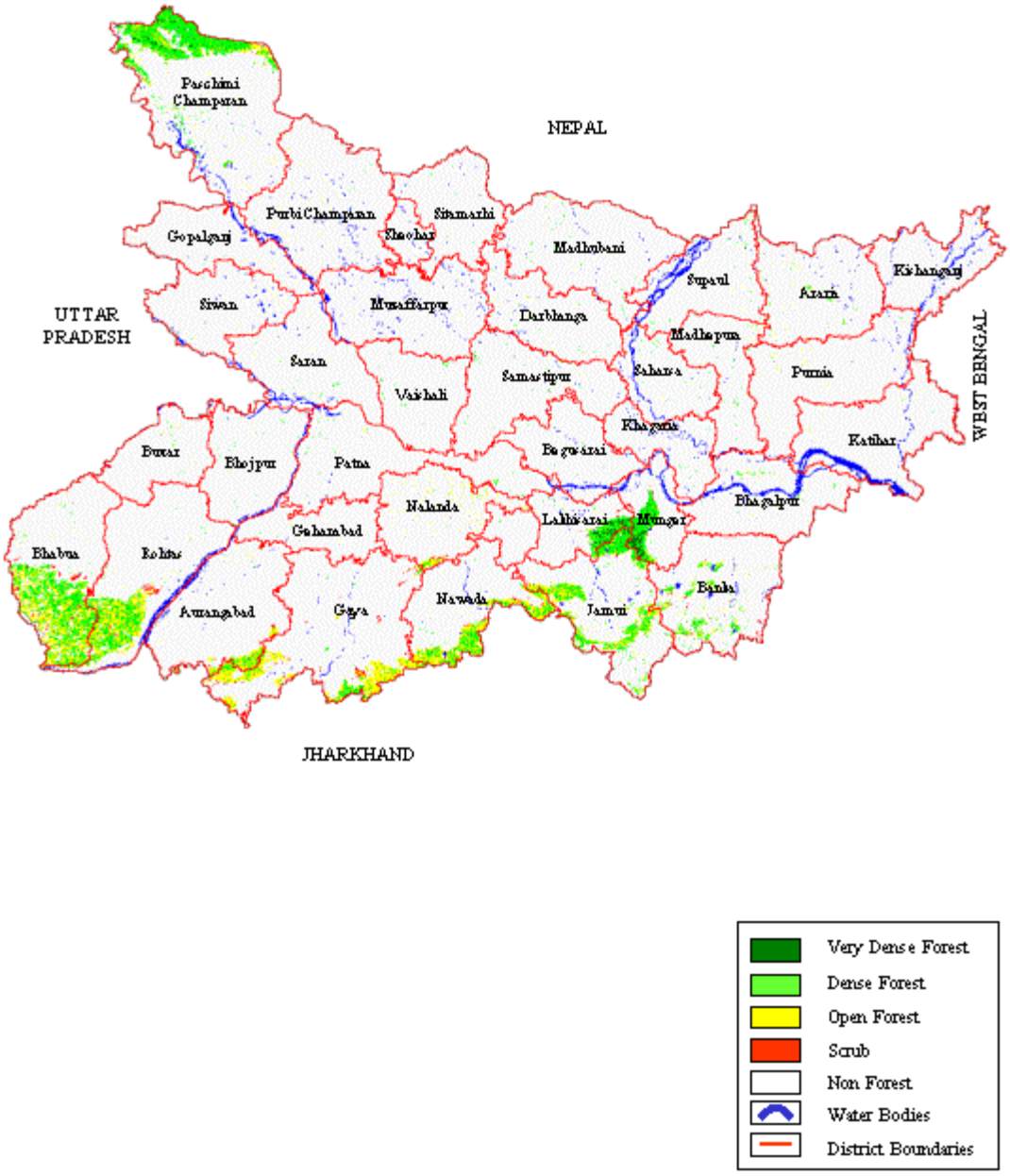


Fig. 7.04

Table 7.04a: District-wise Forest Cover (Bihar)

Number of Districts: 37 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Araria	2,830	0	14	14	28	0.99	-34
Aurangabad	3,305	0	46	100	146	4.42	3
Banka	3,022	0	120	91	211	6.98	14
Begusarai	1,918	0	3	3	6	0.31	-24
Bhabua	3,381	0	544	550	1,094	32.36	54
Bhagalpur	2,567	0	12	7	19	0.74	-2
Bhojpur	2,390	0	7	1	8	0.33	-3
Buxar	1,708	0	8	4	12	0.70	-3
Darbhanga	2,279	0	5	6	11	0.48	-12
Gaya	4,976	0	119	463	582	11.70	34
Gopalganj	2,033	0	0	0	0	0.00	-10
Jamui	3,107	9	392	256	657	21.15	20
Jehanabad	1,569	0	2	1	3	0.19	-1
Katihar	3,057	0	1	4	5	0.16	-6
Khagaria	1,486	0	2	1	3	0.20	-10
Kishanganj	1,884	0	1	8	9	0.48	-3
Lakhisarai	1,356	0	176	18	194	14.31	-33
Madhepura	1,788	0	6	4	10	0.56	-12
Madhubani	3,501	0	10	4	14	0.40	-1
Munger	1,347	43	201	18	262	19.45	-1
Muzaffarpur	3,172	0	2	2	4	0.13	-1
Nalanda	2,367	0	16	47	63	2.66	17
Nawada	2,494	0	191	316	507	20.33	15
Pashchimi Champaran	5,228	24	694	201	919	17.58	-56
Patna	3,202	0	7	8	15	0.47	-19
Purbi Champaran	3,968	0	9	1	10	0.25	-14
Purnia	3,229	0	4	11	15	0.46	-36
Rohtas	3,832	0	310	374	684	17.85	19
Saharsa	1,680	0	5	1	6	0.36	-5
Samastipur	2,904	0	9	3	12	0.41	-20
Saran	2,641	0	7	4	11	0.42	-4
Sheikhpura	612	0	1	0	1	0.16	-1
Sheohar	572	0	1	0	1	0.17	0

Sitamarhi	2,071	0	4	1	5	0.24	-8
Siwan	2,219	0	1	3	4	0.18	-1
Supaul	2,432	0	9	6	15	0.62	-13
Vaishali	2,036	0	12	0	12	0.59	-5
Total	**94,163**	**76**	**2,951**	**2,531**	**5,558**	**5.90**	**-162**

Table 7.04b : Forest cover change matrix of Bihar

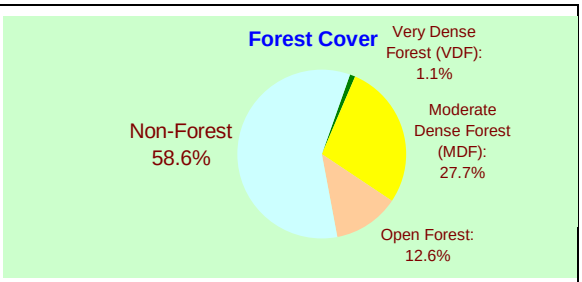
2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	2,369	340	15	648	3,372
Open forest	467	1,830	6	45	2,348
Scrub	2	6	108	6	122
Non-forest	189	355	21	87,756	88,321
Total 2003	3,027	2,531	150	88,455	94,163
Net change	-345	183	28	134	

7.05. CHHATTISGARH

Geographic Area	1,35,191 km^2 (4.1% of country)
Population	20.80 million (2.0% of country)
Urban	4.17 million (20.1%)
Rural	16.62 million (79.9%)
Average Population Density	154 persons per km^2
Tribal Population	32.50%
Livestock Population	NA
No.of Districts	16
No. of Hill Districts	0
No. of Tribal Districts	9

Recorded Forest Area	
Reserved Forest (RF):	25,782 km^2
Protected Forest (PF):	24,036 km^2
Unclassed Forest (UF):	9,954 km^2
Total:	59,772 km^2
Of State's Geographic Area	44.21%
Of Country's Forest Area	7.72%

Forest Cover	
Very Dense Forest (VDF):	1,540 km^2
Moderate Dense Forest (MDF):	37,440 km^2
Open Forest:	17,018 km^2
Total:	55,998 km^2
Of State's Geographic Area:	41.42%
Of Country's Forest Cover:	1.70%



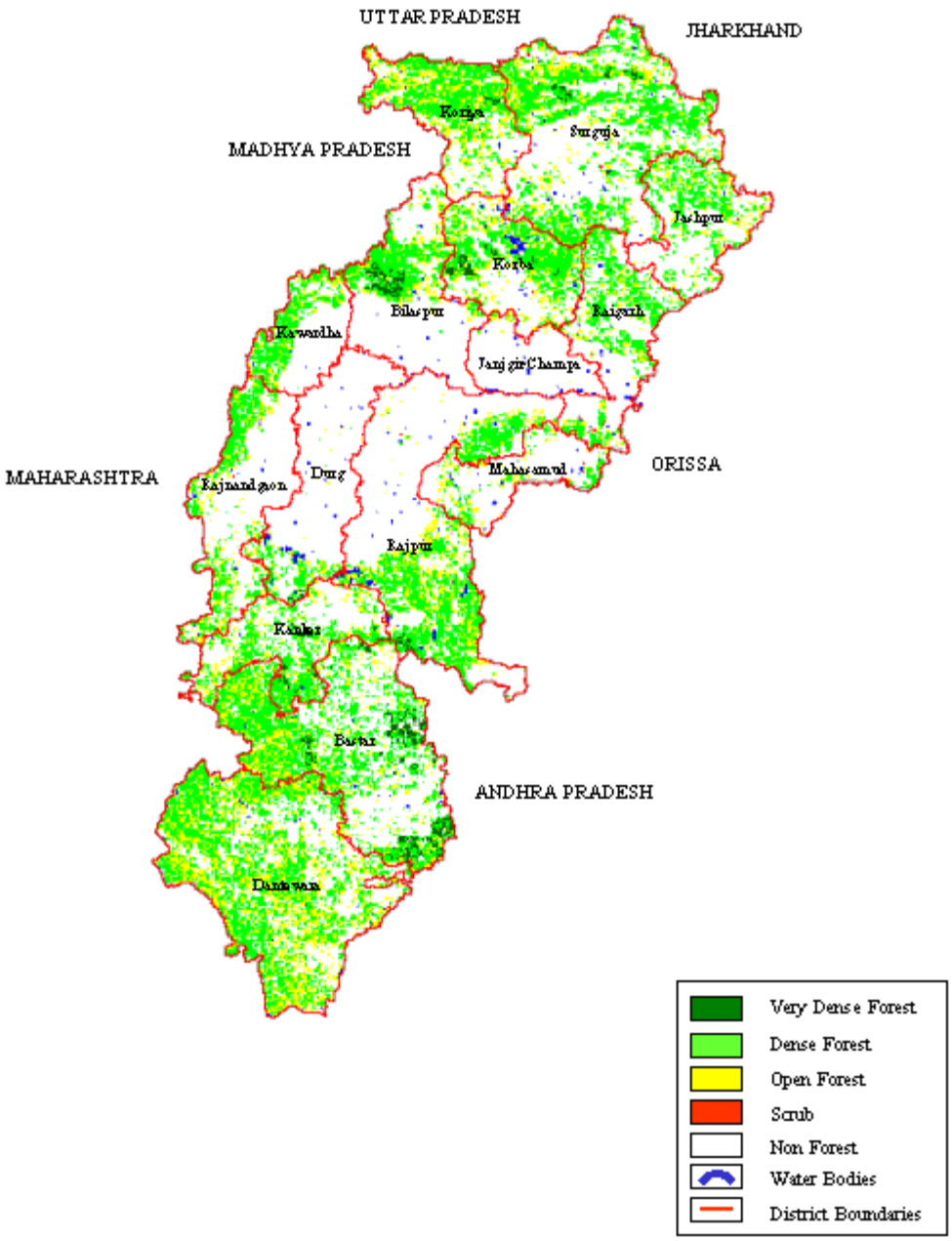

FOREST COVER MAP OF CHHATTISGARH
UTTAR PRADESH
JHARKHAND
MADHYA PRADESH
MAHARASHTRA
ORISSA
ANDHRA PRADESH
Korea
Surguja
Jashpur
Korba
Bilaspur
Raigarh
Kawardha
Janjgir Champa
Mahasamund
Rajnandgaon
Durg
Rajpur
Kanker
Bastar
Dantewara
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.05

Tree Cover	
Culturable Non-Forest Area (CNFA):	69,594 km^2
No. of trees per ha of CNFA:	10.2
Tree Cover:	6,723 km^2
Of State's Geographic Area:	*4.97%*
Of CNFA:	*9.66%*

Forest & Tree Cover	
Total Forest & Tree Cover:	62,721 km^2
Of State's Geographic Area:	*46.39%*
Of Country's Forest & Tree Cover:	*8.06%*
Per capita Forest & Tree Cover:	0.30 ha

Table 7.05a: District-wise Forest Cover (Chhattisgarh)

Number of Districts: 16 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Bastar[T]	14,974	750	5,303	1,991	8,044	53.72	-158
Bilaspur[T]	8,270	222	1,682	600	2,504	30.28	2
Dantewara[T]	17,634	30	6,969	4,329	11,328	64.24	-724
Durg[T]	8,549	31	515	224	770	9.01	-16
Janjgir-Champa	3,852	4	51	102	157	4.08	13
Jashpur[T]	5,838	3	1,580	630	2,213	37.91	60
Kanker[T]	6,506	124	2,192	849	3,165	48.65	-131
Kawardha	4,223	0	1,246	375	1,621	38.39	48
Korba	6,599	149	2,186	1,023	3,358	50.89	36
Koriya	6,604	54	2,607	1,475	4,136	62.63	69
Mahasamud	4,789	0	563	401	964	20.13	4
Raipur	16,468	47	3,865	1,542	5,454	33.12	246
Dhamtari							
Raigarh[T]	7,086	0	1,885	661	2,546	35.93	32
Rajnandgaon[T]	8,068	3	1,727	818	2,548	31.58	49
Surguja[T]	15,731	123	5,069	1,998	7,190	45.71	20
Total	**135,191**	**1,540**	**37,440**	**17,018**	**55,998**	**41.42**	**-450**

Table 7.05b : Forest cover change matrix of Chhattisgarh

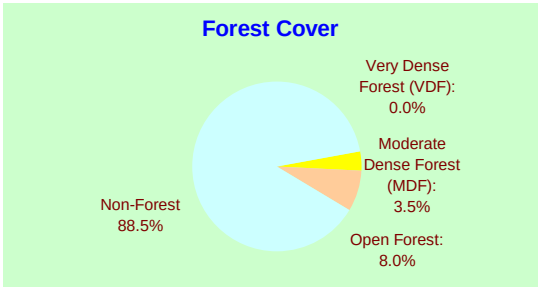
2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	33,727	3180	5	968	37,880
Open forest	4,837	12,749	9	973	18,568
Scrub	12	51	58	79	200
Non-forest	404	1,038	16	77,085	78,543
Total 2003	38,980	17,018	88	79,105	135,191
Net change	1,100	-1,550	-112	562	

7.06. DELHI

Geographic Area	1,483 km^2 (0.05% of country)
Population	13.78 million (1.3% of country)
Urban	12.82 million (93%)
Rural	0.96 million (7%)
Average Population Density	9,294 persons per km^2
Tribal Population	NA
Livestock Population	0.32 million (0.07% of country)
No.of Districts	9
No. of Hill Districts	0
No. of Tribal Districts	0

Recorded Forest Area	
Reserved Forest (RF):	78 km^2
Protected Forest (PF):	7 km^2
Unclassed Forest (UF):	0 km^2
Total:	85 km^2
Of State's Geographic Area	5.73%
Of Country's Forest Area	0.01%

Forest Cover	
Very Dense Forest (VDF):	0 km^2
Moderate Dense Forest (MDF):	52 km^2
Open Forest:	118 km^2
Total:	170 km^2
Of State's Geographic Area:	11.47%
Of Country's Forest Cover:	0.01%



Tree Cover	
Culturable Non-Forest Area (CNFA):	1,278 km^2
No. of trees per ha of CNFA:	24.9
Tree Cover:	98 km^2
Of State's Geographic Area:	*6.61%*
Of CNFA:	*7.67%*

Forest & Tree Cover	
Total Forest & Tree Cover:	268 km^2
Of State's Geographic Area:	*18.08%*
Of Country's Forest & Tree Cover	*0.03%*
Per capita Forest & Tree Cover:	0.00 ha

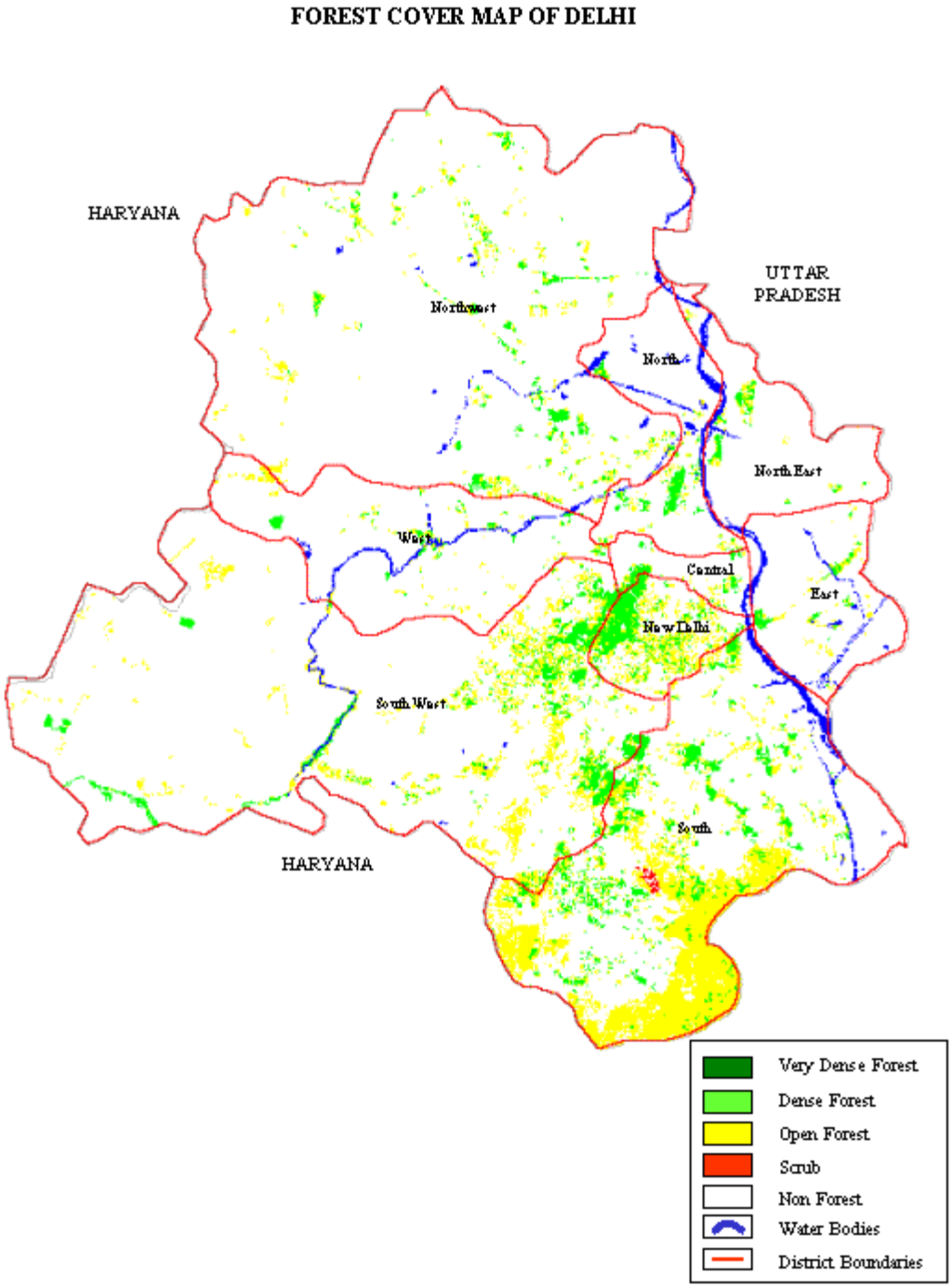

FOREST COVER MAP OF DELHI
HARYANA
UTTAR PRADESH
Northwest
North
North East
West
Central
East
New Delhi
South West
South
HARYANA
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.06

Table7.06a: District-wise Forest Cover (Delhi)

Number of Districts: 9 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Central Delhi	24.68	0	2.8	2.4	5.2	21.07	2.93
East Delhi	63.76	0	0.98	1.96	2.94	4.61	1.37
New Delhi	34.9	0	6.97	7.57	14.54	41.66	4.81
North Delhi	59.16	0	3.02	1.68	4.7	7.94	1.52
North East Delhi	60.29	0	1.1	1.6	2.7	4.48	0.85
North West Delhi	440.31	0	6.63	8.84	15.47	3.51	7.1
South West Delhi	420.54	0	13.88	26.73	40.61	9.66	10.52
South Delhi	249.85	0	15.02	63.93	78.95	31.60	26.44
West Delhi	129.52	0	1.62	3.44	5.06	3.91	3.3
Total	**1,483.00**	**0**	**52.02**	**118.15**	**170.17**	**11.47**	**58.84**

Table 7.06b : Forest cover change matrix of Delhi

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	25	11	0	2	38
Open forest	13	48	0	12	73
Scrub	0	2	1	1	4
Non-forest	14	57	0	1,297	1,368
Total 2003	52	118	1	1,312	1,483
Net change	14	45	-3	-56	

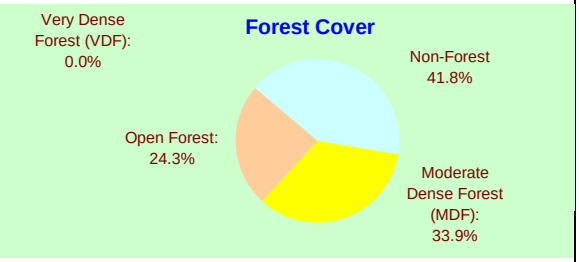
7.07. GOA

Geographic Area	3,702 km^2 (0.11% of country)
Population	1.34 million (0.13% of country)
Urban	0.66 million (49.8%)
Rural	0.67 million (50.2%)
Average Population Density	363 persons per km^2
Tribal Population	---
Livestock Population	0.24 million (0.05% of country)
No.of Districts	2
No. of Hill Districts	0
No. of Tribal Districts	0

Recorded Forest Area	
Reserved Forest (RF):	237 km^2
Protected Forest (PF):	822 km^2
Unclassed Forest (UF):	165 km^2
Total:	1,224 km^2
Of State's Geographic Area	33.06%
Of Country's Forest Area	0.16%

Forest Cover

Very Dense Forest (VDF):	0 km^2
Moderate Dense Forest (MDF):	1,255 km^2
Open Forest:	901 km^2
Total:	2,156 km^2
Of State's Geographic Area:	58.24%
Of Country's Forest Cover:	0.07%



Tree Cover

Culturable Non-Forest Area (CNFA):	1,411 km^2
No. of trees per ha of CNFA:	15.2
Tree Cover:	136 km^2
Of State's Geographic Area:	*3.67%*
Of CNFA:	*9.62%*

Forest & Tree Cover

Total Forest & Tree Cover:	2,292 km^2
Of State's Geographic Area:	*61.91%*
Of Country's Forest & Tree Cover:	*0.29%*
Per capita Forest & Tree Cover:	0.17 ha

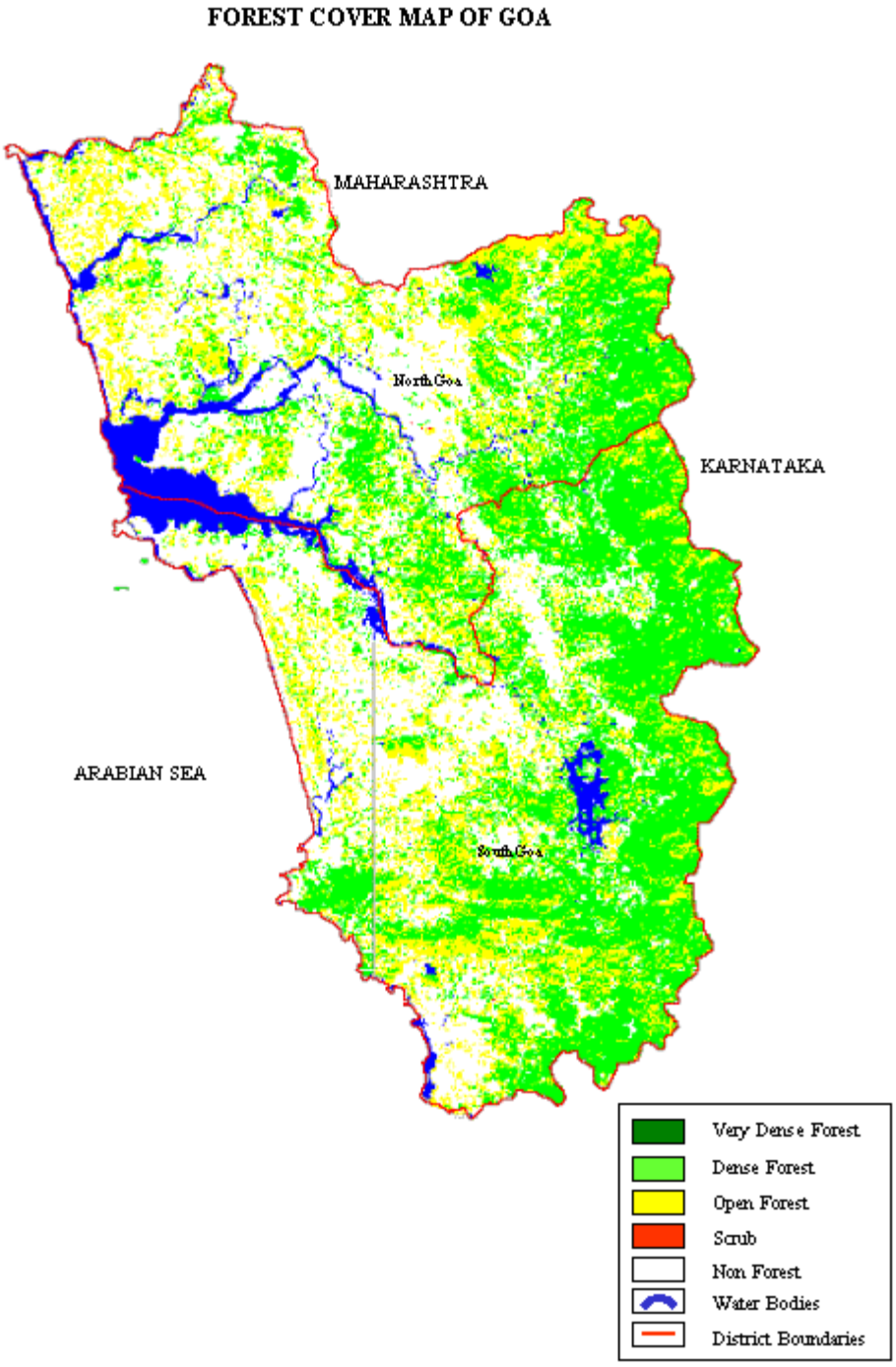

FOREST COVER MAP OF GOA
MAHARASHTRA
North Goa
KARNATAKA
ARABIAN SEA
South Goa
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.07

Table 7.07a: District-wise Forest Cover (Goa)

Number of Districts: 2 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
North Goa	1,736	0	432	456	888	51.15	19
South Goa	1,966	0	823	445	1268	64.50	42
Total	**3,702**	**0**	**1255**	**901**	**2156**	58.24	**61**

Table 7.07b : Forest cover change matrix of Goa

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	1,112	478	0	195	1,785
Open forest	80	206	0	24	310
Scrub	0	0	0	0	0
Non-forest	63	217	0	1,327	1,607
Total 2003	1,255	901	0	1,546	3,702
Net change	-530	591	0	-61	

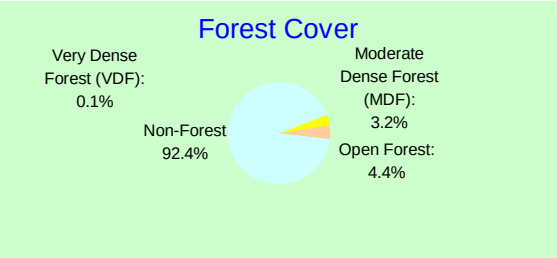
7.08. GUJARAT

Geographic Area	1,96,022 km^2 (6.0% of country)
Population	50.60 million (4.9% of country)
Urban	18.90 million (37.4%)
Rural	31.70 million (62.6%)
Average Population Density	258 persons per km^2
Tribal Population	14.90%
Livestock Population	18.6 million (3.9% of country)
No.of Districts	25
No. of Hill Districts	0
No. of Tribal Districts	8

Recorded Forest Area	
Reserved Forest (RF):	14,155 km^2
Protected Forest (PF):	395 km^2
Unclassed Forest (UF):	4,563 km^2
Total:	19,113 km^2
Of State's Geographic Area	9.75%
Of Country's Forest Area	2.47%

Forest Cover

Very Dense Forest (VDF):	114 km^2
Moderate Dense Forest (MDF):	6,231 km^2
Open Forest:	8,601 km^2
Total:	14,946 km^2
Of State's Geographic Area:	7.62%
Of Country's Forest Cover:	0.46%



Tree Cover

Culturable Non-Forest Area (CNFA):	151,926 km^2
No. of trees per ha of CNFA:	14.1
Tree Cover:	10,586 km^2
Of State's Geographic Area:	*5.40%*
Of CNFA:	*6.97%*

Forest & Tree Cover

Total Forest & Tree Cover:	25,532 km^2
Of State's Geographic Area:	*13.03%*
Of Country's Forest & Tree Cove:r	*3.28%*
Per capita Forest & Tree Cover:	0.05 ha

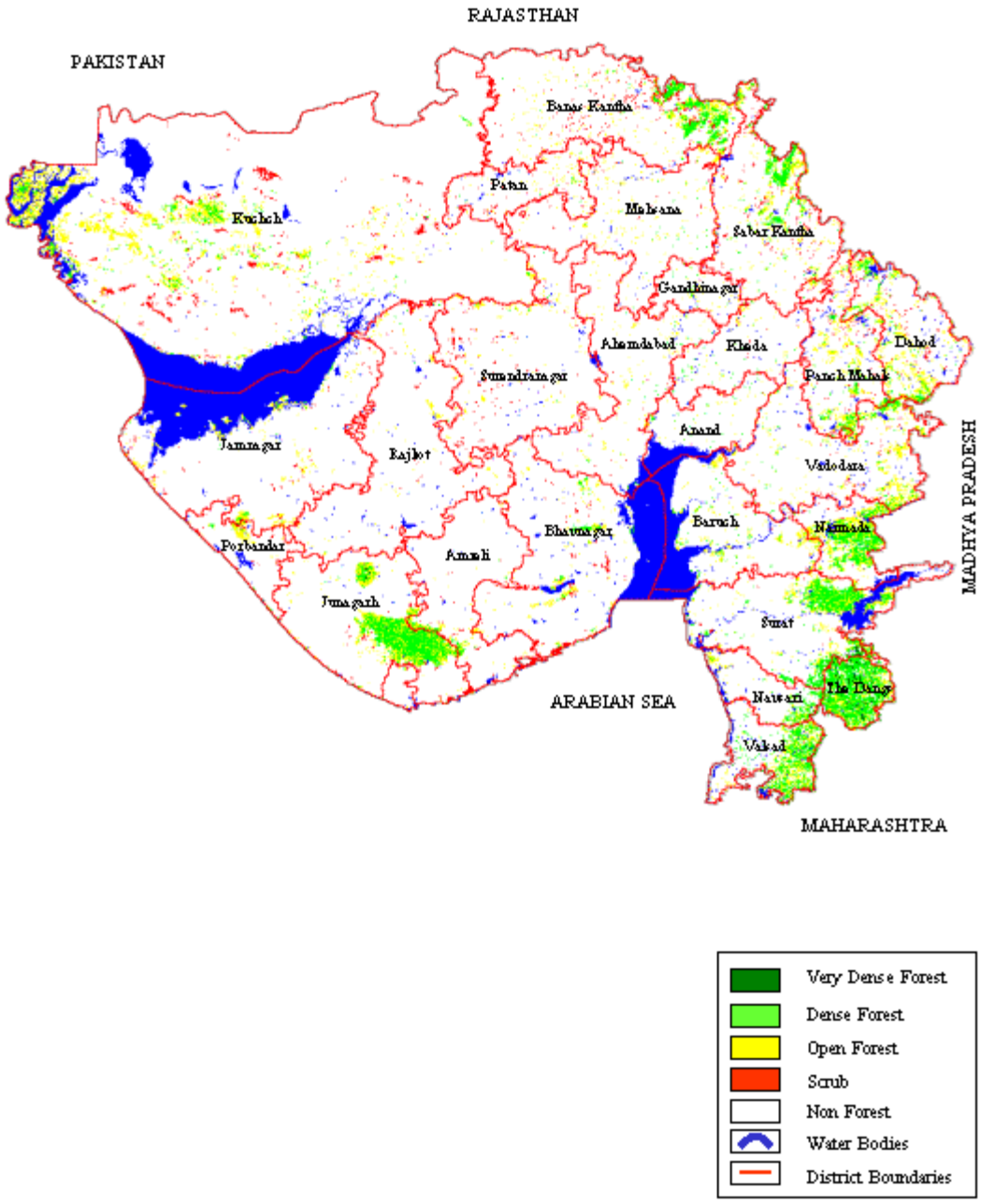

FOREST COVER MAP OF GUJARAT
RAJASTHAN
PAKISTAN
Banas Kantha
Patan
Mahsana
Sabar Kantha
Kachch
Gandhinagar
Ahamdabad
Kheda
Dahod
Surendranagar
Panch Mahals
Anand
Jamnagar
Rajkot
Vadodara
MADHYA PRADESH
Bharuch
Narmada
Porbandar
Bhavnagar
Amreli
Junagarh
Surat
The Dangs
ARABIAN SEA
Navsari
Valsad
MAHARASHTRA
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.08

Table 7.08a: District-wise Forest Cover (Gujarat)

