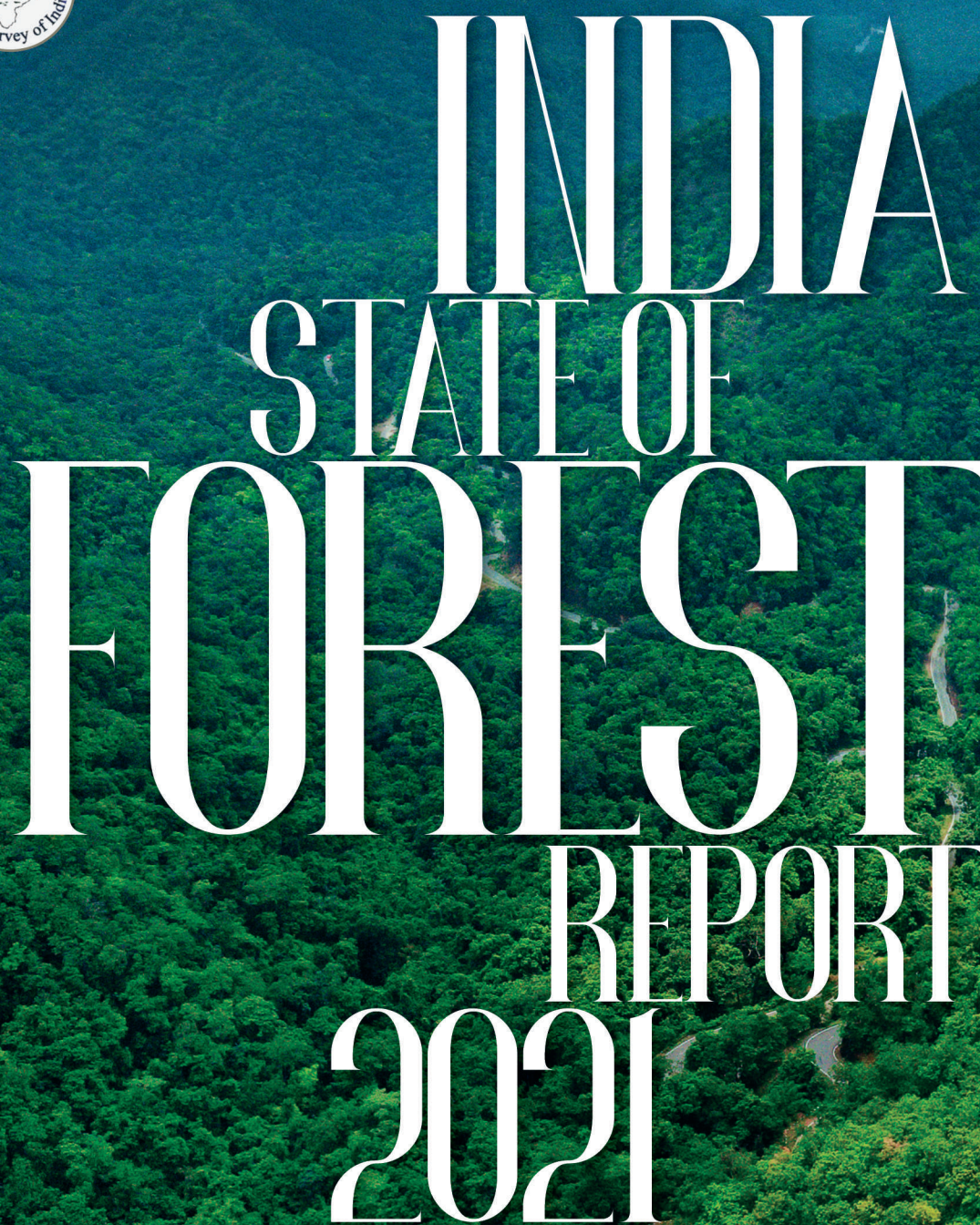




INDIA STATE OF FOREST REPORT 2021



**WE BOW TO
THE EARTH
COVERED
WITH TREES
AND PLANTS**

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INDIA STATE OF FOREST REPORT 2021





सत्यमेव जयते

भूपेन्द्र यादव

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FOREWORD



Forests have a deep cultural connect to civilization and its evolution in Indian subcontinent. Since time immemorial, forests have been a crucible for growth of the mind, a resource base and a sanctuary. In today's time and age, the importance of forests has captured public imagination and a global understanding is slowly emerging that in order to survive, mankind has to ensure the sustainable use of forests and tree resources.

The National Forest Policy and other legislations prescribe the pathway of forest conservation and management for meeting the people's needs. Rapid progress on the economic front necessitates scientific balancing of the developmental needs with the requirements of conservation and ecological security of the nation. From a policy perspective, it is therefore imperative that the state of forest and tree cover in the country is regularly monitored.

India is one of the few countries of the world that has a robust and scientific system of periodic forest and tree cover assessment. Forest and Tree Cover assessment is done on a two-year cycle and the outcomes are published in a biennial report of Forest Survey of India (FSI) as India State of Forest Report (ISFR). The first such report was brought out in 1987 and since then FSI has published 16 reports. The biennial report is an exhaustive and authoritative review of the state of forests in the country. In recent years, the activities of FSI have expanded in their scope. Forest Decision Support System, Forest Fire monitoring, E-Green Watch, Very High Resolution mapping and modernization of forest inventory are additional areas where FSI is contributing to the forestry sector.

India is committed to engage actively in multilateral negotiations under the UNFCCC in a positive, creative and forward-looking manner. Our objective is to establish an effective, cooperative and equitable global architecture based on climate justice and the principles of Equity and Common but Differentiated Responsibilities and Respective Capabilities, under the UNFCCC.

I am happy to share that despite the challenges posed by the COVID-19 pandemic, the task of preparing the 17th India State of Forest Report-2021 has been completed on schedule. I congratulate the Director General, FSI and his team for the preparation of this important document. I am confident that this report will serve as a convenient source of information for policy makers, planners, academicians and other stakeholders who are directly or indirectly involved in the management and conservation of the vast forest resources of the country.

With best wishes.

Bhupender Yadav



अश्विनी कुमार चौबे
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सत्यमेव जयते

FOREWORD

India has a long history and tradition of harmonious co-existence between human and nature. In the Indian way of thinking, plants and animals are members of a family. A wide range of traditional practices and art forms that represent sustainable use of forest and tree resources, reflect such thinking. Encompassing the ecological, economic and social dimensions of the National Forest Policy, it is necessary to have monitoring and assessment of forest resources with regard to biological diversity, climate change and carbon emission / sequestration.

Forest Survey of India (FSI), Dehradun, under the Ministry of Environment, Forest and Climate Change is a premier institution of the country with the mandate to carry out periodic assessment of our country's forest resources. The data and reports of FSI serve as critical inputs for policy making for the forestry sector of the country.

The results of the current India State of Forest Report (ISFR) provide, assessments both at Country and State level. This document will be very useful for the States in formulating policies and strategies for conservation and management of their natural resources. I am happy to note that, FSI has adapted itself to methodology, application of SAR technology for biomass mapping of country, forest fire monitoring programmes, use of PDA devices with specialized applications for collection and processing of inventory data on real time basis and allied techniques. The use of New National Forest Inventory Design data in the current report, for the assessment of growing stock, carbon accounting and other parameters has yielded results with greater precision.

I congratulate the entire team of FSI for their dedicated effort in providing useful information which will help the user agencies to plan effective management of natural resources.

Ashwini Kumar Choubey





सत्यमेव जयते

लीना नन्दन Leena Nandan

सचिव
Secretary

पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
Ministry of Environment, Forest and Climate Change
भारत सरकार / Government of India

FOREWORD



It is indeed a pleasure to announce the release of the India State of Forest Report (ISFR) 2021 by the Forest Survey of India. This report gives an authoritative insight into the state of forests in the country and is therefore widely utilized by researchers, policy makers, planners, State Forest Departments and other institutions. The Forest Survey of India has been constantly improving the quality of the ISFR and the present report stands out for presenting a large amount of distilled data that opens up unique opportunities in analytics.

Forests play a crucial role in our ecosystem; with the constantly increasing pressures on the country's forests, there is an emerging need for detecting and tracking the changes taking place. Periodic assessment of our forestry parameters such as extent of forest and tree cover, distribution of timber species, volume, biomass, carbon stock, regeneration status etc. is vital not only for forest managers but also for planners and policy makers, to ensure strategic planning in the management of forest and land resources. Forest Survey of India has been doing a commendable job by carrying out biennial assessment of forest resource of the country for more than 35 years. The present report contains information not only on the forest cover, forest inventory and the changes with respect to the previous assessment, but also an estimation of Above Ground Biomass (AGB) using Synthetic Aperture Radar (SAR) and climate change hotspots in the forest areas of the country.

I am happy to note that in the current ISFR, digitized forest boundaries of 26 States and UTs have been used to assess the extent of forest cover within the recorded forest areas. I urge the remaining State/ UT Forest Departments to take up this activity on priority and provide accurate digital forest boundaries to FSI. This will help the States to plan appropriately for areas within and outside recorded forest areas.

Over the years, the roles and responsibilities of FSI have seen a change. Today, FSI is involved in many climate change related activities such as preparation of Forest Reference Level, reporting of GHG to UNFCCC, preparation of Biennial Update Report (BUR) and Sustainable Development Goals (SDG) Report etc. FSI also acts as a nodal agency for reporting of country data to FAO for Global Forest Resource Assessment (GFRA). Moreover, many initiatives such as monitoring of CAMPA activities under e-Green Watch portal, developing of Decision Support System (DSS) for taking expeditious decision on forest conservation related cases, issuance of pre-fire warning alerts etc. are also being undertaken by FSI.

I am confident that the Forest Survey of India would continue on its path of keeping up with technological advances and make a sterling contribution to the development of a robust National Forest Monitoring System. I wish the FSI team all the very best for their future endeavours.

Leena Nandan



चन्द्र प्रकाश गोयल Chandra Prakash Goyal

वन महानिदेशक एवं विशेष सचिव
Director General of Forest & Special Secretary
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Ministry of Environment, Forest and Climate Change
भारत सरकार / Government of India



FOREWORD

It gives me immense pleasure to learn that Forest Survey of India (FSI) is bringing out the India State of Forest Report 2021. FSI has been doing a yeoman service in generating a vast wealth of data on the extent and quality of forest and tree cover of India from last 35 years. Keeping pace with technological advancements and refinement in methodologies has been a continuous process at FSI.

Forests in India face a wide range of biotic pressures therefore it is important to monitor constantly the impact of such pressure on the ground and alert the State Forest Departments and related agencies about the risks involved.

Inventory of forests has been one of the most important activities of FSI since its inception. National Forest Inventory was launched in 2002 to estimate growing stock of forests and trees outside forest at the national level. In 2016 a grid based design involving 5km x 5km grids has been adopted both for forest inventory and for inventory of trees outside forests allowing for a reduction in revisit time of forest inventory from 20 years to 5 years, to generate national and state level estimates with better accuracy.

FSI has been estimating the carbon stock in India's forest as per the methodology of 'Good Practices Guidance' (GPG) developed by Inter-governmental panel on Climate Change (IPCC). For estimation of emission factors for different strata, data of National Forest Inventory (NFI) has been used. Biomass equations/ factors were developed through a special study conducted by FSI. GIS techniques have been used for synthesizing the data and to estimate carbon stock under different carbon pools.

Results of the Biomass estimation using SAR technology at PAN India level are being presented. For the first time a biomass map of the country has been prepared. Results of climate change hotspots study for forest areas are also being presented. This information will prove to be very important and relevant for SFDs and other agencies in designing mitigation and adaptation strategies and programmes for the forest areas under their management as well as act as a baseline for state governments to tune their land and development policies by factoring in climate change related requirements.

The entire team of the FSI deserves our congratulations and appreciation for another excellent job done.

I wish team FSI the very best.



Chandra Prakash Goyal



अनूप सिंह, महानिदेशक

Anoop Singh, Director General

भारतीय वन सर्वेक्षण

Forest Survey of India

पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय

Ministry of Environment, Forest and Climate Change

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P R E

दशकूपसमा वापी, दशवापीसमो ह्रदः ।
दशह्रदसमो पुत्रो, दशपुत्रसमो द्रुमः ।।

'Dasha-kupa sama vapi, dasha-vapi sama hradah I
Dasha-hradah samah putro, dasha-putra sama drumah' II

———— Matsya Purana 154:512 ————

The ancient Indian text, Matsya Purana states that, "A pond is equal to ten wells. A reservoir of water is worth ten such ponds. Ten reservoirs of water are equal to a son. A tree is equal to ten such sons".

Trees and forests have held an important place in India since ancient times. Today, the entire world has started to appreciate the importance of forests and trees, not just as a resource base, but also as the key to survival of life on earth. The United Nations Organization has proclaimed its theme for 2021 as "Forest Restoration: a path to recovery and well-being." In this context, the role of Forest Survey of India (FSI) assumes great importance, since its principal mandate is to survey and assess forest resources of India.

FSI carries out the forest cover mapping of the country using satellite data, the findings of which are published in a biennial publication, known as India State of Forest Report (ISFR). I am happy to present the ISFR 2021, which contains nationwide results of forest cover mapping and estimation of the tree cover for the period 2019-20, using medium resolution satellite data (23.5m) from the indigenous LISS-III sensor of IRS Resourcesat series of satellites from Indian Space Research Organization.

The ISFR 2021 provides estimates of National Forest Inventory following a grid based design adopted by FSI since 2016.

Besides providing forest cover estimates of State and District level, the report also provides information on forest cover inside and outside Recorded Forest Areas (RFA), forest cover change analysis in Tribal districts, Hill districts and NE states and assessment of Forest Cover in Tiger Reserves.

Another major focus is on Forest Fire Monitoring by MODIS sensor on board Aqua and Terra Satellite of NASA and SNPP-VIIRS sensor. ISFR 2021 has given special importance to the estimation of carbon stock in the country's forests for providing valuable inputs to MoEF&CC in preparation of GHG inventory of the country and fulfilling of international reporting requirements to the conventions to which the country is a signatory.

ISFR 2021 also presents the results of a study by FSI, in collaboration with BITS Pilani (Goa Campus) to map, climate hot spots in the forest areas of the country. The enhanced understanding about the

F A C E



climate change hotspot areas due to projected adverse climatic impacts in Indian forests would assist in planning and strategizing preventive and adaptive measures against changing climate.

ISFR 2021 has made valuable additions to the existing forest assessment database by utilizing the latest technology and methodology for the assessment of forests and trees outside forests, including in-depth analysis of Mangrove and Bamboo forests.

FSI, in collaboration with Space Application Centre (SAC), ISRO, Ahmedabad, has conducted a special study for estimation of Above Ground Biomass (AGB) at pan-India level using Synthetic Aperture Radar (SAR) data. The interim results for AGB estimates and AGB map for the entire country are presented in this report.

The revamp of e-Green Watch Portal is also being carried out by FSI, in order to overcome the limitations of the existing portal. This will ensure concurrent monitoring as well as information system for monitoring and evaluation of various activities such as compensatory afforestation carried out through CAMPA funds.

On the occasion of the release of ISFR 2021, I would like to express my heartfelt thanks for the continuous support and guidance from Shri Bhupender Yadav, Hon'ble Minister, MoEF&CC, Shri Ashwini Kumar Choubey, Hon'ble Minister of State, MoEF&CC, Shri Rameshwar Prasad Gupta, Former Secretary & Smt. Leena Nandan Secretary, MoEF&CC, Govt. of India, Shri Subhash Chandra, Former Director General of Forests & Special Secretary & Shri C.P. Goyal Director General of Forests & Special Secretary, MoEF&CC, Govt. of India and Dr. Suneesh Buxy, Inspector General of Forests (SU), MoEF&CC.

I express my gratitude to Dr. Subhash Ashutosh and Mr. Pankaj Agrawal, the erstwhile Director Generals of FSI, who made valuable contribution in monitoring and giving direction to the entire exercise.

I also thank the officers and technical staff of FSI for their commitment and zealous efforts in preparing this report in a time bound manner despite the challenges posed by the COVID 19 pandemic.

