Forest Statistics

Forest Survey of India, Dehradun.
Forest Carbon Inventory for India

- Forest cover maps,
- Forest types maps,
- National Forest Inventory,
- Estimation of missing components of forest biomass, and
- Integrating the above four components to estimate the forest carbon and change

For estimation and stratification of ‘Activity data’

For developing ‘Emission factors’
Forest Cover in India – ISFR 2015

<table>
<thead>
<tr>
<th>Class</th>
<th>Area (km²)</th>
<th>% of Geo. Area</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forest Cover</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) VDF (&gt;70 %)</td>
<td>85,905</td>
<td>2.61</td>
</tr>
<tr>
<td>b) MDF (40-70%)</td>
<td>315,374</td>
<td>9.59</td>
</tr>
<tr>
<td>c) OF (10-40%)</td>
<td>300,395</td>
<td>9.14</td>
</tr>
<tr>
<td><strong>Total Forest Cover</strong></td>
<td><strong>701,673</strong></td>
<td><strong>21.34</strong></td>
</tr>
<tr>
<td><strong>Scrub</strong></td>
<td>41,362</td>
<td>1.26</td>
</tr>
<tr>
<td><strong>Other Non-forest</strong></td>
<td><strong>2,544,228</strong></td>
<td><strong>77.40</strong></td>
</tr>
<tr>
<td><strong>Total Geo. Area</strong></td>
<td><strong>3,287,263</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>
## Forest Cover Change Matrix (km²)

The Forest Cover Change Matrix (km²) depicts the changes in forest cover from 2013 to 2015.

<table>
<thead>
<tr>
<th>Class</th>
<th>VDF</th>
<th>MDF</th>
<th>OF</th>
<th>Scrub</th>
<th>Non Forest</th>
<th>Total Forest Cover 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Dense Forest</td>
<td>82,473</td>
<td>623</td>
<td>145</td>
<td>4</td>
<td>257</td>
<td>83,502</td>
</tr>
<tr>
<td>Moderately Dense Forest</td>
<td>2,897</td>
<td>311,063</td>
<td>2,438</td>
<td>93</td>
<td>2,254</td>
<td>318,745</td>
</tr>
<tr>
<td>Open Forest</td>
<td>362</td>
<td>2,580</td>
<td>286,491</td>
<td>596</td>
<td>5,622</td>
<td>295,651</td>
</tr>
<tr>
<td>Scrub</td>
<td>15</td>
<td>130</td>
<td>1,496</td>
<td>38,068</td>
<td>1,674</td>
<td>41,383</td>
</tr>
<tr>
<td>Non Forest</td>
<td>157</td>
<td>978</td>
<td>9,825</td>
<td>2,601</td>
<td>2534,4213</td>
<td>2,547,982</td>
</tr>
<tr>
<td>Total Forest Cover 2015</td>
<td>85,904</td>
<td>315,374</td>
<td>300,395</td>
<td>41,362</td>
<td>2544,228</td>
<td>GA=3287,263</td>
</tr>
<tr>
<td>Net change</td>
<td>2,402</td>
<td>-3,371</td>
<td>4,744</td>
<td>-21</td>
<td>-3,754</td>
<td></td>
</tr>
</tbody>
</table>

### Degradation, Deforestation, Enhancement, Afforestation

![Forest Survey of India logo]
### Forest Types of India

**MAJOR GROUPS (climate)**

1. **Moist Tropical Forests**
2. **Dry Tropical Forests**
3. **Montane Temperate Forests**
4. **Montane Subtropical Forests**
5. **Sub Alpine Forests**
6. **Alpine Scrub**

**TYPE GROUPS (temp. & moisture)**

- Group y1.1-Tropical Wet Evergreen Forests
- Group 1.2-Tropical Semi-Evergreen Forests
- Group 1.3-Tropical Moist Deciduous Forests
- Group 1.4-Littoral And Swamp Forests
- Group 2.5-Tropical Dry Deciduous Forests
- Group 2.6-Tropical thorn Forests
- Group 2.7-Tropical Dry Evergreen Forests
- Group 3.8-Southern Subtropical Broadleaved Hill Forests
- Group 3.9-Subtropical Pine Forests
- Group 3.10- Subtropical Dry Evergreen Forests
- Group 4.11-Montane Wet Temperate Forests
- Group 4.12-Himalayan Moist Temperate Forests
- Group 4.13-Himalayan Dry Temperate Forests
- Group 5.14-Sub Alpine Forests
- Group 6.15-Moist Alpine Scrub
- Group 6.16- Dry Alpine Scrub

**SUB-GROUPS (location)**

- Sub-group- 22 Nos.