Number of Districts: 25 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Ahamdabad	8,707	0	28	149	177	2.03	8
Amreli	6,760	0	65	153	218	3.22	15
Anand	3,214	0	26	34	60	1.87	-116
Banas Kantha[T]	9,858	0	429	432	861	8.73	-61
Bharuch[T]	6,458	0	91	249	340	5.26	58
Bhavnagar	11,155	0	82	238	320	2.87	125
Dahod	4,405	0	182	524	706	16.03	89
Gandhinagar	649	0	9	35	44	6.78	-97
Jamnagar	14,125	0	59	310	369	2.61	16
Junagarh	8,281	9	926	673	1,608	19.42	22
Kuchch	45,652	0	408	1,875	2,283	5.00	249
Kheda	3,980	0	28	74	102	2.56	-56
Mehsana	8,540	0	24	213	237	2.78	99
Narmada	2,580	0	507	498	1,005	38.95	21
Navsari	2,215	0	191	123	314	14.18	-28
Panch Mahals[T]	4,461	0	183	393	576	12.91	-24
Patan	3,332	0	10	89	99	2.97	-32
Porbander	2,326	0	22	92	114	4.90	8
Rajkot	11,203	0	9	139	148	1.32	16
Sabar Kantha[T]	7,390	0	323	476	799	10.81	-131
Surat[T]	7,657	27	856	471	1,354	17.68	-299
Surendernagar	10,489	0	13	159	172	1.64	56
The Dangs[T]	1,762	78	1,013	326	1,417	80.42	20
Vadodra[T]	7,794	0	163	465	628	8.06	-179
Valsad[T]	3,029	0	584	411	995	32.85	15
Total	**196,022**	**114**	**6,231**	**8,601**	**14,946**	7.62	**-206**

Table 7.08b : Forest cover change matrix of Gujarat

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	5723	904	4	2042	8673
Open forest	519	5620	7	333	6479
Scrub	9	263	1659	477	2408

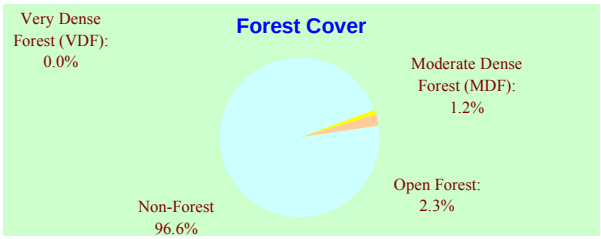
Non-forest	94	1814	73	176481	178462
Total 2003	6345	8601	1743	179333	196022
Net change	-2328	2122	-665	871	

7.09. HARYANA

Geographic Area	44,212 km^2 (1.3% of country)
Population	21.08 million (2.1% of country)
Urban	6.11 million (29%)
Rural	14.97 million (71%)
Average Population Density	477 persons per km^2
Tribal Population	---
Livestock Population	9.14 million (1.9% of country)
No.of Districts	19
No. of Hill Districts	0
No. of Tribal Districts	0

Recorded Forest Area	
Reserved Forest (RF):	249 km^2
Protected Forest (PF):	1,158 km^2
Unclassed Forest (UF):	151 km^2
Total:	1,558 km^2
Of State's Geographic Area	3.52%
Of Country's Forest Area	0.20%

Forest Cover	
Very Dense Forest (VDF):	2 km^2
Moderate Dense Forest (MDF):	518 km^2
Open Forest:	997 km^2
Total:	1,517 km^2
Of State's Geographic Area:	3.43%
Of Country's Forest Cover:	0.05%



Tree Cover	
Culturable Non-Forest Area (CNFA):	40,751 km^2
No. of trees per ha of CNFA:	12.3
Tree Cover:	1,415 km^2
Of State's Geographic Area:	*3.20%*
Of CNFA:	*3.47%*

Forest & Tree Cover	
Total Forest & Tree Cover:	2,932 km^2
Of State's Geographic Area:	*6.63%*
Of Country's Forest & Tree Cover:	*0.38%*
Per capita Forest & Tree Cover:	0.01 ha

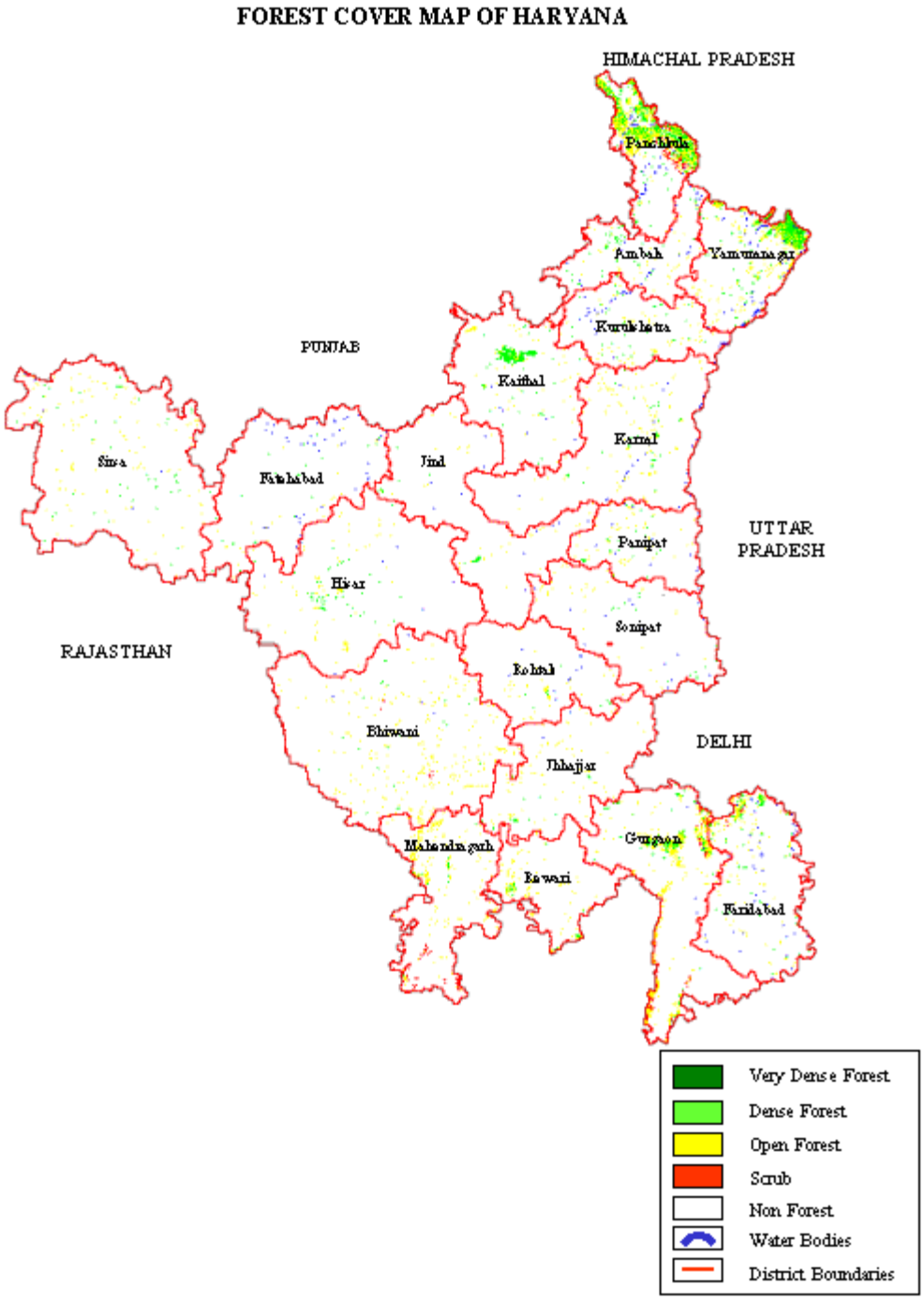

FOREST COVER MAP OF HARYANA
HIMACHAL PRADESH
Panchkula
Ambala
Yamunanagar
Kurukshetra
PUNJAB
Kaithal
Karnal
Sirsa
Fatehabad
Jind
Panipat
UTTAR PRADESH
Hisar
Sonipat
RAJASTHAN
Rohtak
Bhiwani
Jhajjar
DELHI
Gurgaon
Mahendragarh
Rewari
Faridabad
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.09

Table 7.09a: District-wise Forest Cover (Haryana)

Number of Districts: 19 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Ambala	1,574	0	17	18	35	2.22	-13
Bhiwani	4,778	0	10	127	137	2.87	-19
Faridabad	2,151	0	28	51	79	3.67	14
Fatehabad	2,538	0	9	13	22	0.87	-29
Gurgaon	2,766	0	48	157	205	7.41	11
Hisar	3,983	0	20	24	44	1.10	-22
Jind	2,702	0	8	15	23	0.85	7
Jhajhar	1,834	0	4	23	27	1.47	14
Karnal	2,520	0	10	36	46	1.83	-41
Kaithal	2,317	0	50	26	76	3.28	-5
Kurukshetra	1,530	0	15	22	37	2.42	-73
Mahendragarh	1,859	0	6	48	54	2.90	-8
Panipat	1,268	0	6	17	23	1.81	4
Panchkula	898	1	156	207	364	40.53	42
Rohtak	1,745	0	4	19	23	1.32	-6
Rewari	1,582	0	6	40	46	2.91	20
Sirsa	4,277	0	15	45	60	1.40	-120
Sonipat	2,122	0	5	11	16	0.75	11
Yamuna Nagar	1,768	1	101	98	200	11.31	-24
Total	**44,212**	**2**	**518**	**997**	**1,517**	**3.43**	**-237**

Table 7.09b : Forest cover change matrix of Haryana

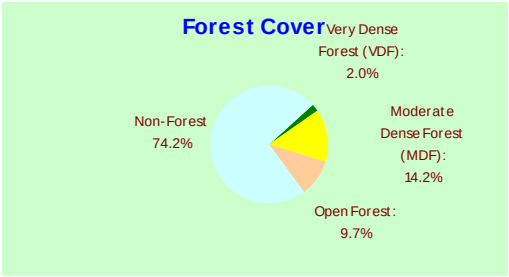
2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	167	123	3	846	1139
Open forest	113	268	12	222	615
Scrub	2	14	22	50	88
Non-forest	238	592	31	41509	42370
Total 2003	520	997	68	42627	44212
Net change	-619	382	-20	257	

7.10. HIMACHAL PRADESH

Geographic Area	55,673 km^2 (1.7% of country)
Population	6.08 million (0.57% of country)
Urban	0.59 million (9.8%)
Rural	5.48 million (90.2%)
Average Population Density	109 persons per km^2
Tribal Population	4.20%
Livestock Population	5.11 million (1.1% of country)
No.of Districts	12
No. of Hill Districts	12
No. of Tribal Districts	3

Recorded Forest Area	
Reserved Forest (RF):	1,896 km^2
Protected Forest (PF):	33,043 km^2
Unclassed Forest (UF):	2,094 km^2
Total:	37,033 km^2
Of State's Geographic Area	66.52%
Of Country's Forest Area	4.78%

Forest Cover	
Very Dense Forest (VDF):	1,093 km^2
Moderate Dense Forest (MDF):	7,883 km^2
Open Forest:	5,377 km^2
Total:	14,353 km^2
Of State's Geographic Area:	25.78%
Of Country's Forest Cover:	0.44%



Tree Cover	
Culturable Non-Forest Area (CNFA):	12,366 km^2
No. of trees per ha of CNFA:	15.5
Tree Cover:	491km^2
Of State's Geographic Area:	*0.88%*
Of CNFA:	*3.97%*

Forest & Tree Cover	
Total Forest & Tree Cover:	14,844 km^2
Of State's Geographic Area:	*26.66%*
Of Country's Forest & Tree Cover:	*1.91%*
Per capita Forest & Tree Cover:	0.24 ha

FOREST COVER MAP OF HIMACHAL PRADESH

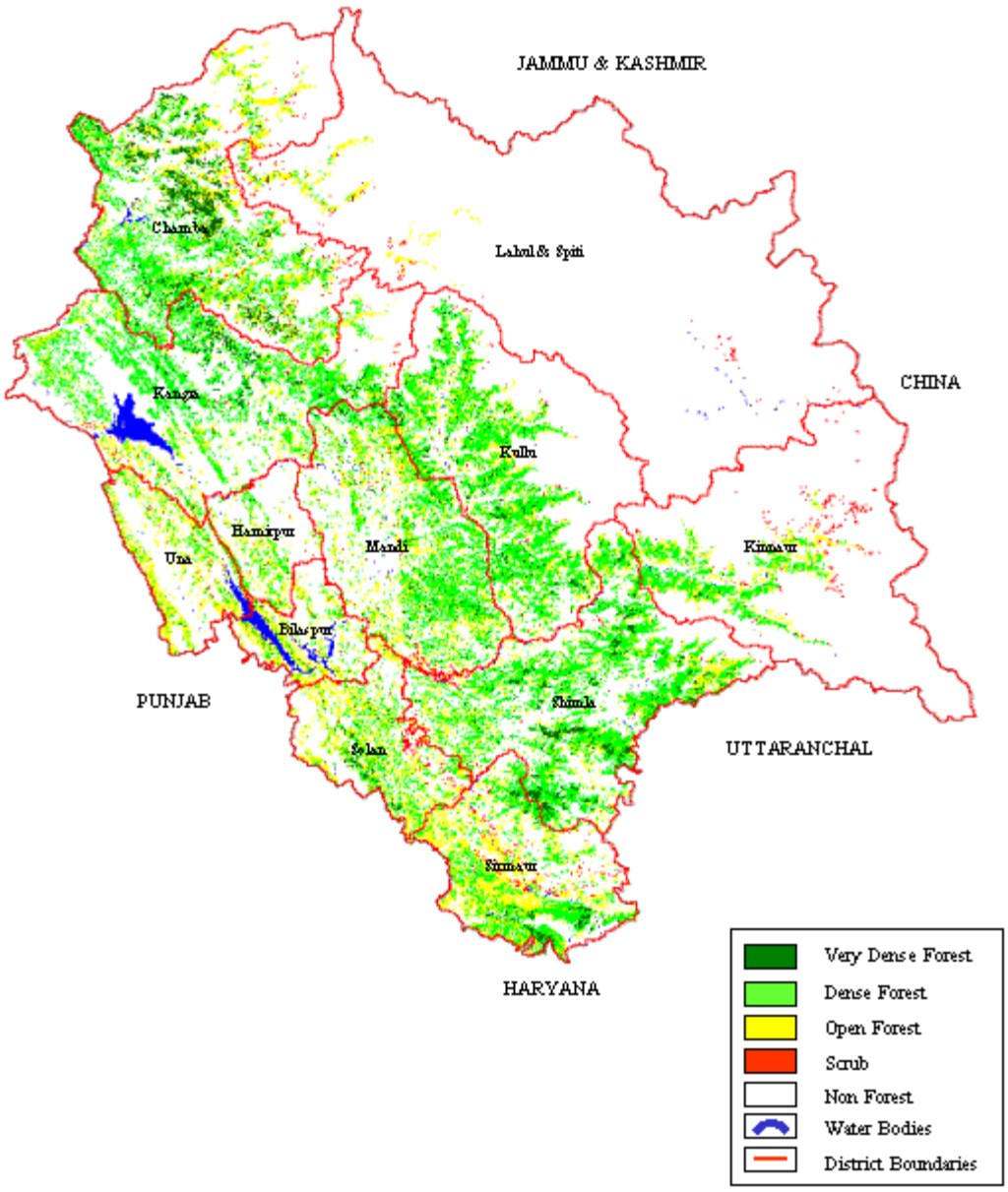


Fig. 7.10

Table 7.10a: District-wise Forest Cover (Himachal Pradesh)

Number of Districts: 12 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Bilaspur[H]	1,167	11	94	253	358	30.68	57
Chamba[TH]	6,522	436	1,130	847	2,413	37.00	71
Hamirpur[H]	1,118	3	106	133	242	21.65	-32
Kangra[H]	5,739	134	1,252	481	1,867	32.53	-163
Kinnaur[TH]	6,401	13	352	248	613	9.58	-34
Kullu[H]	5,503	117	1,295	521	1,933	35.13	-182
Lahul & Spiti[TH]	13,841	7	28	145	180	1.30	26
Mandi[H]	3,950	78	933	637	1,648	41.72	-8
Shimla[H]	5,131	194	1,587	602	2,383	46.44	-61
Sirmaur[H]	2,825	56	631	692	1,379	48.81	267
Solan[H]	1,936	39	314	466	819	42.30	136
Una[H]	1,540	5	161	352	518	33.64	-84
Total	**55,673**	**1,093**	**7,883**	**5,377**	**14,353**	**25.78**	**-7**

Table 7.10b : Forest cover change matrix of Himachal Pradesh

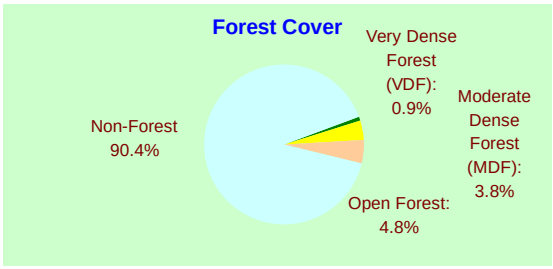
2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	8146	1126	20	1137	10429
Open forest	661	2892	7	371	3931
Scrub	20	140	196	210	566
Non-forest	149	1219	166	39213	40747
Total 2003	8976	5377	389	40931	55673
Net change	-1453	1446	-177	184	

7.11. JAMMU & KASHMIR

Geographic Area	2,22,236 km^2 (6.8% of country)
Population	10.07 million (1.0% of country)
Urban	2.51 million (24.9%)
Rural	7.56 million (75.1%)
Average Population Density	45 persons per km^2
Tribal Population	NA
Livestock Population	8.7 million (1.85% of country)
No.of Districts	14
No. of Hill Districts	14
No. of Tribal Districts	0

Recorded Forest Area	
Reserved Forest (RF):	2551 km^2
Protected Forest (PF):	17643 km^2
Unclassed Forest (UF):	36 km^2
Total:	20,230 km^2
Of State's Geographic Area	9.1%
Of Country's Forest Area	2.61%

Forest Cover	
Very Dense Forest (VDF):	2,102 km^2
Moderate Dense Forest (MDF):	8,395 km^2
Open Forest:	10,770 km^2
Total:	21,267 km^2
Of State's Geographic Area:	9.57%
Of Country's Forest Cover:	0.65%



Tree Cover	
Culturable Non-Forest Area (CNFA):	65,296 km^2
No. of trees per ha of CNFA:	18.7
Tree Cover:	3,826 km^2
Of State's Geographic Area:	*1.72%*
Of CNFA:	*5.86%*

Forest & Tree Cover	
Total Forest & Tree Cover:	25,093 km^2
Of State's Geographic Area:	*11.29%*
Of Country's Forest & Tree Cover:	*3.22%*
Per capita Forest & Tree Cover:	0.25 ha

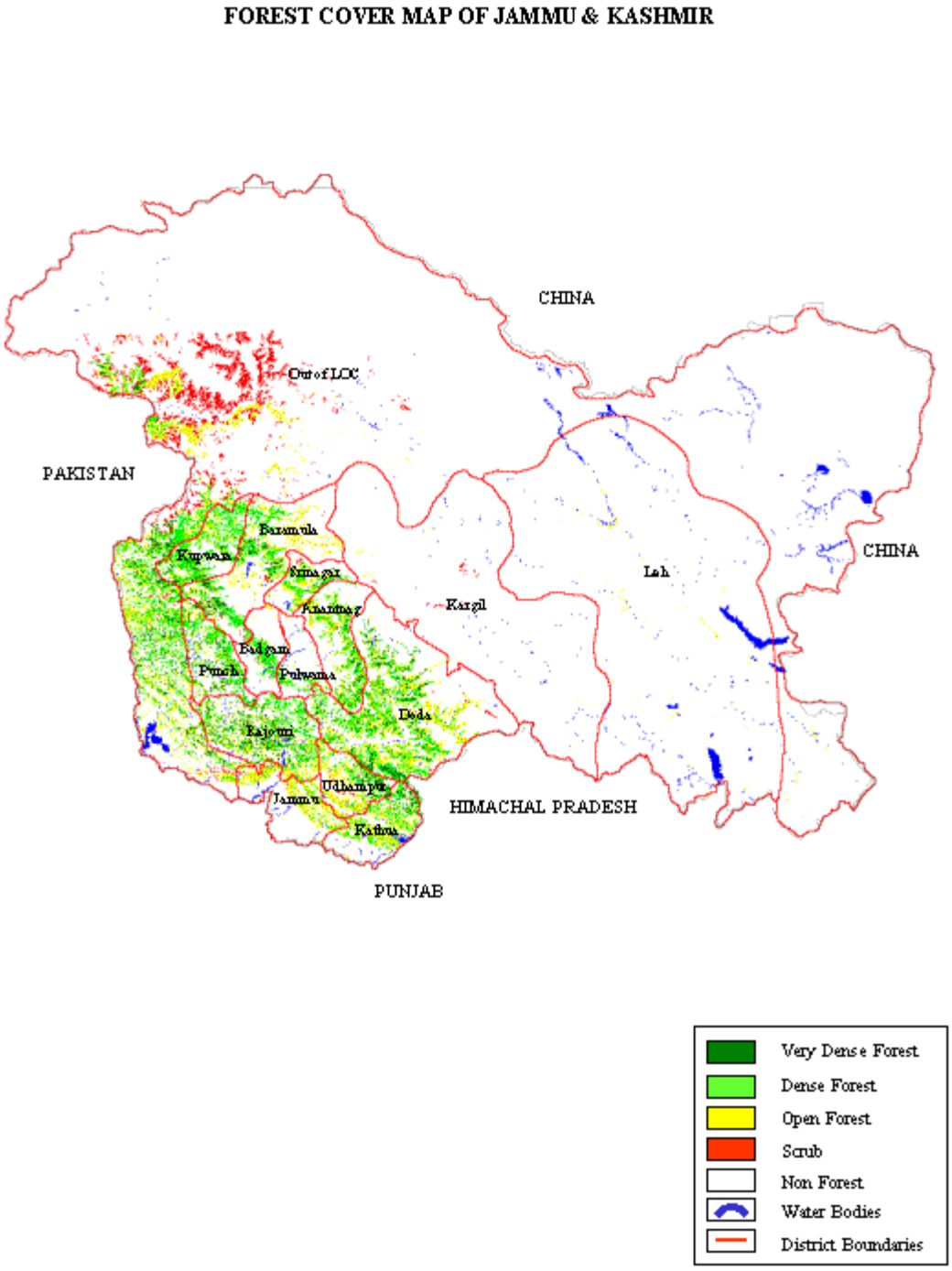

FOREST COVER MAP OF JAMMU & KASHMIR
CHINA
Out of LOC
PAKISTAN
Baramula
Kupwara
Srinagar
Ganderbal
Kargil
Leh
CHINA
Badgam
Punch
Pulwama
Doda
Rajouri
Udhampur
Jammu
Kathua
HIMACHAL PRADESH
PUNJAB
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.11

Table 7.11a: District-wise Forest Cover (Jammu & Kashmir)

Number of Districts: 14 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Anantnag [H]	3,984	138	620	704	1,462	36.70	0
Baramula [H]	4,588	142	583	698	1,423	31.02	0
Badgaon [H]	1,371	25	173	86	284	20.71	0
Doda [H]	11,691	452	1,562	1,956	3,970	33.96	0
Jammu [H]	3,097	6	156	663	825	26.64	0
Kargil [H]	14,037	0	0	26	26	0.19	0
Kathua [H]	2,651	80	512	566	1,158	43.68	0
Kupwara [H]	2,379	90	793	387	1,270	53.38	0
Leh [H]	45,110	0	0	118	118	0.03	0
Pulwama[H]	1,398	4	100	74	178	12.73	0
Punch[H]	1,674	122	358	248	728	43.49	0
Rajouri:[H]	2,630	216	495	564	1,275	48.48	0
Srinagar[H]	2,228	30	330	371	731	32.81	0
Udhampur [H]	4,550	252	644	1,251	2,147	47.19	0
*O.Loc[H]	120,848	545	2,069	3,058	5,672	4.69	0
Total	**222,236**	**2,102**	**8,395**	**10,770**	**21,267**	**9.57**	**0**

***** Area outside LOC i.e. area under illegal occupation of Pakistan and China

Table 6.11b : Forest cover change matrix of J&K

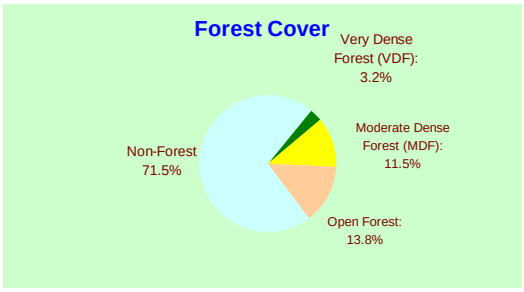
2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	9790	1789	33	236	11848
Open forest	550	8093	388	358	9389
Scrub	22	266	2475	324	3087
Non-forest	135	622	51	197104	197912
Total 2003	10497	10770	2947	198022	222236
Net change	-1351	1381	-140	110	

7.12. JHARKHAND

Geographic Area	79,714 km^2 (2.4% of country)
Population	26.91 million (2.6% of country)
Urban	5.99 million (22.2%)
Rural	20.92 million (77.8%)
Average Population Density	338 persons per km^2
Tribal Population	22.50%
Livestock Population	NA
No.of Districts	18
No. of Hill Districts	0
No. of Tribal Districts	8

Recorded Forest Area	
Reserved Forest (RF):	4,387 km^2
Protected Forest (PF):	19,185 km^2
Unclassed Forest (UF):	33 km^2
Total:	23,605 km^2
Of State's Geographic Area	29.61%
Of Country's Forest Area	3.05%

Forest Cover	
Very Dense Forest (VDF):	2,544 km^2
Moderate Dense Forest (MDF):	9,137 km^2
Open Forest:	11,035 km^2
Total:	22,716 km^2
Of State's Geographic Area:	28.5%
Of Country's Forest Cover:	0.69%



Tree Cover	
Culturable Non-Forest Area (CNFA):	51,555 km^2
No. of trees per ha of CNFA:	10.4
Tree Cover:	5,012 km^2
Of State's Geographic Area:	*6.29%*
Of CNFA:	*9.72%*

Forest & Tree Cover	
Total Forest & Tree Cover:	27,728 km^2
Of State's Geographic Area:	*34.78%*
Of Country's Forest & Tree Cover	*3.56%*
Per capita Forest & Tree Cover:	0.10 ha

FORECT COVER MAP OF JHARKHAD

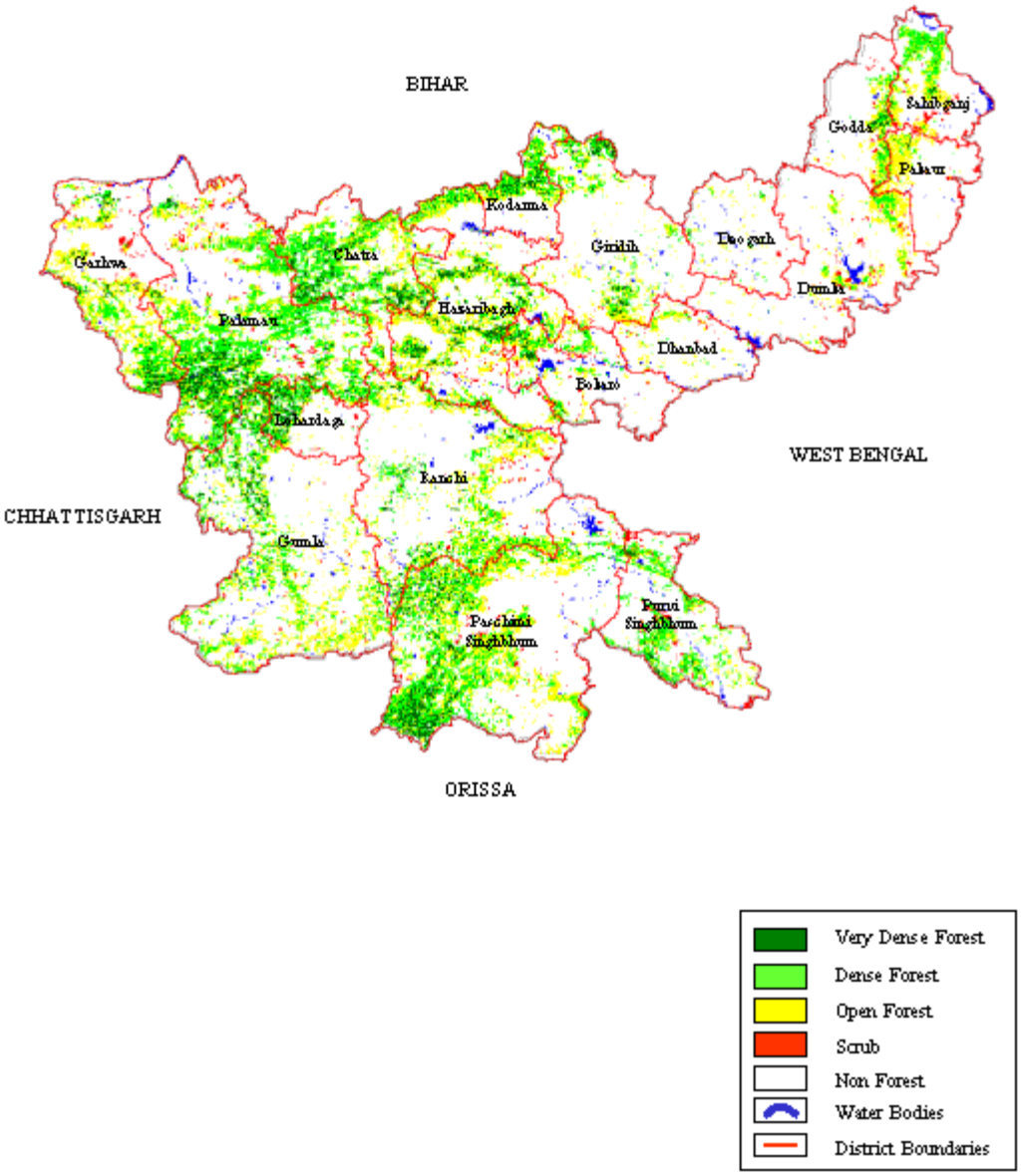


Fig. 7.12

Table 7.12a: District-wise Forest Cover (Jharkhand)

Number of Districts: 18 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Bokaro	1,929	59	223	299	581	30.12	7
Chatra	3,732	251	842	695	1,788	47.91	-107
Deoghar[T]	2,479	3	24	75	102	4.11	14
Dhanbad	2,996	0	45	163	208	6.94	34
Dumka	6,212	0	120	376	496	7.98	8
Garhwa	4,092	147	460	827	1,434	35.04	59
Giridih	4,963	99	302	419	820	16.52	37
Godda	2,110	35	144	296	475	22.51	85
Gumla[T]	9,077	258	903	1,402	2,563	28.24	77
Hazaribagh	5,998	284	627	1,177	2,088	34.81	-74
Kodarma	1,435	94	291	222	607	42.30	-9
Lohardaga[T]	1,491	149	232	135	516	34.61	-41
Pakaur[T]	1,571	8	35	239	282	17.95	-12
Palamu[T]	8,657	492	1,808	1,261	3,561	41.13	-299
Paschimi Singhbhum[T]	9,907	446	1,598	1,767	3,811	38.47	84
Purbi Singhbhum[T]	3,533	49	528	346	923	26.13	38
Ranchi[T]	7,698	148	687	1,040	1,875	24.36	143
Sahibganj	1,834	22	268	296	586	31.95	35
Total	**79,714**	**2,544**	**9,137**	**11,035**	**22,716**	28.50	**79**

Table 7.12b : Forest cover change matrix of Jharkhand

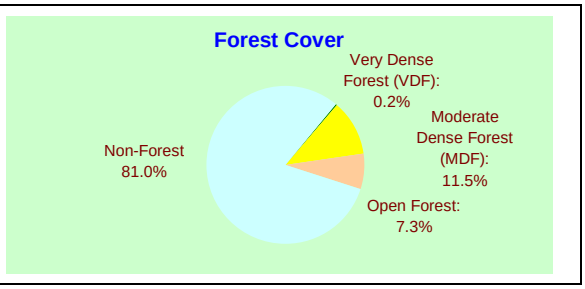
2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	9396	1765	8	618	11787
Open forest	1990	8518	10	332	10850
Scrub	26	83	749	118	976
Non-forest	269	669	40	55123	56101
Total 2003	11681	11035	807	56191	79714
Net change	-106	185	-169	90	

7.13. KARNATAKA

Geographic Area	191,791 km^2 (5.8% of country)	
Population	52.73 million (5.1% of country)	
Urban	17.92 million (34%)	
Rural	34.81 million (66%)	
Average Population Density	275 persons per km^2	
Tribal Population	4.30%	
Livestock Population	29.57 million (6.3% of country)	
No.of Districts	27	
No. of Hill Districts	6	
No. of Tribal Districts	5	

Recorded Forest Area	
Reserved Forest (RF):	29550 km^2
Protected Forest (PF):	3585 km^2
Unclassed Forest (UF):	9949 km^2
Total:	43,084 km^2
Of State's Geographic Area	22.46%
Of Country's Forest Area	5.56%

Forest Cover	
Very Dense Forest (VDF):	431 km^2
Moderate Dense Forest (MDF):	22,030 km^2
Open Forest:	13,988 km^2
Total:	36,449 km^2
Of State's Geographic Area:	19%
Of Country's Forest Cover:	1.11%



Tree Cover	
Culturable Non-Forest Area:	140,680 km^2
No. of trees per ha of CNFA:	11.6
Tree Cover:	5,371 km^2
Of State's Geographic Area	*2.80%*
Of CNFA:	*3.82%*

Forest & Tree Cover	
Total Forest & Tree Cover:	41,820 km^2
Of State's Geographic Area:	*21.80%*
Of Country's Forest & Tree Cover:	*5.37%*
Per capita Forest & Tree Cover:	0.08 ha