I reiterate the commitment of my organization for making available relevant and updated information on forest resources of the country in future through the use of up-to-date methodology and technology and I rededicate myself and my team to the mandate given to FSI.

Anoop Singh



ACKNOWLEDGEMENT

In the 17th cycle of biennial assessment of India's forests, Forest Survey of India has received significant assistance and contributions from various organizations and individuals. Assistance provided by Space Application Centre, Ahmedabad, National Remote Sensing Centre, Hyderabad, Indian Institute of Remote Sensing, Dehradun, BITS Pilani, Goa Campus, Jammu & Kashmir Forest Department, National Sample Survey Organization, Survey of India and Forest Research Institute (FRI) are highly appreciated.

All the State Forest Departments have extended full support in field validation of forest cover mapping and other assessments. The assistance provided by all the SFDs to the officials of FSI during field visits, is gratefully acknowledged.

Contributions of Shri Rajesh Kumar, Ex-DDG, NSSO, Dehradun and Dr. Rajiv Chaturvedi, Faculty of BITS, Pilani, Goa Campus are acknowledged with gratitude. I would like to make a special mention of Mr. Arijit Banerjee, APPCF IT, Rajasthan, who has read and edited all the chapters and without his help timely completion would have been impossible. Mr. Arijit Banerjee & Mr. Rakesh Dogra, Dy. Director General, ICFRE have shared wholeheartedly their vast collection of photographs of forests, habitats and species. I look forward to receiving their continued support in the years to come. Contribution of Sh. P. Kalaivanan, IFS & Sh. Anurag Mishra, IFS are gratefully acknowledged.

The efforts made by Shri Sushant Sharma, Joint Director (TFI), Smt. Meenakshi Joshi, Joint Director (FGD), Shri Prakash Lakhchaura, Dy. Director General (TFI), Shri Dinesh Kumar, Ex. Dy. Director General (FI), Shri Kamal Pandey, Dy. Director (TFI), Dr. Sunil Chandra, Dy. Director (FGD), Shri Sanjay Kumar Agarwal, Dy. Director (FGD), & Shri Abhay Kumar Saxena, Dy. Director (FCM) for the ISFR 2021 are highly appreciated. Contribution of Shri H. Venuprasad, I/C Regional Director, SZ, Shri Chaturbhuja Bahera, Regional Director, CZ, Shri Satya Prakash Negi, Regional Director, NZ, Dr. Soma Das, Regional Director, EZ, Shri S. Elamurugannan, Dy. Director, SZ, FSI for the NFI are gratefully acknowledged.

EXECUTIVE SUMMARY

India is amongst one of the few countries having a robust scientific system for periodic assessment of Forest Cover, Forest Inventory and inventory of Trees Outside Forest. Forest Survey of India (FSI), an organization of Ministry of Environment, Forest & Climate Change carries out these assessments and publishes the findings in its biennial report as 'India State of Forest Report (ISFR)'. The first State of the Forest Report was published in 1987 and the current report (ISFR 2021) is 17th in the series. The ISFR provides valuable inputs for planning, policy formulation and evidence based decision making both at National and State level.

The ISFR 2021, having information on different parameters of the forest resources, is based on the regular nation-wide mapping of Forest Cover, National Forest Inventory and other studies conducted at the national level. The methodology adopted for Forest Cover and Forest Inventory has undergone regular improvements over time.

The Forest Cover as reported in ISFR includes all patches of land with a tree canopy density of more than 10% and with area having more than 1 ha, irrespective of land use, ownership and species of trees. It is assessed by a wall-to-wall mapping exercise using remote sensing followed by extensive ground truthing. Results of the nation-wide Forest Cover Mapping exercise are presented on 1:50,000 scale in three canopy density classes viz Very Dense Forest (canopy density > 70%), Moderately Dense Forest (canopy density 40-70%) and Open Forest (canopy density 10-40%). The tree cover is assessed following a methodology involving remote sensing based stratification and observations on sample plots laid in the strata as part of the National Forest Inventory. Tree cover includes all patches of trees less than 1 ha.

In the current assessment, ortho-rectified LISS III data of IRS Resourcesat-2 with a spatial resolution of 23.5 m for the period October to December 2019 have been used for Forest Cover Mapping. In order to ensure uniformity, consistency and accuracy in the mapping exercise, the procedure has been codified into a manual for Forest Cover Mapping. For the current assessment, ground truthing has been carried out at 3,414 locations across the country. Change matrix showing a quantitative account of class wise change and also the flux of changes among the classes between the current and previous assessment has been presented for all the States & UTs and country as a whole.

National Forest Inventory assesses the growing stock in forests and TOF, bamboo resource, carbon stock and several other parameters. Field data for the same is collected from approximately 30,000 sample plots laid in a 2 years period as per the standardized design. The growing stock and other assessments presented in ISFR 2021 are on the basis of a new grid based forest inventory design adopted by FSI in 2016. This ensures higher sampling intensity with uniformly spread sample plots across the country, leading to higher precision.

In the current ISFR, a new Chapter about 'Above Ground Biomass Estimation using SAR



Data' has been included containing information about spatial distribution of the forest biomass categories which are important for proper management of the forest resources. For this purpose, FSI has collaborated with Space Application Centre (SAC), ISRO, Ahmedabad. The result of this exercise represents that MLR model can be used for AGB estimation at country level. The use of ancillary data in combination with SAR data have been effective in improving coefficient of correlation (r) using MLR model.

Another new chapter on, 'Mapping of Climate Change Hotspots in Indian Forests' has also been included in this ISFR. Forest plants play a significant role in relation to climate change by reducing emission of Green House Gases (GHGs), through expanding the mitigation and adaptation actions with low cost interventions. Therefore, a collaborative study was carried out by FSI with BITS PILANI, Goa Campus to map the climatic hotspots over Indian forest cover using temperature and rainfall data, for the three future time periods i.e. year 2030, 2050 & 2085. To identify climatic hotspots in Indian forests two computer based models were used i.e. RCP 4.5 and RCP 8.5, where RCP 4.5 represents moderate emission scenarios and RCP 8.5 represents the highest emission scenario or worst case scenario.

SALIENT FINDINGS

The key findings of the ISFR 2021 are as follows:

- The total forest cover of the country is 7,13,789 sq km which is 21.71% of the geographical area of the country. The tree cover of the country is estimated as 95,748 sq km which is 2.91% of the geographical area. Thus, the total Forest and Tree cover of the country is 8,09,537 sq km which is 24.62% of the geographical area of the country.
- The current assessment shows an increase of 1,540 sq km (0.22%) of forest cover, 721 sq km (0.76%) of tree cover and 2,261 sq km (0.28%) of forest and tree cover put together, at the national level as compared to the previous assessment i.e. ISFR 2019.
- Forest cover inside the RFA/GW has shown a slight increase of 31 sq km whereas there is an increase of 1,509 sq km of forest cover outside the RFA/GW as compared to previous assessment of 2019.
- The top five States in terms of increase in forest cover are Andhra Pradesh (647 sq km), Telangana (632 sq km), Odisha (537 sq km), Karnataka (155 sq km) and Jharkhand (110 sq km).
- Forest cover in the hill districts of the country is 2,83,104 sq km, which is 40.17% of the total geographical area of these districts. The current assessment shows a decrease of 902 sq km (0.32%) in 140 hill districts of the country.
- The total forest cover in the tribal districts is 4,22,296 sq km, which is 37.53% of the geographical area of these districts. The current assessment shows a decrease of 655 sq km of forest cover inside the RFA/GW in the tribal districts and an increase of 600 sq km outside.



- Total forest cover in the North Eastern region is 1,69,521 sq km, which is 64.66% of its geographical area. The current assessment shows a decrease of forest cover to the extent of 1,020 sq km (0.60%) in the region.
- Mangrove cover in the country has increased by 17 sq km (0.34%) as compared to the previous assessment.
- The total growing stock of wood in the country is estimated as 6,167.50 million cum comprising 4388.15 million cum inside forest areas and 1779.35 million cum outside recorded forest areas (TOF). The average growing stock per hectare in forest has been estimated as 56.60 cum.
- Total bamboo bearing area of the country is estimated as 1,49,443 sq km. There is a decrease of 10,594 sq km in bamboo bearing area as compared to the estimate of ISFR 2019.
- In the present assessment, total carbon stock in forest is estimated as 7,204.0 million tonnes. There is an increase of 79.4 million tonnes in the carbon stock of the country as compared to the last assessment of 2019. The annual increase is 39.7 million tonnes, which is 145.6 million tonnes CO₂ eq.
- Soil Organic Carbon (SOC) represents the largest pool of carbon stock in forests, which has been estimated as 4,010.2 million tonnes. The SOC contributes 56% to the total forest carbon stock of the country.
- Fire prone forest areas of different severity classes have been mapped in the grids of 5km x 5km based on the frequency of forest fires. The analysis reveals that 22.27% of the forest cover of the country is highly to extremely fire prone.
- The correlation analysis between the AGB and the HV, HH and HV/HH polarized backscatter reveals that the HH, HV polarized backscatter has better correlation as compared to HH/HV polarization.
- As per the Climate Hotspot projections for the studied periods i.e. 2030, 2050 and 2085, it has been observed that Ladakh, Jammu & Kashmir, Himachal Pradesh and Uttarakhand are projected to witness highest temperature increase while Andaman & Nicobar Islands, West Bengal, Goa, Tamil Nadu and Andhra Pradesh are projected to witness the least temperature rise over these periods. The North-Eastern States and Upper Malabar Coast of India are projected to experience the highest increase in rainfall; whereas, part of North-Eastern States like Arunachal Pradesh, Sikkim; North-Western parts of the country namely Ladakh, Jammu & Kashmir and Himachal Pradesh are projected to experience least increase and sometimes even decline in rainfall.

Table 1 Forest and Tree Cover of India in 2021

Class	Area (sq km)	Percentage of Geographical Area
	Forest Cover	
Very Dense Forest	99,779	3.04
Moderately Dense Forest	3,06,890	9.33
Open Forest	3,07,120	9.34
Total Forest Cover*	7,13,789	21.71
Tree Cover	95,748	2.91
Total Forest and Tree Cover	8,09,537	24.62
Scrub	46,539	1.42
Non Forest#	25,27,141	76.87
Total Geographical Area	32,87,469	-

* Includes 4,992 sq km under Mangrove Cover

Non-forest includes Tree Cover (Percentage rounded off)



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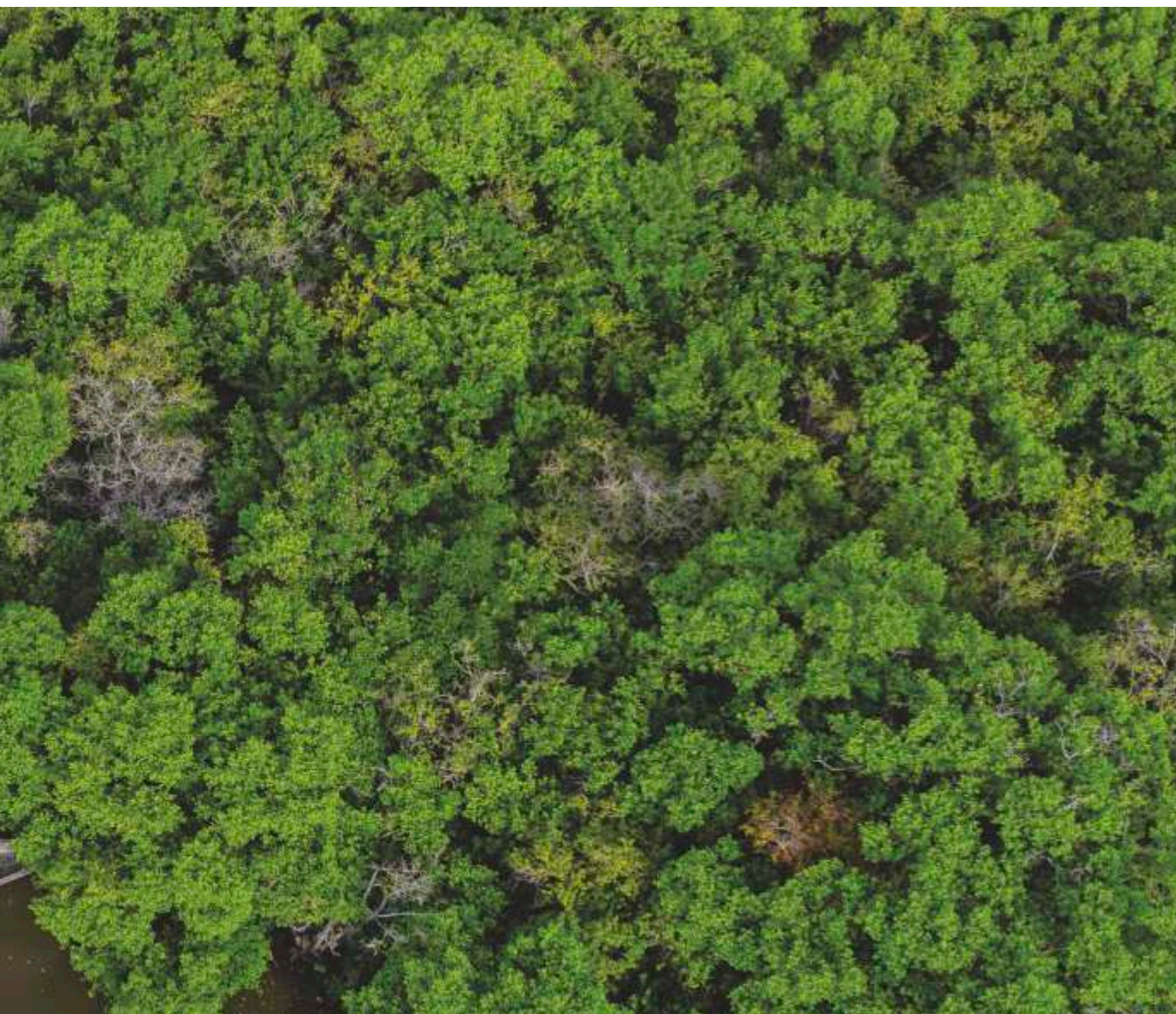
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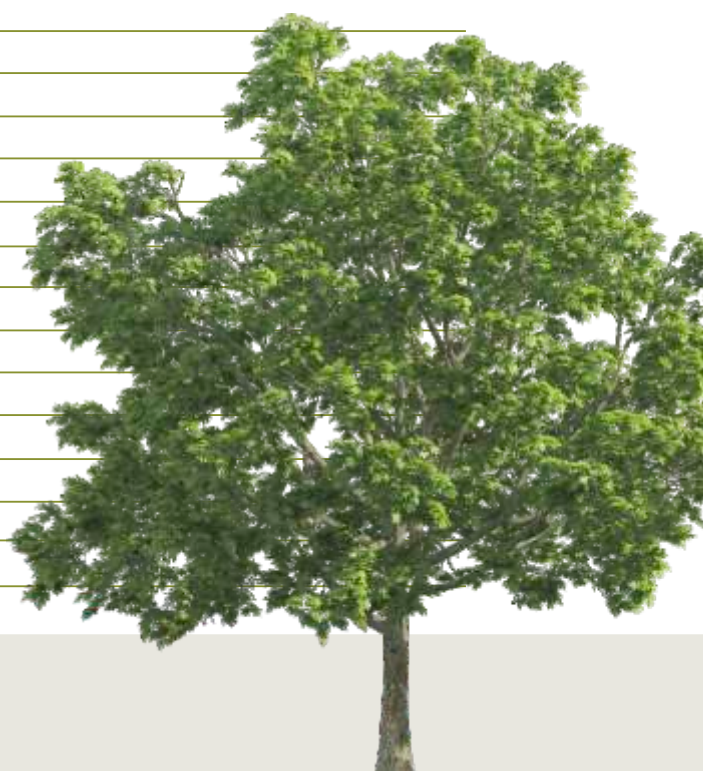
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ACRONYMS AND ABBREVIATIONS