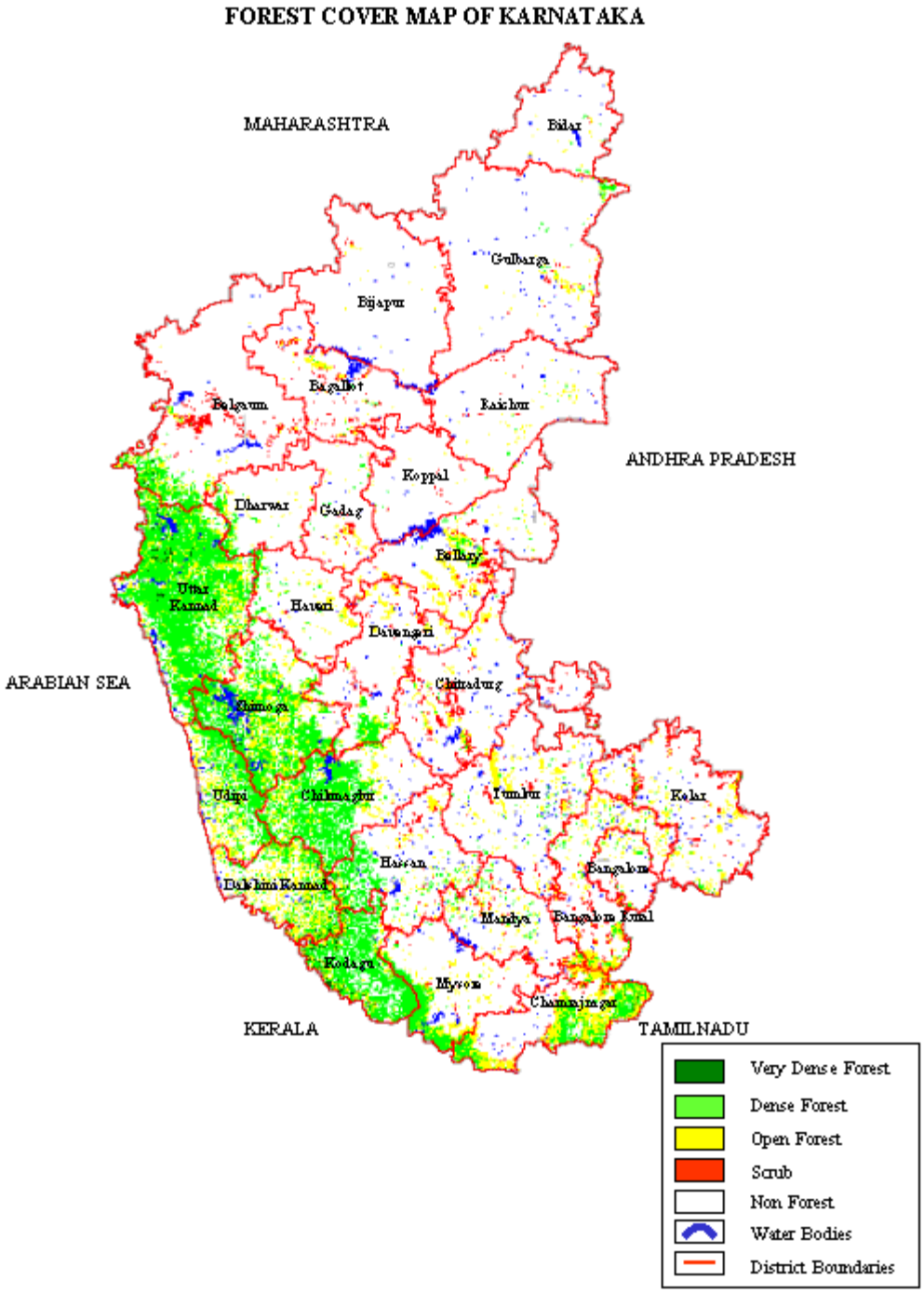

FOREST COVER MAP OF KARNATAKA
MAHARASHTRA
Bidar
Gulbarga
Bijapur
Bagalkot
Belgaum
Raichur
ANDHRA PRADESH
Koppal
Dharwar
Gadag
Bellary
Uttar Kannad
Haveri
Davangeri
ARABIAN SEA
Chitradurg
Shimoga
Udipi
Chikmagalur
Tumkur
Kolar
Hasan
Bangalore
Dakshina Kannad
Mandya
Bangalore Rural
Kodagu
Mysore
Chamarajnagar
KERALA
TAMILNADU
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.13

Table 7.13a: District-wise Forest Cover (Karnataka)

Number of Districts: 27 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Bagalkot	6,575	0	32	182	214	3.25	-170
Bangalore Rural	5,815	0	166	692	858	14.75	22
Bangalore City	2,190	0	45	123	168	7.67	6
Belgaum[H]	13,415	19	703	390	1,112	8.29	-52
Bellary	8,450	0	138	757	895	10.59	34
Bidar	5,448	0	20	42	62	1.14	-94
Bijapur	10,494	0	1	37	38	0.36	-140
Chamrajnagar	5,101	12	1,085	1,523	2,620	51.36	52
Chikmaglur[TH]	7,201	4	2,853	640	3,497	48.56	-57
Chitradurg	8,440	0	49	396	445	5.27	11
Kannad Dakshin[TH]	4,560	71	1,024	1,302	2,397	52.57	-48
Davengeri	5,924	0	342	417	759	12.81	-13
Dharwar	4,260	0	235	182	417	9.79	13
Gadag	4,656	0	23	150	173	3.72	3
Gulbarga	16,224	0	91	239	330	2.03	-143
Hassan	6,814	29	826	447	1,302	19.11	-23
Haveri	4,823	0	182	282	464	9.62	14
Kodagu[TH]	4,102	158	2,464	425	3,047	74.28	39
Kolar	8,223	0	82	500	582	7.08	7
Koppal	7,189	0	11	35	46	0.64	1
Mandya	4,961	0	146	375	521	10.50	5
Mysore[T]	6,854	0	642	503	1,145	16.71	-4
Raichur	6,827	0	20	87	107	1.57	-5
Shimoga[H]	8,477	23	3,052	1,401	4,476	52.80	3
Tumkur	10,597	0	111	595	706	6.66	8
Udipi[T]	3,880	11	1,432	783	2,226	57.37	-46
Kannad Uttar[H]	10,291	104	6,255	1,483	7,842	76.20	35
Total	**191,791**	**431**	**22,030**	**13,988**	**36,449**	19.00	**-542**

Table 7.13b : Forest cover change matrix of Karnataka

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	22219	3266	1	670	26,156
Open forest	179	10565	9	82	10,835
Scrub	14	23	3092	116	3,245
Non-forest	49	134	39	151333	151,555
Total 2003	22,461	13,988	3,141	152,201	191,791
Net change	-3,695	3,153	-104	646	

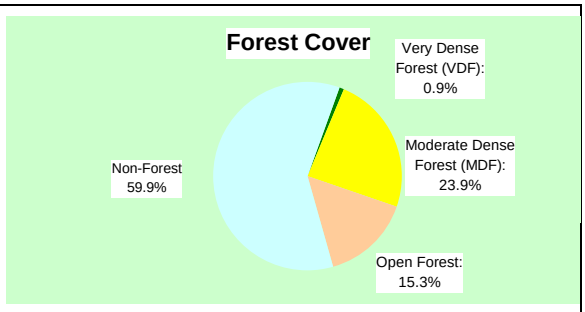
7.14. KERALA

Geographic Area	38,863 km^2 (1.2% of country)
Population	31.84 million (3.1% of country)
Urban	8.26 million (26%)
Rural	23.57 million (74%)
Average Population Density	819 persons per km^2
Tribal Population	1.10%
Livestock Population	5.8 million (1.2% of country)
No.of Districts	14
No. of Hill Districts	10
No. of Tribal Districts	9

Recorded Forest Area	
Reserved Forest (RF):	11098 km^2
Protected Forest (PF):	170 km^2
Unclassed Forest (UF):	0 km^2
Total:	11,268 km^2
Of State's Geographic Area	28.99%
Of Country's Forest Area	1.45%

Forest Cover

Very Dense Forest (VDF):	334 km^2
Moderate Dense Forest (MDF):	9,294 km^2
Open Forest:	5,949 km^2
Total:	15,577 km^2
Of State's Geographic Area:	40.08%
Of Country's Forest Cover:	0.47%



Tree Cover

Culturable Non-Forest Area:	21,922 km^2
No. of trees per ha of CNFA:	13.6
Tree Cover:	1,903 km^2
Of State's Geographic Area:	*4.90%*
Of CNFA:	*8.68%*

Forest & Tree Cover

Total Forest & Tree Cover:	17,480 km^2
Of State's Geographic Area:	*44.98%*
Of Country's Forest & Tree Cover:	*2.25%*
Per capita Forest & Tree Cover:	0.05 ha

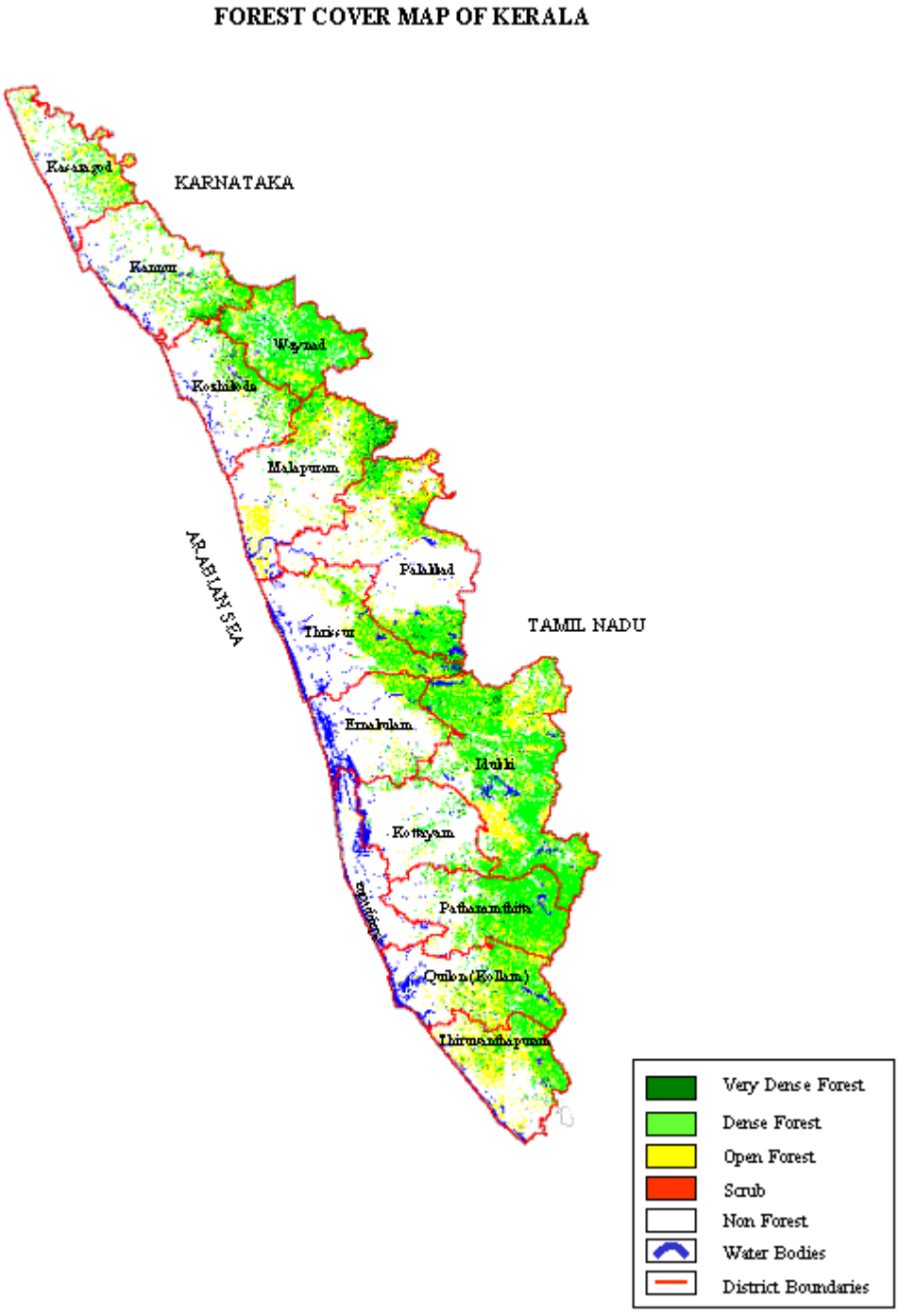

FOREST COVER MAP OF KERALA
KARNATAKA
Kasaragod
Kannur
Wayanad
Kozhikode
Malapuram
Palakkad
Thrissur
Ernakulam
Idukki
Kottayam
Pathanamthitta
Quilon(Kollam)
Thiruvanthapuram
ARABIAN SEA
TAMIL NADU
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.14

Table 7.14a : District-wise Forest Cover (Kerala)

Number of Districts: 14 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Alappuzha	1,414	0	4	17	21	1.49	19
Ernakulam[TH]	2,407	5	228	232	465	19.32	-96
Idukki[TH]	5,019	37	2,442	1,240	3,719	74.10	-7
Kannur[TH]	2,966	36	424	293	753	25.39	-2
Kasaragod[TH]	1,992	0	265	306	571	28.66	6
Kottayam	2,203	0	185	110	295	13.39	67
Kozhikode[H]	2,344	56	346	229	631	26.92	-24
Malapuram[TH]	3,550	69	494	650	1,213	34.17	-142
Palakkad[TH]	4,480	55	823	693	1,571	35.07	110
Pathanamthitta	2,642	0	1,172	371	1,543	58.40	77
Quilon (Kollam)[TH]	2,491	23	640	548	1,211	48.62	-26
Thiruvanthapuram[TH]	2,192	21	421	547	989	45.12	-5
Thrissur	3,032	19	505	394	918	30.28	25
Waynad[TH]	2,131	13	1,345	319	1,677	78.70	15
Total	38,863	334	9,294	5,949	15,577	40.08	17

Table 7.14b : Forest cover change matrix of Kerala

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	7927	2792	2	1051	11772
Open forest	1019	2542	11	216	3788
Scrub	2	18	50	1	71
Non-forest	680	597	9	21946	23232
Total 2003	9628	5949	72	23214	38863
Net change	-2144	2161	1	-18	

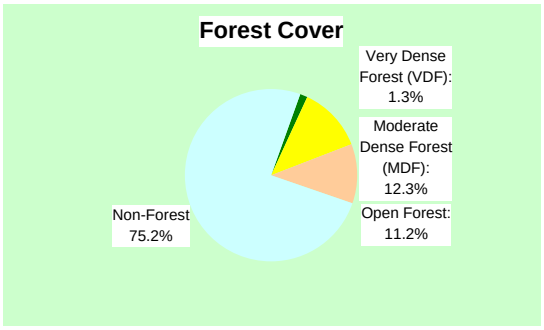
7.15. MADHYA PRADESH

Geographic Area	3,08,245 km^2 (9.4% of country)
Population	60.39 million (5.9% of country)
Urban	16.10 million (26.7%)
Rural	44.28 million (73.3%)
Average Population Density	196 persons per km^2
Tribal Population	19.90%
Livestock Population	46.74 million (9.9% of country)*
No.of Districts	45
No. of Hill Districts	0
No. of Tribal Districts	18

*includes Chhattisgarh Livestock population

Recorded Forest Area	
Reserved Forest (RF):	58,734 km^2
Protected Forest (PF):	35,587 km^2
Unclassed Forest (UF):	900 km^2
Total:	95,221 km^2
Of State's Geographic Area	30.89%
Of Country's Forest Area	12.29%

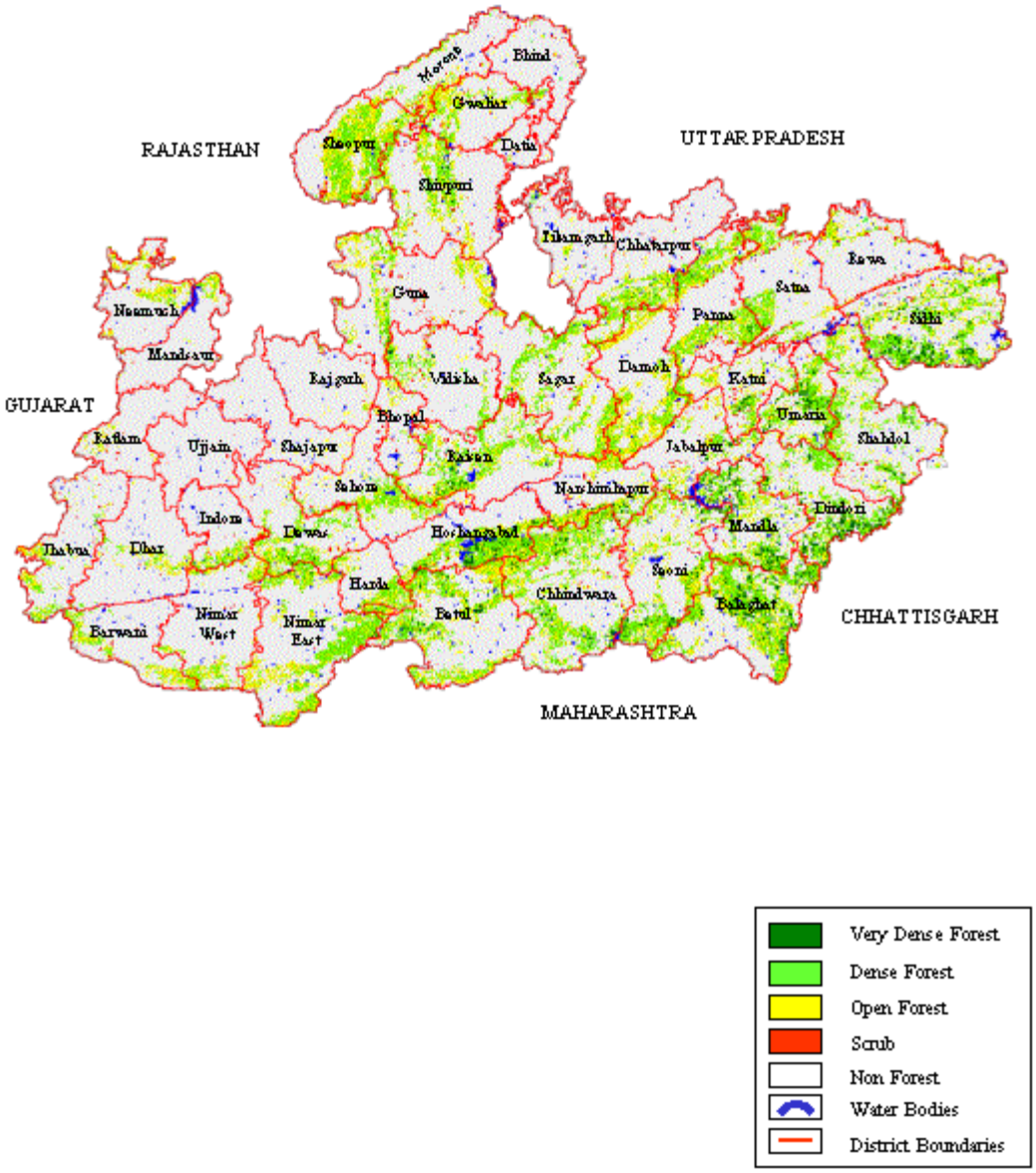
Forest Cover	
Very Dense Forest (VDF):	4,000 km^2
Moderate Dense Forest (MDF):	37,843 km^2
Open Forest:	34,586 km^2
Total:	76,429 km^2
Of State's Geographic Area:	24.79%
Of Country's Forest Cover:	2.33%



Tree Cover	
Culturable Non-Forest Area:	206,462 km^2
No. of trees per ha of CNFA:	10.2
Tree Cover:	7,250 km^2
Of State's Geographic Area:	*2.35%*
Of CNFA:	*3.51%*

Forest & Tree Cover	
Total Forest & Tree Cover:	83,679 km^2
Of State's Geographic Area:	*27.15%*
Of Country's Forest & Tree Cover:	*10.75%*
Per capita Forest & Tree Cover:	0.14 ha

FOREST COVER MAP OF MADHYA PRADESH



Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.15

Table 7.15a: District-wise Forest Cover (Madhya Pradesh)

Number of Districts: 45 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Balaghat[T]	9,229	630	2,547	1,682	4,859	52.65	-18
Barwani	5,422	0	389	512	901	16.62	-40
Betul[T]	10,043	142	1,844	1,551	3,537	35.22	-97
Bhind	4,459	0	40	81	121	2.71	25
Bhopal	2,772	0	97	215	312	11.26	-80
Chhatarpur	8,687	41	803	862	1,706	19.64	12
Chhindwara[T]	11,815	203	2,368	1,838	4,409	37.32	-136
Damoh	7,306	6	903	1,769	2,678	36.65	-48
Datia	2,691	0	81	83	164	6.09	-2
Dewas[T]	7,020	34	993	776	1,803	25.68	86
Dhar[T]	8,153	0	181	404	585	7.18	-46
Dindori[T]	7,470	573	1,478	592	2,643	35.38	-237
Nimar East[T]	10,776	43	2,058	1,479	3,580	33.22	64
Guna	11,064	28	712	1,352	2,092	18.91	-121
Gwaliar	4,560	5	558	760	1,323	29.01	-17
Harda[T]	3,330	1	598	446	1,045	31.38	-12
Hoshangabad[T]	6,707	261	1,292	849	2,402	35.81	74
Indore	3,898	0	299	255	554	14.21	64
Jabalpur[T]	5,211	50	408	620	1,078	20.69	6
Jhabua[T]	6,778	0	336	506	842	12.42	-39
Katni	4,950	89	477	625	1,191	24.06	35
Mandla[T]	5,800	443	1,309	980	2,732	47.10	-37
Mandsaur	5,535	0	89	175	264	4.77	2
Morena[T]	4,989	0	254	523	777	15.57	-97
Narshimhapur	5,133	74	517	783	1,374	26.77	62
Neemuch	4,256	0	219	676	895	21.03	-4
Panna	7,135	64	1,595	1,069	2,728	38.23	6
Raisen	8,466	79	1,569	1,084	2,732	32.27	36
Rajgarh	6,153	0	23	156	179	2.91	-89
Ratlam[T]	4,861	0	37	145	182	3.74	-2
Rewa	6,314	10	224	474	708	11.21	65
Sagar	10,252	2	1,722	1,198	2,922	28.50	105
Satna	7,502	19	942	717	1,678	22.37	14
Sehore	6,578	0	740	724	1,464	22.26	27

Seoni[T]	8,758	239	1,412	1,387	3,038	34.69	-109
Shahdol[T]	9,952	99	1,491	893	2,483	24.95	-43
Shajapur	6,195	0	0	123	123	1.99	-27
Sheopur	6,606	13	1,876	1,743	3,632	54.98	-117
Shivpuri	10,277	55	1,139	1,285	2,479	24.12	-67
Sidhi[T]	10,526	529	2,104	1,380	4,013	38.12	-81
Tikamgarh	5,048	0	101	224	325	6.44	-29
Ujjain	6,091	0	0	13	13	0.21	-24
Umaria	4,076	236	1,108	528	1,872	45.93	73
Vidisha	7,371	32	495	375	902	12.24	24
Nimar West[T]	8,030	0	415	674	1,089	13.56	3
Total	**308,245**	**4,000**	**37,843**	**34,586**	**76,429**	**24.79**	**-836**

Table 7.15b : Forest cover change matrix of Madhya Pradesh

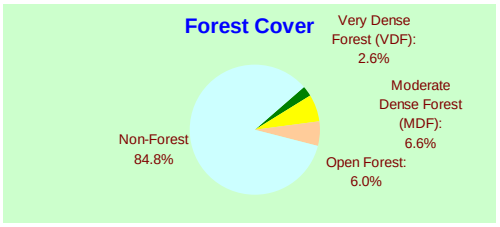
2001 Assessment	**2003 Assessment**				**Total 2001**
	Dense forest	**Open forest**	**Scrub**	**Non-forest**	
Dense forest	31239	10739	7	2399	44384
Open forest	9734	19749	19	3379	32881
Scrub	9	198	1738	1507	3452
Non-forest	861	3900	614	222153	227528
Total 2003	41843	34586	2378	229438	308245
Net change	-2541	1705	-1074	1910	

7.16. MAHARASHTRA

Geographic Area	3,07,713 km^2 (9.4% of country)
Population	96.75 million (9.4% of country)
Urban	41.02 million (42.4%)
Rural	55.73 million (57.6%)
Average Population Density	314 persons per km^2
Tribal Population	9.30%
Livestock Population	36.4 million (7.7% of country)
No.of Districts	35
No. of Hill Districts	7
No. of Tribal Districts	11

Recorded Forest Area	
Reserved Forest (RF):	49,217 km^2
Protected Forest (PF):	8,196 km^2
Unclassed Forest (UF):	4,526 km^2
Total:	61,939 km^2
Of State's Geographic Area	20.17%
Of Country's Forest Area	*7.99%*

Forest Cover	
Very Dense Forest (VDF):	8,070 km^2
Moderate Dense Forest (MDF):	20,317 km^2
Open Forest:	18,478 km^2
Total:	46,865 km^2
Of State's Geographic Area:	15.23 %
Of Country's Forest Cover:	1.43%



Tree Cover	
Culturable Non-Forest Area (CNFA):	232,567 km^2
No. of trees per ha of CNFA:	11.5
Tree Cover:	9,320 km^2
Of State's Geographic Area:	*3.03%*
Of CNFA:	*4.01%*

Forest & Tree Cover	
Total Forest & Tree Cover:	56,185 km^2
Of State's Geographic Area:	*18.26%*
Of Country's Forest & Tree Cover:	*7.22%*
Per capita Forest & Tree Cover:	0.06 ha

FOREST COVER MAP OF MAHARASHTRA

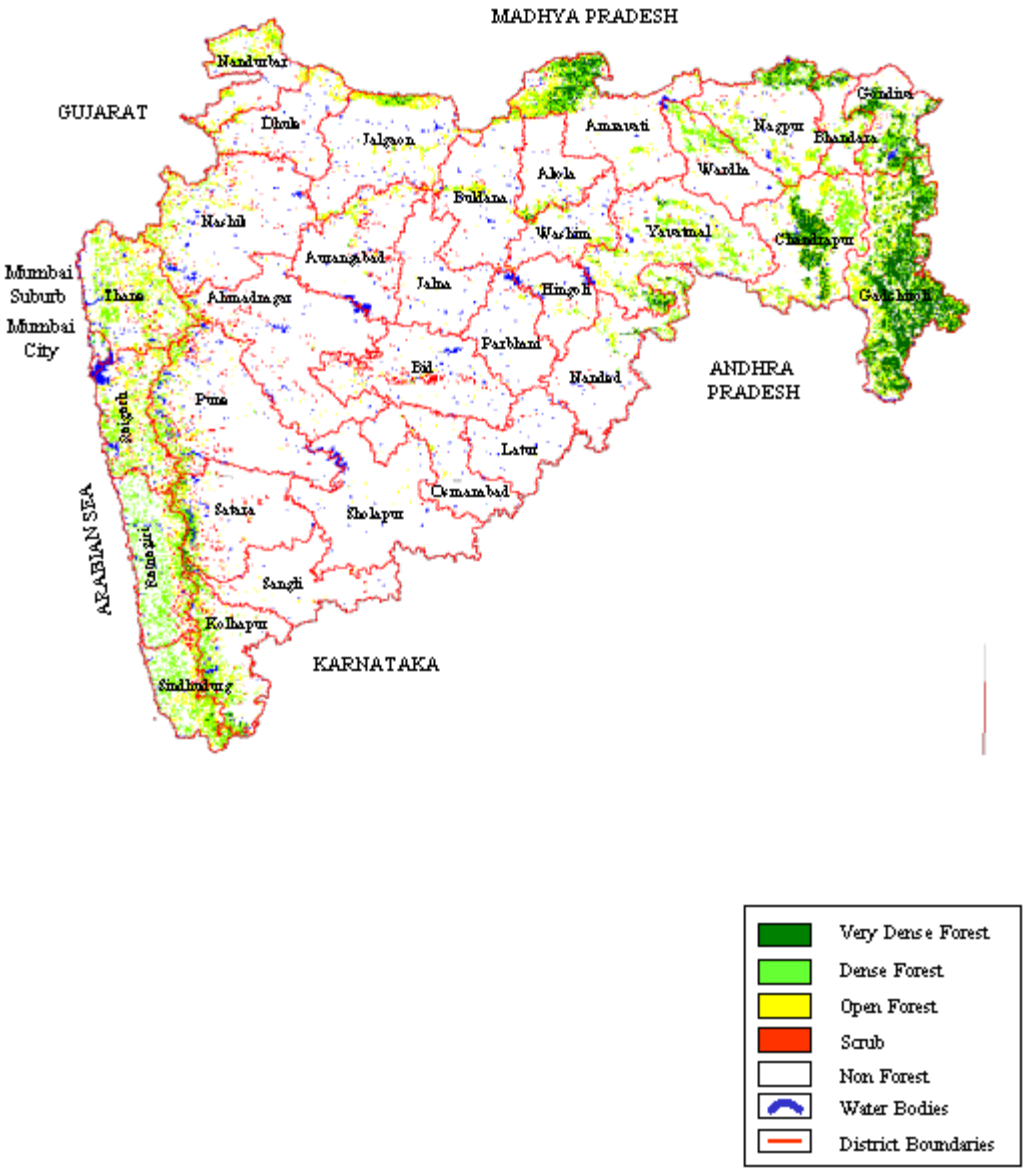


Fig. 7.16

Table 7.16a : District-wise Forest Cover (Maharashtra)

Number of Districts: 35 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Ahmadnagar[T]	17,048	0	70	148	218	1.28	-94
Akola	5,390	15	111	195	321	5.92	-42
Amravati[T]	12,210	677	1395	997	3069	25.44	-31
Aurangabad	10,107	2	60	344	406	4.02	-83
Bhandara	3,588	137	526	223	886	26.28	16
Bid	10,693	0	10	107	117	1.09	-144
Bombay City	157	0	0	1	1	0.64	0
Bombay Sub	446	0	48	38	86	19.28	4
Buldhana	9,661	20	154	420	594	6.15	-25
Chandrapur[T]	11,443	1262	1639	1039	3940	35.33	96
Dhule[T]	7,189	0	97	377	474	6.59	-19
Gadchiroli[T]	14,412	4201	3725	2143	10069	69.87	14
Gondia	5,733	812	887	461	2160	37.14	-45
Hingoli	4,686	0	54	71	125	2.62	6
Jalgaon	11,765	50	377	834	1261	10.72	19
Jalna	7,718	0	6	45	51	0.66	-51
Kolhapur[H]	7,685	95	1068	543	1706	22.20	-108
Latur	7,157	0	1	10	11	0.15	-55
Nagpur[T]	9,892	359	961	664	1984	21.21	136
Nanded	10,528	53	438	369	860	8.32	23
Nandurbar	5,961	0	445	769	1214	20.37	-224
Nasik	15,530	0	325	748	1073	6.91	-25
Osmanabad	7,569	0	11	59	70	0.92	-22
Parbhani	6,355	0	7	50	57	0.94	-74
Pune[TH]	15,643	2	671	660	1333	8.52	19
Raigarh[H]	7,152	2	1107	1205	2314	32.35	26
Ratnagiri[H]	8,208	33	1486	1192	2711	33.03	500
Sangli	8,572	43	59	49	151	1.76	1
Satara[H]	10,480	121	391	365	877	8.37	-32
Sholapur	14,895	0	18	30	48	0.32	-5
Sindhudurg[H]	5,207	54	1286	883	2223	42.69	-155
Thane[T]	9,558	2	1170	1557	2729	28.55	58
Wardha	6,309	0	438	386	824	13.44	1
Washim	5,184	2	79	216	297	6.13	-17

Yavatmal	13,582	128	1198	1280	2606	19.35	78
Total	**307,713**	**8,070**	**20,317**	**18,478**	**46,865**	**15.23**	**-256**

Table 7.16b : Forest cover change matrix of Maharashtra

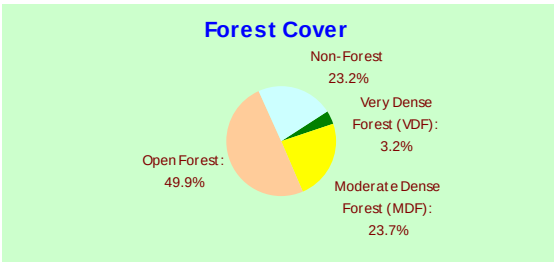
2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	24,026	3,941	78	2849	30894
Open forest	2,769	11,113	69	2,637	16588
Scrub	193	580	3,169	2,195	6137
Non-forest	1,400	2,843	859	248,992	254094
Total 2003	28,388	18,477	4,175	256,673	307713
Net change	-2,506	1,889	-1,962	2,579	

7.17. MANIPUR

Geographic Area	22,327 km^2 (0.7% of country)
Population	2.39 million (0.2% of country)
Urban	0.57 million (23.9%)
Rural	1.82 million (76.1%)
Average Population Density	107 persons per km^2
Tribal Population	34.40%
Livestock Population	1.29 million (0.3% of country)
No.of Districts	9
No. of Hill Districts	9
No. of Tribal Districts	9

Recorded Forest Area	
Reserved Forest (RF):	1,467 km^2
Protected Forest (PF):	4,171 km^2
Unclassed Forest (UF):	11,780 km^2
Total:	17,418 km^2
Of State's Geographic Area	78.01%
Of Country's Forest Area	2.25%

Forest Cover	
Very Dense Forest (VDF):	720 km^2
Moderate Dense Forest (MDF):	5,818 km^2
Open Forest:	10,681 km^2
Total:	17, 219 km^2
Of State's Geographic Area:	77.12 %
Of Country's Forest Cover:	0.52%



Tree Cover	
Culturable Non-Forest Area (CNFA):	2,864 km^2
No. of trees per ha of CNFA:	13.6
Tree Cover:	136 km^2
Of State's Geographic Area	*0.61%*
Of CNFA:	*4.75%*

Forest & Tree Cover	
Total Forest & Tree Cover:	17,355 km^2
Of State's Geographic Area:	*77.73%*
Of Country's Forest & Tree Cover:	*2.23%*
Per capita Forest & Tree Cover:	0.73 ha

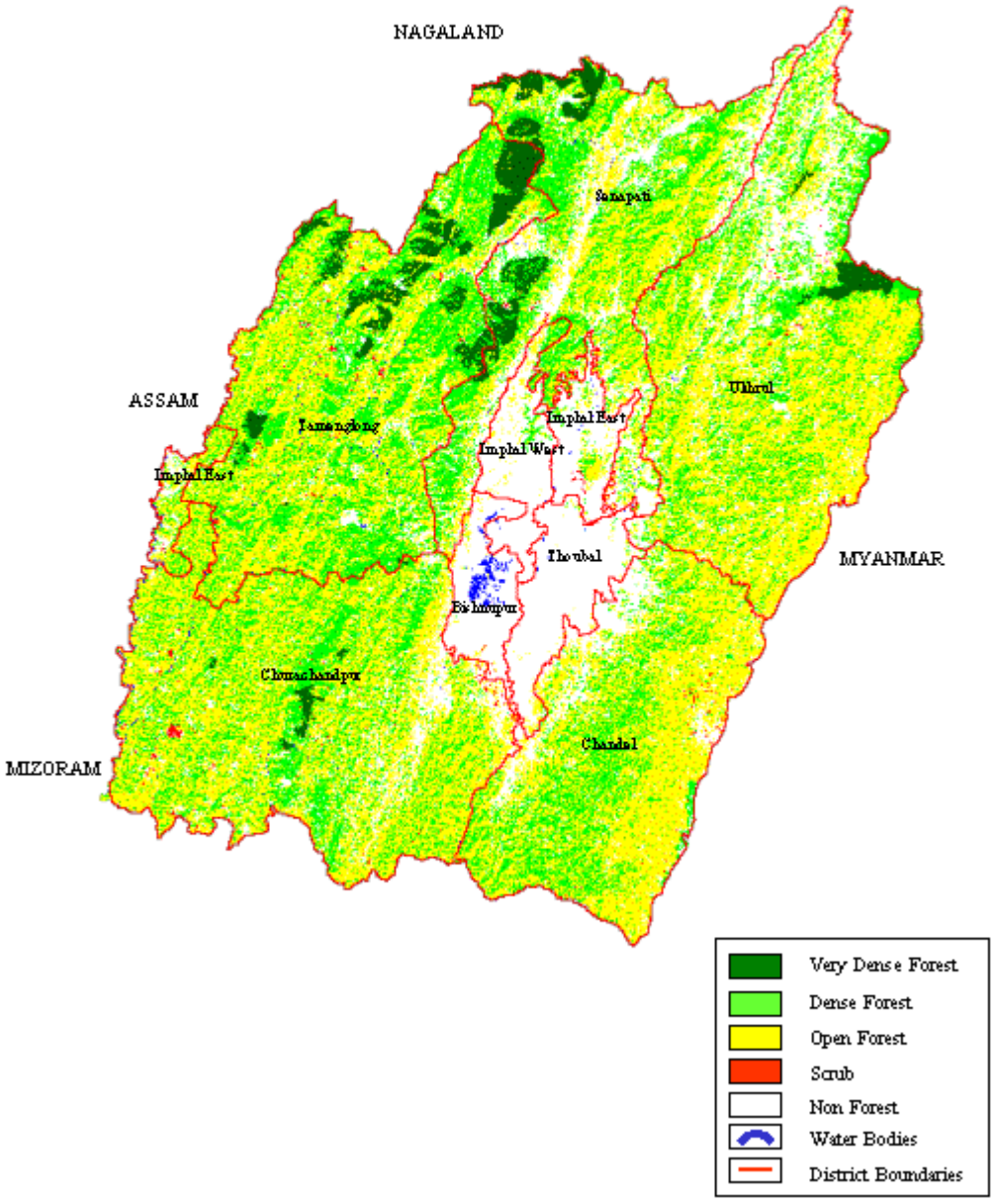

FOREST COVER MAP OF MANIPUR
NAGALAND
ASSAM
MIZORAM
MYANMAR
Senapati
Ukhrul
Jiramzyong
Imphal East
Imphal West
Thoubal
Bishnupur
Churachandpur
Chandel
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.17

Table7.17a : District-wise Forest Cover (Manipur)

Number of Districts: 9 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Bishnupur[TH]	496	0	1	14	15	3.02	3
Chandel[TH]	3,313	0	768	1935	2703	81.59	-15
Churachandpur[TH]	4,570	35	1322	2800	4157	90.96	-16
Imphal East[TH]	669	0	66	162	228	34.08	65
Imphal West[TH]	559	0	33	40	73	13.06	34
Senapati[TH]	3,271	235	1004	1320	2559	78.23	217
Tamenglong[TH]	4,391	367	1551	1951	3869	88.11	-60
Thoubal[TH]	514	0	5	28	33	6.42	9
Ukhrul[TH]	4,544	83	1068	2431	3582	78.83	56
Total	**22,327**	**720**	**5818**	**10681**	**17219**	**77.12**	**293**

Table 7.17b : Forest cover change matrix of Manipur

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	3594	1974	7	135	**5710**
Open forest	2669	7726	32	789	**11216**
Scrub	17	90	25	58	**190**
Non-forest	258	891	10	4052	**5211**
Total 2003	6538	10681	74	5034	**22327**
Net change	828	-535	-116	-117	

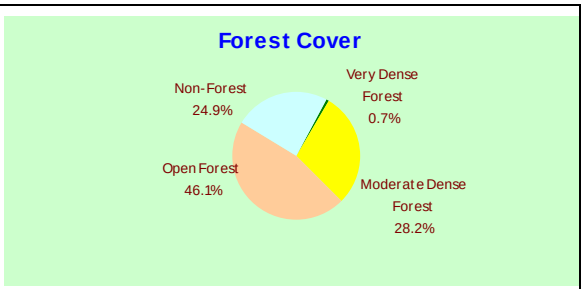
7.18. MEGHALAYA

Geographic Area	22,429 km^2 (0.7% of country)
Population	2.31 million (0.2% of country)
Urban	0.45 million (19.6%)
Rural	1.85 million (80.4%)
Average Population Density	103 persons per km^2
Tribal Population	85.50%
Livestock Population	1.2 million (0.3% of country)
No. of Districts	7
No. of Hill Districts	7
No. of Tribal Districts	7

Recorded Forest Area	
Reserved Forest (RF):	1,112 km^2
Protected Forest (PF):	12 km^2
Unclassed Forest (UF):	8,372 km^2
Total:	9,496 km^2
Of State's Geographic Area	*42.34%*
Of Country's Forest Area	*1.23%*

Forest Cover

Very Dense Forest	168 km^2
Moderate Dense Forest:	6,323 km^2
Open Forest:	10,348 km^2
Total:	16,839 km^2
Of State's Geographic Area:	*75.08 %*
Of Country's Forest Cover:	*2.48 %*



Tree Cover

Culturable Non-Forest Area:	7,543 km^2
No. of trees per ha of CNFA:	13.6
Tree Cover:	352 km^2
Of State's Geographic Area	*1.57%*
Of CNFA:	*4.67%*

Forest & Tree Cover

Total Forest & Tree Cover:	17,191 km^2
Of State's Geographic Area:	*76.65%*
Of Country's Forest & Tree Cover:	*2.21%*
Per capita Forest & Tree Cover:	0.74 ha

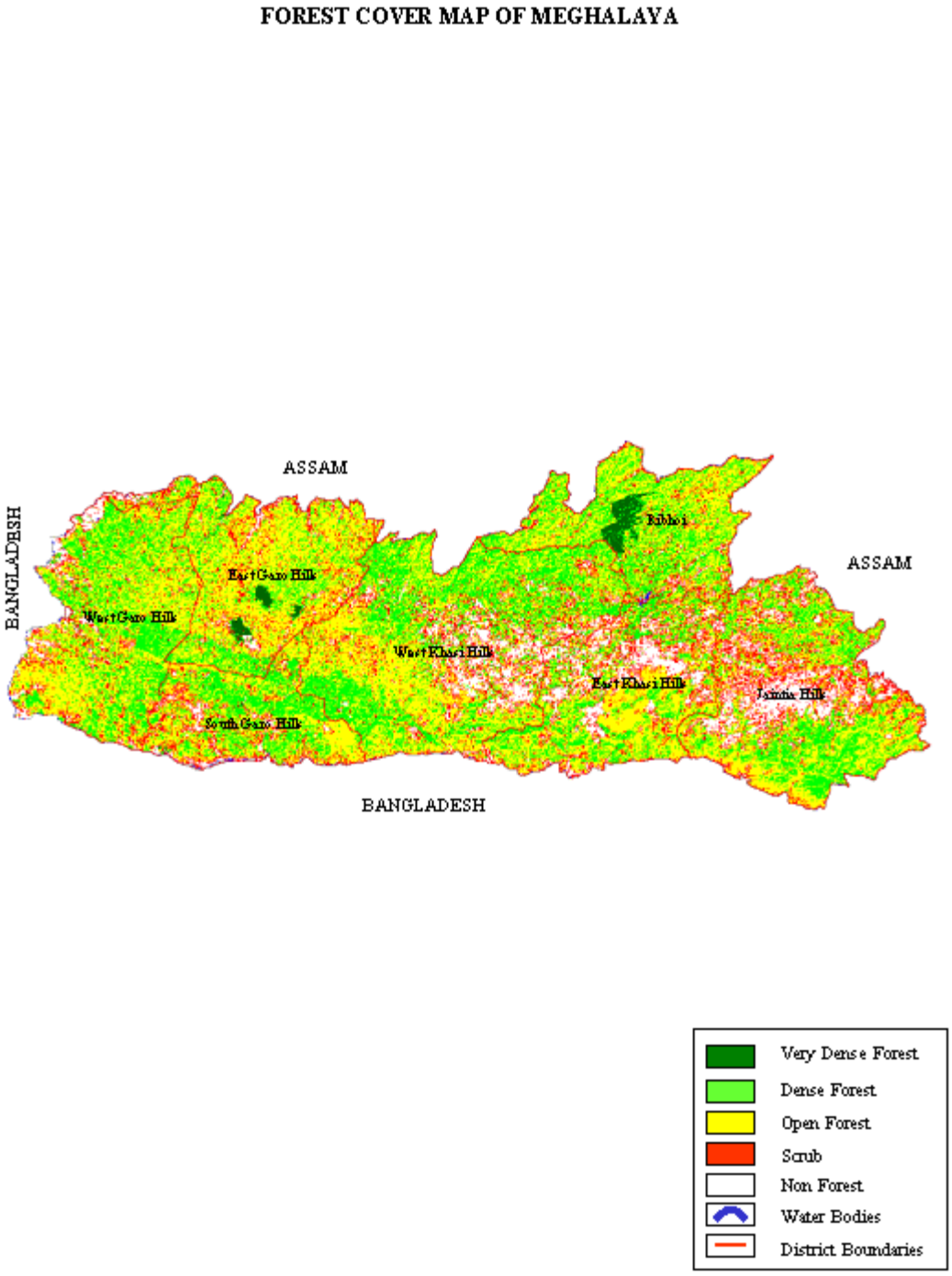

FOREST COVER MAP OF MEGHALAYA
ASSAM
BANGLADESH
East Garo Hills
West Garo Hills
West Khasi Hills
East Khasi Hills
Jaintia Hills
South Garo Hills
Ribhoi
ASSAM
BANGLADESH
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.18

Table 7.18a: District-wise Forest Cover (Meghalaya)

Number of Districts: 7 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
East Garo Hills[TH]	2,603	68	585	1,486	2,139	82.17	-34
South Garo Hills[TH]	1,849	4	595	858	1,457	78.80	-145
East Khasi Hills[TH]	2,820	-	643	1,234	1,877	66.56	143
Jaintia Hills[TH]	3,819	-	1,006	1,451	2,457	64.34	520
Ri Bhoi[TH]	2,376	95	768	1,230	2,093	88.09	330
West Garo Hills[TH]	3,715	-	1,172	1,787	2,959	79.65	367
West Khasi Hills[TH]	5,247	1	1,554	2,302	3,857	73.51	74
Total	**22,429**	**168**	**6,323**	**10,348**	**16,839**	**75.08**	**1,255**

Table 7.18b: Forest cover change matrix Meghalaya

(sq.km)

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	3,914	1,623	3	141	5,681
Open forest	1,695	7,597	68	543	9,903
Scrub	47	99	76	37	259
Non-forest	835	1,029	22	4,700	6,586
Total 2003	6,491	10,348	169	5,421	22,429
Net change	810	445	-90	-1165	

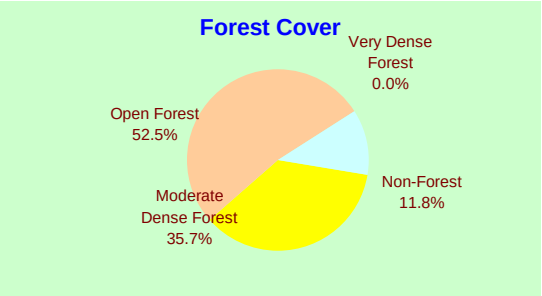
7.19. MIZORAM

Geographic Area	21,081 km^2 (0.6% of country)
Population	0.89 million (0.08% of country)
Urban	0.44 million (50%)
Rural	0.45 million (50%)
Average Population Density	42 persons per km^2
Tribal Population	94.70%
Livestock Population	0.2 million (0.04% of country)
No.of Districts	8
No. of Hill Districts	8
No. of Tribal Districts	8

Recorded Forest Area	
Reserved Forest (RF):	7,909 km^2
Protected Forest (PF):	3,568 km^2
Unclassed Forest (UF):	5,240 km^2
	Total: 16,717 km^2
Of State's Geographic Area	*79.30%*
Of Country's Forest Area	*2.16%*

Forest Cover

Very Dense Forest	84 km^2
Moderate Dense Forest:	7,404km^2
Open Forest:	10,942 km^2
Total:	18,430 km^2
Of State's Geographic Area:	*87.42%*
Of Country's Forest Cover:	*2.71%*



Tree Cover

Culturable Non-Forest Area:	2,449 km^2
No. of trees per ha of CNFA:	14.0
Tree Cover:	130 km^2
Of State's Geographic Area	*0.62%*
Of CNFA:	*5.31%*

Forest & Tree Cover

Total Forest & Tree Cover:	18,560 km^2
Of State's Geographic Area:	*88.04%*
Of Country's Forest & Tree Cover:	*2.38%*
Per capita Forest & Tree Cover:	2.09 ha

FOREST COVER MAP OF MIZORAM

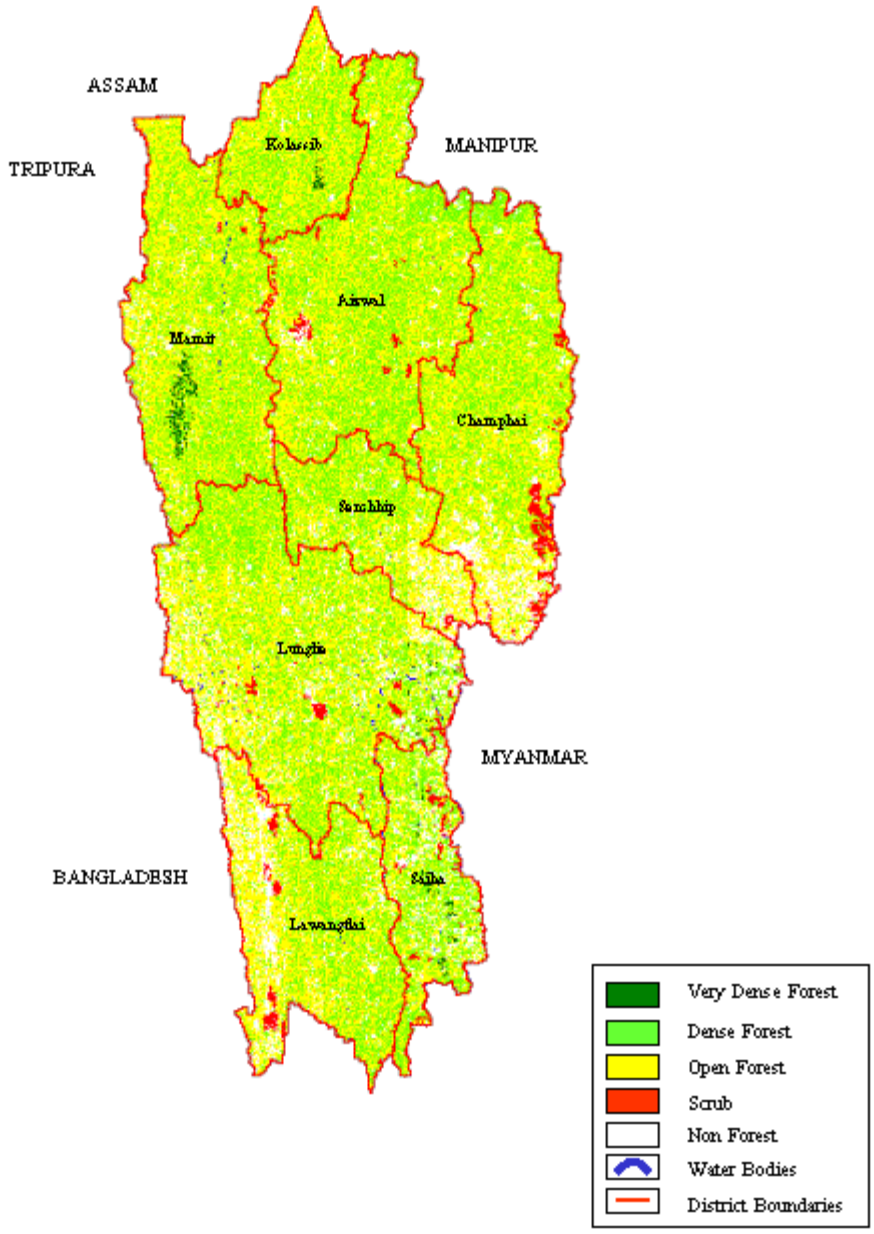


Fig. 7.19

Table 7.19a: District-wise Forest Cover (Mizoram)

Number of Districts: 8 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Aizawl[TH]	3,575	0	1,594	1,868	3,462	96.84	347
Champhai[TH]	3,185	0	1,068	1,686	2,754	86.47	279
Kolasib[TH]	1,382	9	535	800	1,344	97.25	22
Lawngtlai[TH]	2,557	0	713	1,359	2,072	81.03	206
Lunglei[TH]	4,536	5	1,483	2,374	3,862	85.14	205
Mamit[TH]	3,025	49	1,083	1,634	2,766	91.44	47
Saiha[TH]	1,400	21	548	553	1,122	80.14	-14
Serchhip[TH]	1,421	0	380	668	1,048	73.75	-156
Total	**21,081**	**84**	**7404**	**10942**	**18,430**	**87.42**	**936**

Table 7.19b: Forest cover change matrix of Mizoram

(sq.km)

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	3,781	4,749	71	335	8,936
Open forest	3,042	4,335	58	1,123	8,558
Scrub	104	229	85	49	467
Non-forest	561	1,629	60	870	3,120
Total 2003	7,488	10,942	274	2,377	21,081
Net change	-1,448	2,384	-193	-743	

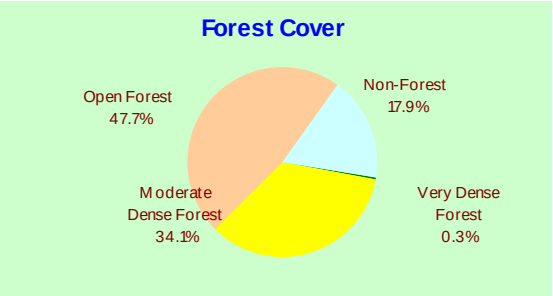
7.20. NAGALAND

Geographic Area	16,579 km^2 (0.5% of country)
Population	1.99 million (0.2% of country)
Urban	0.35 million (17.7%)
Rural	1.64 million (82.3%)
Average Population Density	120 persons per km^2
Tribal Population	87.70%
Livestock Population	1.1 million (0.2% of country)
No.of Districts	8
No. of Hill Districts	8
No. of Tribal Districts	8

Recorded Forest Area	
Reserved Forest (RF):	308 km^2
Protected Forest (PF):	508 km^2
Unclassed Forest (UF):	7,813km^2
Total:	8,629 km^2
Of State's Geographic Area	*52.05%*
Of Country's Forest Area	*1.11%*

Forest Cover

Very Dense Forest:	57 km^2
Moderate Dense Forest:	5,650 km^2
Open Forest:	7,902 km^2
Total:	13,609 km^2
Of State's Geographic Area:	*82.09%*
Of Country's Forest Cover:	*2.00%*



Tree Cover

Culturable Non-Forest Area:	4,637 km^2
No. of trees per ha of CNFA:	13.6
Tree Cover:	217 km^2
Of State's Geographic Area	*1.31%*
Of CNFA:	*4.67%*

Forest & Tree Cover

Total Forest & Tree Cover:	13,826 km^2
Of State's Geographic Area:	*83.39%*
Of Country's Forest & Tree Cover	*1.78%*
Per capita Forest & Tree Cover:	0.69 ha

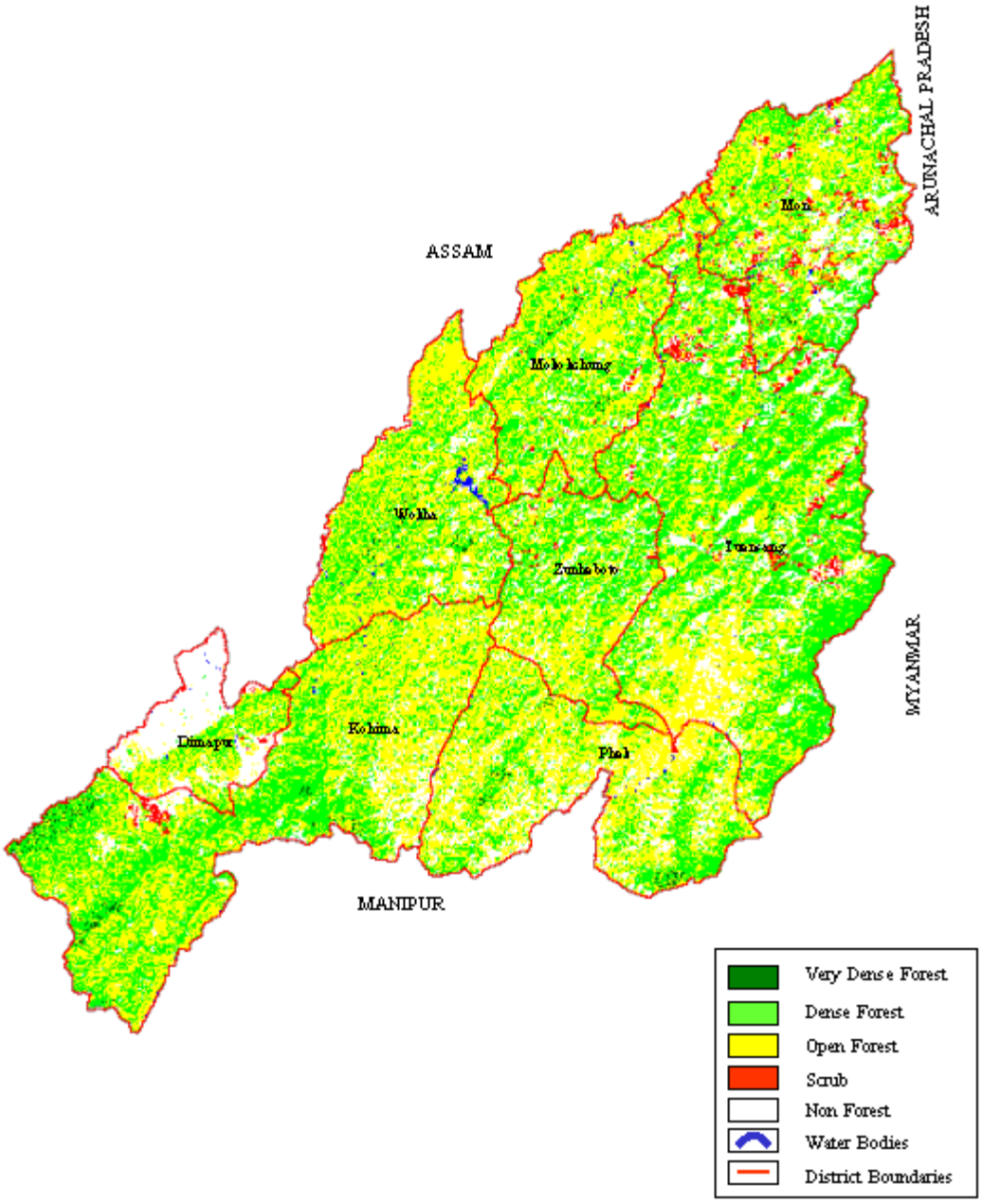

FOREST COVER MAP OF NAGALAND
ARUNACHAL PRADESH
ASSAM
Mon
Mokokchung
Wokha
Tuensang
Zunheboto
MYANMAR
Dimapur
Kohima
Phek
MANIPUR
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.20

Table 7.20a: District-wise Forest Cover (Nagaland)

Number of Districts: 8 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Dimapur[TH]	758	0	125	230	355	46.83	6
Kohima[TH]	3,283	31	1,229	1,669	2,929	89.22	34
Mokokchung[TH]	1,615	5	507	895	1,407	87.12	9
Mon[TH]	1,786	1	611	789	1,401	78.44	42
Phek[TH]	2,026	11	482	1,118	1,611	79.52	38
Tuensang[TH]	4,228	2	1,717	1,665	3,384	80.04	67
Wokha[TH]	1,628	7	518	924	1,449	89.00	24
Zunheboto[TH]	1,255	0	461	612	1,073	85.50	44
Total	**16,579**	**57**	**5,650**	**7,902**	**13,609**	**82.09**	**264**

Table 7.20b: Forest cover change matrix of Nagaland

(sq.km)

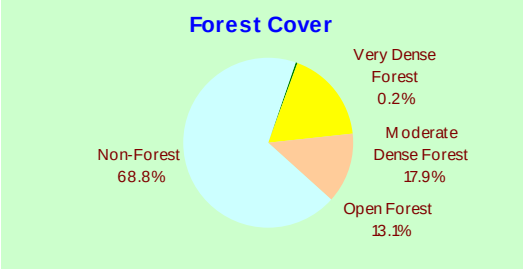
2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	3,483	1,571	18	321	5,393
Open forest	1,572	5,330	39	1,011	7,952
Scrub	3	17	9	18	47
Non-forest	649	984	165	1,389	3,187
Total 2003	5,707	7,902	231	2,739	16,579
Net change	314	-50	184	-448	

7.21. ORISSA

Geographic Area	1,55,707 km^2 (4.7% of country)
Population	36.71 million (3.6% of country)
Urban	5.50 million (15%)
Rural	31.21 million (85%)
Average Population Density	236 persons per km^2
Tribal Population	22.20%
Livestock Population	22.7 million (4.8% of country)
No.of Districts	30
No. of Hill Districts	0
No. of Tribal Districts	12

Recorded Forest Area	
Reserved Forest (RF):	26329km^2
Protected Forest (PF):	15525 km^2
Unclassed Forest (UF):	16282 km^2
Total:	58136 km^2
Of State's Geographic Area	37.34%
Of Country's Forest Area	*7.50%*

Forest Cover	
Very Dense Forest:	288 km^2
Moderate Dense Forest:	27,882 km^2
Open Forest:	20,196 km^2
Total:	48,366 km^2
Of State's Geographic Area:	*31.06%*
Of Country's Forest Cover:	*7.16 %*



Tree Cover	
Culturable Non-Forest Area:	90,297 km^2
No. of trees per ha of CNFA:	11.0
Tree Cover:	6,381 km^2
Of State's Geographic Area	*4.10%*
Of CNFA:	*7.07%*

Forest & Tree Cover	
Total Forest & Tree Cover:	54,747 km^2
Of State's Geographic Area:	*35.16%*
Of Country's Forest & Tree Cover	*7.03%*
Per capita Forest & Tree Cover:	0.15 ha

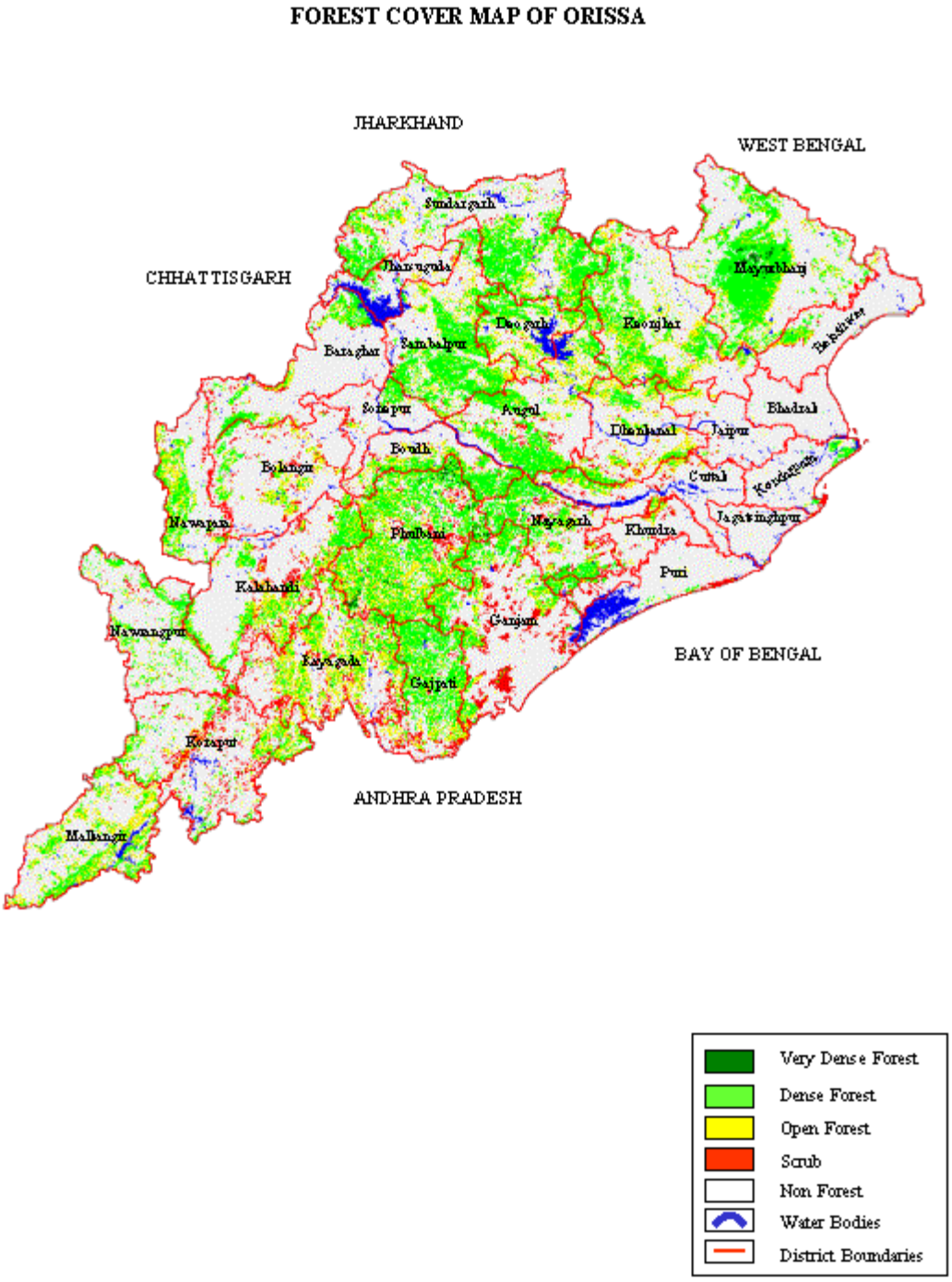

FOREST COVER MAP OF ORISSA
JHARKHAND
WEST BENGAL
CHHATTISGARH
ANDHRA PRADESH
BAY OF BENGAL
Sundargarh
Jharsuguda
Mayurbhanj
Baleshwar
Baragarh
Sambalpur
Deogarh
Keonjhar
Sonepur
Angul
Bhadrak
Dhenkanal
Jajpur
Boudh
Balangir
Cuttak
Kendrapara
Nuapara
Phulbani
Nayagarh
Khurda
Jagatsinghpur
Puri
Kalahandi
Ganjam
Nawrangpur
Rayagada
Gajapati
Koraput
Malkangir
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.21

Table 7.21a: District-wise Forest Cover (Orissa)

Number of Districts: 30 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Angul	6,375	0	1,712	944	2,656	41.66	6
Baleshwar[T]	3,806	0	154	155	309	8.12	3
Baragarh	5,837	0	552	319	871	14.92	-33
Bhadrak	2,505	0	22	7	29	1.16	-2
Bolangir	6,575	0	352	600	952	14.48	-40
Boudh	3,098	1	808	443	1,252	40.41	-28
Cuttack	3,932	0	265	359	624	15.87	-32
Deogarh	2,940	0	784	590	1,374	46.73	16
Dhenkanal	4,452	0	505	776	1,281	28.77	15
Gajpati[T]	4,325	0	1,620	864	2,484	57.43	-68
Ganjam	8,206	0	1,191	759	1,950	23.76	-238
Jagatsinghpur	1,668	0	4	14	18	1.08	-6
Jajpur	2,899	0	82	180	262	9.04	3
Jharsuguda	2,081	0	157	132	289	13.89	13
Kalahandi[T]	7,920	0	1,145	1,115	2,260	28.54	121
Kendarpara	2,644	0	150	56	206	7.79	-11
Keonjhar[T]	8,303	0	1,713	1,523	3,236	38.97	-142
Khandamal[T]	8,021	175	3,157	2,119	5,451	67.96	61
Khurda	2,813	0	211	151	362	12.87	-72
Koraput[T]	8,807	0	729	828	1,557	17.68	73
Malkangiri[T]	5,791	0	911	1,301	2,212	38.20	24
Mayurbhanj[T]	10,418	99	2,910	996	4,005	38.44	-127
Nawapara	3,852	0	585	628	1,213	31.49	-24
Nawrangpur[T]	5,291	0	683	440	1,123	21.22	-27
Nayagarh	3,890	0	1,121	484	1,605	41.26	-100
Puri	3,479	0	71	28	99	2.85	-112
Rayagada[T]	7,073	13	1,085	1,963	3,061	43.28	328
Sambalpur[T]	6,657	0	2,281	1,007	3,288	49.39	-1
Sonepur	2,337	0	200	112	312	13.35	-1
Sundargarh[T]	9,712	0	2,722	1,303	4,025	41.44	-71
Total	**155,707**	**288**	**27,882**	**20,196**	**48,366**	**31.06**	**-472**

Table 7.21b: Forest cover change matrix of Orissa

(sq.km)

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	21,738	4,222	69	1,943	27,972
Open forest	5,165	13,777	135	1,789	20,866
Scrub	73	140	4,574	995	5,782
Non-forest	1,194	2,057	568	97,268	101,087

Total 2003	28,170	20,196	5,346	101,995	155,707
Net change	198	-670	-436	908	

7.22. PUNJAB

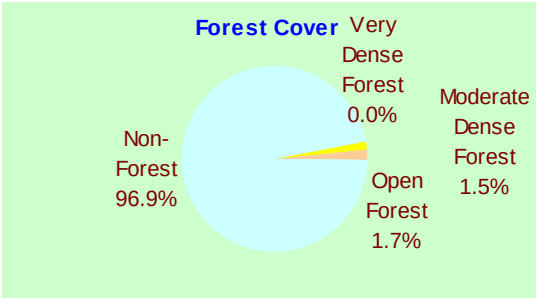
Geographic Area	50,362 km^2 (1.5% of country)
Population	24.29 million (2.4% of country)
Urban	8.25 million (33.9%)
Rural	16.04 million (66.1%)
Average Population Density	482 persons per km^2
Tribal Population	NA
Livestock Population	10.2 million (2.2% of country)
No.of Districts	17
No. of Hill Districts	0
No. of Tribal Districts	0

Recorded Forest Area

Reserved Forest (RF):	44 km^2
Protected Forest (PF):	1,137 km^2
Unclassed Forest (UF):	1,903 km^2
Total:	3,084 km^2
Of State's Geographic Area:	*6.12 %*
Of Country's Forest Area:	*0.4 %*