AFOLU	- Agriculture, Forestry and Other Land Use
AGB	- Above Ground Biomass
ALOS	- Advanced Land Observing Satellite
AWiFS	- Advanced Wide Field Sensor
BGB	- Below Ground Biomass
BEF	- Biomass Expansion Factor
BUR	- Biennial Update Reports
CBD	- Convention on Biological Diversity
CMIP	- Coupled Model Inter-comparison Project
CNFA	- Culturable Non-Forest Area
CNN	- Convolutional Neural Network (model)
CO₂	- Carbon Dioxide
CO₂ eq	- Carbon Dioxide Equivalent
COP	- Conference of the Parties
DBH	- Diameter at Breast Height
DEM	- Digital Elevation Model
DF	- Dense Forest
DIP	- Digital Image Processing
DN	- Digital Number
DOM	- Dead Organic Matter
FAO	- The Food & Agriculture Organization of United Nations
FCC	- False Colour Composite
FDC	- Forest Development Corporation
FPC	- Forest Protection Committee
FRL	- Forest Reference Level
FSI	- Forest Survey of India
FWI	- Fire Weather Index
GA	- Geographic Area
GCP	- Ground Control Point
GFRA	- Global Forest Resource Assessment
GHG	- Green House Gas
GIS	- Geographical Information System
GPG	- Good Practices Guidance
GPM	- Global Precipitation Measurement
GPS	- Global Positioning System
GW	- Green Wash
HH	- Horizontal-Horizontal (Polarization)
HTTP	- Hyper Text Transfer Protocol
HV	- Horizontal-Vertical (Polarization)
IMD	- India Meteorological Department



INC	- Initial National Communication
IPCC	- Intergovernmental Panel for Climate Change
IPPU	- Industrial Processes and Product Use
IRDP	- Integrated Rural Development Programme
IRS	- Indian Remote Sensing (Satellite)
ISFR	- India State of Forest Report
ISRO	- Indian Space Research Organization
IUCN	- International Union for Conservation of Nature
JAXA	- Japan Aerospace Exploration Agency
JFM	- Joint Forest Management
LiDAR	- Light Detection and Ranging
LISS	- Linear Imaging Self-scanning Sensor
LST	- Land Surface Temperature
LULUCF	- Land Use, Land-Use Change and Forestry
MDF	- Moderately Dense Forest
MODIS	- Moderate Resolution Imaging Spectroradiometer
MSS	- Multi Spectral Scanner
NAEB	- National Afforestation and Eco-development Board
NATCOM	- National Communication to UNFCCC
NASA	- National Aeronautics and Space Administration
NDC	- Nationally Determined Contributions
NDVI	- Normalized Difference Vegetation Index
NDMA	- National Disaster Management Authority
NF	- Non-Forest
NFMS	- National Forest Monitoring System
NP	- National Park
NRSC	- National Remote Sensing Centre
NSO	- National Statistical Office
NTCA	- National Tiger Conservation Authority
NTFP	- Non-Timber Forest Products
NWDB	- National Wasteland Development Board
OF	- Open Forest
PA	- Protected Area
PALSAR	- Phased Array type L-band Synthetic Aperture Radar
PAN	- Pan-Chromatic
PF	- Protected Forest
PISFR	- Pre-Investment Survey of Forest Resources
POP	- Permanent Observation Plots
RADAR	- Radio Detection and Ranging
RCP	- Representative Concentration Pathway
REDD+	- Reducing Emissions from Deforestation and Forest Degradation Plus
RF	- Reserved Forest

RFA	- Recorded Forest Area
RGI	- Registrar General of India
SAC	- Space Application Centre
SAR	- Synthetic Aperture RADAR
SDG	- Sustainable Development Goals
SFD	- State Forest Department
SFR	- State of Forest Report
SNC	- Second National Communication
SNPP-VIIRS	- Suomi National Polar orbiting Partnership - Visible Infrared Imaging Radiometer Suite
SOC	- Soil organic carbon
SOI	- Survey of India
SOM	- Soil organic matter
SRTM	- Shuttle Radar Topography Mission
TAC	- Technical Advisory Committee
TC	- Tree Cover
TM	- Thematic Mapper
TOF	- Trees Outside Forests
TR	- Tiger Reserve
UFS	- Urban Frame Survey
UNFCCC	- United Nations Framework Convention on Climate Change
UN-REDD	- United Nations Reduced Emissions from Degradation and Deforestation
UT	- Union Territory
VDF	- Very Dense Forest
VFPC	- Village Forest Protection Committee
VIIRS	- Visible Infrared Imaging Radiometer Suite
Vol.	- Volume
WCRP	- World Climate Research Programme
WFS	- Web Feature Service
WII	- Wildlife Institute of India
WLS	- Wildlife Sanctuary
WMO	- World Meteorological Organization
WMS	- Web Map Service
WP	- Working Plan
WPA	- Wildlife Protection Act
WWF	- World Wildlife Fund



GLOSSARY

Above-ground biomass	The AGB carbon pool consists of all living vegetation above the soil, inclusive of stems, stumps, branches, bark, seeds and foliage.
Activity / Flux	One of the main approaches to emissions accounting by estimating the net balance of additions to and removals from, a carbon pool.
Adaptation	Adjustment in natural or human systems to a new or changing environment.
Allometric Equation	Allometric equations are the best fitted regression models, used to estimate the biomass or volume of aboveground tree components based on diameter at breast height (DBH) and height data.
Asiatic Lion	The Asiatic Lion (also known as the Persian Lion or Indian Lion) is a member of the Panthera leo leo subspecies that is restricted to India.
Backscatter	Backscatter is the reflection of waves, particles, or signals back to the direction from which they came.
Base	A specification or product that has been formally reviewed and agreed upon, that thereafter serves as the basis for further development.
Bamboo	Pure: 200 and more clump/ha for clump forming bamboo or 12000 and more culms / ha for non-clump forming Dense: 51 to 200 clump / ha for clump forming or 3001 to 12000 culms / ha for non-clump forming Scattered: 1 to 50 clump / ha for clump forming or 1 to 3000 culms / ha for non-clump forming
Below-ground biomass	The BGB carbon pool consists of the biomass contained within live roots.
Biodiversity	It refers to the variety of life on Earth at all its levels, from genes to ecosystems, and can encompass the evolutionary, ecological, and cultural processes that sustain life.
Biomass	Biomass is the organic material that comes from plant or animal and can be used as renewable bioenergy sources.
Biomass Expansion Factor (BEF)	The ratio of aboveground biomass and bole biomass (defined by a merchantable measure or a minimum DBH). It is used to quantify carbon stock in forests.
Block Plantation	Tree plantations in compact blocks of more than 0.1 ha on lands outside recorded forest areas.
Canopy	The cover of branches and foliage formed by crown of trees.
Canopy Cover	The percentage of ground covered by a vertical projection of outermost perimeter of natural spread of foliage of plants.
Canopy Density	Percent area of land covered by canopy of trees. It is expressed as a decimal coefficient, taking closed canopy as unity.
Carbon dioxide equivalent (CO₂ eq)	It is a metric measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential, by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential.
Carbon Pool	Carbon pools are major components of an ecosystem that can either accumulate or release carbon.
Carbon Sequestration	It is a natural or artificial process by which carbon dioxide is removed from the atmosphere and held in solid or liquid form.
Carnivores	It is an organism that mostly eats meat, or the flesh of animals.
Cartographic Limit	The minimum area of a feature which can be presented on a map at a given scale.
Catchment	A catchment is an area where water is collected by the natural landscape.



Change Matrix	It presents change in forest cover classes for a given region (State or UT) during the period of two consecutive assessments in a matrix form by showing the changes of area from one class to another.
Climate change	Refers to any significant change in the measures of climate lasting for an extended period of time.
Convolutional Neural Network	Convolutional Neural Network (CNN) is a kind of deep learning neural network designed for structured data specifically for image data. It uses connections to extract features from local regions of the input based on the weights and biases of the input features.
Conservativeness	Where accounting relies on assumptions, values and procedures with high uncertainty, the most conservative option in the biological range should be chosen so as not overestimate sinks or underestimate sources of GHGs. Conservative carbon estimates are often achieved through omission of minor carbon pools.
Crown Area	It is the area of horizontal projection of a tree crown on the ground.
Culturable Non Forest Area	It is the net geographical area, lying outside recorded forest 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.
Dead Organic Matter	The DOM carbon pool contains all non-living woody biomass and can be divided into wood (fallen trees, roots and stumps with diameter over 10cm) and litter (greater than 2mm and less than 10cm diameter) components.
Dense Forest	All lands with a forest cover having a canopy density of 40 percent and above.
Digital Image Processing	Interpretation and classification of digital satellite data using computer and a DIP software.
Drone	A drone, also known as Unmanned Aerial Vehicle (UAV), is a flying device that is controlled remotely. Such devices fly using multiple propellers and are capable to digitally scan and capture photos, record videos using cameras from the air.
Downscaling	Downscaling is a procedure to infer high-resolution information from low-resolution variables, more specifically it is the process of relocating coarse resolution climate model to fine spatial scale observed data.
Emissions	Release of greenhouse gases and/or their precursors into the atmosphere over a specified area and period of time.
Emission factor	Emission factor gives gains and losses in carbon stock as a standard rate of emissions per unit activity. It is used to scale emissions to activity data.
Endangered Species	It is considered to be facing a very high risk of extinction in the wild due to factors such as habitat loss, poaching and presence of invasive species.
Error Matrix (Confusion matrix)	It is a means to quantitatively assess the accuracy of classification of an interpreted satellite data. Under this, the reference data (ground truth) is compared with the corresponding results of the classification on the randomly selected locations on category-by-category basis. It is presented in a square matrix.
False Colour Composite	The image generated by projecting any three spectral bands of the satellite data on the red, green and blue channels and does not show features in true colours.
Farm Forestry	The practice of cultivating and managing trees in compact blocks on agricultural lands.
Forest Area	The area recorded as a forest in the Government records. It is also referred to as "Recorded Forest Area".

Forest Blank	A patch within a forest which bears few or no trees.
Forest Cover	All lands, more than one hectare in area, with a tree canopy density of more than 10 percent irrespective of ownership and legal status. Such lands may not necessarily be a recorded forest area. It also includes orchards, bamboo and palm.
Forest Fire Danger Rating	It is a system for rating the risk of forest fires on the basis of qualitative or numeric indices of fire potential. It is used as a guide in a wide variety of fire management activities.
Forest Inventory	The measurement of certain parameters of forests to assess the growing stock and other characteristics of forests.
Forest Reference Level	It is the base line emission levels from the forests. It is used for determining performance of the country towards REDD+ implementation.
Gain Loss Approach	A method to estimate annual emissions or removals of CO ₂ as the sum of gains and losses in carbon pools occurring on areas of land subject to human activities.
Geographic Information System	A computer based system for capturing, storing, manipulating, analysing and displaying data, which are spatially referenced to the earth.
Global Forest Resources Assessment	It is led by Forestry Department of FAO of UN, for an assessment of status and trends of the global forest resources. It contains information on various thematic elements of sustainable forest management and conservation.
Greenhouse gases	Gases that has the property of absorbing infrared radiation (net heat energy) emitted from Earth's surface and re-radiating it back to Earth's surface, thus contributing to the greenhouse effect.
Green Wash	The extent of wooded areas generally shown in light green colour on the Survey of India topographic sheets.
Growing Stock	The sum (by number or volume) of all the trees growing/living in the forest or a specified part of it.
Hill District	A district with more than 50 percent of its geographic area under "hill talukas" based on criteria adopted by the NITI Aayog for Hill Area and Western Ghats Development Programmes.
Hotspot	An area which is prone to adverse climatic impact.
Inventory/Periodic Accounting	One of the main approaches to emissions accounting by measuring the difference in carbon stocks between two points in time.
IUCN Red List	The International Union for Conservation of Nature Red List of Threatened Species is the world's most comprehensive inventory of the global conservation status of biological species.
Land Cover	Broad land use classes interpreted from satellite data. It includes very dense forest, moderately dense forest, open forest, scrub and non-forest for the purpose of this report.
Litter	Woody material of trees having diameter <5cm which is not decomposed.
Land Use, Land-Use Change and Forestry	It is a category within UNFCCC accounting framework for greenhouse gas (GHG) emissions. It includes carbon pools of living biomass (above and below ground), dead organic matter (dead wood and litter) and organic soil carbon. The LULUCF sector covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land-use change and forestry activities.
Mangroves	Salt tolerant evergreen forest ecosystem found mainly in tropical and subtropical coastal and/or inter-tidal regions.
Mangrove Cover	Area covered under mangrove vegetation as interpreted from remote sensing data. It is included in the forest cover.
Microwave Remote	It is the technology which uses electromagnetic radiation with a wavelength

Sensing	between 1 cm and 1 m (commonly referred to as microwaves) as a measurement tool. The sensor transmits a (radio) signal in the microwave bandwidth and records the part that is backscattered by the target towards the sensor itself.
Mitigation	Mitigation in context of climate change refers to efforts to reduce or prevent emission of greenhouse gases.
Moderately Dense Forest	All lands with forest cover having a canopy density between 40 to 70 percent.
Moderate Resolution Imaging Spectro-radiometer	It is an extensive program using sensors on two satellites (Terra and Aqua), each providing complete daily coverage of earth. With the MODIS sensor, it is generally possible to obtain images in the morning (Terra) and afternoon (Aqua) for any particular location. Night time data are also available in the thermal range of the spectrum. The data have a variety of resolutions; spectral, spatial and temporal.
Nationally Determined Contributions (NDC)	NDC articulates commitments by each country to reduce its national emissions and adapt to the impacts of climate change. Countries across the globe adopted this international climate agreement at UNFCCC Conference of the Parties (COP21) in Paris in December 2015.
Net Change (in Forest Cover)	The sum of positive and negative changes in forest cover over a period of two assessments for a given area.
Non Forest Land	Land without forest cover.
Open Forest	Lands with forest cover having a canopy density between 10 to 40 percent.
Physiographic Division	Physiographic divisions separate the Earth into different areas based on the predominant types of landforms found in each region. As example: Mountain, Plain, Plateau, Desert, Islands etc. are different physiographic divisions. In early 20th century geomorphology is renamed as physiography at regional scale.
Precipitation	Precipitation is rain, snow, sleet, or hail - any kind of weather condition where something's falling from the sky.
Prey Species	The term prey species refers to an animal that is sought, captured, and eaten by a predator.
Pristine Area	Area that is original and pure; not spoiled or worn from use.
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.
Recorded Forest Area	Area recorded as forest in Government records.
REDD+	REDD+ is a United Nations-backed framework that aims to curb climate change by stopping the destruction of forests. REDD stands for "Reducing Emissions from Deforestation and forest Degradation"; the "+" signifies the role of conservation, sustainable management of forests and enhancement of forest carbon stocks.
Reducing Emissions from Deforestation and Forest Degradation	A framework to reduce emissions from deforestation and degradation, conservation of existing carbon stocks and enhancement of carbon stocks.
Remote sensing	Remote sensing is the acquisition of data, such as total forest area, forest type, canopy cover and height, from sensors on board aircraft or space-based platforms.
Representative	The Representative Concentration Pathways (RCPs) describe four different
Concentration Pathways	21 st century pathways of greenhouse gas (GHG) emissions and atmospheric concentrations, air pollutant emissions and land use.