Forest Cover

Very Dense Forest:	0 km^2
Moderate Dense Forest:	743 km^2
Open Forest:	837 km^2
Total:	1,580 km^2
Of State's Geographic Area:	*3.14 %*
Of Country's Forest Cover:	*0.23 %*



Tree Cover

Culturable Non-Forest Area (CNFA):	45,290 km^2
No. of trees per ha of CNFA:	12.6
Tree Cover:	1,608 km^2
Of State's Geographic Area:	*3.19%*
Of CNFA:	*3.55%*

Forest & Tree Cover

Total Forest & Tree Cover:	3,188 km^2
Of State's Geographic Area:	*6.33%*
Of Country's Forest & Tree Cover:	*0.41 %*
Per capita Forest & Tree Cover:	0.01 ha

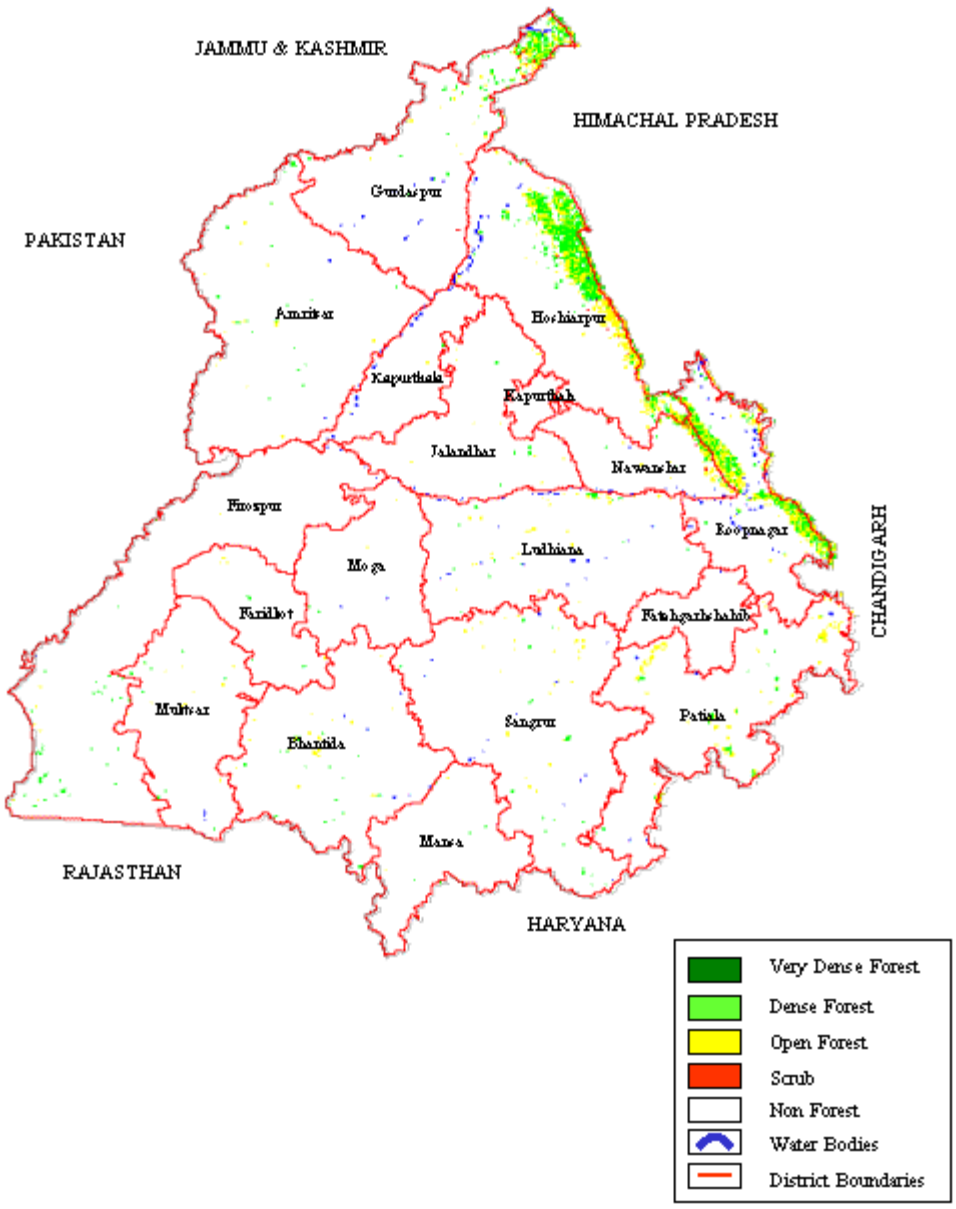

FOREST COVER MAP OF PUNJAB
JAMMU & KASHMIR
HIMACHAL PRADESH
PAKISTAN
Gurdaspur
Amritsar
Hoshiarpur
Kapurthala
Kapurthala
Jalandhar
Nawanshar
Ferozpur
Roopnagar
Ludhiana
Moga
Faridkot
Fatehgarhsahib
Muktsar
Bhantida
Sangrur
Patiala
Mansa
RAJASTHAN
HARYANA
CHANDIGARH
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.22

Table 7.22: District-wise Forest Cover (Punjab)

Number of Districts: 17 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Amritsar	5,088	0	15	12	27	0.53	-106
Bhantida	3,353	0	12	13	25	0.75	-76
Faridkot	1,458	0	2	5	7	0.48	-8
Fategarhsahib	1,180	0	0	0	0	0.00	-12
Firozpur	5,874	0	25	7	32	0.54	-111
Gurdaspur	3,551	0	96	96	192	5.41	-21
Hoshiarpur	3,386	0	327	307	634	18.72	-84
Jalandhar	2,624	0	3	5	8	0.30	-22
Kapurthala	1,633	0	1	3	4	0.24	-22
Ludhiana	3,578	0	17	24	41	1.15	-55
Mansa	2,198	0	2	0	2	0.09	-49
Moga	1,689	0	2	2	4	0.24	-6
Muktsar	2,593	0	9	6	15	0.58	-56
Nawanshar	1,282	0	34	63	97	7.57	-48
Patiala	3,654	0	20	63	83	2.27	-55
Roopnagar	2,113	0	162	212	374	17.70	28
Sangrur	5,108	0	16	19	35	0.69	-149
Total	**50,362**	**0**	**743**	**837**	**1580**	**3.14**	**-852**

Table 7.22b: Forest cover change matrix Punjab

(sq.km)

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	392	159	3	995	1,549
Open forest	224	522	3	134	883
Scrub	3	9	5	13	30
Non-forest	124	147	11	47,618	47,900
Total 2003	743	837	22	48,760	50,362
Net change	-806	-46	-8	860	

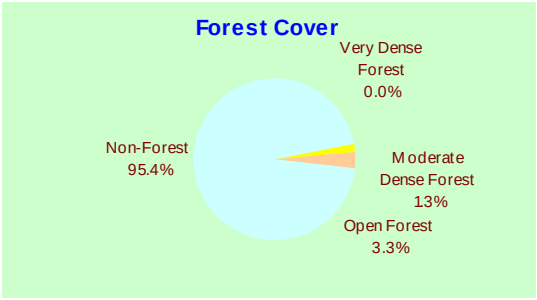
7.23. RAJASTHAN

Geographic Area	3,42,239 km^2 (10.4% of country)
Population	56.47 million (5.5% of country)
Urban	13.20 million (23.4%)
Rural	43.27 million (76.6%)
Average Population Density	165 persons per km^2
Tribal Population	12.40%
Livestock Population	48.4 million (10.3% of country)
No.of Districts	29
No. of Hill Districts	0
No. of Tribal Districts*	5

Recorded Forest Area	
Reserved Forest (RF):	11,860 km^2
Protected Forest (PF):	17,652 km^2
Unclassed Forest (UF):	2,976 km^2
Total:	32,488 km^2
Of State's Geographic Area:	*9.49 %*
Of Country's Forest Area:	*4.19%*

* Total no. of districts is 32 but the data of Dausa, Hanumangarh & Karauli is given jointly with the parent districts.

Forest Cover	
Very Dense Forest:	14 km^2
Moderate Dense Forest:	4,482 km^2
Open Forest:	11,330 km^2
Total:	15,826 km^2
Of State's Geographic Area:	*4.62 %*
Of Country's Forest Cover:	*2.33 %*



Tree Cover	
Culturable Non-Forest Area (CNFA):	3,03,157 km^2
No. of trees per ha of CNFA:	8.0
Tree Cover:	8,638 km^2
Of State's Geographic Area:	*2.52%*
Of CNFA:	*2.85%*

Forest & Tree Cover	
Total Forest & Tree Cover:	24,464 km^2
Of State's Geographic Area:	*7.15 %*
Of Country's Forest & Tree Cover:	*3.14%*
Per capita Forest & Tree Cover:	0.04 ha

FOREST COVER MAP OF RAJASTHAN

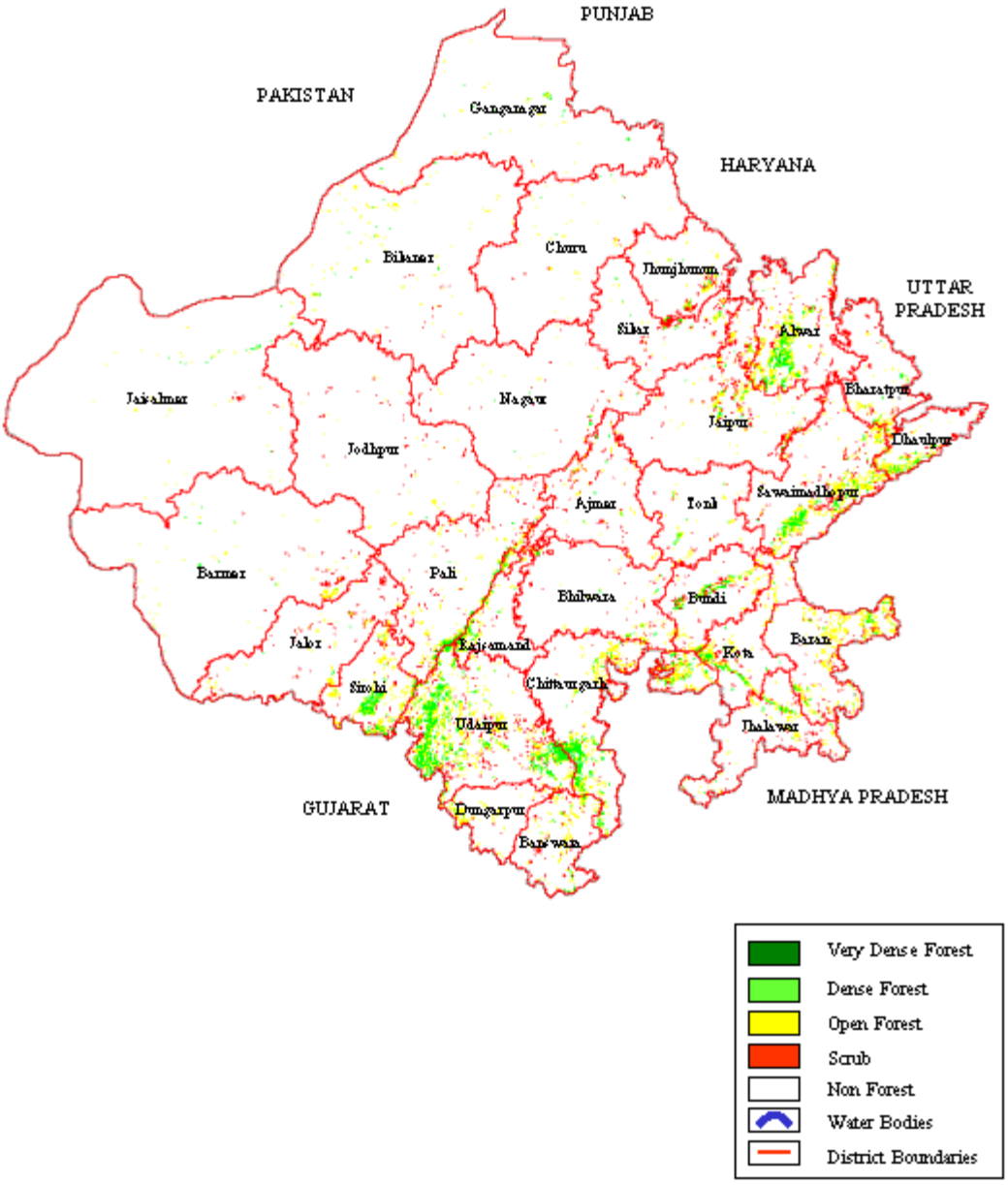


Fig. 7.23

Table 7.23a: District-wise Forest Cover (Rajasthan)

Number of Districts: 29* (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Ajmer	8,481	0	51	215	266	3.14	-89
Alwar	8,380	14	370	828	1,212	14.46	3
Banswara[T]	5,037	0	51	321	372	7.39	-21
Baran	6,992	0	136	946	1,082	15.47	-58
Barmer	28,387	0	12	159	171	0.60	-31
Bharatpur	5,066	0	39	197	236	4.66	-13
Bhilwara	10,455	0	36	184	220	2.10	2
Bikaner	27,244	0	36	167	203	0.75	1
Bundi	5,550	0	143	298	441	7.95	-14
Chittaurgarh[T]	10,856	0	581	1,094	1,675	15.43	48
Churu	16,830	0	8	85	93	0.55	18
Dhaulpur	3,033	0	101	320	421	13.88	6
Dungarpur[T]	3,770	0	17	233	250	6.63	10
Ganganagar	20,634	0	31	133	164	0.79	-169
Jaipur	14,069	0	114	508	622	4.42	-16
Jaisalmer	38,401	0	39	91	130	0.34	4
Jalor	10,640	0	18	187	205	1.93	-77
Jhalawar	6,219	0	87	306	393	6.32	-40
Jhunjhunun	5,928	0	29	157	186	3.14	-76
Jodhpur	22,850	0	7	93	100	0.44	-38
Kota	5,443	0	163	453	616	11.32	0
Nagaur	17,718	0	15	103	118	0.67	-69
Pali	12,387	0	210	404	614	4.96	-3
Rajsamand	3,860	0	130	286	416	10.78	-74
Sawaimadhopur	10,528	0	299	990	1,289	12.24	3
Sikar	7,732	0	37	147	184	2.38	-1
Sirohi[T]	5,136	0	307	578	885	17.23	22
Tonk	7,194	0	36	136	172	2.39	-30
Udaipur[T]	13,419	0	1,379	1,711	3,090	23.03	161
Total	**342,239**	**14**	**4,482**	**11,330**	**15,826**	**4.62**	**-541**

* Total number of districts is 32 but the boundaries of three new districts: Dausa, Hanumangarh and Karauli could not be delineated and their data is given jointly with the parent districts.

Table 7.23b: Forest cover change matrix of Rajasthan

					(sq.km)
	2003 Assessment				
2001 Assessment	**Dense forest**	**Open forest**	**Scrub**	**Non-forest**	**Total 2001**
Dense forest	4,098	433	7	1,784	6,322
Open forest	337	9,669	39	0	10,045
Scrub	3	148	4,179	595	4,925
Non-forest	58	1,080	339	319,470	320,947
Total 2003	4,496	11,330	4,564	321,849	342,239
Net change	-1,826	1,285	-361	902	

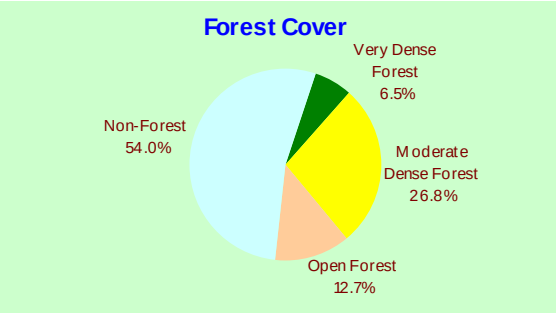
7.24. SIKKIM

Geographic Area	7,096 km^2 (0.2% of country)
Population	0.54 mill. (0.05% of country)
Urban	0.06 million (11.1%)
Rural	0.48 million (88.9%)
Average Population Density	76 persons per km^2
Tribal Population	22.40%
Livestock Population	0.39 million (0.1% of country)
No.of Districts	4
No. of Hill Districts	4
No. of Tribal Districts	4

Recorded Forest Area	
Reserved Forest (RF):	5,452 km^2
Protected Forest (PF):	389 km^2
Unclassed Forest (UF):	0 km^2
Total:	5,841 km^2
Of State's Geographic Area	*82.31%*
Of Country's Forest Area	*0.75%*

Forest Cover

Very Dense Forest:	458 km^2
Moderate Dense Forest:	1,904 km^2
Open Forest:	900 km^2
Total:	3,262 km^2
Of State's Geographic Area:	*45.97 %*
Of Country's Forest Cover:	*0.48%*



Tree Cover

Culturable Non-Forest Area (CNFA):	322 km^2
No. of trees per ha of CNFA:	20.3
Tree Cover:	22 km^2
Of State's Geographic Area:	*0.31%*
Of CNFA:	*6.77%*

Forest & Tree Cover

Total Forest & Tree Cover:	3,284 km^2
Of State's Geographic Area:	*46.28%*
Of Country's Forest & Tree Cover:	*0.42%*
Per capita Forest & Tree Cover:	0.61 ha

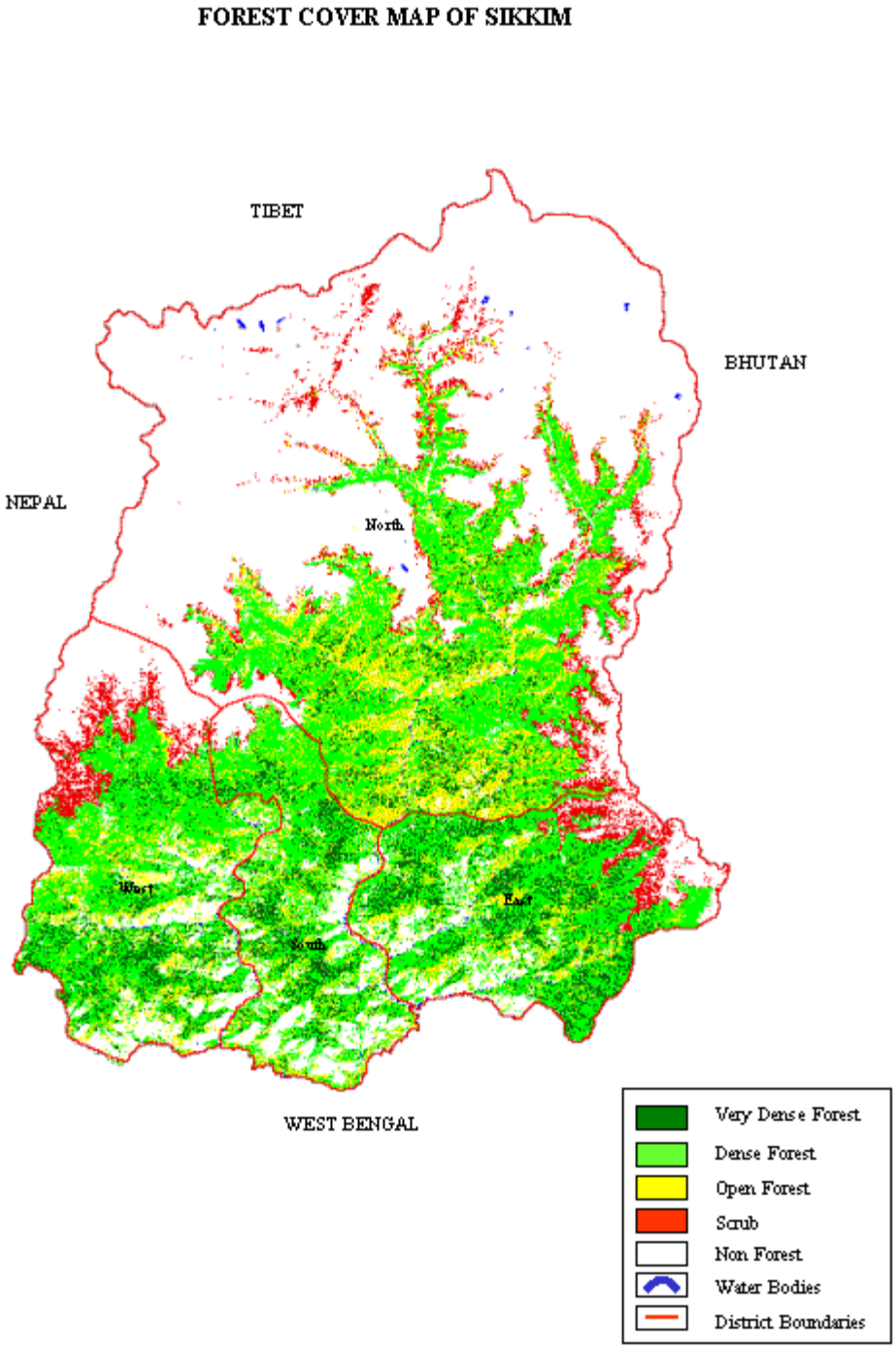

FOREST COVER MAP OF SIKKIM
TIBET
BHUTAN
NEPAL
North
West
East
South
WEST BENGAL
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.24

Table 7.24a: District-wise Forest Cover (Sikkim)

Number of Districts: 4 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
East Sikkim[TH]	954	162	396	121	679	71.17	9
North Sikkim[TH]	4,226	92	747	487	1326	31.38	25
South Sikkim[TH]	750	95	311	123	529	70.53	19
West Sikkim[TH]	1,166	109	450	169	728	62.44	16
Total	**7,096**	**458**	**1904**	**900**	**3262**	**45.97**	**69**

Table 7.24b: Forest cover change matrix of Sikkim

(sq.km)

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	1,859	437	8	87	2,391
Open forest	289	413	36	64	802
Scrub	27	4	236	74	341
Non-forest	187	46	80	3,249	3,562
Total 2003	2,362	900	360	3,474	7,096
Net change	-29	98	19	-88	

7.25. TAMIL NADU

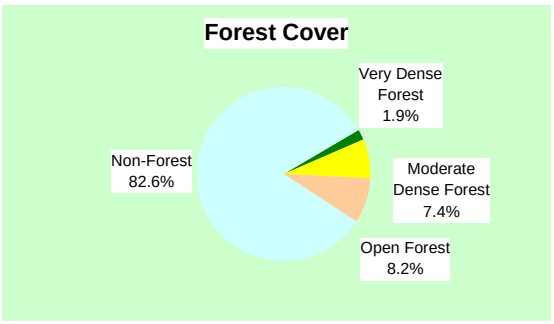
Geographic Area	1,30,058 km^2 (4.0% of country)
Population	62.11 mill. (6.0% of country)
Urban	27.24 million (43.9%)
Rural	34.87 million (56.1%)
Average Population Density	478 persons per km^2
Tribal Population	1.00%
Livestock Population	25.0 million (5.3% of country)
No.of Districts	30
No. of Hill Districts	5
No. of Tribal Districts	6

Recorded Forest Area

Reserved Forest (RF):	19,388 km^2
Protected Forest (PF):	2,183 km^2
Unclassed Forest (UF):	1,306 km^2
Total:	22,877 km^2
Of State's Geographic Area	*17.59%*
Of Country's Forest Area	*3.95%*

Forest Cover

Very Dense Forest:	2,440 km^2
Moderate Dense Forest:	9,567 km^2
Open Forest:	10,636 km^2
Total:	22,643 km^2
Of State's Geographic Area:	*17.41 %*
Of Country's Forest Cover:	*3.33 %*



Tree Cover	
Culturable Non-Forest Area (CNFA):	98,851 km^2
No. of trees per ha of CNFA:	13.7
Tree Cover:	4,991 km^2
Of State's Geographic Area:	*3.84%*
Of CNFA:	*5.05%*

Forest & Tree Cover	
Total Forest & Tree Cover:	27,634 km^2
Of State's Geographic Area:	*21.25%*
Of Country's Forest & Tree Cover:	*3.55%*
Per capita Forest & Tree Cover:	0.04 ha

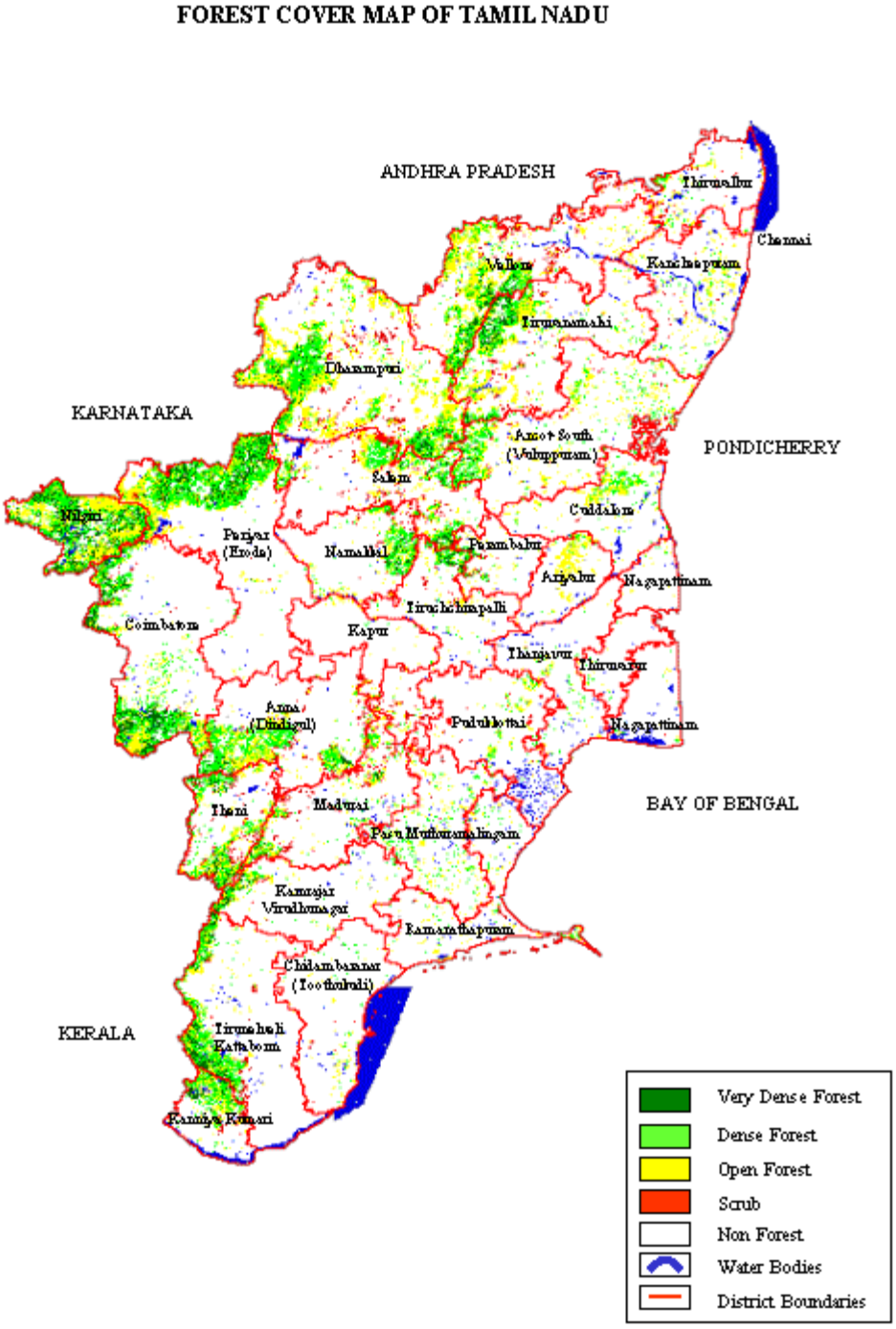

FOREST COVER MAP OF TAMIL NADU
ANDHRA PRADESH
KARNATAKA
KERALA
PONDICHERRY
BAY OF BENGAL
Thiruvallur
Chennai
Vellore
Kancheepuram
Tiruvannamalai
Dharampuri
Cuddalore
Salem
Namakkal
Perambalur
Ariyalur
Nagapattinam
Tiruchchirappalli
Karur
Thanjavur
Thiruvarur
Pudukkottai
Madurai
Ramanathapuram
Virudhunagar
Tirunelveli
Kanniya Kumari
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.25

Table 7.25a: District-wise Forest Cover (Tamil Nadu)

Number of Districts: 30 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Ariyalur	1,947	0	28	255	283	14.54	-71
Chennai	144	0	3	3	6	4.17	1
Coimbatore[H]	7,469	405	833	566	1,804	24.15	12
Cuddalore	3,706	0	185	248	433	11.68	35
Dharampuri[T]	9,622	193	1,051	1,710	2,954	30.70	259
Dindigul	5,580	63	662	541	1,266	22.69	98
Erode	8,209	378	1,174	678	2,230	27.17	83
Kancheepuram	4,474	0	106	271	377	8.43	-23
Kanniya Kumari[H]	1,684	78	253	204	535	31.77	30
Kapur	2,901	0	13	75	88	3.03	11
Madurai[H]	4,277	31	197	303	531	12.42	17
Nagapattinam	2,140	0	16	37	53	2.48	-25
Namakkal[T]	3,413	40	294	217	551	16.14	31
Perambalur[T]	1,748	9	54	67	130	7.44	10
Pudukkottai	4,651	0	81	157	238	5.12	15
Ramanathapuram	4,232	0	101	134	235	5.55	18
Salem[T]	5,235	67	528	539	1,134	21.66	30
Sivaganga	4,086	0	169	309	478	11.70	-2
Thanjavur	3,415	0	60	69	129	3.78	59
The Nilgiri[H]	2,549	404	878	789	2,071	81.25	48
Theni	2,764	89	405	337	831	30.07	107
Thiruvallur	3,413	0	62	160	222	6.50	1
Thiruvarur	2,716	0	10	16	26	0.96	4
Tiruchchirapalli[T]	4,511	69	153	172	394	8.73	22
Tirunelveli [H]	6,810	203	549	347	1,099	16.14	50
Tiruvanamalai[T]	6,191	165	478	672	1,315	21.24	123
Toothukudi	4,621	0	46	106	152	3.29	7
Vellore	6,077	165	608	920	1,693	27.86	235
Vuluppuram	7,190	27	431	598	1,056	14.69	-42
Virudhunagar	4,283	54	139	136	329	7.68	18
Total	**130,058**	**2,440**	**9,567**	**10,636**	**22,643**	**17.41**	**1,161**

Table 7.25b: Forest cover change matrix of Tamil Nadu

					(sq.km)
	2003 Assessment				
2001 Assessment	Dense forest	Open forest	Scrub	Non-forest	Total 2001
Dense forest	10,050	2,253	11	185	12,499
Open forest	1,767	7,104	57	55	8,983
Scrub	60	991	1,961	168	3,180
Non-forest	130	288	11	104,967	105,396
Total 2003	12,007	10,636	2,040	105,375	130,058
Net change	-492	1,653	-1,140	-21	

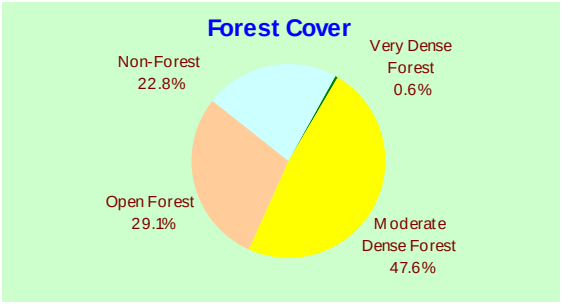
7.26. TRIPURA

Geographic Area	10,486 km^2 (0.3% of country)
Population	3.19 million (0.3% of country)
Urban	0.54 million (17%)
Rural	2.65 million (83%)
Average Population Density	304 persons per km^2
Tribal Population	31.00%
Livestock Population	1.6 million (0.3% of country)
No.of Districts	3*
No. of Hill Districts	3
No. of Tribal Districts	3

Recorded Forest Area	
Reserved Forest (RF):	3,588 km^2
Protected Forest (PF):	664 km^2
Unclassed Forest (UF):	2,041 km^2
Total:	6,293 km^2
Of State's Geographic Area	*60.01%*
Of Country's Forest Area	*0.81%*

*total number of districts is 4 but the data of Dhalai district is given jointly with the parent district.

Forest Cover	
Very Dense Forest:	58 km^2
Moderate Dense Forest:	4,988 km^2
Open Forest:	3,047 km^2
Total:	8,093 km^2
Of State's Geographic Area:	*77.18 %*
Of Country's Forest Cover:	*1.19 %*



Tree Cover	
Culturable Non-Forest Area (CNFA):	2,446 km^2
No. of trees per ha of CNFA:	13.6
Tree Cover:	116 km^2
Of State's Geographic Area:	*1.11%*
Of CNFA:	*4.76%*

Forest & Tree Cover	
Total Forest & Tree Cover:	8,209 km^2
Of State's Geographic Area:	*78.29 %*
Of Country's Forest & Tree Cover:	*1.05%*
Per capita Forest & Tree Cover:	0.26 ha

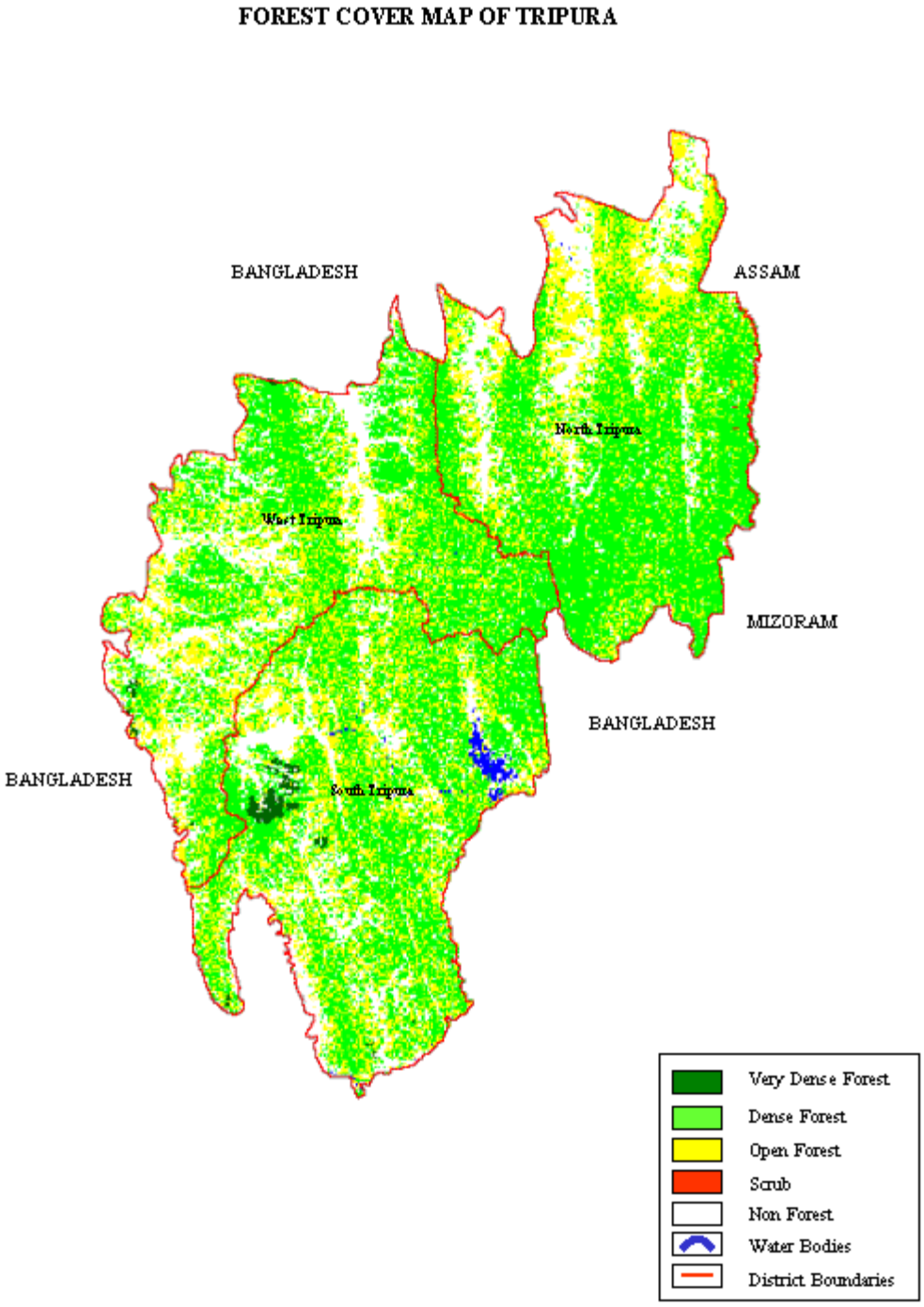

FOREST COVER MAP OF TRIPURA
BANGLADESH
ASSAM
North Tripura
West Tripura
MIZORAM
BANGLADESH
BANGLADESH
South Tripura
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.26

Table 7.26a: District-wise Forest Cover (Tripura)

Number of Districts: 3* (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
North Tripura TH	3,872	0	1879	981	2860	73.86	264
South Tripura TH	3,581	47	1620	1116	2783	77.72	259
West Tripura TH	3,033	11	1489	950	2450	80.78	505
Total	**10,486**	**58**	**4988**	**3047**	**8093**	**77.18**	**1028**

* Total number of districts is 4 but the boundaries of the newly created district of Dhalai could not be delineated and its data is given jointly with the parent districts.

Table 7.26b: Forest cover change matrix of Tripura

(sq.km)

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	2,779	463	0	221	3,463
Open forest	1,811	1,627	1	163	3,602
Scrub	26	11	0	7	44
Non-forest	430	946	0	2,001	3,377
Total 2003	5,046	3,047	1	2,392	10,486
Net change	1,583	-555	-43	-985	

7.27. UTTAR PRADESH

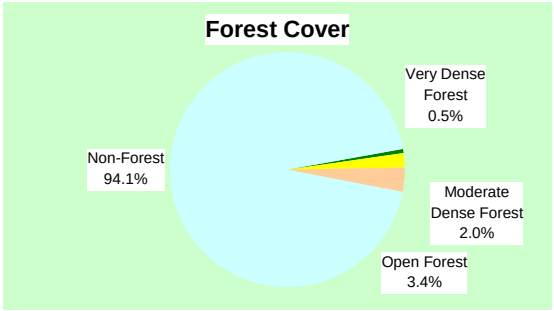
Geographic Area	2,40,928 km^2 (7.3% of country)
Population	166.05 mill. (16.2% of country)
Urban	34.51 million (20.8%)
Rural	131.54 million (79.2%)
Average Population Density	689 persons per km^2
Tribal Population	---
Livestock Population	64.8 mill. (13.8% of country)*
No.of Districts	70
No. of Hill Districts	0
No. of Tribal Districts	1

Recorded Forest Area	
Reserved Forest (RF):	11,078 km^2
Protected Forest (PF):	2,425 km^2
Unclassed Forest (UF):	3.323 km^2
Total:	16,826 km^2
Of State's Geographic Area	*6.98%*
Of Country's Forest Area	*2.17%*

*includes Uttaranchal livestock population

Forest Cover

Very Dense Forest:	1,297 km^2
Moderate Dense Forest:	4,699 km^2
Open Forest:	8,122 km^2
Total:	14,118 km^2
Of State's Geographic Area:	*5.86 %*
Of Country's Forest Cover:	*2.08 %*



Tree Cover

Culturable Non-Forest Area (CNFA):	214,390 km^2
No. of trees per ha of CNFA:	12.3
Tree Cover:	7,715 km^2
Of State's Geographic Area:	*3.20%*
Of CNFA:	*3.60%*

Forest & Tree Cover

Total Forest & Tree Cover:	21,833 km^2
Of State's Geographic Area:	*9.06%*
Of Country's Forest & Tree Cover:	*2.81%*
Per capita Forest & Tree Cover:	0.01 ha

FOREST COVER MAP OF UTTAR PRADESH

Fig. 7.27

Table 7.27a: District-wise Forest Cover (Uttar Pradesh)

Number of Districts: 70 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Agra	4,027	-	74	199	273	6.78	16
Aligarh	3,650	-	6	49	55	1.51	14
Allahabad	5,137	-	28	69	97	1.89	-64
Ambedkar Nagar	2,337	-	2	32	34	1.45	-185
Azamgarh	4,234	-	1	30	31	0.73	-15
Bagpat	1,321	-	4	11	15	1.14	-3
Bahraich & Shravasti	6,878	210	294	347	851	12.37	-58
Balrampur	3,349	144	253	135	532	15.89	35
Ballia	2,981	-	-	23	23	0.77	13
Banda	4,532	-	27	76	103	2.27	-80
Barabanki	4,402	-	4	82	86	1.95	-4
Bareilly	4,120	-	7	36	43	1.04	9
Basti	2,688	-	6	12	18	0.67	13
Bijnor	4,561	42	252	129	423	9.27	36
Budaun	5,168	-	16	26	42	0.81	12
Bulandshahar	2,910	-	35	81	116	3.99	32
Chandauli	2,549	2	190	327	519	20.36	44
Chitrkoot	3,092	-	346	208	554	17.92	73
Deoria	2,538	-	1	16	17	0.67	1
Etah	4,446	-	8	81	89	2.00	-9
Etawah	2,311	-	46	139	185	8.01	-12
Faizabad	2,174	-	5	51	56	2.58	11
Farrukhabad	2,181	-	13	32	45	2.06	9
Fatehpur	4,152	-	6	36	42	1.01	-12
Firozabad	2,361	-	5	39	44	1.86	1
Gautam Buddh Nagar	1,442	-	12	23	35	2.43	18
Ghaziabad	2,590	-	17	26	43	1.66	-73
Ghazipur	3,377	-	4	43	47	1.39	31
Gonda	4,003	1	59	47	107	2.67	-4
Gorakhpur	3,321	-	40	25	65	1.96	27
Hamirpur	4,282	-	67	111	178	4.16	47
Hardoi	5,986	-	7	118	125	2.09	44
Hathras	1,840	-	1	24	25	1.36	-5
Jyotiba Phule Nagar	2,249	-	30	52	82	3.65	6
Jalaun	4,565	-	68	179	247	5.41	11
Jaunpur	4,038	-	13	42	55	1.36	19

Jhansi	5,024	-	34	168	202	4.02	26
Kannauj	2,093	-	-	29	29	1.39	19
Kanpur Nagar & Dehat	6,176	-	16	97	113	1.83	-105
Kaushambi	2,124	-	9	22	31	1.46	28
Kheri[T]	7,680	366	502	446	1,314	17.11	-149
Kushinagar	2,906	-	4	30	34	1.17	25
Lalitpur	5,039	-	146	426	572	11.35	14
Lucknow	2,528	-	115	183	298	11.79	169
Maharaj Ganj	2,952	202	141	118	461	15.62	17
Mahoba	2,884	-	20	74	94	3.26	12
Mainpuri	2,760	-	1	15	16	0.58	-33
Mathura	3,340	-	7	54	61	1.83	8
Mau	1,713	-	1	17	18	1.05	15
Meerut	2,590	-	30	32	62	2.39	-110
Mirzapur	4,521	-	316	466	782	17.30	151
Moradabad	3,718	-	4	21	25	0.67	8
Muzzaffarnagar	4,008	-	13	27	40	1.00	0
Orraiya	2,015	-	10	59	69	3.42	-2
Pilibhit	3,499	290	204	203	697	19.92	13
Pratapgarh	3,717	-	28	67	95	2.56	57
Raibareli	4,609	-	6	91	97	2.10	34
Rampur	2,367	3	20	49	72	3.04	-13
Saharanpur	3,689	-	147	224	371	10.06	82
Sant Kabir Nagar	1,646	-	-	2	2	0.12	2
Sant Ravidas Nagar	1,015	-	-	1	1	0.10	1
Shahjahanpur	4,575	20	54	44	118	2.58	9
Siddharth Nagar	2,895	-	10	29	39	1.35	-35
Sitapur	5,743	-	15	201	216	3.76	-132
Sonbhadra	6,788	17	846	1,606	2,469	36.37	-28
Sultanpur	4,436	-	18	157	175	3.94	87
Unnao	4,558	-	34	197	231	5.07	193
Varanasi	1,528	-	1	11	12	0.79	11
Total	**240,928**	**1,297**	**4,699**	**8,122**	**14,118**	**5.86**	**372**

Table 7.27b: Forest cover change matrix of Uttar Pradesh

					(sq.km)
	2003 Assessment				
2001 Assessment	Dense forest	Open forest	Scrub	Non-forest	Total 2001
Dense forest	4,799	1,404	20	2,742	8,965
Open forest	692	3,642	88	359	4,781
Scrub	29	158	312	179	678
Non-forest	476	2,918	329	222,781	226,504
Total 2003	5,996	8,122	749	226,061	240,928
Net change	-2,969	3,341	71	-443	

7.28. UTTRANCHAL

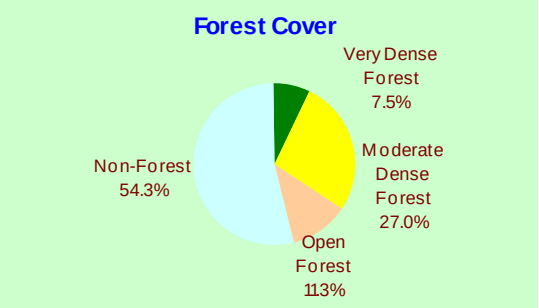
Geographic Area	53,483 km^2 (1.6% of country)
Population	8.48 million (0.8% of country)
Urban	2.17 million (25.6%)
Rural	6.31 million (74.4%)
Average Population Density	159 persons per km^2
Tribal Population	3.00%
Livestock Population	NA
No.of Districts	13
No. of Hill Districts	13
No. of Tribal Districts	0

Recorded Forest Area

Reserved Forest (RF):	23,827km^2
Protected Forest (PF):	10,673 km^2
Unclassed Forest (UF):	162 km^2
Total:	34,662 km^2
Of State's Geographic Area	64.81%
Of Country's Forest Area	*4.47%*

Forest Cover

Very Dense Forest:	4,002 km^2
Moderate Dense Forest:	14,420 km^2
Open Forest:	6,043 km^2
Total:	24,465 km^2
Of State's Geographic Area:	*45.74 %*
Of Country's Forest Cover:	*3.60 %*



Tree Cover

Culturable Non-Forest Area (CNFA):	13,090 km^2
No. of trees per ha of CNFA:	15.4
Tree Cover:	571 km^2
Of State's Geographic Area:	*1.07%*
Of CNFA:	*4.36%*

Forest & Tree Cover

Total Forest & Tree Cover:	25,036 km^2
Of State's Geographic Area:	*46.81 %*
Of Country's Forest & Tree Cover:	*3.22%*
Per capita Forest & Tree Cover:	0.30 ha

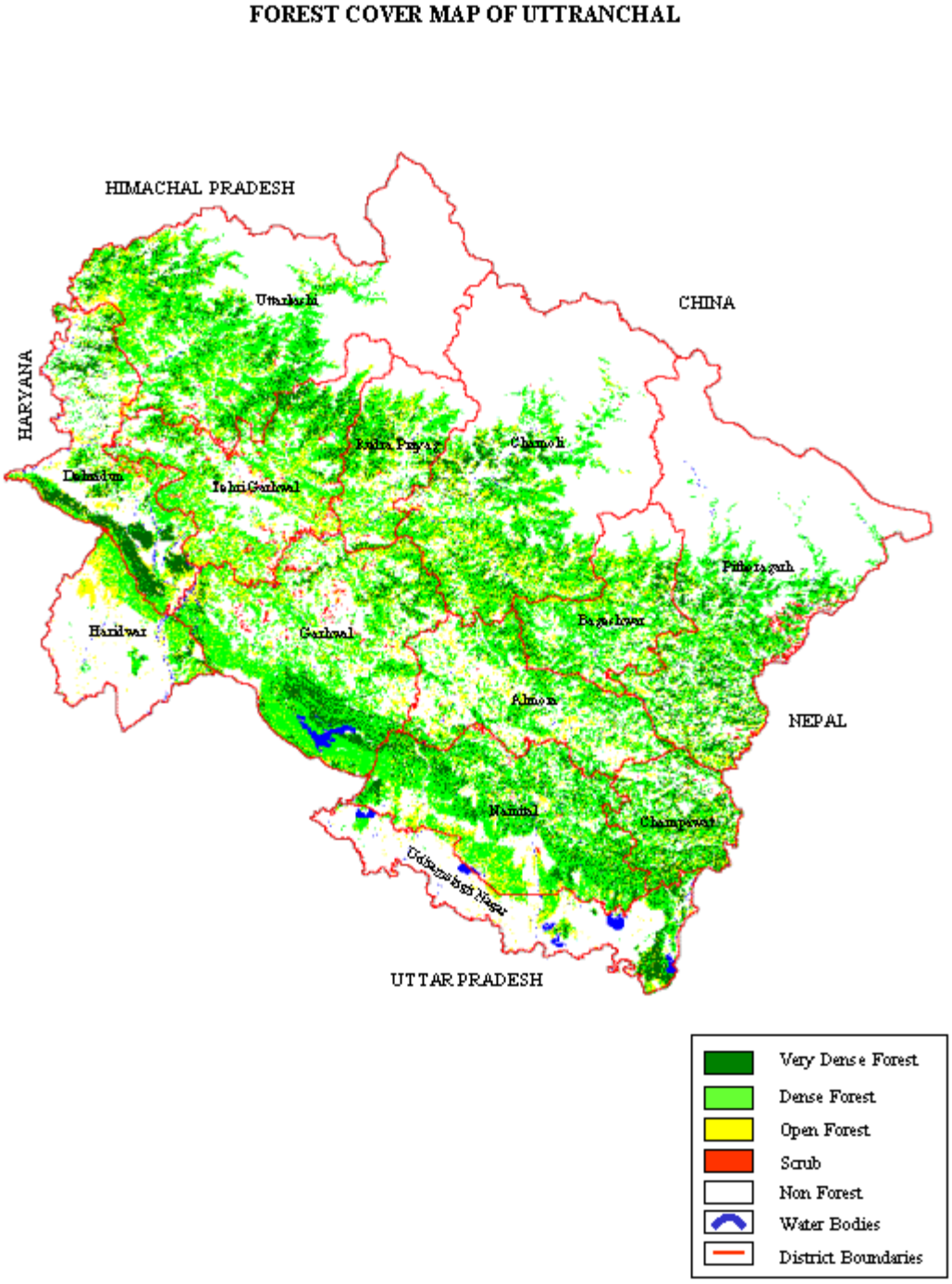

FOREST COVER MAP OF UTTRANCHAL
HIMACHAL PRADESH
CHINA
HARYANA
NEPAL
UTTAR PRADESH
Uttarkashi
Rudra Prayag
Chamoli
Dehradun
Tehri Garhwal
Pithoragarh
Haridwar
Garhwal
Bageshwar
Almora
Nainital
Champawat
Udhamsingh Nagar
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.28

Table 7.28a: District-wise Forest Cover (Uttaranchal)

Number of Districts: 13 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Almora[H]	3,139	168	969	440	1,577	50.24	82
Bageshwar[H]	2,246	159	875	346	1,380	61.44	83
Chamoli[H]	8,030	406	1,558	734	2,698	33.60	115
Champawat[H]	1,766	327	605	230	1,162	65.80	37
Dehradun[H]	3,088	487	664	442	1,593	51.59	107
Garhwal[H]	5,329	450	2,065	756	3,271	61.38	129
Haridwar[H]	2,360	29	333	272	634	26.86	22
Nainital[H]	4,251	548	1,944	602	3,094	72.78	-14
Pithoragarh[H]	7,090	470	1,229	378	2,077	29.29	44
Rudra Prayag[H]	1,984	179	605	336	1,120	56.45	-33
Tehri Garhwal[H]	3,642	227	1,255	656	2,138	58.70	74
Udhamsingh Nagar[H]	2,542	144	256	177	577	22.70	-192
Uttarkashi[H]	8,016	408	2,062	674	3,144	39.22	73
Total	**53,483**	**4,002**	**14,420**	**6,043**	**24,465**	**45.74**	**527**

Table 7.28b: Forest cover change matrix of Uttaranchal

(sq.km)

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	17,311	1,193	1	518	19,023
Open forest	485	4,207	3	220	4,915
Scrub	24	145	305	124	598
Non-forest	602	498	11	27,836	28,947
Total 2003	18,422	6,043	320	28,698	53,483
Net change	-601	1,128	-278	-249	

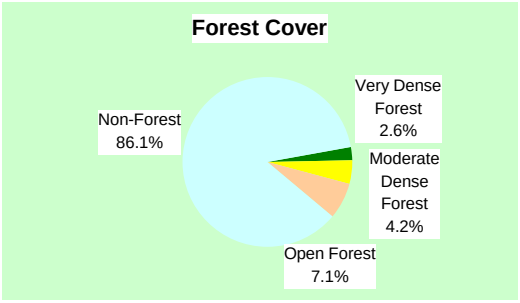
7.29. WEST BENGAL

Geographic Area	88,752 km^2 (2.7% of country)
Population	80.22 million (7.8% of country)
Urban	22.49 million (28%)
Rural	57.73 million (72%)
Average Population Density	904 persons per km^2
Tribal Population	5.60%
Livestock Population	35.1 million (7.5% of country)
No.of Districts	18
No. of Hill Districts	1
No. of Tribal Districts	11

Recorded Forest Area	
Reserved Forest (RF):	7,054 km^2
Protected Forest (PF):	3,772 km^2
Unclassed Forest (UF):	1,053 km^2
Total:	11,879 km^2
Of State's Geographic Area	*13.38%*
Of Country's Forest Area	*1.53%*

Forest Cover

Very Dense Forest	2,303 km^2
Moderate Dense Forest:	3,742 km^2
Open Forest:	6,298 km^2
Total:	12,343 km^2
Of State's Geographic Area:	*13.91 %*
Of Country's Forest Cover:	*1.82 %*



Tree Cover

Culturable Non-Forest Area (CNFA):	67,350 km^2
No. of trees per ha of CNFA:	14.4
Tree Cover:	1,731 km^2
Of State's Geographic Area:	*1.95%*
Of CNFA:	*2.57%*

Forest & Tree Cover

Total Forest & Tree Cover:	14,074 km^2
Of State's Geographic Area:	*15.86 %*
Of Country's Forest & Tree Cover:	*1.81%*
Per capita Forest & Tree Cover:	0.02 ha

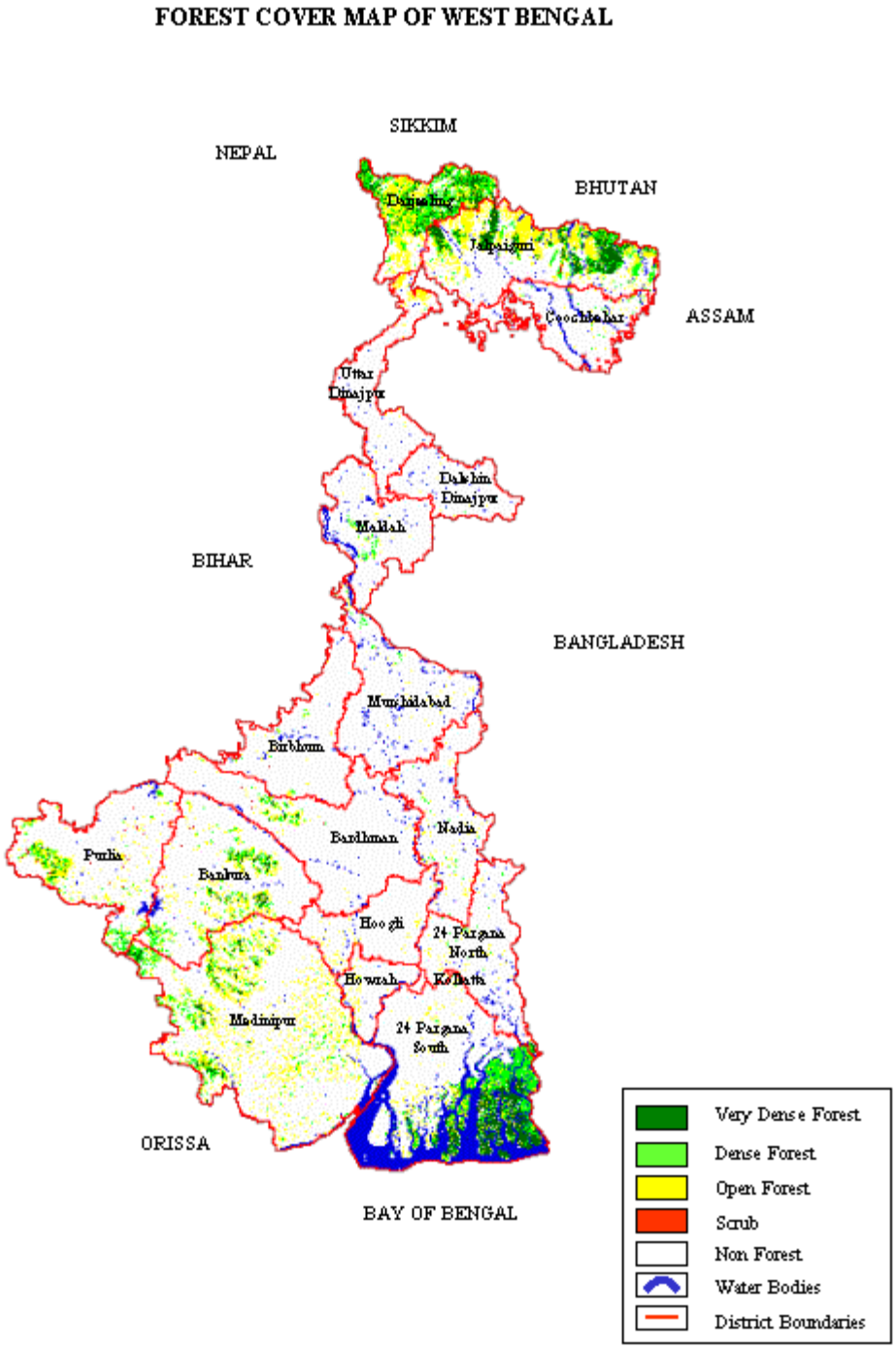

FOREST COVER MAP OF WEST BENGAL
SIKKIM
NEPAL
BHUTAN
Darjeeling
Jalpaiguri
Coochbehar
ASSAM
Uttar Dinajpur
Dakshin Dinajpur
Maldah
BIHAR
BANGLADESH
Murshidabad
Birbhum
Burdhwan
Nadia
Purlia
Bankura
Hoogli
24 Pargana North
Howrah
Kolkata
Midnipur
24 Pargana South
ORISSA
BAY OF BENGAL
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.29

Table 7.29a: District-wise Forest Cover (West Bengal)

Number of Districts: 18 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Bankura[T]	6,882	101	295	584	980	14.24	45
Bardhman[T]	7,024	16	74	135	225	3.20	23
Birbhum[T]	4,545	0	16	43	59	1.30	0
Calcutta	185	0	0	0	0	0.00	0
Coochbehar	3,387	0	25	62	87	2.57	49
Dakshin Dinajpur[T]	2,219	0	2	13	15	0.68	-1
Darjeeling[TH]	3,149	472	893	856	2221	70.53	25
Howrah	1,467	0	5	75	80	5.45	78
Hoogli	3,149	0	2	68	70	2.22	57
Jalpaiguri[T]	6,227	607	566	1,220	2,393	38.43	49
Maldah[T]	3,733	0	59	49	108	2.89	0
Midinipur[T]	14,081	186	573	1,814	2,573	18.27	1,105
Murshidabad[T]	5,324	0	25	61	86	1.62	21
Nadia	3,927	1	26	78	105	2.67	61
24 Pargana North	4,094	16	36	75	127	3.10	-11
Purulia[T]	6,259	34	234	496	764	12.21	69
24 Pargana South[T]	9,960	870	907	508	2,285	22.94	45
Uttar Dinajpur	3,140	0	4	161	165	5.25	35
Total	**88,752**	**2,303**	**3,742**	**6,298**	**12,343**	**13.91**	**1,650**

Table 7.29b: Forest cover change matrix of West Bengal

(sq.km)

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	5,367	498	1	480	6,346
Open forest	378	3,648	2	319	4,347
Scrub	2	57	72	18	149
Non-forest	298	2,095	0	75,517	77,910
Total 2003	6,045	6,298	75	76,334	88,752
Net change	-301	1,951	-74	-1,576	

7.30. ANDAMAN & NICOBAR ISLANDS

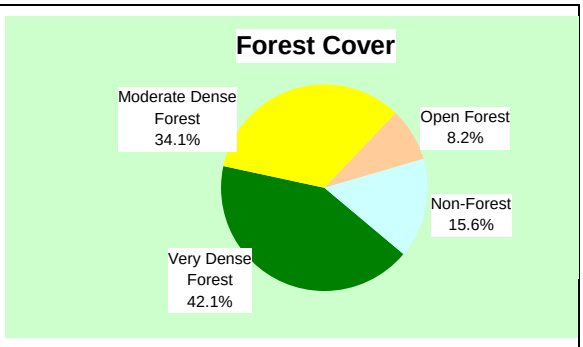
Geographic Area	8,249 km^2 (0.3% of country)
Population	0.36 million (0.03% of country)
Urban	0.12 million (32.7%)
Rural	0.24 million (67.3%)
Average Population Density	43 persons per km^2
Tribal Population	9.50%
Livestock Population	0.15 million (0.03% of country)
No.of Districts	2
No. of Hill Districts	0
No. of Tribal Districts	2

Recorded Forest Area

Reserved Forest (RF):	2,929 km^2
Protected Forest (PF):	4,242 km^2
Unclassed Forest (UF):	0 km^2
Total:	7,171 km^2
Of State's Geographic Area	*86.93%*
Of Country's Forest Area	*0.93%*

Forest Cover

Very Dense Forest:	3,475 km^2
Moderate Dense Forest:	2,809 km^2
Open Forest:	680 km^2
Total:	6,964 km^2
Of UT's Geographic Area:	*84.42 %*
Of Country's Forest Cover:	*1.03 %*



Tree Cover

Culturable Non-Forest Area (CNFA):	973 km^2
No. of trees per ha of CNFA:	12.1
Tree Cover:	33 km^2
Of UT's Geographic Area:	*0.40%*
Of CNFA:	*3.42%*

Forest & Tree Cover

Total Forest & Tree Cover:	6,997 km^2
Of UT's Geographic Area:	*84.82%*
Of Country's Forest & Tree Cover:	*0.90%*
Per capita Forest & Tree Cover:	1.94 ha

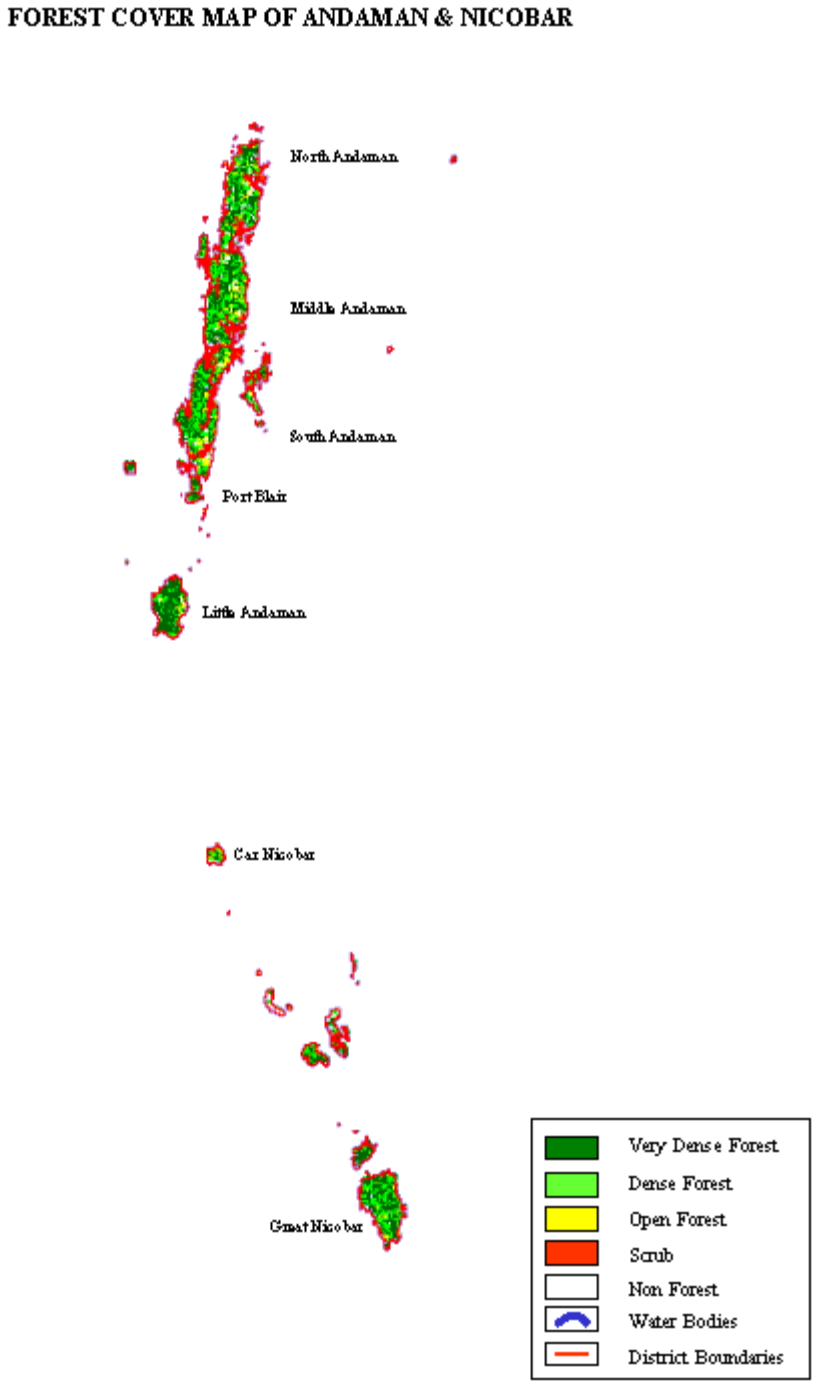

FOREST COVER MAP OF ANDAMAN & NICOBAR
North Andaman
Middle Andaman
South Andaman
Port Blair
Little Andaman
Car Nicobar
Great Nicobar
Very Dense Forest
Dense Forest
Open Forest
Scrub
Non Forest
Water Bodies
District Boundaries

Fig. 7.30

Table 7.30a: District-wise Forest Cover (Andaman & Nicobar)

Number of Districts: 2 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Andaman[T]	6,408	2,613	2,202	572	5,387	84.07	-13
Nicobar[T]	1,841	862	607	108	1,577	85.66	47
Total	**8,249**	**3,475**	**2,809**	**680**	**6,964**	**84.42**	**34**

Table 7.30b: Forest cover change matrix of Andaman & Nicobar Islands

(sq.km)

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	6,281	228	0	84	6,593
Open forest	3	321	0	13	337
Scrub	0	0	0	0	0
Non-forest	0	131	1	1,187	1,319
Total 2003	6,284	680	1	1,284	8,249
Net change	-309	343	1	-35	

7.31. CHANDIGARH

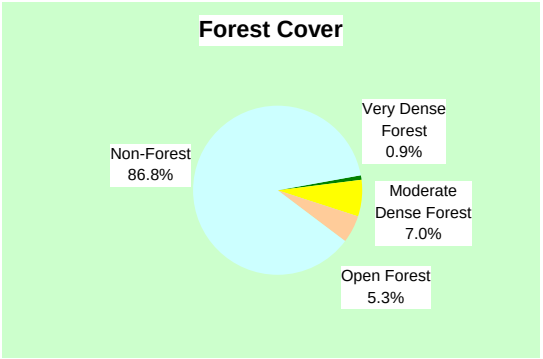
Geographic Area	114 km^2 (0.003% of country)
Population	0.9 million (0.08% of country)
Urban	0.81 million (89.8%)
Rural	0.09 million (10.2%)
Average Population Density	7,903 persons per km^2
Tribal Population	---
Livestock Population	0.03 million (0.006% of country)
No.of Districts	1
No. of Hill Districts	0
No. of Tribal Districts	0

Recorded Forest Area

Reserved Forest (RF):	31 km^2
Protected Forest (PF):	0 km^2
Unclassed Forest (UF):	3 km^2
Total:	34 km^2
Of State's Geographic Area	*29.82%*
Of Country's Forest Area	*0.005%*

Forest Cover

Very Dense Forest:	1 km^2
Moderate Dense Forest:	8 km^2
Open Forest:	6 km^2
Total:	15 km^2
Of UT's Geographic Area:	*13.16 %*
Of Country's Forest Cover:	*0.002 %*



Tree Cover	
Culturable Non-Forest Area (CNFA):	76 km^2
No. of trees per ha of CNFA:	33.6
Tree Cover:	8 km^2
Of UT's Geographic Area:	*7.09%*
Of CNFA:	*10.53%*

Forest & Tree Cover	
Total Forest & Tree Cover:	23 km^2
Of UT's Geographic Area:	*20.18 %*
Of Country's Forest & Tree Cover:	*0.003%*
Per capita Forest & Tree Cover:	0.03 ha