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	Degraded forest lands having canopy density less than 10 percent.
Shuttle Radar Topography Mission	An international research effort that generates the most complete, high resolution digital topographic database of the Earth.
Silviculture	Silviculture is the art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the diverse needs and values of landowners and society such as wildlife habitat, timber, water resources, restoration, and recreation on a sustainable basis.
Sink	A carbon sink is a carbon pool from which more carbon flows in than out: forests can act as sink through the process of tree growth and resultant biological carbon sequestration.
Source (of carbon)	A carbon source is a carbon pool from which more carbon flows out than flows in: forests can often represent a net source of carbon due to the processes of decay, combustion and respiration.
Soil Organic Matter	It is the organic component of soil containing small plant residues, small living soil organism and decomposed organic matter.
Spatial Resolution	The minimum area on earth's surface that can be captured by a satellite sensor as being separate from its surroundings and is represented by a "pixel".
Speckle Noise	Speckle noise is the disturbance that arises due to the effect of environmental conditions on the imaging sensor during image acquisition. Speckle noise is mostly detected in case of medical images, active Radar images and Synthetic Aperture Radar (SAR) images.
Spectral Resolution	It refers to the width and number of spectral bands. The range of wave lengths that a satellite imaging system can detect. The narrower the bands, the greater the spectral resolution.
Stock Difference Approach	An approach to estimate mean annual carbon emissions for land subject to human activities such as deforestation and forest degradation. It is estimated as the ratio of difference in carbon stock at two points in time and the number of intervening years.
Stratification	Stratification is the division of the area into more homogenous units of carbon density. The purpose of stratification is to increase the accuracy and precision of accounting by reducing field data variability.
Sustainable Development Goals	It is known as global goals, and are adopted as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace as well as prosperity by 2030. These goals are adopted by all United Nations Member States in 2015.
Synthetic Aperture Radar	Synthetic Aperture Radar (SAR) is a type of active data collection where a sensor produces its own energy and then records the amount of that energy reflected back after interacting with the Earth. This technique is used for producing fine-resolution images from a resolution-limited radar sensor mounted either on an airplane or on a satellite platform in space.
Thematic Maps	Maps, generally showing forest cover, forest types, major species composition, crown density, other land uses etc. themes; prepared by interpretation of satellite images and verified by ground truth checking are commonly designated as thematic maps in forestry sector.
Tiger Census	National Tiger Conservation Authority (NTCA) in collaboration with the State Forest Departments, Conservation NGO's and coordinated by the Wildlife Institute of India (WII), has been conducting a National assessment for the "Status of Tigers, Co-predators, Prey and their Habitat" every four years. Such assessments are called 'Tiger Census'.

Tiger Corridors	A tiger corridor is a stretch of land linking tiger habitats, allowing movement of tigers, prey and other wildlife. Without corridors, tiger habitat can become fragmented and tiger populations isolated leaving the tigers vulnerable to localised extinction.
Tiger Reserves	A protected area statutorily designated for the conservation of the tigers is referred to as Tiger Reserve.
Tree	A large woody perennial plant having a single well defined stem (bole or trunk) and more or less definite crown. It also includes bamboos, palms, fruit trees, etc. and excludes non-perennial non-woody species like banana and tall shrubs or climbers. For the purpose of assessing growing stock and tree cover, only those trees having diameter at breast height (dbh) of 10 cm or more are measured.
Tree Cover	It comprises of tree patches of size less than 1 ha occurring outside the recorded forest area. Tree cover includes trees in all formations including linear, block and in scattered array.
Trees Outside Forests	It refers to all trees growing outside recorded forest areas irrespective of patch size.
Tribal Districts	The Districts identified as tribal districts under Tribal Sub-Plan (Government of India).
Uncertainty	Lack of knowledge of the true value of a variable. It is often expressed in terms of probability.
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	Lands with forest cover having a canopy density of 70 per cent and above.
Visual Interpretation	A manual method of satellite data interpretation using on-screen technique.
Vulnerability	Vulnerability refers to the inability (of a system) to withstand the effects of a hazard (or hostile environment).
WFS	The Web Feature Service (WFS) is an interface specified by the Open GIS Consortium (OGC) that allows for the exchange of geographic data across the Web. It defines the rules for requesting and retrieving geographic information using the Hyper Text Transmission Protocol (HTTP). WFS offers direct fine-grained access to geographic information at the feature and feature property level. Therefore, a WFS describes discovery, query, or data transformation operations in the web platform.
WMS	A Web Map Service (WMS) defines an interface that allows a client to get maps of geospatial data and gain detailed information on specific features shown on the map, without the facility of editing. A "map" is defined here as a visual representation of geospatial data, not the geospatial data itself.



Units and their Dimensions used in ISFR 2021

Sl. No.	Name of Unit	Symbol	Value
1.	Meter	m	1 m = 100 cm
2.	Square Kilometer	sq km	1 sq km = 1,000,000 m
3.	Tonnes	t	1 t = 1,000 kg
4.	Hectare	ha	1 ha = 0.01 sq km, 100 ha = 1 sq km
5.	Million hectare	m ha	1 m ha = 1,000,000 ha, = 10^6 ha = 10,000 sq km
6.	Million Tonnes	Mt	1 Mt = 1,000,000 tonnes = 10^6 tonnes
7.	Million cubic meter	m cum	1 m cum = 1,000,000 m ³ = 10^6 m ³
8.	Giga tonnes	Gt	1 Gt = 1,000,000,000 tonnes = 10^9 tonnes = 1,000 million tonne = 1 billion tonnes
9.	CO ₂ equivalent	CO ₂ eq	1 C = 44/12 CO ₂ eq = 3.67 CO ₂ eq
10.	Decibel	dB	1 dB = 1/10 of a bel (B)
11.	Giga hertz	GHz	1 GHz = 10^9 Hz
12.	Micro meter	µm	



13.4 BIHAR



Geographical Area
94,163 sq km

Geographical Coordinates
Latitude 24° 16' N to 27° 45' N
Longitude 83° 16' E to 88° 30' E

Population (as per Census 2011)
104.10 million
Urban 11.76 million (11.29 %)
Rural 92.34 million (88.71 %)
Tribal 1.34 million (1.28 %)

Average Population Density
1,106 per sq km

Livestock population
(as per 19th Live Stock Census)
32.93 million

No. of Districts
38

No. of Hill Districts
0

No. of Tribal Districts
0

Table 13.4.1 Land Use Pattern

Land Use Types	Area (in '000 ha)	Percentage
Geographical Area	9,416	
Reporting area for land utilization	9,360	100.00
Forests	622	6.65
Not available for land cultivation	2,150	22.97
Permanent pastures and other grazing lands	15	0.16
Land under misc. tree crops and groves	248	2.65
Culturable wasteland	44	0.47
Fallow land other than current fallows	120	1.28
Current fallows	919	9.82
Net area sown	5,242	56.00

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2017-18)

13.4.1 Forest Cover

Figure 13.4.1
Forest Cover
of Bihar

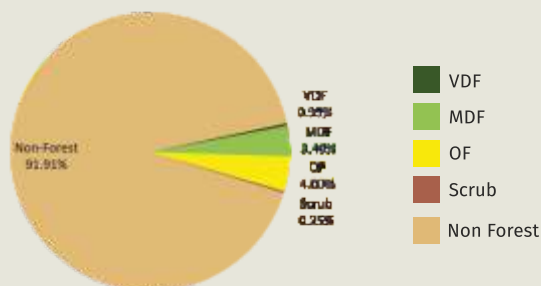


Table 13.4.2
Forest Cover of Bihar (in sq km)

Class	Area	% of GA
VDF	333.42	0.35
MDF	3,285.83	3.49
OF	3,761.54	4.00
Total	7,380.79	7.84
Scrub	235.89	0.25

Table 13.4.3 District- wise Forest Cover in Bihar (in sq km)

District	Geo-graphical Area (GA)	2021 Assessment				%of GA	Change wrt 2019 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Araria	2,830	0.00	8.10	142.78	150.88	5.33	-0.13	0.38
Arwal	638	0.00	1.63	2.51	4.14	0.65	0.14	0.39
Aurangabad	3,305	0.00	62.44	97.41	159.85	4.84	3.09	16.85
Banka	3,020	0.00	99.96	177.06	277.02	9.17	16.29	21.59
Begusarai	1,918	0.00	28.93	53.65	82.58	4.31	0.63	0.00
Bhagalpur	2,569	0.00	46.41	23.52	69.93	2.72	0.20	0.00
Bhojpur	2,395	0.00	19.44	12.55	31.99	1.34	-0.26	1.25
Buxar	1,703	0.00	2.94	2.95	5.89	0.35	0.00	0.00
Darbhanga	2,279	0.00	43.54	94.44	137.98	6.05	0.32	0.00
East Champaran	3,968	0.00	64.61	101.19	165.80	4.18	1.94	0.00
Gaya	4,976	0.00	132.03	470.52	602.55	12.11	12.24	66.50
Gopalganj	2,033	0.00	2.64	5.92	8.56	0.42	3.65	0.00
Jamui	3,098	28.97	352.76	279.44	661.17	21.34	13.22	3.21
Jehanabad	931	0.00	0.00	4.43	4.43	0.48	4.43	5.13
Kaimur	3,332	0.00	519.83	531.73	1,051.56	31.56	-4.83	25.65
Katihar	3,057	0.00	6.22	55.76	61.98	2.03	0.00	0.00
Khagaria	1,486	0.00	3.18	15.27	18.45	1.24	0.00	0.00
Kishanganj	1,884	0.00	16.32	87.23	103.55	5.50	-0.15	0.00
Lakhisarai	1,228	17.00	143.5	22.91	183.41	14.94	3.00	4.80
Madhepura	1,788	0.00	0.93	51.91	52.84	2.96	-0.04	0.40
Madhubani	3,501	0.00	40.39	164.98	205.37	5.87	1.30	0.00
Munger	1,419	37.97	223.61	24.43	286.01	20.16	2.41	9.43
Muzaffarpur	3,172	0.00	52.17	114.12	166.29	5.24	4.47	0.00
Nalanda	2,355	0.00	6.86	31.71	38.57	1.64	6.72	10.59
Nawada	2,494	0.00	214.68	302.20	516.88	20.72	3.38	18.13
Patna	3,202	0.00	19.55	8.48	28.03	0.88	4.49	0.54
Purnia	3,229	0.00	5.00	50.67	55.67	1.72	0.00	0.00

BIHAR



(in sq km)

District	Geo-graphical Area (GA)	2021 Assessment				%of GA	Change wrt 2019 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Rohtas	3,881	0.14	351.25	318.52	669.91	17.26	-2.32	40.92
Saharsa	1,687	0.00	4.17	30.22	34.39	2.04	-0.23	0.00
Samastipur	2,904	0.00	105.39	48.83	154.22	5.31	0.86	0.00
Saran	2,641	0.00	26.28	33.04	59.32	2.25	0.19	0.00
Sheikhpura	689	0.00	1.00	0.19	1.19	0.17	0.19	0.00
Sheohar	349	0.00	2.00	19.57	21.57	6.18	0.99	0.00
Sitamarhi	2,294	0.00	37.41	110.38	147.79	6.44	0.01	0.00
Siwan	2,219	0.00	2.11	5.55	7.66	0.35	0.50	0.00
Supaul	2,425	0.00	3.89	130.43	134.32	5.54	-4.46	0.00
Vaishali	2,036	0.00	86.19	29.51	115.70	5.68	3.88	0.00
West Champaran	5,228	249.34	548.47	105.53	903.34	17.28	-1.32	10.13
Grand Total	94,163	333.42	3,285.83	3,761.54	7,380.79	7.84	74.80	235.89

13.4.1.1 Forest Cover Inside and Outside Recorded Forest Area (or Green Wash)

The Forest Cover inside and outside Recorded Forest Area (RFA) has been analysed in different categories and presented in Table given below.

Table 13.4.4 Forest Cover inside and outside Recorded Forest Area (or Green Wash) in Bihar

(in sq km)

Forest Cover Inside the Recorded Forest Area (or Green Wash)				Forest Cover Outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
314	2,457	2,060	4,831	19	829	1,702	2,550
6.50%	50.86%	42.64%		0.74%	32.51%	66.75%	

*in case of Bihar, RFA boundaries have been used.

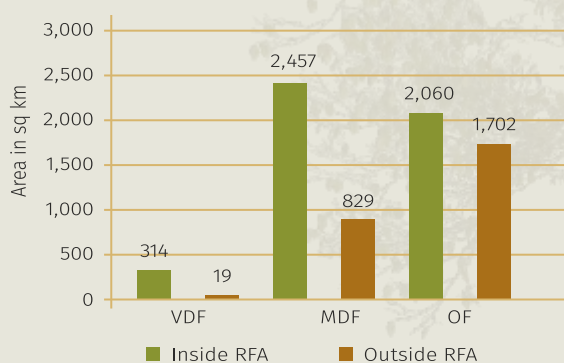


Figure 13.4.2
Forest Cover Inside and Outside of RFA in Bihar

Table 13.4.5 Forest Cover Change Matrix for Bihar

(in sq km)

Class	2021 Assessment					Total ISFR 2019
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	333	0	0	0	0	333
Moderately Dense Forest	0	3,244	27	7	2	3,280
Open Forest	0	33	3,612	17	31	3,693
Scrub	0	0	62	172	16	250
Non Forest	0	9	61	40	86,497	86,607
Total ISFR 2021	333	3,286	3,762	236	86,546	94,163
Net Change	0	6	69	-14	-61	

Table 13.4.6 Altitude-wise Forest Cover in Bihar

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	93,821	330	3,145	3,637	7,112	232
500-1000	342	3	141	125	269	4
Total	94,163	333	3,286	3,762	7,381	236

(based on SRTM, Digital Elevation Model, 30 m, 2016)

Table 13.4.7 Forest Cover in different slope classes in Bihar

(in sq km)

Slope (In degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	91,177	172	2,132	2,942	5,246	150
5-10	1,576	72	487	372	931	32
10-15	594	38	277	177	492	19
15-20	363	25	176	116	317	13
20-25	222	15	105	72	192	10
25-30	122	7	57	43	107	7
>30	109	4	52	40	96	5
Total	94,163	333	3,286	3,762	7,381	236

(based on SRTM, Digital Elevation Model, 30 m, 2016)



BIHAR



Figure 13.4.3
Forest Cover
Map of Bihar



LEGEND

- Very Dense Forest
- Moderately Dense Forest
- Open Forest
- Scrub
- Non-Forest
- Water-bodies
- International Boundary
- State Boundary
- District Boundary
- Capital

13.4.2 Forest Types

The area under different forest types of Bihar as per the Champion & Seth classification (1968), according to the Atlas Forest Types of India 2020 are presented in the following Table.

Table 13.4.8 Area statistics of the Forest Types found in Bihar

(in sq km)

Sl. No.	Forest Type	Area	% of the total mapped area*
1.	2/E1 Cane brakes	2.61	0.03
2.	3B/C1b Moist teak forest	4.16	0.06
3.	3C/C2b(1) <i>Bhabar-dun</i> sal	278.11	3.68
4.	3C/C3a West Gangetic moist mixed deciduous forest	176.39	2.33
5.	4D/SS2 <i>Barringtonia</i> swamp forest	1.63	0.02
6.	4D/2S2 Eastern wet alluvial grassland	11.36	0.15
7.	5B/C1a Dry Siwalik sal forest	392.89	5.20

(in sq km)

Sl. No.	Forest Type	Area	% of the total mapped area*
9.	5B/C2 Northern dry mixed deciduous forest	2,266.39	29.97
10.	5/DS1 Dry deciduous scrub	246.39	3.26
11.	5/E2 <i>Boswellia</i> forest	327.59	4.33
12.	5/E9 Dry bamboo brakes	69.34	0.92
13.	5/1S2 <i>Khair-sissu</i> forest	2.61	0.03
	Sub Total	5,360.05	70.89
14.	TOF/Plantation	2,195.82	29.04
	Total (Forest Cover & Scrub)	7,555.87	
	Grassland forest type (outside forest cover)		
15.	4D/2S2 Eastern wet alluvial grassland	5.28	0.07
	Grand Total	7,561.15	100.00

*Forest Types have been assigned to the natural forest formations under forest cover and scrub categories shown in forest cover mapping (ISFR, 2019). Grassland forest type outside forest cover has also been mapped. The total mapped area, therefore, is sum of forest cover, scrub and grassland forest types (found in non-forest).

13.4.3 Fire Prone Forest Areas

Forest Cover under different classes of forest fire proneness is given in following table.

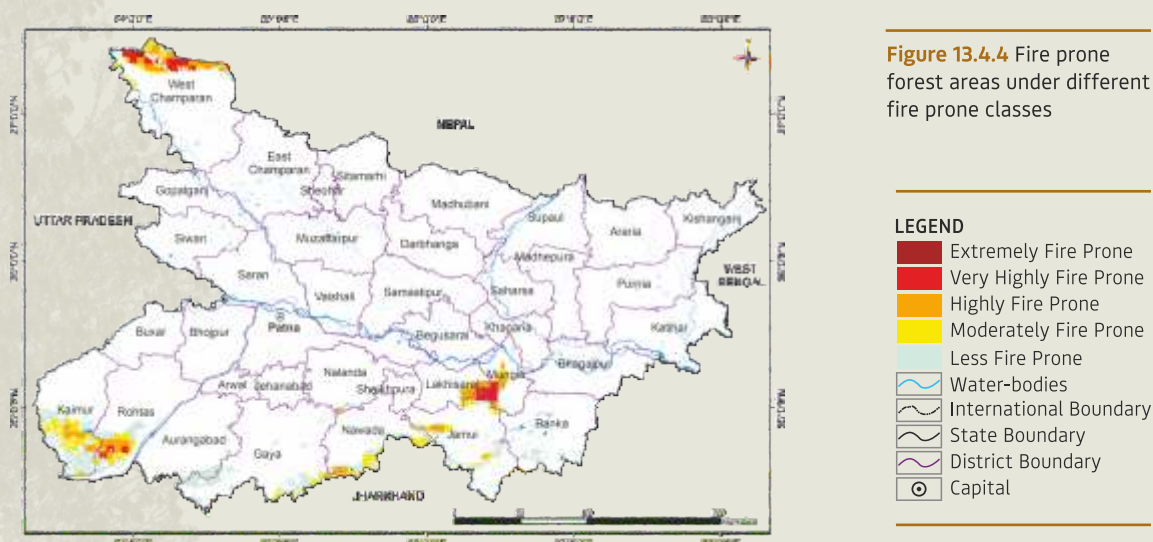


Table 13.4.9 Forest Fire Prone Classes

(in sq km)

Sl. No.	Forest Fire Prone Classes	Forest Cover	% of Total Forest Cover
1.	Extremely fire prone	24.38	0.33
2.	Very highly fire prone	471.89	6.39
3.	Highly fire prone	984.48	13.34
4.	Moderately fire prone	1,173.58	15.90
5.	Less fire prone	4,726.67	64.04
	Total	7,381.00	100.00



13.4.4 Tree Cover

Tree cover is defined as all tree patches of size less than 1 ha occurring outside the recorded forest area. Tree cover includes trees in all formations including scattered trees. Tree cover in Bihar has been estimated as given in following table.

Table 13.4.10 Tree Cover in Bihar (in sq km)

2019 Assessment	2021 Assessment	Change wrt 2019 Assessment
2,003	2,341	338

13.4.5 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in following table.

Table 13.4.11 Extent of TOF in Bihar (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
2,550	2,341	4,891

13.4.6 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Bihar is given in the Table 13.4.12. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 13.4.13

Table 13.4.12 Growing Stock in Bihar (in m cum)

Sl. No.	Growing Stock (GS)	2019 Assessment	2021 Assessment	Change wrt 2019 Assessment	% of Country's GS
1.	Growing Stock in Recorded Forest Area	26.73	30.52	3.79	0.70
2.	Growing Stock in TOF	40.46	41.04	0.58	2.31

Table 13.4.13 Diameter class distribution of top five tree species inside RFA in Bihar (in '000)

Sl. No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Shorea robusta</i>	20,756	4,788	514
2.	<i>Lannea coromandelica</i>	11,323	434	67
3.	<i>Madhuca latifolia</i>	7,377	654	139
4.	<i>Terminalia tomentosa</i>	7,058	708	137
5.	<i>Anogeissus latifolia</i>	6,266	482	0

13.4.7 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Bihar in Rural and Urban areas are given in the Table 13.4.14 and Table 13.4.15 respectively.

Table 13.4.14 Top five tree species in TOF (Rural) in Bihar

Sl. No.	Species	Relative Abundance (%)
1.	<i>Mangifera indica</i>	34.16
2.	<i>Dalbergia sissoo</i>	11.52
3.	<i>Borassus flabelliformis</i>	7.86
4.	<i>Litchi senensis</i>	3.86
5.	<i>Syzygium cumini</i>	3.39

Table 13.4.15 Top five tree species in TOF (Urban) in Bihar

Sl. No.	Species	Relative Abundance (%)
1.	<i>Litchi senensis</i>	13.87
2.	<i>Mangifera indica</i>	13.80
3.	<i>Bombax ceiba</i>	8.82
4.	<i>Dalbergia sissoo</i>	5.73
5.	<i>Psidium guajava</i>	4.53

13.4.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 56.88 million tonnes (208.56 million tonnes of CO₂ equivalent) which is 0.79% of total forest carbon of the country. Pool wise forest carbon in Bihar is given in the following table.

Table 13.4.16 Forest Carbon in Bihar in different pools (in '000 tonnes)

Sl. No.	Carbon Pools	Forest Carbon
1.	AGB	14,743
2.	BGB	5,249
3.	Dead wood	231
4.	Litter	785
5.	SOC	35,873
	Total	56,881

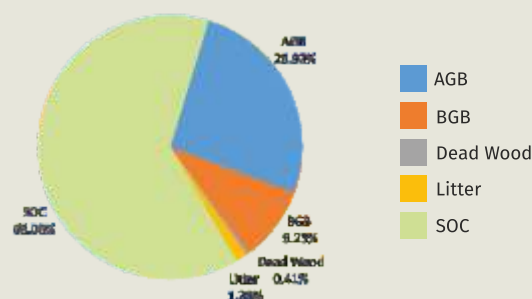


Figure 13.4.5 Forest Carbon in Bihar

13.4.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash which include culms of 1 year age and above are given in the following table.

**Table 13.4.17 Growing Stock of Bamboo in Bihar**

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	1,103	0.74
Total number of culms (in millions)	235	0.44
Total equivalent green weight (in '000 tonnes)	1,672	0.42

13.4.10 Major Invasive Species

Major invasive species as assessed from forest inventory data are presented in the Table 13.4.18.

Table 13.4.18 Major invasive species in the State inside the RFA/Green Wash in Bihar

(in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	261
2.	<i>Chromolaena odorata</i>	47
3.	<i>Argemone mexicana</i>	17
4.	<i>Cassia tora</i>	15
5.	<i>Senna occidentalis</i>	14

Major invasive species are given in terms of their estimated extent.



ANNEXURE-II

Volume equations to compute volume of wood in predominate trees in each State/UT are provided in the following tables:

ANDHRA PRADESH

Sl. No.	Species Name	Volume Equation
1	<i>Albizia amara</i>	$V=(0.13817-2.16947*D+11.4087*D^2+1.11636*D^3)$
2	<i>Anogeissus latifolia</i>	$V=(0.034725-0.78412*D+7.1873*D^2+6.9495*D^3)$
3	<i>Dalbergia paniculata</i>	$\sqrt{V}=(-0.144504+2.943115*D)$
4	<i>Ficus species</i>	$V=(0.088074-1.449236*D+8.760534*D^2)$
5	<i>Hardwickia binata</i>	$V=(0.025091-0.185618*D+3.561089*D^2+10.80139*D^3)$
6	<i>Lannea coromandelica</i>	$V=(0.057424-1.153088*D+8.542648*D^2)$
7	<i>Pterocarpus marsupium</i>	$V=(0.058424-1.233468*D+9.433633*D^2)$
8	<i>Tamarindus indica</i>	$V=(0.088074-1.449236*D+8.760534*D^2)$
9	<i>Terminalia crenulata</i>	$V=(0.05061-1.11994*D+8.77839*D^2)$
10	<i>Xylia xylocarpa</i>	$V=(0.098-1.52*D+8.963*D^2)$

ARUNACHAL PRADESH

Sl. No.	Species Name	Volume Equation
1	<i>Bischofia javanica</i>	$V=(0.00978-0.21005*D+5.62160*D^2)$
2	<i>Bombax ceiba</i>	$V=(0.00978-0.21005*D+5.62160*D^2)$
3	<i>Castanopsis indica</i>	$V=(0.05331-0.87098*D+6.52533*D^2+1.74231*D^3)$
4	<i>Castanopsis species</i>	$V=(0.05331-0.87098*D+6.52533*D^2+1.74231*D^3)$
5	<i>Duabanga grandiflora</i>	$\sqrt{V}=(0.13199+3.35856*D-0.79250*?D)$
6	<i>Gmelina arborea</i>	$V=0.01156+0.21230*D+5.10448*D^2)$
7	<i>Pinus roxburghii</i>	$\sqrt{V}=(0.291801+6.041763*D-2.430993*?D)$
8	<i>Pterospermum acerifolium</i>	$V=(0.00978-0.21005*D+5.62160*D^2)$
9	<i>Sterculia villosa</i>	$\sqrt{V}=(0.35895+4.99513*D-2.14135*?D)$
10	<i>Terminalia myriocarpa</i>	$V=(-0.096981+10.65*D^2)$

ASSAM

Sl. No.	Species Name	Volume Equation
1	<i>Albizia species</i>	$\sqrt{V}=(-0.07109+2.99732*D-0.26953*?D)$
2	<i>Bauhinia retusa</i>	$V=(-0.04262+6.09491*D^2)$
3	<i>Bombax ceiba</i>	$V=(0.04507-0.93461*D+5.48513*D^2+9.16037*D^3)$
4	<i>Gmelina arborea</i>	$V=(0.1156+0.21230*D+5.10448*D^2)$
5	<i>Lannea coromandelica</i>	$\sqrt{V}=(-0.32985+2.21152*D+0.78769*?D)$
6	<i>Schima wallichii</i>	$\sqrt{V}=(0.28069+4.61980*D-1.65381*?D)$
7	<i>Shorea robusta</i>	$\sqrt{V}=(-0.22388+3.29474*D)$
8	<i>Stereospermum personatum</i>	$\sqrt{V}=(0.49746+5.98454*D-2.84986*?D)$
9	<i>Tectona grandis</i>	$\sqrt{V}=(-0.405890+1.98158*D+0.987373*?D)$
10	<i>Terminalia bellirica</i>	$\sqrt{V}=(-0.14325+3.07937*D)$

BIHAR

Sl. No.	Species Name	Volume Equation
1	<i>Anogeissus latifolia</i>	$\sqrt{V}=(-0.07738+2.592167*D)$
2	<i>Boswellia serrata</i>	$V=(0.03356-1.124*D+10.306*D^2)$
3	<i>Butea monosperma</i>	$V=(0.136196-2.07674*D+10.1566*D^2)$
4	<i>Ficus racemosa</i>	$V=(0.05396-0.82031*D+6.17975*D^2)$
5	<i>Ficus religiosa</i>	$V=(0.05396-0.82031*D+6.17975*D^2)$
6	<i>Lannea coromandelica</i>	$\sqrt{V}=(-0.32985+2.21152*D+0.78769*D^2)$
7	<i>Madhuca latifolia</i>	$V=(-0.00092-0.55547*D+7.3446*D^2)$
8	<i>Mallotus philippinensis</i>	$V=(0.14749-2.87503*D+19.61977*D^2-19.11630*D^3)$
9	<i>Shorea robusta</i>	$V=(0.1563-2.45104*D+11.90581*D^2)$
10	<i>Terminalia crenulata</i>	$V=(0.08565-1.51685*D+10.24871*D^2)$

CHHATTISGARH

Sl. No.	Species Name	Volume Equation
1	<i>Anogeissus latifolia</i>	$V=(-0.02958+8.05003*D^2)$
2	<i>Boswellia serrata</i>	$V=(0.044621-1.25694*D+10.86801*D^2-3.009085*D^3)$
3	<i>Cleistanthus collinus</i>	$V=(-0.03915+0.16295*D+4.09182*D^2)$
4	<i>Diospyros melanoxylon</i>	$V=(0.12401-2.00966*D+10.87747*D^2)$
5	<i>Lagerstroemia parviflora</i>	$V=(0.0568-1.19611*D+9.11319*D^2)$
6	<i>Lannea coromandelica</i>	$\sqrt{V}=(-0.11751+2.86874*D)$
7	<i>Madhuca latifolia</i>	$V=(-0.00092-0.55547*D+7.3446*D^2)$
8	<i>Pterocarpus marsupium</i>	$V=(-0.04659+8.06901*D^2)$
9	<i>Shorea robusta</i>	$V=(0.17279-2.54241*D+13.08048*D^2-3.49087*D^3)$
10	<i>Terminalia crenulata</i>	$V=(0.00376-0.77604*D+8.35533*D^2)$

DELHI

Sl. No.	Species Name	Volume Equation
1	<i>Acacia arabica</i>	$V=(0.16609-2.78851*D+17.22127*D^2-11.60248*D^3)$
2	<i>Acacia catechu</i>	$V=(0.16609-2.78851*D+17.22127*D^2-11.60248*D^3)$
3	<i>Acacia lenticularis</i>	$\sqrt{V}=(-0.00142+2.61911*D-0.54703*D^2)$
4	<i>Azadirachta indica</i>	$V=(-0.03510+5.32981*D^2)$
5	<i>Cassia fistula</i>	$V=(0.05159-0.53331*D+3.46016*D^2+10.18473*D^3)$
6	<i>Ehretia laevis</i>	$V=(-0.03844+0.946490*D-5.40987*D^2+33.17338*D^3)$
7	<i>Ficus virens</i>	$\sqrt{V}=(0.03629+3.95389*D-0.84421*D^2)$
8	<i>Holoptelea integrifolia</i>	$\sqrt{V}=(0.21569+4.329878*D-1.504977*D^2)$
9	<i>Leucaena leucocephala</i>	$V=(0.081467-1.063661*D+6.452918*D^2)$
10	<i>Prosopis juliflora</i>	$V=(0.081467-1.063661*D+6.452918*D^2)$

GOA

Sl. No.	Species Name	Volume Equation
1	<i>Anacardium occidentale</i>	$V=(4.5899*D^2-0.422*D+0.0148)$
2	<i>Careya arborea</i>	$\sqrt{V}=(-0.23738+2.33289*D+0.48512*D^2)$
3	<i>Dillenia pentagyna</i>	$V=(0.070-1.295*D+9.429*D^2)$
4	<i>Lagerstroemia lanceolata</i>	$\sqrt{V}=(-0.13034+2.824203*D)$
5	<i>Lannea coromandelica</i>	$\sqrt{V}=(0.404153+5.555051*D-2.545525*D^2)$
6	<i>Schleichera trijuga</i>	$V=(0.01-0.912*D+11.396*D^2)$
7	<i>Syzygium cumini</i>	$\sqrt{V}=(0.30706+5.12731*D-2.0987*D^2)$
8	<i>Terminalia crenulata</i>	$\sqrt{V}=(-0.20394+3.159215*D)$
9	<i>Terminalia paniculata</i>	$V=(0.131-1.87132*D+9.47861*D^2)$
10	<i>Xylia xylocarpa</i>	$V=(0.007602-0.033037*D+1.868567*D^2+4.483454*D^3)$

GUJARAT

Sl. No.	Species Name	Volume Equation
1	<i>Adina cordifolia</i>	$\sqrt{V}=(0.21569+4.329878*D-1.504977*D^2)$
2	<i>Anogeissus latifolia</i>	$V=(0.030502-1.105937*D+12.261268*D^2)$
3	<i>Butea monosperma</i>	$V=(-0.032-0.0619*D+7.208*D^2)$
4	<i>Diospyros melanoxylon</i>	$V=(0.033867-0.975148*D+8.255412*D^2)$
5	<i>Lannea coromandelica</i>	$\sqrt{V}=(0.404153+5.555051*D-2.545525*D^2)$
6	<i>Madhuca latifolia</i>	$V=(0.074069-1.230020*D+7.726902*D^2)$
7	<i>Mitragyna parviflora</i>	$V=(0.099768-1.744274*D+10.086934*D^2)$
8	<i>Tectona grandis</i>	$V=(0.032011-0.995414*D+9.91129*D^2)$
9	<i>Terminalia crenulata</i>	$V=(0.060344-1.569539*D+12.090296*D^2)$
10	<i>Wrightia tinctoria</i>	$\sqrt{V}=(0.050294+3.115497*D-0.687813*D^2)$