FOREST COVER MAP OF CHANDIGARH

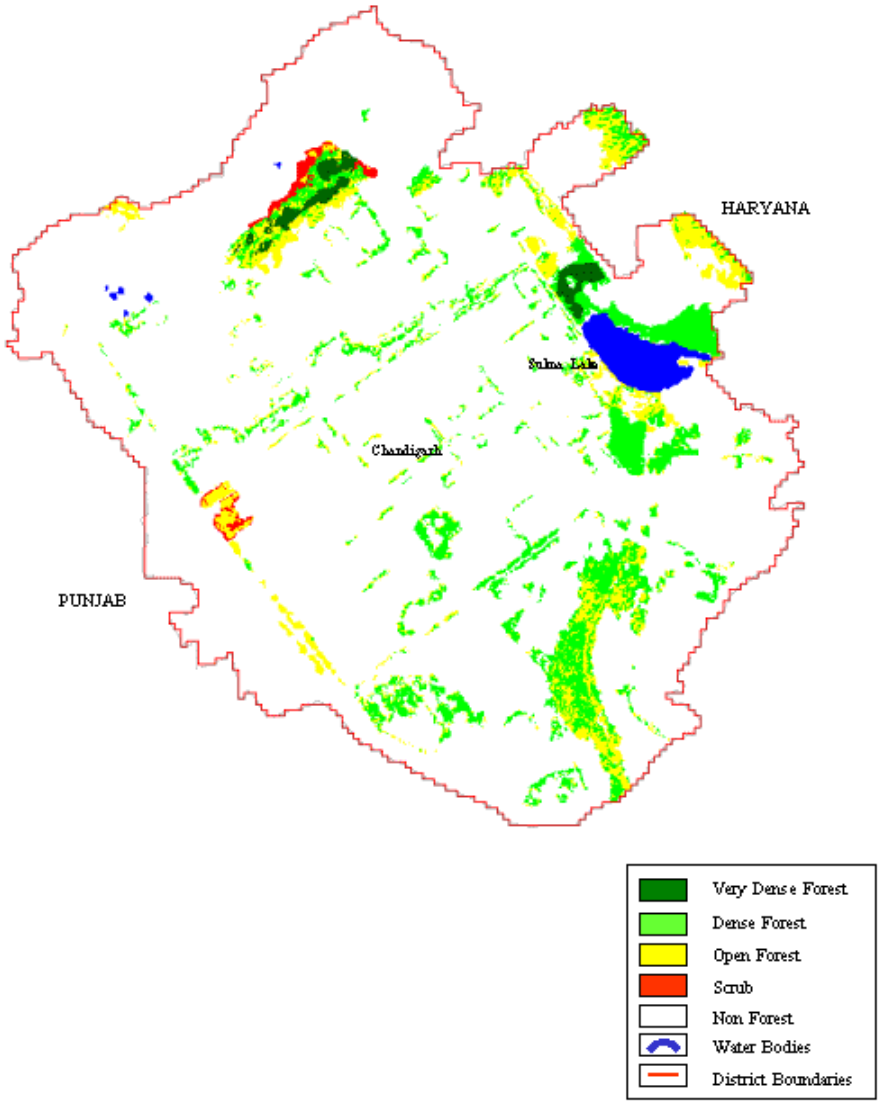


Fig. 7.31

Table 7.31a: District-wise Forest Cover (Chandigarh)

Number of Districts: 1 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Chandigarh	114	1	8	6	15	13.16	6
Total	**114**	**1**	**8**	**6**	**15**	**13.16**	**6**

Table 7.31b: Forest cover change matrix of Chandigarh

(sq.km)

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	3	1	0	1	5
Open forest	2	2	0	0	4
Scrub	0	0	0	0	0
Non-forest	4	3	1	97	105
Total 2003	9	6	1	98	114
Net change	4	2	1	-7	

7.32. DADRA & NAGAR HAVELI

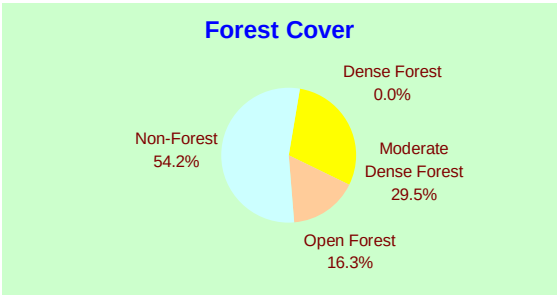
Geographic Area	491 km^2 (0.15% of country)
Population	0.22 million (0.02% of country)
Urban	0.05 million (22.9%)
Rural	0.17 million (77.1%)
Average Population Density	449 persons per km^2
Tribal Population	79.00%
Livestock Population	0.07 million (0.01% of country)
No.of Districts	1
No. of Hill Districts	0
No. of Tribal Districts	1

Recorded Forest Area

Reserved Forest (RF):	199 km^2
Protected Forest (PF):	5 km^2
Unclassed Forest (UF):	0 km^2
Total:	204 km^2
Of State's Geographic Area	41.55%
Of Country's Forest Area	*0.026%*

Forest Cover

Very Dense Forest:	0 km^2
Moderate Dense Forest:	145 km^2
Open Forest:	80 km^2
Total:	225 km^2
Of UT's Geographic Area:	*45.82 %*
Of Country's Forest Cover:	*0.033%*



Tree Cover	
Culturable Non-Forest Area (CNFA):	233 km^2
No. of trees per ha of CNFA:	21.0
Tree Cover:	35 km^2
Of UT's Geographic Area:	*7.10%*
Of CNFA:	*15.02%*

Forest & Tree Cover	
Total Forest & Tree Cover:	260 km^2
Of UT's Geographic Area:	*52.95 %*
Of Country's Forest & Tree Cover:	*0.03%*
Per capita Forest & Tree Cover:	0.12 ha

FOREST COVER MAP OF DADRA AND NAGAR HAVELI

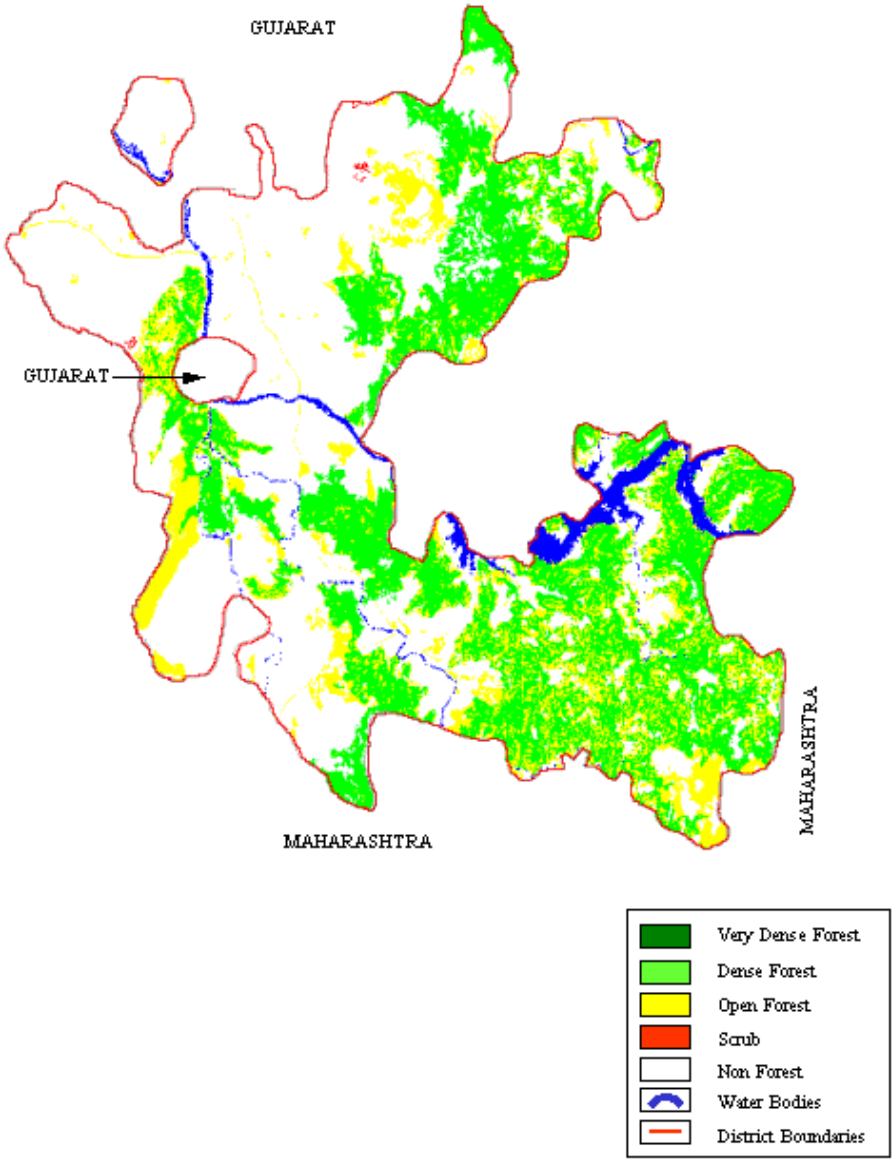


Fig. 7.32

Table 7.32a: District-wise Forest Cover (Dadra & Nagar Haveli)

Number of Districts: 1 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Dadra & Nagar Haveli[T]	491	0	145	80	225	45.82	6
Total	**491**	**0**	**145**	**80**	**225**	**45.82**	**6**

Table 7.32b: Forest cover change matrix of Dadra Nagar Haveli

(sq.km)

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	145.00	5.17	0	0.83	151
Open forest	0	67.52	0	0.48	68
Scrub	0	0	0	0	0
Non-forest	0	7.31	0	264.69	272
Total 2003	145	80	0	266	491
Net change	-6	12	0	-6	

7.33. DAMAN AND DIU

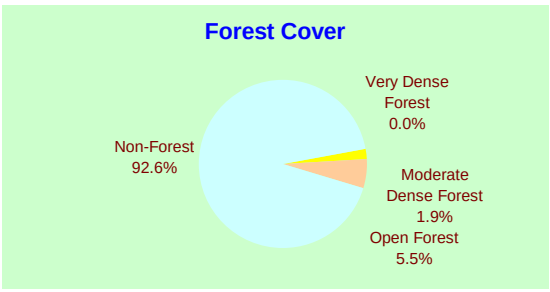
Geographic Area	112 km^2 (0.003% of country)
Population	0.16 million (0.01% of country)
Urban	0.06 million (36.3%)
Rural	0.10 (63.7%)
Average Population Density	1,411 persons per km^2
Tribal Population	11.50%
Livestock Population	0.01 million (0.002% of country)
No.of Districts	2
No. of Hill Districts	0
No. of Tribal Districts	1

Recorded Forest Area

Reserved Forest (RF):	0 km^2
Protected Forest (PF):	1 km^2
Unclassed Forest (UF):	0 km^2
Total:	1 km^2
Of State's Geographic Area	*0.89%*
Of Country's Forest Area	*0.0001%*

Forest Cover

Very Dense Forest:	0 km^2
Moderate Dense Forest:	2.17 km^2
Open Forest:	6.17 km^2
Total:	8.34 km^2
Of UT's Geographic Area:	*7.45 %*
Of Country's Forest Cover:	*0.001 %*



Tree Cover	
Culturable Non-Forest Area (CNFA):	96 km^2
No. of trees per ha of CNFA:	10.6
Tree Cover:	6 km^2
Of UT's Geographic Area:	*5.23%*
Of CNFA:	*6.25%*

Forest & Tree Cover	
Total Forest & Tree Cover:	14.34 km^2
Of UT's Geographic Area:	*12.80%*
Of Country's Forest & Tree Cover:	*0.002 %*
Per capita Forest & Tree Cover:	0.01 ha

FOREST COVER MAP OF DAMAN AND DIU

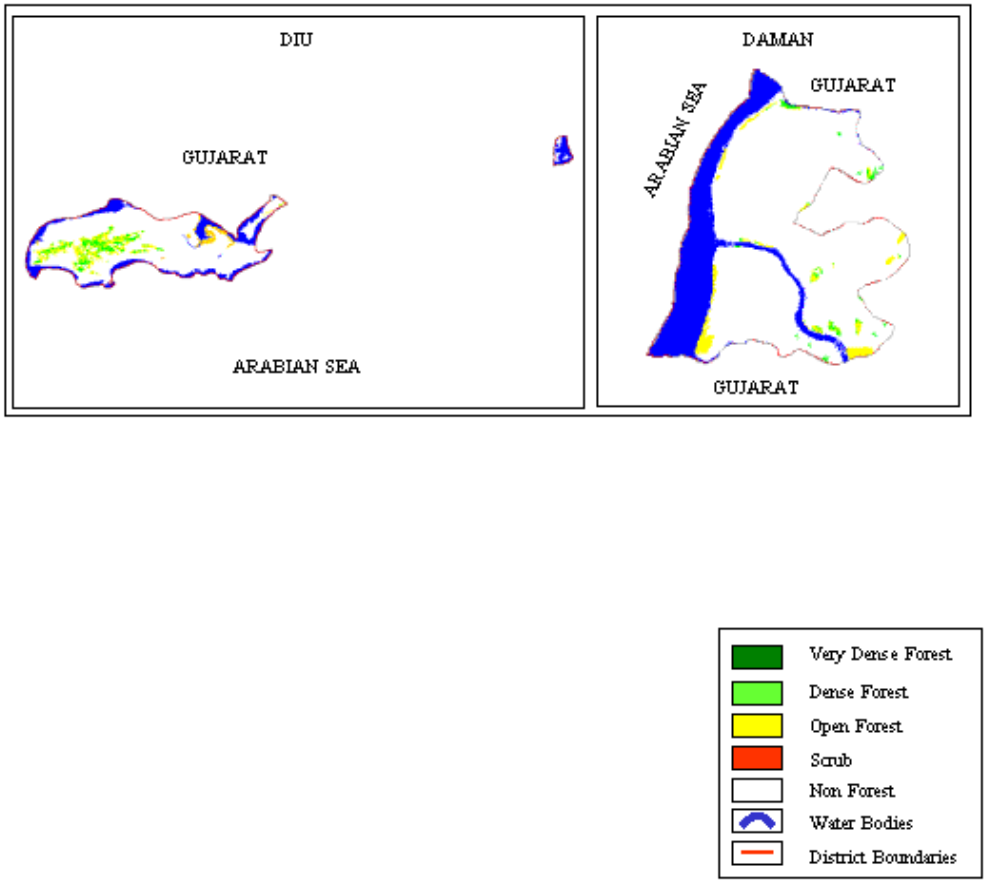


Fig. 7.33

Table 7.33a: District-wise Forest Cover (Daman & Diu)

Number of Districts: 2 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Daman[T]	72	0	0.63	2.37	3	4.17	0.57
Diu	40	0	1.54	3.8	5.34	13.35	1.58
Total	**112**	**0**	**2.17**	**6.17**	**8.34**	**7.45**	**2.15**

Table 7.33b: Forest cover change matrix of Daman & Diu

(sq.km)

2001 Assessment	2003 Assessment				Total 2001
	Dense forest	Open forest	Scrub	Non-forest	
Dense forest	1.39	0.00	0.00	0.35	1.74
Open forest	0.34	3.08	0.00	0.03	3.45
Scrub	0.00	0.00	0.00	0.00	0.00
Non-forest	0.44	2.09	0.00	103.28	105.81
Total 2003	2.17	5.17	0.00	103.66	111.00
Net change	0.43	1.72	0.00	-2.15	

7.34 LAKSHADWEEP

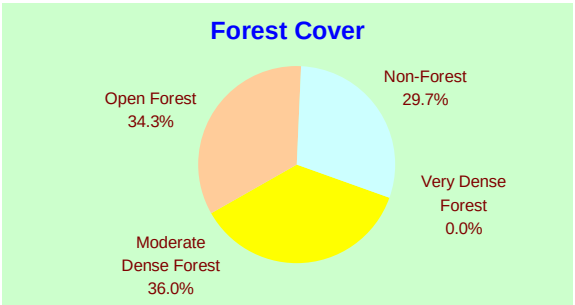
Geographic Area	32 km^2 (0.001% of country)
Population	0.061 million (0.005% of country)
Urban	0.027 million (44.5%)
Rural	0.034 million (55.5%)
Average Population Density	1,894 persons per km^2
Tribal Population	93.20%
Livestock Population	0.02 million (0.004% of country)
No.of Districts	1
No. of Hill Districts	0
No. of Tribal Districts	1

Recorded Forest Area

Reserved Forest (RF):	0 km^2
Protected Forest (PF):	0 km^2
Unclassed Forest (UF):	0 km^2
Total:	0 km^2
Of State's Geographic Area	0.00%
Of Country's Forest Area	*0.00%*

Forest Cover

Very Dense Forest:	0 km^2
Moderate Dense Forest:	12 km^2
Open Forest:	11 km^2
Total:	23 km^2
Of UT's Geographic Area:	*71.88 %*
Of Country's Forest Cover:	*0.0 %*



Tree Cover	
Culturable Non-Forest Area (CNFA):	25 km^2
No. of trees per ha of CNFA:	13.7
Tree Cover:	2 km^2
Of UT's Geographic Area:	*7.24%*
Of CNFA:	*9.01%*

Forest & Tree Cover	
Total Forest & Tree Cover:	25 km^2
Of UT's Geographic Area:	*76.56 %*
Of Country's Forest & Tree Cover:	*0.003 %*
Per capita Forest & Tree Cover:	0.05 ha

Table 7.34a: District-wise Forest Cover (Lakshdweep)

Number of Districts: 1 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Lakshdweep[T]	32	0	11.52	10.98	22.5	70.31	-4.99
Total	**32**	**0**	**11.52**	**10.98**	**22.5**	**70.31**	**-4.99**

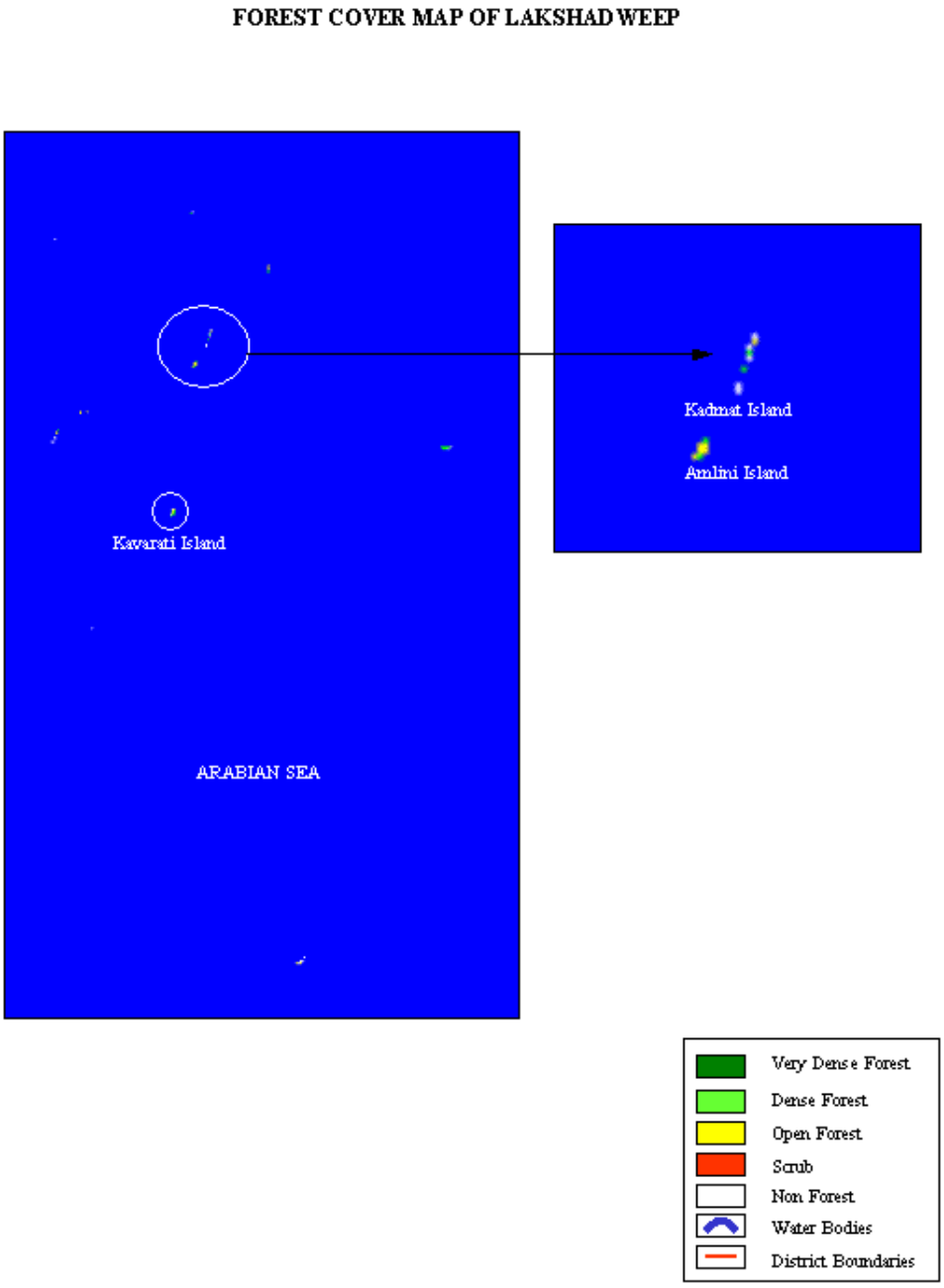


Fig. 7.34

Table 7.34b: Forest cover change matrix of Lakshedweep

					(sq.km)
	2003 Assessment				
2001 Assessment	Dense forest	Open forest	Scrub	Non-forest	Total 2001
Dense forest	11.52	10.98	0	4.99	27.49
Open forest	0	0	0	0	0
Scrub	0	0	0	0	0
Non-forest	0	0	0	4.51	4.51
Total 2003	11.52	10.98	0	9.58	32.00
Net change	-15.97	10.98	0	4.99	

7.35. PONDICHERRY

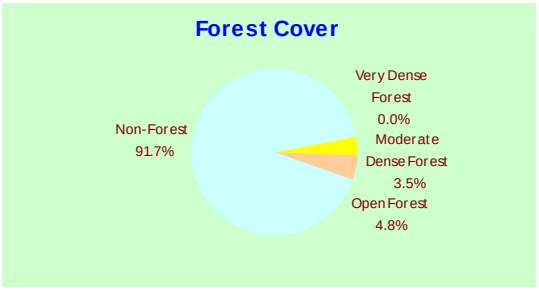
Geographic Area	480 km^2 (0.015% of country)
Population	0.97 million (0.1% of country)
Urban	0.65 million (66.6%)
Rural	0.32 million (33.4%)
Average Population Density	2,029 persons per km^2
Tribal Population	NA
Livestock Population	0.14 million (0.03% of country)
No.of Districts	4
No. of Hill Districts	0
No. of Tribal Districts	0

Recorded Forest Area

Reserved Forest (RF):	0 km^2
Protected Forest (PF):	0 km^2
Unclassed Forest (UF):	0 km^2
Total:	0 km^2
Of State's Geographic Area	0.00%
Of Country's Forest Area	*0.00%*

Forest Cover

Very Dense Forest:	0 km^2
Moderate Dense Forest:	17 km^2
Open Forest:	23 km^2
Total:	40 km^2
Of UT's Geographic Area:	*8.33 %*
Of Country's Forest Cover:	*0.01 %*



Tree Cover

Culturable Non-Forest Area (CNFA):	426 km^2
No. of trees per ha of CNFA:	18.8
Tree Cover:	35 km^2
Of UT's Geographic Area:	*7.19%*
Of CNFA:	*8.21%*

Forest & Tree Cover

Total Forest & Tree Cover:	75 km^2
Of UT's Geographic Area:	*15.42%*
Of Country's Forest & Tree Cover:	*0.01 %*
Per capita Forest & Tree Cover:	0.01 ha

FOREST COVER MAP OF PONDICHERRY

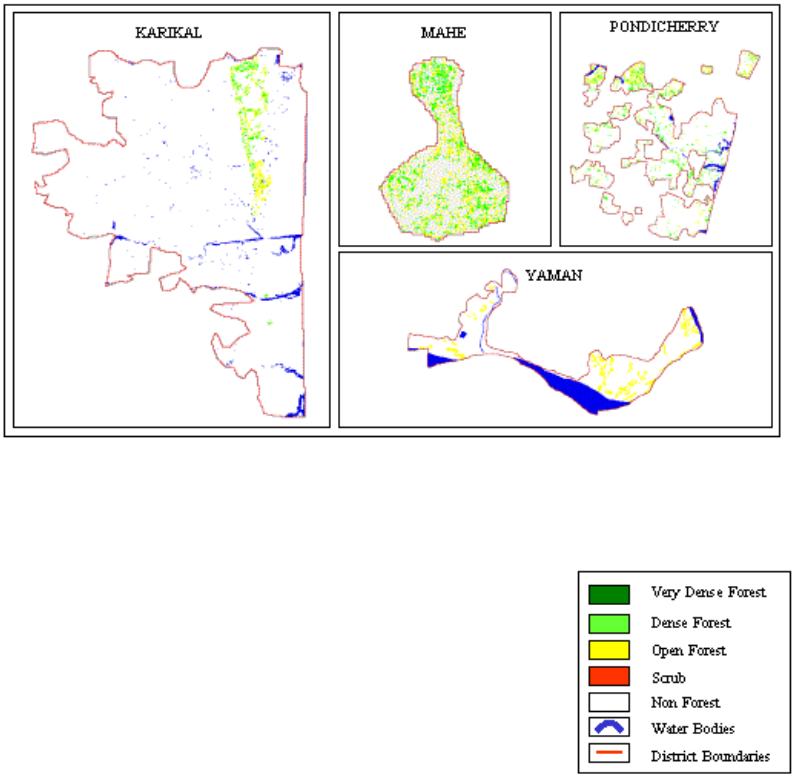


Fig. 7.35

Table 7.35a: District-wise Forest Cover (Pondicherry)

Number of Districts: 4 (Area in km^2)

District	Geographic Area	Forest Cover				Percent	Change
		Very Dense	Moderate Dense	Open Forest	Total Forest		
Karaikal	161	0	1	2	3	1.86	2
Mahe	9	0	1	2	3	33.33	3
Pondicherry	293	0	15	17	32	10.92	0
Yanam	17	0	0	2	2	11.76	-1
Total	**480**	**0**	**17**	**23**	**40**	**8.33**	**4**

Table 7.33b: Forest cover change matrix of Pondicherry

					(sq.km)
	2003 Assessment				
2001 Assessment	Dense forest	Open forest	Scrub	Non-forest	Total 2001
Dense forest	13	21	0	1	35
Open forest	0	1	0	0	1
Scrub	0	0	0	0	0
Non-forest	4	1	0	439	444
Total 2003	17	23	0	440	480
Net change	-18	22	0	-4	

7.36: INDIA

Demography

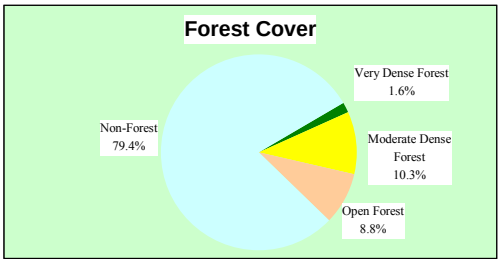
Geographic Area:	3,287,263 km^2
Human Population:	1,027,015,247
	Rural: 72.2%, Urban: 27.8%
Population Density:	312
Tribal Population:	6.3%
Livestock Population:	470.86 million

Recorded Forest Area

Reserved Forest (RF):	399,919 km^2
Protected Forest (PF):	238,434 km^2
Unclassed Forest (UF):	136,387 km^2
Total:	774,740 km^2
Of Country's Geographic Area	*23.57 %*

Forest Cover

Very Dense Forest:	51,285 km^2
Moderate Dense Forest:	339,279 km^2
Open Forest:	287,769 km^2
Total:	678,333 km^2
Of Country's Geographic Area:	*20.64 %*



Tree Cover

Culturable Non-Forest Area (CNFA):	2,188,668 km^2
No. of trees per ha of CNFA:	12.25
Tree Cover:	99,896 km^2
Of Country's Geographic Area:	*3. 04%*
Of CNFA:	*4.56%*

Forest & Tree Cover

Total Forest & Tree Cover:	778,229 km^2
Of Country's Geographic Area:	*23.68%*
Per capita Forest & Tree Cover:	0.07 ha

7.37 Overview

As per latest census report (2001), the country has 593 districts. FSI has made an attempt to provide information on forest cover for all the districts. However, due to non availability of administrative boundaries of four newly carved districts, forest cover information in case of these districts has been given as per the old undivided districts. Therefore, though the forest cover of all 593 districts has been assessed, information pertaining to 589 districts (covering entire geographic area of the country) is provided in

this report. It is found that of the total of 589 districts, the forest cover is less than 1 percent in 59 districts, between 1 and 5 percent in 140 districts, between 5 and 10 percent in 61 districts, between 10 and 20 percent in 98 districts, between 20 and 33 percent in 85 districts, between 33 and 66 percent 88 districts and over 66 percent in 58 districts. This information is presented in Table 7.36.

Table 7.36: Forest Cover Percent and Number of Districts

Forest Cover Range	Number of Districts	Cumulative			
		Forest Cover	Number of Districts	Forest Cover	Number of Districts
< 1%	59	< 1 %	59	---	---
1 % to < 5 %	140	< 5 %	199	>= 1 %	530
5 % to <10 %	61	< 10 %	260	>= 5 %	390
10 % to <20 %	98	< 20 %	358	>= 10 %	329
20 % to <33 %	85	< 33 %	443	>= 20 %	231
33 % to <67 %	88	< 67 %	531	>= 33 %	146
>= 67 %	58	---	---	>= 67 %	58
Total	589				

An overview of State and UT wise forest and tree cover is presented in Table 7.37.

Table 7.37 An Overview of State and UT wise Forest & Tree Cover

(Area in km^2)

S. No.	State/UT	Geog. Area	Recorded Forest Area		Forest Cover		Forest & Tree Cover	
			Area	(%)	Area	(%)	Area	(%)
1	Andhra Pradesh	275,069	63,821	23.20	44,419	16.15	56,539	20.55
2	Arunachal Pradesh	83,743	51,540	61.55	68,019	81.22	68,382	81.66
3	Assam	78,438	27,018	34.45	27,826	35.48	28,761	36.67
4	Bihar	94,163	6,473	6.87	5,558	5.90	7,178	7.62
5	Chhattisgarh	135,191	59,772	44.21	55,998	41.42	62,721	46.39
6	Delhi	1,483	85	5.73	170	11.47	268	18.08
7	Goa	3,702	1,224	33.06	2,156	58.24	2,292	61.91
8	Gujarat	196,022	19,113	9.75	14,946	7.62	25,532	13.03
9	Haryana	44,212	1,558	3.52	1,517	3.43	2,932	6.63
10	Himachal Pradesh	55,673	37,033	66.52	14,353	25.78	14,844	26.66
11	Jammu & Kashmir	222,236	20,230	9.10	21,267	9.57	25,093	11.29
12	Jharkhand	79,714	23,605	29.61	22,716	28.50	27,728	34.78
13	Karnataka	191,791	43,084	22.46	36,449	19.00	41,820	21.80
14	Kerala	38,863	11,268	28.99	15,577	40.08	17,480	44.98
15	Madhya Pradesh	308,245	95,221	30.89	76,429	24.79	83,679	27.15
16	Maharashtra	307,713	61,939	20.17	46,865	15.23	56,185	18.26
17	Manipur	22,327	17,418	78.01	17,219	77.12	17,355	77.73
18	Meghalaya	22,429	9,496	42.34	16,839	75.08	17,191	76.65
19	Mizoram	21,081	16,717	79.30	18,430	87.42	18,560	88.04
20	Nagaland	16,579	8,629	52.05	13,609	82.09	13,826	83.39
21	Orissa	155,707	58,136	37.34	48,366	31.06	54,747	35.16
22	Punjab	50,362	3,084	6.12	1,580	3.14	3,188	6.33

23	Rajasthan	342,239	32,488	9.49	15,826	4.62	24,464	7.15
24	Sikkim	7,096	5,841	82.31	3,262	45.97	3,284	46.28
25	Tamilnadu	130,058	22,877	17.59	22,643	17.41	27,634	21.25
26	Tripura	10,486	6,293	60.01	8,093	77.18	8,209	78.29
27	Uttar Pradesh	240,928	16,826	6.98	14,118	5.86	21,833	9.06
28	Uttaranchal	53,483	34,662	64.81	24,465	45.74	25,036	46.81
29	West Bengal	88,752	11,879	13.38	12,343	13.91	14,074	15.86
30	Andaman & Nicobar	8,249	7,171	86.93	6,964	84.42	6,997	84.82
31	Chandigarh	114	34	29.82	15	13.16	23	20.18
32	Dadra & Nagar Haveli	491	204	41.55	225	45.82	260	52.95
33	Daman & Diu	112	1	0.89	8.34	7.45	14	12.80
34	Lakshdweep	32	0	0.00	23	71.88	25	76.56
35	Pondicherry	480	0	0.00	40	8.33	75	15.42
	Total	**3,287,263**	**774,740**	**23.57**	**678,333**	**20.64**	**778,229**	**23.68**

The States and UTs can be ranked as per different criteria related to forest and tree cover. This is done in respect of six criteria mentioned below:

i) According to extent of recorded forest area
ii) According recorded forest area as percentage of geographic area;
iii) According to extent of forest cover
iv) According to forest cover as percentage of geographic area;
v) According to the extent of forest & tree cover;
vi) According to forest & tree cover as percentage of geographic area.

These rankings are displayed in Table 7.38.