HARYANA

Sl. No.	Species Name	Volume Equation
1	<i>Acacia arabica</i>	$V=(0.16609-2.78851*D+17.22127*D^2-11.60248*D^3)$
2	<i>Acacia catechu</i>	$V=(0.02384-0.72161*D+7.46888*D^2)$
3	<i>Acacia tortilis</i>	$V=(0.16609-2.78851*D+17.22127*D^2-11.60248*D^3)$
4	<i>Anogeissus latifolia</i>	$\sqrt{V}=(0.2122+4.947663*D-1.5929*D^2)$
5	<i>Dalbergia sissoo</i>	$V=(0.00331+0.000636*D^2*10000)$
6	<i>Eucalyptus species</i>	$V=(0.02894-0.89284*D+8.72416*D^2)$
7	<i>Lannea coromandelica</i>	$V=(0.14004-2.3599*D+11.90726*D^2)$
8	<i>Phoenix sylvestris</i>	$V=(0.0239-0.6266*D+5.4067*D^2)$
9	<i>Prosopis juliflora</i>	$V=(0.17553-0.71434*D+7.94663*D^2)$
10	<i>Syzygium cumini</i>	$V=(0.08481-1.81774*D+12.63047*D^2-6.69555*D^3)$

HIMACHAL PRADESH

Sl. No.	Species Name	Volume Equation
1	<i>Abies densa</i>	$\sqrt{V}=(-0.084305+3.060072*D)$
2	<i>Abies pindrow</i>	$V=(7.92*D^2+0.244*D-0.061)$
3	<i>Abies smithiana</i>	$V=(0.163269-2.232068*D+11.770869*D^2+1.06041*D^3)$
4	<i>Cedrus deodara</i>	$V=(10.03982*D^2-1.28303*D+0.07367)$
5	<i>Pinus excelsa</i>	$V=(10.44*D^2-0.851*D+0.020)$
6	<i>Pinus roxburghii</i>	$\sqrt{V}=(0.05131+3.9859*D-1.0245*D^2)$
7	<i>Quercus leucotrichophora</i>	$V=(0.0988-1.5547*D+10.1631*D^2)$
8	<i>Quercus semecarpifolia</i>	$V=(0.098800-1.55471*D+10.16317*D^2)$
9	<i>Rhododendron arboreum</i>	$\sqrt{V}=(0.306492+4.31536*D-1.749908*D^2)$
10	<i>Shorea robusta</i>	$\sqrt{V}=(0.16306+4.8991*D-1.57402*D^2)$

JHARKHAND

Sl. No.	Species Name	Volume Equation
1	<i>Anogeissus latifolia</i>	$\sqrt{V}=(-0.07738+2.592167*D)$
2	<i>Boswellia serrata</i>	$V=(0.03356-1.124*D+10.306*D^2)$
3	<i>Buchanania latifolia</i>	$V=(0.031-0.64087*D+6.04066*D^2)$
4	<i>Butea monosperma</i>	$V=(0.0417-0.47789*D+3.50714*D^2+9.76048*D^3)$
5	<i>Diospyros melanoxylon</i>	$V=(0.12401-2.00966*D+10.87747*D^2)$
6	<i>Lannea coromandelica</i>	$\sqrt{V}=(-0.11751+2.86874*D)$
7	<i>Madhuca latifolia</i>	$V=(-0.00092-0.55547*D+7.3446*D^2)$
8	<i>Schleichera trijuga</i>	$V=(0.010-0.912*D+11.396*D^2)$
9	<i>Shorea robusta</i>	$V=(0.022585-0.70158*D+8.714*D^2)$
10	<i>Terminalia crenulata</i>	$V=(0.08565-1.51685*D+10.24871*D^2)$

KARNATAKA

Sl. No.	Species Name	Volume Equation
1	<i>Anogeissus latifolia</i>	$V=(0.030502-1.105937*D+12.261268*D^2)$
2	<i>Careya arborea</i>	$\sqrt{V}=(0.23738+2.33289*D+0.48512*D^2)$
3	<i>Lagerstroemia lanceolata</i>	$V=(0.066188-1.334512*D+9.403257*D^2)$
4	<i>Olea dioica</i>	$V=(-0.03001+5.75523*D^2)$
5	<i>Poeciloneuron indicum</i>	$\sqrt{V}=(-0.153973+2.724109*D)$
6	<i>Syzygium cumini</i>	$\sqrt{V}=(0.30706+5.12731*D-2.0987*D^2)$
7	<i>Tectona grandis</i>	$\sqrt{V}=(-0.40589+1.98158*D+0.987373*D^2)$
8	<i>Terminalia crenulata</i>	$\sqrt{V}=(-0.203947+3.159215*D)$
9	<i>Terminalia paniculata</i>	$V=(0.131-1.87132*D+9.47861*D^2)$
10	<i>Xylia xylocarpa</i>	$\sqrt{V}=(0.01631+2.20921*D)$

KERALA

Sl. No.	Species Name	Volume Equation
1	<i>Artocarpus hirsute</i>	$V=(0.076-1.319*D+11.37*D^2)$
2	<i>Diospyros species</i>	$\sqrt{V}=(-0.184139+2.892723*D)$
3	<i>Lagerstroemia lanceolata</i>	$V=(-0.06183+0.411348*D+1.84813*D^2+12.43582*D^3-4.26661*D^4)$
4	<i>Syzygium cumini</i>	$\sqrt{V}=(0.30706+5.12731*D-2.0987*D^2)$
5	<i>Tectona grandis</i>	$\sqrt{V}=(-0.40589+1.98158*D+0.987373*D^2)$
6	<i>Terminalia bellirica</i>	$\sqrt{V}=(-0.153973+2.724109*D)$
7	<i>Terminalia crenulata</i>	$\sqrt{V}=(-0.203947+3.159215*D)$
8	<i>Terminalia paniculata</i>	$V=(0.131-1.87132*D+9.47861*D^2)$
9	<i>Vateria indica</i>	$\sqrt{V}=(-0.15493+3.1119*D)$
10	<i>Xylia xylocarpa</i>	$\sqrt{V}=(0.01631+2.20921*D)$

MADHYA PRADESH

Sl. No.	Species Name	Volume Equation
1	<i>Anogeissus latifolia</i>	$V=(0.145667-2.704089*D+17.4656*D^2-10.4903*D^3)$
2	<i>Boswellia serrata</i>	$V=(0.050452-1.228748*D+9.123381*D^2)$
3	<i>Butea monosperma</i>	$V=(0.0417-0.47789*D+3.50714*D^2+9.76048*D^3)$
4	<i>Diospyros melanoxylon</i>	$V=(0.033867-0.975148*D+8.255412*D^2)$
5	<i>Lagerstroemia parviflora</i>	$V=(0.0568-1.19611*D+9.11319*D^2)$
6	<i>Lannea coromandelica</i>	$\sqrt{V}=(-0.11751+2.86874*D)$
7	<i>Madhuca latifolia</i>	$V=(-0.00092-0.55547*D+7.3446*D^2)$
8	<i>Shorea robusta</i>	$\sqrt{V}=(0.19994+4.57179*D-1.56823*D^2)$
9	<i>Tectona grandis</i>	$V=(-0.003673-0.379175*D+6.368282*D^2)$
10	<i>Terminalia crenulata</i>	$V=(0.060344-1.569539*D+12.090296*D^2)$

MAHARASHTRA

Sl. No.	Species Name	Volume Equation
1	<i>Anogeissus latifolia</i>	$V=(-0.061856+7.952136*D^2)$
2	<i>Boswellia serrata</i>	$V=(0.050452-1.228748*D+9.123381*D^2)$
3	<i>Butea monosperma</i>	$V=(0.18573-2.85418*D+15.03576*D^2)$
4	<i>Careya arborea</i>	$\sqrt{V}=(0.23738+2.33289*D+0.48512*D^2)$
5	<i>Lagerstroemia parviflora</i>	$V=(0.06466-1.371984*D+9.629971*D^2)$
6	<i>Lannea coromandelica</i>	$V=(0.093318-1.531417*D+9.011590*D^2)$
7	<i>Madhuca latifolia</i>	$V=(0.074069-1.230020*D+7.726902*D^2)$
8	<i>Pterocarpus marsupium</i>	$V=(0.028252-0.833643*D+8.033788*D^2)$
9	<i>Tectona grandis</i>	$\sqrt{V}=(-0.106720+2.562418*D)$
10	<i>Terminalia crenulata</i>	$V=(0.048532-1.05615*D+8.204564*D^2)$

MANIPUR

Sl. No.	Species Name	Volume Equation
1	<i>Albizia species</i>	$\sqrt{V}=(-0.07109+2.99732*D-0.26953*?D)$
2	<i>Albizia procera</i>	$V=(0.13817-2.16947*D+11.4087*D^2+1.11636*D^3)$
3	<i>Callicarpa arborea</i>	$V=(0.11079-1.81103*D+11.4132*D^2+0.38528*D^3)$
4	<i>Castanopsis species</i>	$V=(-0.02301+0.12721*D+2.4127*D^2+8.12834*D^3)$
5	<i>Duabanga grandiflora</i>	$\sqrt{V}=(-0.01217+3.3993*D-0.28981*?D)$
6	<i>Ficus species</i>	$\sqrt{V}=(0.03629+3.95389*D-0.84421*?D)$
7	<i>Gmelina arborea</i>	$\sqrt{V}=(-0.00189+2.10033*D)$
8	<i>Pinus kesiya</i>	$V=(-0.01523+5.65779*D^2)$
9	<i>Quercus species</i>	$V=(0.14153-2.27358*D+12.9049*D^2)$
10	<i>Schima wallichii</i>	$\sqrt{V}=(0.28069+4.61980*D-1.65381*?D)$

MEGHALAYA

Sl. No.	Species Name	Volume Equation
1	<i>Albizia species</i>	$\sqrt{V}=(-0.07109+2.99732*D-0.26953*?D)$
2	<i>Areca catechu</i>	$V=(0.0239-0.6266*D+5.4067*D^2)$
3	<i>Artocarpus chaplasha</i>	$\sqrt{V}=(-0.15154+2.79983*D)$
4	<i>Artocarpus heterophyllus</i>	$\sqrt{V}=(-0.15154+2.79983*D)$
5	<i>Callicarpa arborea</i>	$\sqrt{V}=(-0.04506+2.33446*D)$
6	<i>Careya arborea</i>	$\sqrt{V}=(-0.07109+2.99732*D-0.26953*?D)$
7	<i>Gmelina arborea</i>	$\sqrt{V}=(-0.00189+2.10033*D)$
8	<i>Hevea brasiliensis</i>	$\sqrt{V}=(-0.226400+2.935870*D)$
9	<i>Pinus kesiya</i>	$V=(-0.01523+5.65779*D^2)$
10	<i>Schima wallichii</i>	$\sqrt{V}=(0.28069+4.61980*D-1.65381*?D)$

MIZORAM

Sl. No.	Species Name	Volume Equation
1	<i>Albizia species</i>	$\sqrt{V}=(-0.07109+2.99732*D-0.26953*?D)$
2	<i>Callicarpa arborea</i>	$\sqrt{V}=(-0.04506+2.33446*D)$
3	<i>Castanopsis species</i>	$V=(0.05331-0.87098*D+6.52533*D^2+1.74231*D^3)$
4	<i>Cedrela toona</i>	$\sqrt{V}=(-0.05514+2.67753*D)$
5	<i>Duabanga grandiflora</i>	$\sqrt{V}=(-0.01217+3.3993*D-0.28981*?D)$
6	<i>Dysoxylum binectariferum</i>	$V=(-0.04752+0.50667*D+1.88433*D^2+11.30632*D^3)$
7	<i>Gmelina arborea</i>	$\sqrt{V}=(-0.00189+2.10033*D)$
8	<i>Macaranga species</i>	$V=(0.13333-2.18825*D+13.12678*D^2)$
9	<i>Schima wallichii</i>	$\sqrt{V}=(0.28069+4.61980*D-1.65381*?D)$
10	<i>Tectona grandis</i>	$V=(0.19112-3.25372*D+17.9194*D^2-1.66117*D^3)$

NAGALAND

Sl. No.	Species Name	Volume Equation
1	<i>Albizia species</i>	$\sqrt{V}=(-0.07109+2.99732*D-0.26953*?D)$
2	<i>Alnus species</i>	$V=(0.0741-1.3603*D+10.9229*D^2)$
3	<i>Artocarpus chaplasha</i>	$\sqrt{V}=(-0.226400+2.935870*D)$
4	<i>Bauhinia retusa</i>	$\sqrt{V}=(-0.226400+2.935870*D)$
5	<i>Cedrela toona</i>	$\sqrt{V}=(-0.05514+2.67753*D)$
6	<i>Erythrina species</i>	$V=(-0.07803+1.70258*D-9.1618*D^2+33.91455*D^3)$
7	<i>Ficus species</i>	$\sqrt{V}=(0.03629+3.95389*D-0.84421*?D)$
8	<i>Quercus semiserrata</i>	$\sqrt{V}=(-0.226400+2.935870*D)$
9	<i>Schima wallichii</i>	$\sqrt{V}=(0.28069+4.61980*D-1.65381*?D)$
10	<i>Sterculia villosa</i>	$\sqrt{V}=(0.35895+4.99513*D-2.14135*?D)$

ODISHA

Sl. No.	Species Name	Volume Equation
1	<i>Anogeissus latifolia</i>	$?V=(-0.357373+2.430449*D+0.794626*?D)$
2	<i>Diospyros melanoxylon</i>	$V=(-0.009124-0.494103*D+7.610416*D^2)$
3	<i>Ficus bengalensis</i>	$V=(0.020853-0.610255*D+6.108230*D^2)$
4	<i>Lannea coromandelica</i>	$V=(0.057424-1.153088*D+8.542648*D^2)$
5	<i>Madhuca latifolia</i>	$V=(-0.058016+0.352354*D+2.92291*D^2+3.624110*D^3)$
6	<i>Mangifera indica</i>	$V=(0.108-1.706*D+7.559*D^2)$
7	<i>Schleichera trijuga</i>	$?V=(-0.24358+3.58273*D)$
8	<i>Shorea robusta</i>	$?V=(0.19994+4.57179*D-1.56823*?D)$
9	<i>Syzygium cumini</i>	$\text{Loge}V=2.132776+2.479397 \text{ Loge}D$
10	<i>Terminalia crenulata</i>	$V=(0.05061-1.11994*D+8.77839*D^2)$

PUNJAB

Sl. No.	Species Name	Volume Equation
1	<i>Acacia catechu</i>	$V=(0.16609-2.78851*D+17.22127*D^2-11.60248*D^3)$
2	<i>Albizia lebbeck</i>	$V=(-0.0367+5.87369*D^2)$
3	<i>Butea monosperma</i>	$\sqrt{V}=(-0.24276+2.95525*D)$
4	<i>Dalbergia sissoo</i>	$V=(0.00331+6.36*D^2)$
5	<i>Eucalyptus species</i>	$V=0.02894-0.89284*D+8.72416*D^2)$
6	<i>Grewia oppositifolia</i>	$V=(0.05858-1.20414*D+9.80167*D^2)$
7	<i>Holoptelea integrifolia</i>	$V=(0.17553-0.71434*?D+7.94663*D^2)$
8	<i>Lannea coromandelica</i>	$V=(0.14004-2.3599*D+11.90726*D^2)$
9	<i>Prosopis juliflora</i>	$V=(0.17553-0.71434*?D+7.94663*D^2)$
10	<i>Terminalia arjuna</i>	$\sqrt{V}=(-0.203947+3.159215*D)$