Table 7.38: Ranking of 35 States and UTs

S. No.	Criteria / State/UT	Geog. Area	Recorded Forest Area		Forest Cover		Forest & Tree Cover	
			Area	(%)	Area	(%)	Area	(%)
1	Andhra Pradesh	4	2	20	6	22	8	22
2	Arunachal Pradesh	14	6	7	2	4	2	4
3	Assam	16	11	14	8	15	9	15
4	Bihar	12	24	29	25	31	24	32
5	Chhattisgarh	10	4	10	3	13	3	12
6	Delhi	30	31	31	31	26	30	25
7	Goa	29	29	15	27	9	29	9
8	Gujarat	7	15	25	18	29	11	28
9	Haryana	20	28	32	29	34	28	34
10	Himachal Pradesh	17	8	5	19	18	20	19
11	Jammu & Kashmir	6	14	27	12	27	12	30
12	Jharkhand	15	12	18	10	17	9	17
13	Karnataka	8	7	21	7	20	7	20
14	Kerala	21	20	19	17	14	17	14
15	Madhya Pradesh	2	1	16	1	19	1	18
16	Maharashtra	3	3	22	5	23	5	24
17	Manipur	23	16	4	14	6	18	6
18	Meghalaya	22	21	11	15	7	19	7
19	Mizoram	24	18	3	13	1	16	1
20	Nagaland	25	22	9	21	3	22	3

21	Orissa	9	5	13	4	16	6	16
22	Punjab	19	27	30	28	35	27	35
23	Rajasthan	1	10	26	16	33	17	33
24	Sikkim	28	26	2	26	10	26	13
25	Tamil Nadu	11	13	23	11	21	10	21
26	Tripura	26	25	8	23	5	23	5
27	Uttar Pradesh	5	17	28	20	32	15	31
28	Uttaranchal	18	9	6	9	12	13	11
29	West Bengal	13	19	24	22	24	21	26
30	A&N Islands	27	23	1	24	2	25	2
31	Chandigarh	33	32	17	34	25	34	23
32	Dadra & Nagar Haveli	31	30	12	30	11	31	10
33	Daman & Diu	34	33	33	35	30	35	29
34	Lakshdweep	35	34	35	33	8	33	8
35	Pondicherry	32	35	34	32	28	32	27

ANNEXURE-I

GLOSSARY OF IMPORTANT TERMS

Block Plantation :

Tree plantations in compact blocks of more than 0.1ha on lands outside recorded forest areas.

Canopy (or Crown) :

The cover of branches and foliage formed by the crown of trees.

Canopy Density :

Percent area of land covered by the canopy of trees. Also referred to as "Crown Density".

Cartographic Limitation/Resolution:

The minimum mapable size or dimension of features at a given map scale (about 400 ha at 1: 1 miilion, about 25 ha at 1:250,000 scale and about 1 ha at 1:50,000 scale).

Change Matrix:

It describes the change in forest cover for a given region (state or UT) over a period of two assessments by showing the extent of areas changing from one class of land cover to another between the two periods.

Crown Area:

The area of crown of individual trees computed by measuring the width of the horizontal projection of tree crown on the ground.

Culturable Non Forest Area (CNFA):

It is the net geographical area, lying outside recorded forest area and forest cover, which can support tree vegetation (thus, excluding areas under wetlands, riverbeds, perennial snow covered mountains, etc.). CNFA is the area over which the sample data on tree cover is aggregated for the assessment of tree cover.

Dense Forest:

All lands with a forest cover having a canopy density of 40 percent and above.

Digital Image Processing (DIP):

Interpretation and classification of land use or land cover from digital data (from remote sensing satellites) using computer aided technology.

Error Matrix:

It is a means to quantitatively assess the accuracy of classification of a map generated by interpretation of data obtained by remote sensing. It is a square matrix of numbers laid out in rows and columns denoting class or category of land

cover. The numbers in individual cells indicate the number of randomly selected locations that were categorised in a particular class denoted along the row but on the ground were actually found to belong to the class denoted in the column. The matrix is also known as "confusion matrix".

False Color Composite:

Product generated by combining the data contained in three different spectral bands into one image by assigning blue, green and red colour to the data in three spectral bands, respectively.

Farm Forestry:

The practice of planting/cultivating and managing trees on farms or agricultural lands.

Forest Area:

Geographic areas recorded as forests in Government records. It is also referred to as "recorded forest area".

Forest Blanks:

A part of forest area where, for any reason, only a few or no trees are growing.

Forest Cover:

All lands, more than one hectare in area, with a tree canopy density of more than 10 percent. Such lands may not be statutorily notified as forest area.

Forest Inventory:

The measuring and describing the quantity and quality of forest crop and many other characteristics of the land area upon which forest crop is growing

Geographic Area:

The total physical area within the boundaries on a map. (The geographic area of India includes area that is under illegal occupation of Pakistan and China)

Geographic Information System (GIS):

A system for capturing, storing, checking, manipulating, analysing and displaying data that are spatially referenced to the earth.

Green Wash:

The extent of wooded areas generally shown with light green tinge on the SOI maps or toposheets.

Growing Stock:

The sum-total of all the trees, by number or volume or biomass, growing within a particular area of interest.

Hill Districts:

Districts with more than 50 percent geographic area under "hill talukas" based on criteria adopted by the Planning Commission for Hill Area and Western Ghats Development Programmes.

Land Cover:

Broad land use classes interpreted from satellite data. The land cover classes used in this report are dense forest, open forest, scrub and non-forest.

Mangroves:

Salt tolerant forest ecosystem found mainly in tropical and sub-tropical coastal and/or inter-tidal regions.

Mangrove Cover:

Area covered under mangrove vegetation as interpreted digitally from remote sensing data. It is classified into dense mangrove cover (canopy density over 40 percent) and open mangrove cover (canopy density from 10 to 40 percent).

Moderately Dense Forest:

All lands with forest cover having a canopy density between 40 to 70 percent.

Net Change (in Forest Cover) :

The sum-total of positive and negative changes in forest cover within a given region that took place during the period of two assessments.

Non Forest Area:

Geographic area outside recorded forest area.

Non Forest:

Lands without any forest cover.

Open Forest:

All lands with a forest having a canopy density between 10 to 40 percent.

Protected Forest:

An area notified under the provisions of the Indian Forest Act or other State Forest Acts, having limited degree of protection. In Protected forest all activities are permitted unless prohibited.

Physiographic Zone:

A physiographic zone constitutes geographical areas that exhibit broad similarities in factors responsible for the growth of tree vegetation. Physiographic zones have been used as strata for assessing tree cover in the country.

Recorded Forest Area:

Same as "forest area"; i.e., geographic areas recorded as forests in Government records.

Reserved Forests:

An area so constituted under the provisions of the Indian Forest Act or other State Forest Acts, having full degree of protection. In Reserved forests all activities are prohibited unless permitted.

Scrub:

All lands, generally in and around forest areas, having bushes and/or poor tree growth chiefly of small or stunted trees with canopy density less than 10 percent.

Spatial Resolution:

The area on earth's surface that can be "seen" by a sensor as being separate from its surroundings and is represented by a "pixel".

Thematic Maps:

Maps, generally on 1:50,000 scale, showing forest types, major species composition, crown density and other land uses prepared by interpretation of aerial photographs and verified by ground truthing.

Tree :

Tree, in this report, denotes all perennial woody vegetation (including bamboos, palms, coconut, neem, peepal, fruit trees, etc.). It excludes non-perennial non-woody species (e.g., banana) and tall shrubs or climbers (e.g., lantana or canes). For the purpose of assessing tree cover, only those trees having diameter of 10 cm or more at breast height (1.37 m) have been considered. In case of trees having multiple branches below breast height, the individual stems with diameter over 10 cm at breast height have been considered as individual trees.

Tree Cover:

The term used in this report refers to the notional area covered by crown of trees that is too small to be delineated by digital interpretation of remote sensing data used for forest cover delineation.

Trees Outside Forests:

Tree wealth existing outside recorded forest areas.

Tribal Districts:

Districts identified as tribal districts under Tribal Sub-Plan (Government of India).

Unclassed Forests:

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

Very Dense Forest:

All lands with a forest cover having a canopy density of 70 percent and above.

Visual Interpretation:

A non-computer based method of satellite data interpretation, normally by using magnifying glass and light table.

Village Woodlot:

Naturally growing trees (sometimes supplemented with tree plantations) growing on village community land or panchayat land.

Annexure-II

Distribution of Districts Within Physiographic Zones

(Total number of Districts : 593)

S. No.	State/UT	Name of District
1. Western Himalayas: (No. of Districts: 41-complete, 4-partial) Area: 338,556 km^2		
1.	Himachal Pradesh	Bilaspur, Chamba, Hamirpur, Kangra, Kinnaur, Kullu, Lahul & Spiti, Mandi, Shimla, Sirmaur, Solan, Una.
2.	Jammu & Kashmir	Anantanag, Badgam, Baramula, Doda, Jammu, Kargil, Kathua, Kupwara, Leh (Ladakh), Pulwama, Punchh, Rajauri, Srinagar Udhampur.
3.	Sikkim	East, North, South, West.
4.	Punjab	Gurdaspur*, Hoshiarpur*, Rupnagar*.
5.	Uttaranchal	Almora, Bageshwar, Chamoli, Champawat, Dehradun, Nainital, PauriGarhwal, Pithoragarh, Rudraprayag, Tehri Garhwal, Uttarkashi.
6.	West Bengal	Darjeeling*
2. Eastern Himalyas: (No. of Districts: 10-complete) Area:65,317 km^2		
1.	Arunachal Pradesh	Dibang Valley, East Kameng, East Siang, Lower Sabansiri, Papum Pare, Tawang, Upper Siang, Upper Sabansiri, West-Kameng, West Siang.
3. North East Ranges: (No. of Districts: 43-complete, 4-Partial) Area: 133,990 km^2		
1.	Arunachal Pradesh	Changlang, Lohit, Tirap.
2.	Assam	Cachar, Golaghat*, Hailakandi, Karimganj, Karbi- Anglong* North Cachar Hills, , Nagaon*, Tinsukia*.
3.	Manipur	Bishnupur, Chandel, Churachandpur, Imphal East, Imphal West, Senapati, Tamenglong, Thoubal, Ukhrul.
4.	Meghalaya	East Garo Hills, East Khasi Hills, Jaintia Hills, RiBhoi, South Garo Hills, West Garo Hills, West Khasi Hills.
5.	Mizoram	Aizwal, Champhai, Kolasib, Lawngtlai, Lunglei, Mamit, Saiha, Serchhip.
6.	Nagaland	Dimapur, Kohima, Mokokchung, Mon, Phek, Tuensang, Wokha, Zunheboto.
7.	Tripura	Dhalai, North Tripura, South Tripura, West Tripura.
4. Northern Plains: (No. of Districts: 102-complete, 8-partial) Area: 295,780 km^2		
1.	Chandigarh	Chandigarh.
2.	Delhi	Central, East, New Delhi, North, North East, North West,

S. No.	State/UT	Name of District
		South, South West, West.
3.	Haryana	Ambala, Bhiwani, Faridabad, Fatehbad, Gurgaon, Hissar, Jhajjar, Jind, Kaithal, Karnal, Kurkshetra, Mahendragarh*, Panchkula, Panipat, Rewari, Rohtak, Sirsa, Sonipat, Yamunanagar.
4.	Punjab	Amritsar, Bathinda, Faridkot, Fatehgarh Sahib, Firozpur, Gurdaspur*, Hoshiarpur*, Jalandhar, Kapurthala,Ludhiana, Mansa, Moga, Muktsar, Nawanshahr, Patiala, Rupnagar*,Sangrur.
5.	Uttar Pradesh	Agra*, Aligarh, Allahabad*, Ambedkar Nagar, Auraiya, Azamgarh, Baghpat, Bahraich, Ballia, Balrampur, Barabanki, Bareilly, Basti, Bijnor, Budaun, Bulandshahar, Chandauli*, Deoria, Etah, Etawah, Faizabad, Farrukhabad, Fatehpur, Firozabad, Gautam Buddha Nagar, Ghaziabad, Ghazipur, Gonda, Gorakhpur, Hardoi, Hathras, Jaunpur, Jyotiba Phule Nagar, Kannauj, Kanpur Dehat, Kanpur Nagar, Kaushambi, Kheri, Kushinagar, Lucknow, Maharajganj, Mainpuri, Mathura, Mau, Meerut, Mirzapur*, Moradabad, Muzaffarnagar, Pilibhit, Pratapgarh, RaiBareli, Rampur, Saharanpur, Sant Kabir Nagar, Sant Ravidas Nagar, Shahjahanpur, Sharavasti, Siddharth Nagar, Sitapur, Sultanpur, Unnao, Varanasi.
6.	Uttaranchal	Hardwar, Udhamsingh Nagar.
5. Eastern Plains: (No. of Districts: 62-complete, 11-partial) Area: 223,339 km^2		
1.	Assam	Barpeta, Bongaigaon, Darrang, Dhemaji, Dhubri, Dibrugarh, Goalpara, Golaghat*, Jorhat, Kamrup, Karbi Anglong*, Kokrajhar, Lakhimpur, Marigaon, Nagaon*, Nalbari, Sibsagar, Sonitpur, Tinsukia*.
2.	Bihar	Araria, Aurangabad, Banka*, Begusarai, Bhagalpur, Bhojpur, Buxar, Darbhanga, Gaya*, Gopalganj, Jamui*, Jehanabad, Kaimur(Bhabua)*, Katihar, Khagaria, Kishanganj, Lakhisarai*, Madhepura, Madhubani, Munger*, Muzaffarpur, Nalanda, Nawada, Paschim Champaran, Patna, Purba Champaran, Purnia, Rohtas, Saharsa, Samastipur, Saran, Sheikhpura, Sheohar, Sitamarhi, Siwan, Supaul, Vaishali.
3.	West Bengal	Bankura, Bardhaman, Birbhum, Dakshin Dinajpur, Darjiling*, Hawra, Hoogli, Jalpaiguri, Coochbehar, Kolkata, Maldah, Medinipur, Murshidabad, Nadia, North- 24 Parganas, South-24 Parganas, Uttar Dinajpur.
6. Western Plains: (No. of Districts: 17-complete, 8-partial) Area: 319,098 km^2		
1.	Daman & Diu	Diu
2.	Gujarat	Ahmadabad*, Amreli, Banas Kantha*, Bhavnagar, Jamnagar,

S. No.	State/UT	Name of District
		Junagarh, Kuchchh, Patan*, Porbandar, Rajkot, Surendranagar.
3.	Rajasthan	Barmer, Bikaner, Churu, Ganganagar, Hanumangarh, Jaisalmer, Jalor, Jhunjhunu*, Jodhpur, Nagaur*, Pali*, Sikar*, Sirohi*.
7. Central Highlands: (No. of Districts: 52-complete, 19-partial) Area: 373,675 km^2		
1.	Bihar	Kaimur* (Bhabua).
2.	Gujrat	Sabar Kantha*.
3.	Haryana	Mahendargarh*.
4.	Madhya Pradesh	Bhind, Bhopal, Chhatarpur, Damoh, Datia, Dewas, Dhar*, Guna, Gwalior, Indore, Jabalpur*, Jhabua*,Katni*, Mandsaur, Morena, Narsimha-Pur*, Neemuch, Panna, Raisen, Rajgarh, Ratlam, Rewa, Sagar, Satna, Sehore, Shajapur, Sheopur, Shivpuri, Tikamgarh,Ujjain, Vidisha,WestNimar*.
3.	Rajasthan	Ajmer, Alwar, Banswara, Baran, Bharatpur, Bhilwara, Bundi, Chittaurgarh, Dausa, Dhaulpur, Dungarpur, Jaipur, Jhalawar, Jhunjhunu*, Karauli, Kota, Nagaur,* Pali*, Rajsamand, Sawai Madhopur, Sikar*, Sirohi*, Tonk, Udaipur.
4.	Uttar Pradesh	Agra*, Allahabad*, Banda, Chandauli*, Chitarkoot, Hamirpur, Jalaun, Jhansi, Lalitpur, Mahoba, Mirzapur*, Sonbhadra*.
8. North Deccan: (No. of Districts: 33-complete, 15-partial) Area: 355,988 km^2		
1.	Gujarat	Narmada, Vadodara*.
2.	Madhya Pradesh	Balaghat, Barwani, Betul, Chhindwara, Dhar*, Dindori, East Nimar, Harda, Hosangabad, Jabalpur*, Jhabua*, Mandla, Narsingpur*, Seoni, Shahdol*, Umaria*, West Nimar*,
3.	Maharashtra	Ahmadnagar, Akola, Amrawati, Aurangabad, Bhandara, Bid, Buldana, Chandrapur, Dhule*, Gadchiroli, Gondiya, Hingoli, Jalgoan, Jalna, Kolhapur*, Latur, Nagpur, Nanded, Nandurbar*, Nashik*, Osmanabad, Parbhani, Pune*, Sangli*, Satara*, Solapur, Wardha, Washim, Yavatmal.
9. East Deccan: (No. of Districts: 48-complete, 15-partial) Area: 336,289 km^2		
1.	Bihar	Banka*, Gaya*, Jamui*, Lakhisarai*, Maungar* .
2.	Chhattisgarh	Bastar, Bilaspur, Dantewada, Dhamtari, Durg, Janjgir-Champa, Jashpur, Kanker, Kawardha, Korba, Koriya, Mahasamund, Raigarh, Raipur, Rajnandgaon, Surguja
3.	Jharkhand	Bokaro, Chatra, Deoghar, Dhanbad, Dumka, Garhwa, Giridih, Godda, Gumla, Hazaribagh, Kodarma, Lohardaga, Pakaur, Palamu, Pashchimi Singhbhum, Purbi Singhbhum, Ranchi, Sahibaganj.

S. No.	State/UT	Name of District
4.	Madhya Pradesh	Katni*, Shahdol*, Sidhi, Umaria*.
5.	Orissa	Anugul, Balangir, Balasore*, Bargarh, Cuttack*,Debagarh, Dhenkanal, Jajapur*, Jharsuguda, Kalahandi*, Kendujhar, Koraput*, Mayurbhanj*, Nabarangapur, Nuapada, Sambalpur, Sonapur, Sundargarh.
6.	Uttar Pradesh	Sonbhadra*.
7.	West Bengal	Puruliya.
10. South Deccan: (No. of Districts: 26-complete, 11-partial) Area: 292,416 km^2		
1.	Andhra Pradesh	Adilabad, Anantpur*, Hydrabad, Karimnagar, Khammam*, Kurnool*, Mahboob Nagar*, Medak, Nalgonda*, Nizamabad, Ranga Reddy, Warangal.
2.	Karnataka	Bagalkot, Banglore, Banglore Rural, Belgaum, Bellary, Bidar, Bijapur, Chamarajanagar*, Chikmagalur*, Chitradurga, Davanagere, Dharwad, Gadag, Gulbarga, Hassan, Haveri, Kodagu*, Kolar*, Koppal, Mandya, Mysore, Raichur, Shimoga*, Tumkur, Uttar kannada*.
11. Western Ghats: (No. of Districts: 5-complete, 30-partial) Area: 72,381 km^2		
1.	Dadra & Nagar Haveli	Dadra & Nagar Haveli.
2.	Gujarat	Navsari*, Surat*, The Dangs, Valsad*.
3.	Karnataka	Chikmangalur*, Dakshina kannada*, Kodagu*, Shimoga*, Udupi*, Uttar Kannad*.
4.	Kerala	Ernakulam*, Idukki, Kasaragod*, Kollam*, Kottayam*, Palakkad*, Pathanmitta*, Wayanad.
5.	Maharashtra	Dhule*, Kolhapur*, Nandurbar*, Nashik*, Pune*, Raigarh*, Ratnagiri*, Sangli*, Satara*, Sindhudurg*, Thane*.
5.	Tamilnadu	Coimbatore*, Kanniyakumari*, The Nilgiris, Tiruneiveli*, Theni*.
12. Eastern Ghats: (No. of Districts: 12-complete, 28-partial) Area: 191,698 km^2		
1.	Andhra Pradesh	Anantapur*,Chittoor, Cuddapah, East Godawari*, Guntur*, Khammam*, Krishna*, Kurnul*,Mahaboobnagar*, Nalgonda*, Nellore*, Prakasham*, Srikakulam*, Visakhapatnam*, Vizianagaram*, West Godawari*.
2.	Orissa	Baudh, Gajpati, Ganjam*, Kalahandi*, Kandhamal, Kordha*, Koraput*, Malkangiri, Nayagarh, Rayagada.
3.	Karnataka	Chamrajnagar*, Kolar*.
4.	Tamilnadu	Coimbatore*, Dharmapuri, Dindigul, Erode, Karur*, Madurai*, Tiruchirapalli*, Tiruvanamalai*, Namakkal, Salem*, Theni*, Vellore*.

S. No.	State/UT	Name of District
13. **West Coast: (No. of Districts: 20-complete, 21-partial) Area: 121,242 km^2**		
1.	Daman & Diu	Daman.
2.	Goa	North Goa, South Goa.
3.	Gujarat	Ahmadabad*, Anand, Banas kantha*, Bharuch, Dohad, Gandhinagar, Kheda, Mahesana, Navsari*, Panchmahals, Patan*, SabarKantha*, Surat*, Vadodara*, Valsad*,
4.	Karnataka	Dakshina Kannada*, Udupi*, Uttar kannada*.
5.	Kerala	Alappuzha, Ernakulam*, Kannur, Kasaragod*, Kollam*, Kottayam*, Kozhikode, Malapuram, Palakkad*, Pathanamthitta*, Thiruvananthapuram, Thrissur.
6.	Lakshadweep	Lakshadweep.
7.	Maharashtra	Mumbai(City), Mumbai (Suburban), Raigarh*, Ratnagiri*, Sindhudurg*, Thane*.
8.	Pondicherry	Mahe.
14. East Coast: (No. of Districts: 24-complete, 23-partial) Area: 167,494 km^2		
1.	Andaman & Nicobar Islands	Andamans, Nicobars.
2.	Andhra Pradesh	East Godavari*, Guntur*, Krishna*, Nellore*, Prakasam*, Srikakulam*, Visakhapatnam*, Vizianagaram*, West Godavari*.
3.	Orissa	Balasore*, Bhadrak, Cuttack*, Ganjam*, Jagatsinghapur, Jajapur*, Kendrapara, Khordha*, Mayurbhanj*, Puri.
4.	Pondicherry	Karaikal, Pondicherry, Yanam.
5.	Tamil Nadu	Ariyalur, Chennai, Cluddalore, Kancheepuram, Kanyakumari*, Karur*, Madurai*, Nagapattinam, Perambalur, Pudukkottai, Ramanathapuram, Sivaganga, Salem*, Thanjavur, Thiruvalllur, Thiruvarur, Tiruchirappalli*, Tirunelveli*, Tiruvanamalai*, Toothu-Kudi, Viluppuram, Virudhunagar, Vellore*.

- Total No. of Districts are 593 out of which 97 Districts fall in two Physiographic zones & one district fall in three Physiographic zones.
- Districts fall in two Physiographic zones & one District falls in three Physiographic zones.

Annexure III

Volume Equations

Volume equations to compute volume of wood in predominant trees in each physiographic zone are provided in the following Tables:

01 Western Himalayas

Sl.No.	Species Name	Volume Equation
1	**Abies pindrow**	$V=0.26949-1.61804D+8.79495D^2+2.49489D^3$
2	*Abies smithiana*	$\sqrt{V} =0.20050+4.58840D-1.42603\sqrt{D}$
3	*Cryptomeria japonica*	$V=-0.01097+5.30991D^2$
4	*Quercus semecarpifolia*	$V=0.08355-1.28586D+8.76867D^2+1.12150D^3$
5	*Rhododendron arboreum*	$V=0.06007-0.21874\sqrt{D}+3.63428D^2$
6	*Schima wallichii*	$V=-0.01637+6.08487D^2$
7	*Shorea robusta*	$V/D^2=0.1919/D^2-2.7070/D+11.7563$
8	*Symplocos theaefolia*	$V=-0.03754+0.000587D^2$ dia in cm
9	*Tectona grandis*	$V/D=0.00341/D-0.65623+7.881D$

02 Eastern Himalayas

Sl.No.	Species Name	Volume Equation
1	**Callicarpa arborea**	$\sqrt{V}=-0.07109+2.99732D-0.26953\sqrt{D}$
2	*Castanopsis spp*	$V=0.05331-0.87098D+6.52533D^2+1.74231D^3$
3	*Duabanga sonneratioides*	$\sqrt{V}=-0.05931+2.63098D$
4	*Michelia spp.*	$V=0.23057-3.51494D+17.62619D^2$
5	*Quercus species*	$V/D2=5.09470+0.00563/D^2$
6	*Syzygium cumini*	$\sqrt{V}=-0.05923+2.33654D$

03 North Eastern Ranges

Sl.No.	Species Name	Volume Equation
1	**Callicarpa arborea**	$\sqrt{V}=-0.04506+2.33446D$
2	*Cynometra polyandra*	$V=0.15958-1.57976D+8.25014D^2-0.48518D^3$
3	*Dipterocarpus turbinatus*	$\sqrt{V} = -0.4464+3.6062D$
4	*Eugenia species*	$V=-0.02792+0.92933D-5.56465D^2+25.77488D^3$
5	*Gmelina arborea*	$V=0.01156+0.21230D+5.10448D^2$
6	*Macaranga spp.*	$\sqrt{V}=-0.07109+2.99732D-0.26953\sqrt{D}$
7	*Schleichera Trijuga*	$V=0.010-0.912D+11.396D^2$

04 Northern Plain

Sl.No.	Species Name	Volume Equation
1	**Acacia catechu**	$V=0.16609-2.78851D+17.22127D^2-11.60248D^3$
2	*Diospyros species*	$V=0.06206-1.43609D+9.778164D^2$
3	*Eucalyptus species*	V = 0.02894-0.89284D+8.72416D2
4	*Holarrhena antidysenterica*	$V = 0.17994-2.78776D+14.44961D^2$
5	*Lagerstroemia parviflora*	V = 0.10529-1.68829D+10.29573D2
6	*Mallotus philippinensis*	$V = 0.14749-2.87503D+19.61977D^2-19.11630D^3$
7	*Shorea robusta*	$\sqrt{V} = 0.16306+4.8991D-1.57402\sqrt{D}$
8	*Tectona grandis*	$V=0.08847-0.46936D+11.98979D^2+1.970560D^3$

05 Eastern Plain

Sl.No.	Species Name	Volume Equation
1	**Albizia species**	$\sqrt{V}=-0.07109+2.99732D-0.26953\sqrt{D}$
2	*Amoora wallichii*	$\sqrt{V}=0.00905+3.7648D-0.64993\sqrt{D}$
3	*Lagerstroemia parviflora*	$V=0.11740-1.58941D+9.76464D^2$
4	*Lannea coromandelica*	$\sqrt{V}=-0.32985+2.21152D+0.78769\sqrt{D}$
5	*Schima wallichii*	$V=0.27609-3.68443D+15.86687D^2$
6	*Shorea robusta*	$V/D2=0.00389/D^2-0.27516/D+6.90733$

06 Western Plains

Sl.No.	Species Name	Volume Equation
1	**Acacia ferruginea**	$\sqrt{V}=-0.00142+2.61911D-0.54703\sqrt{D}$
2	*Anogeissus pendula*	$V/D2=0.00085/D^2-0.35165/D+4.77386-0.90585D$
3	*Boswellia serrata*	$\sqrt{V}=-0.11629+2.4254D$
4	*Butea monosperma (old)*	$\sqrt{V} = -0.24276+2.95525D$
5	*Capparis deciduas*	$V=0.081467-1.063661D+6.452918D^2$
6	*Lannea coromandelica*	$V=-0.00146-0.39953D+5.33895D^2$
7	*Wrightia tinctoria*	$V=0.028917\_7.777047D^3$

07 Central Highlands

Sl.No.	Species Name	Volume Equation
1	**Acacia catechu**	$V=-0.02471+0.16897D+1.12083D^2+2.9328D3$
2	*Anogeissus latifolia*	$\sqrt{V}=-0.20236+3.13059D$
3	*Boswellia serrata*	$\sqrt{V}=-0.1503+2.79425D$
4	*Cassia fistula*	$\sqrt{V}=-0.153973+2.724109D$

Sl.No.	Species Name	Volume Equation
5	*Diospyros melanoxylon*	$V=0.15581-2.2075D+9.17559D^2$
6	*Lannea coromandelica*	$V/D2=0.14004/D^2-2.35990/D+11.90726$

08 North Deccan

Sl.No.	Species Name	Volume Equation
1	**Anogeisus latifolia**	$V/D=0.145667/D-2.704089+17.4656D-10.4903D^2$
2	*Boswellia serrata*	$V=0.050452-1.228748D+9.123381D^2$
3	*Dalbergia latifolia*	$\sqrt{V}=-0.144504+2.943115D$
4	*Lannea coromandelica*	$V=0.093318-1.531417D+9.011590D^2$
5	*Syzygium cumini*	$V/D=0.076856/D-1.359767+8.72548D-0.591440D^2$
6	*Tectona grandis*	$\sqrt{V}=-0.405890+1.98158D+0.987373\sqrt{D}$
7	*Terminalia tomentosa*	$\sqrt{V}=-0.203947+3.159215D$
8	*Wrightia tinctoria*	$\sqrt{V}=0.050294+3.115497D-0.687813\sqrt{D}$

09 East Deccan

Sl.No.	Species Name	Volume Equation
1	**Anogeisus latifolia**	$V/D2=-0.02958/D^2+8.05003$
2	*Cleistanthus collinus*	$V=0.030925-0.567037D+5.709471D^2$
3	*Diospysos melanoxylon*	$V=0.12401-2.00966D+10.87747D^2$
4	*Lagerstroemia parviflora*	$V=0.06913-1.37605D+11.89119D^2$
5	*Lannea coromandelica*	$V=0.057424-1.153088D+8.542648D^2$
6	*Madhuca latifolia*	$V=-0.00092-0.55547D+7.34460D^2$
7	*Shorea robusta*	$V=0.05823-1.22994D+10.51982D^2$
8	*Terminalia tomentosa*	$V=0.05061-1.11994D+8.77839D^2$

10 South Deccan

Sl.No.	Species Name	Volume Equation
1	*Anogeisus latifolia*	$V=0.289-2.653D+11.771D^2$
2	*Chloroxylon swietenia*	$V=-0.0532D+3.2378D^2$
3	*Dalbergia paniculata*	$V=0.18945-2.46215D+10.54462D^2$
4	*Diospyros melanoxylon*	$V=0.024814-0.578532D+6.11017D^2$
5	*Grewia species*	$V=-0.01611+4.90810D^2$
6	*Hardwickia binata*	$V=0.063632+5.355486D^3$
7	*Terminalia crenulata*	$V=0.051812-1.076790D+7.991280D^2$

11 Western Ghat

Sl.No.	Species Name	Volume Equation
1	**Artocarpus hirsute**	$V=0.076-1.319D+11.370D^2$
2	**Olea dioica**	$V=-0.03001+5.75523D^2$
3	*Palaquim ellipticum*	$V=0.16948-1.85075D+10.63682D^2$
4	*Syzygium cumini*	$\sqrt{V}=0.30706+5.12731D-2.09870\sqrt{D}$
5	*Tectona grandis*	$V=-0.2414+2.8458D-5.5816D^2+14.816D^3$
6	*Terminalia tomentosa*	$\sqrt{V}=-0.203947+3.159215D$

12 Eastern Ghat

Sl.No.	Species Name	Volume Equation
1	**Anacardium occidentale**	$\sqrt{V}=0.06063+3.43666D-0.75571\sqrt{D}$
2	*Anogeisus latifolia*	$V=0.13928-2.87067D+20.22404D^2-13.80572D^3$
3	**Bombax ceiba**	$V/D2=0.136196/D^2-2.07674/D+10.1566$
4	*Chickrassia tabularis*	$V=-0.079733-0.0021006D+0.001114D^2$(dia in cm)
5	*Grewia tiliaefolia*	$\log_e V=2.2491+2.5206 \log_e D$
6	*Pterocarpus marsupium*	$\sqrt{V}=-0.16276+2.82002D+0.04034\sqrt{D}$
7	*Shorea robusta*	$\sqrt{V}=0.19994+4.57179D-1.56823\sqrt{D}$
8	*Xylia xylocarpus*	$V=0.098-1.52D+8.963D^2$

13 West coast

Sl.No.	Species Name	Volume Equation
1	**Acacia ferruginea**	$V=-0.048108+5.873169D^2$
2	**Adina cordifolia**	$\sqrt{V}=0.21569+4.329878D-1.504977\sqrt{D}$
3	*Azadirachta indica/ Melia indica*	$V=-0.03510+5.32981D^2$
4	*Bombax ceiba*	$V/D^2= 0.18573/D^2 -2.85418/D+15.03576$
5	*Lagerstroemia lanceolata*	$V=0.23839-2.48071D+10.14106D^2$
6	*Lannea coromandelica*	$\sqrt{V}=0.404153+5.555051D-2.545525\sqrt{D}$

14 East coast

Sl.No.	Species Name	Volume Equation
1	**Bauhinia species**	$V=-0.04262+6.09491D^2$
2	*Boswellia serrata*	$V=0.36432-1.32768\sqrt{D}+9.48471D^2$
3	**Careya arborea**	$V=0.0219-0.9274D+7.4162 D^2$
4	**Cleistanthus collinus**	$\sqrt{V}=0.12956+3.7819D-1.04671\sqrt{D}$
5	*Hovea brasiliensis*	$\log_e V=2.1795+2.5045 \log_e D$
6	*Syzygium cumini*	$\log_e V=2.132776+2.479397 \log_e D$
7	*Tectona grandis*	$V=0.023613-0.531006D+6.731036D^2$

Annexure-IV

Method for Calculating Volume of Trees Using Volume Equations

For calculating volume of trees, the volume equations, generated by FSI for different tree species, given in Annexure III have been used. In the volume equation, volume is a function of the diameter (D) and by putting the value of diameter (in meter), volume (in cu.m.) for that tree can directly be obtained.

As an example, let us consider a plot with two tree species, namely, *Cryptomeria japonica* and *Callicarpa arborea*. Suppose there are four trees of Cryptomeria japonica with diameters 15cm, 25cm, 35cm and 45cm and 5 trees of *Callicarpa arborea* with diameters 13cm, 23cm, 38cm, 49cm and 55cm, then the volume for each tree can be calculated using volume equations in the following manner.

Species 1: - *Cryptomeria japonica*

Its volume equation is $V = - 0.01097 + 5.30991 * D^2$, where V is the volume in cu.m. and D is the diameter in meter. Substituting the value of D in the above volume equation, we get the volume of different diameter for that particular species.

Diameter (in cm)	Volume (in cu.m.)
15	0.109
25	0.321
35	0.639
45	1.064

Species 2: - *Callicarpa arborea*

Its volume equation is $\sqrt{V} = - 0.04506 + 2.33446 D$, where V in cu.m. and D in m.

Diameter (in cm)	Volume (in cu.m.)
13	0.067
23	0.242
38	0.709
49	1.207
55	1.535

Volume by species and diameter classes for the said plot may be indicated as given below:

Species	Diameter classes (in cm.)					Total (in cu.m)
	10 -20	**20 - 30**	**30 - 40**	**40 - 50**	**50+**	
Cryptomeria japonica	0.109	0.321	0.639	1.064	0.000	2.133
Callicarpa arborea	0.067	0.242	0.709	1.207	1.535	3.760
Total plot volume	0.175	0.563	1.349	2.272	1.535	5.893

Annexure-IV

Accuracy of Assessment