RAJASTHAN

Sl. No.	Species Name	Volume Equation
1	<i>Acacia catechu</i>	$V=(0.26949-1.61804*D+8.79495*D^2+2.49489*D^3)$
2	<i>Acacia lenticularis</i>	$V=(-0.048108+5.873169*D^2)$
3	<i>Anogeissus latifolia</i>	$V=(-0.01662+4.4268*D^2)$
4	<i>Anogeissus pendula</i>	$V=(0.00085-0.35165*D+4.77386*D^2-0.90585*D^3)$
5	<i>Boswellia serrata</i>	$\sqrt{V}=(-0.11629+2.4254*D)$
6	<i>Butea monosperma</i>	$V=(-0.032-0.0619*D+7.208*D^2)$
7	<i>Diospyros melanoxylon</i>	$\sqrt{V}=(-0.184139+2.892723*D)$
8	<i>Lannea coromandelica</i>	$\sqrt{V}=(0.404153+5.555051*D-2.545525*D^2)$
9	<i>Madhuca latifolia</i>	$V=(0.081467-1.063661*D+6.452918*D^2)$
10	<i>Tectona grandis</i>	$V=(0.062108-0.927983*D+6.613031*D^2)$

SIKKIM

Sl. No.	Species Name	Volume Equation
1	<i>Abies densa</i>	$V=(0.10774-2.09529*D+12.62008*D^2-1.61065*D^3)$
2	<i>Acer species</i>	$\sqrt{V}=(-0.10851+3.0425*D)$
3	<i>Alnus species</i>	$V=(0.0741-1.3603*D+10.9229*D^2)$
4	<i>Castanopsis species</i>	$V=(0.05331-0.87098*D+6.52533*D^2+1.74231*D^3)$
5	<i>Engelhardtia spicata</i>	$V=(0.007602-0.033037*D+1.868567*D^2+4.483454*D^3)$
6	<i>Eurya japonica</i>	$V=(-0.01097+5.30991*D^2)$
7	<i>Machilus species</i>	$V=(4.84009*D^2-0.02402)$
8	<i>Schima wallichii</i>	$\sqrt{V}=(-0.112426+2.54133*D)$
9	<i>Shorea robusta</i>	$\sqrt{V}=(-0.22388+3.29474*D)$
10	<i>Symplocos theaeifolia</i>	$V=(-0.03754+5.87*D^2)$

TAMILNADU

Sl. No.	Species Name	Volume Equation
1	<i>Acacia Mearnsii</i>	$V=(0.088074-1.449236*D+8.760534*D^2)$
2	<i>Albizia amara</i>	$\sqrt{V}=(-0.07109+2.99732*D-0.26953*D^2)$
3	<i>Anogeissus latifolia</i>	$V=(0.045731-1.020606*D+9.656667*D^2)$
4	<i>Commiphora ostdets</i>	$V=(0.088074-1.449236*D+8.760534*D^2)$
5	<i>Eucalyptus globules</i>	$\sqrt{V}=(-0.115412+3.12191*D)$
6	<i>Eucalyptus species</i>	$V=(0.02894-0.89284*D+8.72416*D^2)$
7	<i>Ficus species</i>	$V=(0.088074-1.449236*D+8.760534*D^2)$
8	<i>Pterocarpus marsupium</i>	$V=(0.058424-1.233468*D+9.433633*D^2)$
9	<i>Tamarindus indica</i>	$V=(0.131-1.87132*D+9.47861*D^2)$
10	<i>Tectona grandis</i>	$\sqrt{V}=(-0.405890+1.98158*D+0.987373*D^2)$

TELANGANA

Sl. No.	Species Name	Volume Equation
1	<i>Anogeissus latifolia</i>	$V=(-0.061856+7.952136*D2)$
2	<i>Boswellia serrata</i>	$V=(0.028917+7.777047*D3)$
3	<i>Cleistanthus collinus</i>	$V=(0.011617-0.309699*D+4.629527*D2)$
4	<i>Dalbergia paniculata</i>	$\sqrt{V}=(-0.144504+2.943115*D)$
5	<i>Lagerstroemia parviflora</i>	$V=(0.066188-1.334512*D+9.403257*D2)$
6	<i>Lannea coromandelica</i>	$V=(0.091153-1.66153*D+10.24624*D2)$
7	<i>Madhuca latifolia</i>	$V=(0.046883-0.894379*D+7.220441*D2)$
8	<i>Tectona grandis</i>	$V=(0.023613-0.531006*D+6.731036*D2)$
9	<i>Terminalia crenulata</i>	$V=(0.051812-1.076790*D+7.991280*D2)$
10	<i>Xylia xylocarpa</i>	$V=(0.05823+4.597986*D3)$

TRIPURA

Sl. No.	Species Name	Volume Equation
1	<i>Albizia species</i>	$\sqrt{V}=(-0.07109+2.99732*D-0.26953*D^2)$
2	<i>Artocarpus chaplasha</i>	$\sqrt{V}=(-0.15154+2.79983*D)$
3	<i>Artocarpus heterophyllus</i>	$\sqrt{V}=(-0.15154+2.79983*D)$
4	<i>Gmelina arborea</i>	$\sqrt{V}=(-0.00189+2.10033*D)$
5	<i>Hevea brasiliensis</i>	$\sqrt{V}=(-0.226400+2.935870*D)$
6	<i>Lannea coromandelica</i>	$\sqrt{V}=(-0.21972+2.86603*D)$
7	<i>Macaranga species</i>	$V=(0.13333-2.18825*D+13.12678*D2)$
8	<i>Pterospermum acerifolium</i>	$\sqrt{V}=(0.21596+4.14881*D-1.38264*D^2)$
9	<i>Schima wallichii</i>	$\sqrt{V}=(-0.11242+2.54133*D)$
10	<i>Tectona grandis</i>	$V=(0.19112-3.25372*D+17.9194*D2-1.66117*D3)$

UTTAR PRADESH

Sl. No.	Species Name	Volume Equation
1	<i>Acacia catechu</i>	$V=(0.16609-2.78851*D+17.22127*D2-11.60248*D3)$
2	<i>Anogeissus latifolia</i>	$\sqrt{V}=(-0.07738+2.592167*D)$
3	<i>Butea monosperma</i>	$\sqrt{V}=(-0.24276+2.95525*D)$
4	<i>Ficus racemosa</i>	$\sqrt{V}=(0.03629+3.95389*D-0.84421*D^2)$
5	<i>Lannea coromandelica</i>	$V=(0.14004-2.3599*D+11.90726*D2)$
6	<i>Mallotus philippinensis</i>	$V=0.14749-2.87503*D+19.61977*D2-19.11630*D3$
7	<i>Shorea robusta</i>	$\sqrt{V}=(0.16306+4.8991*D-1.57402*D^2)$
8	<i>Syzygium cumini</i>	$V=(0.08481-1.81774*D+12.63047*D2-6.9555*D3)$
9	<i>Tectona grandis</i>	$V=(0.08847-1.46936*D+11.98979*D2+1.970560*D3)$
10	<i>Terminalia crenulata</i>	$V=(0.18149-2.85865*D+18.60799*D2)$

UTTARAKHAND

Sl. No.	Species Name	Volume Equation
1	<i>Abies smithiana</i>	$V=(0.163269-2.232068*D+11.770869*D^2+1.06041*D^3)$
2	<i>Lyonia ovalifolia</i>	$V=(0.007602-0.033037*D+1.868567*D^2+4.483454*D^3)$
3	<i>Mallotus philippinensis</i>	$V=(0.14749-2.87503*D+19.61977*D^2-19.11630*D^3)$
4	<i>Pinus roxburghii</i>	$\sqrt{V}=(0.05131+3.9859*D-1.0245*D^2)$
5	<i>Quercus floribunda</i>	$V=(0.0988-1.5547*D+10.1631*D^2)$
6	<i>Quercus leucotrichophora</i>	$\sqrt{V}=(0.240157+3.820069*D-1.39452*D^2)$
7	<i>Quercus semecarpifolia</i>	$V=(0.098800-1.55471*D+10.16317*D^2)$
8	<i>Rhododendron arboreum</i>	$\sqrt{V}=(0.306492+4.31536*D-1.749908*D^2)$
9	<i>Shorea robusta</i>	$\sqrt{V}=(0.16306+4.8991*D-1.57402*D^2)$
10	<i>Terminalia crenulata</i>	$V=(0.08658-2.04096*D+13.28405*D^2-3.58047*D^3)$

WEST BENGAL

Sl. No.	Species Name	Volume Equation
1	<i>Acacia auriculiformis</i>	$V=(0.04235-0.74240*D+7.26875*D^2)$
2	<i>Butea monosperma</i>	$V=(0.031-0.64087*D+6.04066*D^2)$
3	<i>Eucalyptus species</i>	$V=(0.02894-0.89284*D+8.72416*D^2)$
4	<i>Lagerstroemia spaciola</i>	$V=(0.11740-1.58941*D+9.76464*D^2)$
5	<i>Madhuca latifolia</i>	$V=(0.046883-0.894379*D+7.220441*D^2)$
6	<i>Schima wallichii</i>	$\sqrt{V}=(0.28069+4.61980*D-1.65381*D^2)$
7	<i>Shorea robusta</i>	$V=(0.16019-2.81861*D+16.19328*D^2)$
8	<i>Sterculia villosa</i>	$V=(0.025584-0.89224*D+9.5879*D^2)$
9	<i>Tectona grandis</i>	$V=(0.19112-3.25372*D+17.9194*D^2-1.66117*D^3)$
10	<i>Trewia nudiflora</i>	$V=(0.0549-1.31*D+10.0*D^2)$

ANDAMAN & NICOBAR ISLANDS

Sl. No.	Species Name	Volume Equation
1	<i>Bombax ceiba</i>	$V=(0.136196-2.07674*D+10.1566*D^2)$
2	<i>Canarium euphyllum</i>	$V=(0.004338-0.7315*D+11.1750*D^2)$
3	<i>Dillenia pentagyna</i>	$V=(0.070-1.295*D+9.429*D^2)$
4	<i>Dipterocarpus species</i>	$V=(-0.045595+8.576*D^2)$
5	<i>Dipterocarpus turbinatus</i>	$?V=(0.06063+3.43666*D-0.75571*D^2)$
6	<i>Perishia insignis</i>	$?V=(0.06063+3.43666*D-0.75571*D^2)$
7	<i>Pterocarpus indicus</i>	$?V=(0.06063+3.43666*D-0.75571*D^2)$
8	<i>Pterocymbium tinctorium</i>	$V=(0.019795-0.99448*D+10.101*D^2)$
9	<i>Terminalia procera</i>	$V=(0.05061-1.11994*D+8.77839*D^2)$
10	<i>Tetrameles nudiflora</i>	$?V=(0.06063+3.43666*D-0.75571*D^2)$

CHANDIGARH

Sl. No.	Species Name	Volume Equation
1	<i>Acacia arabica</i>	$V=(0.16609-2.78851*D+17.22127*D^2-11.60248*D^3)$
2	<i>Acacia catechu</i>	$V=(0.02384-0.72161*D+7.46888*D^2)$
3	<i>Dalbergia sissoo</i>	$V=(0.00331+6.36*D^2)$
4	<i>Eucalyptus species</i>	$V=(0.02894-0.89284*D+8.72416*D^2)$
5	<i>Leucaena leucocephala</i>	$V=(0.17553-0.71434*D+7.94663*D^2)$
6	<i>Melia azadirachta</i>	$V=(-0.03510+5.32981*D^2)$
7	<i>Morus species</i>	$V=(-0.0351+5.32981*D^2)$
8	<i>Populus species</i>	$?V=(-0.143393+3.040067*D)$
9	<i>Prosopis juliflora</i>	$V=(0.17553-0.71434*D+7.94663*D^2)$
10	<i>Terminalia bellirica</i>	$?V=(-0.14017+3.36423*D)$

DADRA & NAGAR HAVELI AND DAMAN & DIU

Sl. No.	Species Name	Volume Equation
1	<i>Acacia catechu</i>	$V=(-0.048108+5.873169*D^2)$
2	<i>Anogeissus latifolia</i>	$V=(0.030502-1.105937*D+12.261268*D^2)$
3	<i>Bridelia retusa</i>	$V=(-0.032-0.0619*D+7.208*D^2)$
4	<i>Butea monosperma</i>	$V=(-0.032-0.0619*D+7.208*D^2)$
5	<i>Grewia tiliaefolia</i>	$?V=(-0.153973+2.724109*D)$
6	<i>Lannea coromandelica</i>	$?V=(0.404153+5.555051*D-2.545525*D^2)$
7	<i>Madhuca latifolia</i>	$V=(0.074069-1.230020*D+7.726902*D^2)$
8	<i>Tectona grandis</i>	$?V=(-0.40589+1.98158*D+0.987373*D^2)$
9	<i>Terminalia belerica</i>	$V=(0.074706-1.430082*D+10.181971*D^2)$
10	<i>Terminalia crenulata</i>	$?V=(-0.203947+3.159215*D)$

JAMMU & KASHMIR

Sl. No.	Species Name	Volume Equation
1	<i>Abies densa</i>	$V=(0.10774-2.09529*D+12.62008*D^2-1.61065*D^3)$
2	<i>Abies pindrow</i>	$V=(0.10774-2.09529*D+12.62008*D^2-1.61065*D^3)$
3	<i>Abies smithiana</i>	$\sqrt{V}=(0.20050+4.58840*D-1.42603*D^2)$
4	<i>Cedrus deodara</i>	$V=(10.03982*D^2-1.28303*D+0.07367)$
5	<i>Mallotus philippinensis</i>	$V=(0.14749-2.87503*D+19.61977*D^2-19.11630*D^3)$
6	<i>Pinus excelsa</i>	$V=(0.02-0.851*D+10.44*D^2)$
7	<i>Pinus roxburghii</i>	$V=(0.128812-2.285176*D+11.950158*D^2)$
8	<i>Quercus floribunda</i>	$V=(0.04430-0.84266*D+6.36239*D^2+2.27556*D^3)$
9	<i>Quercus leucotrichophora</i>	$V=(0.04430-0.84266*D+6.36239*D^2+2.27556*D^3)$
10	<i>Taxus baccata</i>	$V=(0.007602-0.033037*D+1.868567*D^2+4.483454*D^3)$

Annexure- III A

Estimated number of trees by species and diameter class in Forest at Country level

(in '000)

S. No.	Species	Diameter Class (cm)			Total	Percent
		10-30	30-60	60+		
1.	<i>Abies densa</i>	6,635	9,197	3,325	19,157	0.14
2.	<i>Abies pindrow</i>	22,439	28,248	12,693	63,380	0.45
3.	<i>Abies smithiana</i>	17,511	12,741	8,288	38,540	0.28
4.	<i>Acacia catechu</i>	1,69,582	5,035	242	1,74,859	1.25
5.	<i>Adina cordifolia</i>	37,944	10,747	2,521	51,212	0.37
6.	<i>Anogeissus latifolia</i>	4,60,793	50,692	2,211	5,13,696	3.67
7.	<i>Bombax ceiba</i>	27,396	14,030	4,770	46,196	0.33
8.	<i>Boswellia serrata</i>	57,114	44,927	1,372	1,03,413	0.74
9.	<i>Buchanania latifolia</i>	2,46,855	6,674	80	2,53,609	1.81
10.	<i>Butea monosperma</i>	1,80,760	17,530	410	1,98,700	1.42
11.	<i>Careya arborea</i>	47,302	4,894	216	52,412	0.37
12.	<i>Castanopsis species</i>	1,01,217	19,698	5,417	1,26,332	0.90
13.	<i>Cedrus deodara</i>	53,279	33,084	13,170	99,533	0.71
14.	<i>Cleistanthus collinus</i>	2,51,938	7,264	207	2,59,409	1.85
15.	<i>Dalbergia paniculata</i>	58,339	13,786	839	72,964	0.52
16.	<i>Diospyros melanoxylon</i>	2,70,396	30,424	1,219	3,02,039	2.16
17.	<i>Ficus benghalensis</i>	5,316	1,555	2,489	9,360	0.07
18.	<i>Ficus species</i>	59,542	8,682	4,397	72,621	0.52
19.	<i>Lagerstroemia lanceolata</i>	15,124	7,250	1,751	24,125	0.17
20.	<i>Lagerstroemia parviflora</i>	2,89,492	20,529	611	3,10,632	2.22
21.	<i>Lannea coromandelica</i>	3,50,309	57,522	1,809	4,09,640	2.92
22.	<i>Madhuca latifolia</i>	1,42,701	41,677	4,732	1,89,110	1.35
23.	<i>Mallotus philippinensis</i>	1,47,779	5,555	202	1,53,536	1.10
24.	<i>Pinus wallichiana</i>	1,01,327	53,843	11,991	1,67,161	1.19
25.	<i>Pinus roxburghii</i>	1,98,874	96,353	10,344	3,05,571	2.18
26.	<i>Pterocarpus marsupium</i>	88,887	23,645	1,869	1,14,401	0.82
27.	<i>Quercus dilatata</i>	24,730	5,956	1,761	32,447	0.23
28.	<i>Quercus leucotrichophora</i>	2,27,538	39,869	4,241	2,71,648	1.94
29.	<i>Quercus semecarpifolia</i>	20,741	10,395	4,365	35,501	0.25
30.	<i>Rhododendron arboreum</i>	1,11,116	17,939	846	1,29,901	0.93
31.	<i>Schima wallichii</i>	1,00,980	14,326	2,368	1,17,674	0.84
32.	<i>Schleichera trijuga</i>	66,949	22,181	1,832	90,962	0.65
33.	<i>Shorea robusta</i>	9,78,143	2,22,651	17,983	12,18,777	8.70
34.	<i>Syzygium cumini</i>	1,15,438	33,494	3,951	1,52,883	1.09
35.	<i>Tectona grandis</i>	8,23,427	94,170	2,769	9,20,366	6.57
36.	<i>Terminalia belerica</i>	44,992	12,232	3,727	60,951	0.44
37.	<i>Terminalia tomentosa</i>	4,03,689	85,807	5,621	4,95,117	3.53
38.	<i>Terminalia myriocarpa</i>	23,902	11,658	1,857	37,417	0.27
39.	<i>Terminalia paniculata</i>	79,806	21,253	4,449	1,05,508	0.75
40.	<i>Xylia xylocarpa</i>	1,25,985	25,021	2,050	1,53,056	1.09
41.	Rest of Species	53,38,884	6,31,021	84,225	60,54,130	43.21
Total		1,18,95,171	18,73,555	2,39,220	1,40,07,946	100.00

Annexure- III B

Estimated volume by species and diameter class in Forest at Country level

(in million cum)

S. No.	Species	Diameter Class (cm)			Total	Percent
		10-30	30-60	60+		
1	<i>Abies densa</i>	1.60	12.56	21.68	35.84	0.82
2	<i>Abies pindrow</i>	5.90	39.92	71.48	117.30	2.67
3	<i>Abies smithiana</i>	3.28	19.18	71.61	94.07	2.15
4	<i>Acacia catechu</i>	17.82	4.18	0.78	22.78	0.52
5	<i>Adina cordifolia</i>	5.05	11.59	13.97	30.61	0.7
6	<i>Anogeissus latifolia</i>	69.55	51.87	8.26	129.68	2.96
7	<i>Bombax ceiba</i>	4.36	14.17	18.83	37.36	0.85
8	<i>Boswellia serrata</i>	10.96	41.14	4.21	56.31	1.28
9	<i>Buchanania latifolia</i>	19.51	3.65	0.21	23.37	0.53
10	<i>Butea monosperma</i>	24.04	14.90	1.69	40.63	0.93
11	<i>Careya arborea</i>	17.74	7.63	1.08	26.45	0.6
12	<i>Castanopsis species</i>	11.77	16.66	19.99	48.42	1.1
13	<i>Cedrus deodara</i>	10.61	44.80	66.99	122.40	2.79
14	<i>Cleistanthus collinus</i>	20.06	3.49	0.49	24.04	0.55
15	<i>Dalbergia paniculata</i>	8.52	13.89	3.46	25.87	0.59
16	<i>Diospyros melanoxylon</i>	26.57	27.54	4.52	58.63	1.34
17	<i>Ficus benghalensis</i>	0.60	1.52	20.17	22.29	0.51
18	<i>Ficus species</i>	7.29	8.93	39.94	56.16	1.28
19	<i>Lagerstroemia lanceolata</i>	2.27	8.73	8.44	19.44	0.44
20	<i>Lagerstroemia parviflora</i>	30.06	17.13	2.41	49.60	1.13
21	<i>Lannea coromandelica</i>	52.58	51.85	6.68	111.11	2.53
22	<i>Madhuca latifolia</i>	18.27	37.47	16.32	72.06	1.64
23	<i>Mallotus philippinensis</i>	14.78	4.32	0.74	19.84	0.45
24	<i>Pinus wallichiana</i>	21.61	76.46	59.83	157.90	3.6
25	<i>Pinus roxburghii</i>	33.33	104.01	43.51	180.85	4.12
26	<i>Pterocarpus marsupium</i>	14.42	25.05	8.51	47.98	1.09
27	<i>Quercus dilatata</i>	3.18	6.44	9.45	19.07	0.44
28	<i>Quercus leucotrichophora</i>	28.52	34.62	17.06	80.20	1.83
29	<i>Quercus semecarpifolia</i>	3.97	13.93	21.74	39.64	0.9
30	<i>Rhododendron arboreum</i>	12.71	14.62	3.22	30.55	0.7
31	<i>Schima wallichii</i>	15.66	14.28	10.08	40.02	0.91
32	<i>Schleichera trijuga</i>	11.60	26.58	8.99	47.17	1.07
33	<i>Shorea robusta</i>	136.38	251.20	89.36	476.94	10.87
34	<i>Syzygium cumini</i>	13.97	30.74	19.72	64.43	1.47
35	<i>Tectona grandis</i>	100.63	80.62	10.64	191.89	4.37
36	<i>Terminalia belerica</i>	6.62	13.85	14.80	35.27	0.8
37	<i>Terminalia tomentosa</i>	54.18	90.88	25.02	170.08	3.88
38	<i>Terminalia myriocarpa</i>	6.16	15.82	11.71	33.69	0.77
39	<i>Terminalia paniculata</i>	9.55	20.40	19.76	49.71	1.13
40	<i>Xylia xylocarpa</i>	16.50	18.76	5.20	40.46	0.92
41	Rest of Species	533.86	535.80	368.38	1,438.04	32.77
Total		1,406.04	1,831.18	1,150.93	4,388.15	100.00

Annexure- III C

Estimated number of trees by species and diameter class in TOF at Country level

(in '000)

S. No.	Species	Diameter Class (cm)			Total	Percent
		10-30	30-60	60+		
1	<i>Acacia arabica</i>	1,83,077	44,856	1,533	2,29,466	3.29
2	<i>Acacia auriculiformis</i>	1,06,085	4,526	237	1,10,848	1.59
3	<i>Acacia lenticularis</i>	39,580	7,185	146	46,911	0.67
4	<i>Albizia species</i>	25,449	7,142	383	32,974	0.47
5	<i>Areca catechu</i>	3,61,189	152	0	3,61,341	5.18
6	<i>Artocarpus heterophyllus</i>	43,027	14,123	1,547	58,697	0.84
7	<i>Azadirachta indica</i>	3,73,956	97,243	5,630	4,76,829	6.84
8	<i>Bombax ceiba</i>	30,616	9,829	1,103	41,548	0.60
9	<i>Borassus flabelliformis</i>	16,222	91,643	909	1,08,774	1.56
10	<i>Butea monosperma</i>	1,57,770	29,945	1,216	1,88,931	2.71
11	<i>Castanopsis species</i>	54,753	6,311	505	61,569	0.88
12	<i>Cocos nucifera</i>	2,32,033	1,03,513	316	3,35,862	4.81
13	<i>Dalbergia sissoo</i>	61,190	14,034	538	75,762	1.09
14	<i>Elaeis guineensis</i>	505	6,795	9,461	16,761	0.24
15	<i>Eucalyptus species</i>	1,61,778	14,994	964	1,77,736	2.55
16	<i>Ficus benghalensis</i>	5,921	3,531	4,652	14,104	0.20
17	<i>Ficus racemosa</i>	13,345	6,296	2,020	21,661	0.31
18	<i>Ficus religiosa</i>	9,584	5,228	5,710	20,522	0.29
19	<i>Ficus species</i>	25,872	3,101	1,359	30,332	0.43
20	<i>Hevea brasiliensis</i>	1,71,486	7,832	33	1,79,351	2.57
21	<i>Holoptelea integrifolia</i>	33,143	6,804	465	40,412	0.58
22	<i>Madhuca latifolia</i>	26,009	26,879	19,861	72,749	1.04
23	<i>Mangifera indica</i>	4,95,599	1,18,445	29,285	6,43,329	9.22
24	<i>Phoenix sylvestris</i>	39,057	17,468	29	56,554	0.81
25	<i>Pinus roxburghii</i>	61,131	14,788	1,197	77,116	1.11
26	<i>Pinus wallichiana</i>	25,622	11,474	2,614	39,710	0.57
27	<i>Pongamia pinnata</i>	45,004	7,707	975	53,686	0.77
28	<i>Populus species</i>	83,990	7,710	5,153	96,853	1.39
29	<i>Prosopis cineraria</i>	58,645	37,118	1,349	97,112	1.39
30	<i>Prosopis juliflora</i>	1,29,250	3,549	320	1,33,119	1.91
31	<i>Prunus species</i>	21,782	1,842	3,706	27,330	0.39
32	<i>Quercus leucotrichophora</i>	26,750	11,399	280	38,429	0.55
33	<i>Schima wallichii</i>	45,433	5,087	320	50,840	0.73
34	<i>Shorea robusta</i>	1,28,132	24,606	4,082	1,56,820	2.25
35	<i>Syzygium cumini</i>	51,611	17,758	2,053	71,422	1.02
36	<i>Tamarindus indica</i>	26,327	21,496	8,123	55,946	0.80
37	<i>Tectona grandis</i>	2,03,459	12,846	599	2,16,904	3.11
38	<i>Terminalia arjuna</i>	34,198	14,720	1,357	50,275	0.72
39	<i>Terminalia tomentosa</i>	62,158	9,046	1,165	72,369	1.04
40	<i>Zizyphus mauritiana</i>	1,21,281	10,108	414	1,31,803	1.89
41	Rest of Species	19,33,019	2,43,278	27,129	22,03,426	31.59
Total		57,25,038	11,02,407	1,48,738	69,76,183	100.00

Annexure- III D

Estimated volume by species and diameter class in TOF at Country level

(in million cum)

S. No.	Species	Diameter Class (cm)			Total	Percent
		10-30	30-60	60+		
1	<i>Acacia arabica</i>	19.05	26.85	3.33	49.23	2.77
2	<i>Acacia auriculiformis</i>	6.36	2.42	0.51	9.29	0.52
3	<i>Acacia lenticularis</i>	4.64	4.35	0.35	9.34	0.52
4	<i>Albizia species</i>	3.38	5.23	1.09	9.70	0.55
5	<i>Areca catechu</i>	8.97	0.06	0.00	9.03	0.51
6	<i>Artocarpus heterophyllus</i>	5.14	8.80	5.19	19.13	1.07
7	<i>Azadirachta indica</i>	41.13	64.38	15.14	120.65	6.78
8	<i>Bombax ceiba</i>	3.74	8.11	4.61	16.46	0.92
9	<i>Borassus flabelliformis</i>	3.00	47.59	1.65	52.24	2.94
10	<i>Butea monosperma</i>	17.78	21.70	4.48	43.96	2.47
11	<i>Castanopsis species</i>	6.90	5.36	2.55	14.81	0.83
12	<i>Cocos nucifera</i>	42.94	36.62	0.70	80.26	4.51
13	<i>Dalbergia sissoo</i>	11.50	12.02	1.54	25.06	1.41
14	<i>Elaeis guineensis</i>	0.05	5.61	16.07	21.73	1.22
15	<i>Eucalyptus species</i>	15.17	11.19	2.72	29.08	1.63
16	<i>Ficus benghalensis</i>	0.62	3.10	29.10	32.82	1.84
17	<i>Ficus racemosa</i>	1.38	4.64	7.52	13.54	0.76
18	<i>Ficus religiosa</i>	1.06	4.40	30.76	36.22	2.04
19	<i>Ficus species</i>	2.31	1.86	5.74	9.91	0.56
20	<i>Hevea brasiliensis</i>	15.16	3.66	0.07	18.89	1.06
21	<i>Holoptelea integrifolia</i>	3.50	4.70	1.43	9.63	0.54
22	<i>Madhuca latifolia</i>	2.90	19.23	60.57	82.70	4.65
23	<i>Mangifera indica</i>	54.40	81.96	93.97	230.33	12.94
24	<i>Phoenix sylvestris</i>	5.88	6.43	0.05	12.36	0.69
25	<i>Pinus roxburghii</i>	7.96	12.54	4.89	25.39	1.43
26	<i>Pinus wallichiana</i>	6.40	12.80	15.88	35.08	1.97
27	<i>Pongamia pinnata</i>	3.47	4.32	2.39	10.18	0.57
28	<i>Populus species</i>	7.73	3.82	12.21	23.76	1.34
29	<i>Prosopis cineraria</i>	5.90	19.00	2.71	27.61	1.55
30	<i>Prosopis juliflora</i>	7.76	2.12	1.06	10.94	0.61
31	<i>Prunus species</i>	1.08	1.25	8.20	10.53	0.59
32	<i>Quercus leucotrichophora</i>	3.93	9.34	1.07	14.34	0.81
33	<i>Schima wallichii</i>	7.52	4.94	1.47	13.93	0.78
34	<i>Shorea robusta</i>	12.33	15.65	10.17	38.15	2.14
35	<i>Syzygium cumini</i>	6.22	13.47	6.95	26.64	1.50
36	<i>Tamarindus indica</i>	2.94	13.89	22.99	39.82	2.24
37	<i>Tectona grandis</i>	21.08	8.81	3.61	33.50	1.88
38	<i>Terminalia arjuna</i>	4.43	10.22	4.47	19.12	1.07
39	<i>Terminalia tomentosa</i>	5.91	6.01	3.42	15.34	0.86
40	<i>Zizyphus mauritiana</i>	11.52	5.57	1.12	18.21	1.02
41	Rest of Species	187.66	172.00	100.79	460.44	25.89
Total		580.80	706.02	492.54	1779.35	100.00

Annexure- IV

State/UTs wise Standard Error for Growing stock & Tree Cover

Sr. No.	State/UTs	SE% Forest	SE% TOF	SE% Tree Cover
1	Andhra Pradesh	4.36	4.43	2.73
2	Arunanchal Pradesh	8.46	13.36	3.77
3	Assam	7.25	5.13	5.25
4	Bihar	7.55	4.40	4.05
5	Chhattisgarh	2.69	3.84	3.43
6	Delhi	12.23	7.15	6.57
7	Goa	6.58	5.45	9.85
8	Gujarat	4.87	2.95	13.51
9	Haryana	10.34	4.46	6.22
10	Himanchal Pradesh	3.88	5.37	5.21
11	Jharkhand	3.85	4.96	3.87
12	Karnataka	3.73	4.10	4.34
13	Kerala	3.90	3.75	3.83
14	Madhya Pradesh	2.05	3.41	2.70
15	Maharashtra	3.11	2.18	2.26
16	Manipur	11.45	11.23	9.17
17	Meghalaya	7.75	7.17	10.38
18	Mizoram	10.34	10.96	8.34
19	Nagaland	13.55	9.32	4.13
20	Odisha	3.53	4.63	2.99
21	Punjab	9.22	7.03	6.39
22	Rajasthan	4.97	2.76	2.23
23	Sikkim	11.71	7.03	8.27
24	Tamil Nadu	5.67	2.27	6.78
25	Telangana	3.79	4.49	6.40
26	Tripura	6.19	7.20	8.81
27	Uttar Pradesh	4.25	1.91	2.63
28	Uttarakhand	3.77	4.30	4.42
29	West Bengal	8.72	4.97	5.27
30	A & N Island	8.96	15.60	10.50
31	Chandigarh	12.91	7.87	9.79
32	Dadar & Nagar Haveli & Daman & Diu	15.95	12.52	16.49
33	Jammu & Kashmir	4.13	4.77	5.25
34	Ladakh*	-	22.02	-
35	Lakshadweep	-	4.73	5.58
36	Puducherry*		11.60	7.24
Total		4.60	6.10	4.01

Note*:- Due to inadequate data, Standard Error (SE) is not given.



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