**TYPES (local edaphic cond.)**

- Types - 200 Nos.

*As per Champion and Seth classification (1968)*
### Forest Cover in Different Forest Type Groups

<table>
<thead>
<tr>
<th>Type Group</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 Tropical Wet Evergreen</td>
<td>2.92</td>
</tr>
<tr>
<td>Group 2 Tropical Semi-Evergreen</td>
<td>13.79</td>
</tr>
<tr>
<td>Group 3 Tropical Moist Deciduous</td>
<td>19.73</td>
</tr>
<tr>
<td>Group 4 Littoral &amp; Swamp</td>
<td>0.69</td>
</tr>
<tr>
<td>Group 5 Tropical Dry Deciduous</td>
<td>41.87</td>
</tr>
<tr>
<td>Group 6 Tropical Thorn</td>
<td>2.25</td>
</tr>
<tr>
<td>Group 7 Tropical Dry Evergreen</td>
<td>0.13</td>
</tr>
<tr>
<td>Group 8 Subtropical Broadleaved Hill</td>
<td>2.69</td>
</tr>
<tr>
<td>Group 9 Subtropical Pine</td>
<td>2.63</td>
</tr>
<tr>
<td>Group 10 Subtropical Dry evergreen</td>
<td>0.03</td>
</tr>
<tr>
<td>Group 11 Montane Wet Temperate</td>
<td>0.69</td>
</tr>
<tr>
<td>Group 12 Himalayan Moist Temperate</td>
<td>4.12</td>
</tr>
<tr>
<td>Group 13 Himalayan Dry Temperate</td>
<td>0.84</td>
</tr>
<tr>
<td>Group 14 Sub-Alpine Forests</td>
<td>1.89</td>
</tr>
<tr>
<td>Group 15 Moist Alpine Scrub</td>
<td>0.23</td>
</tr>
<tr>
<td>Group 16 Dry Alpine Scrub</td>
<td>0.43</td>
</tr>
<tr>
<td>Sub Total</td>
<td>94.93</td>
</tr>
<tr>
<td>Plantation/TOF</td>
<td>5.07</td>
</tr>
<tr>
<td>Total*</td>
<td>100.0</td>
</tr>
</tbody>
</table>
NFI Methodology since 2002

- Stratified country into 14 physiographic zones
- 60 districts are selected randomly for inventory in a cycle of 2 yrs
- District are divided into grid of $2\frac{1}{2}' \times 2\frac{1}{2}'$.

- A square sample plot of size 0.1 ha is laid out at the centre of each selected forest sub-grid.
- Two sub-grids of $1\frac{1}{4}' \times 1\frac{1}{4}'$ are selected randomly.
- Each grid of $2\frac{1}{2}' \times 2\frac{1}{2}'$ are divided into four sub-grids of $1\frac{1}{4}' \times 1\frac{1}{4}'$.

- dbh of all tree over 10 cm recorded, litter and soil sample collected, regeneration status, bamboo, land use, legal status, crop composition, etc are recorded.

- Inconsistency check of sample data is done through software and then processed for generating different estimates.
Data Collection

Square Plot
- Length of diagonal = 44.8 M
- Length of side = 31.6 M

Circular Plot
- Radius of circle = 80 M

2.0 Ha Circular plot for qualitative information like - land use, crop composition, origin of stand, fire incidence, soil, regeneration, grazing etc.

0.1 Ha Square plot for tree measurements - like dbh, height, species name, crown-diameter etc.

- Area under different land use classes
- Intensity of regeneration
- Incidence of fire
- Injuries to crop
- Grazing
- Presence of weeds
- Presence of grass
- Soil erosion
Sample Point and Attached plots

- **Soil & Forest Floor (1m x 1m)**
- **Litter, Shrub, Climbers (NE & SW) & Tree Regeneration (3m x 3m)**
- **Tree Regeneration (all 4 subplots) (3m x 3m)**
- **0.1 ha Plot**
- **Bamboo (non-clump forming)**
- **Sample Tree (North Quadrant)**
- **Herb (NE & SW) (1m x 1m)**
- **Dead Wood (NE & SW) (5m x 5m)**

**Curtsey:** P Somsundram
Remaining Components of Forest Biomass

The following biomass components are not generally measured under NFI:

- Biomass of stem below 10 cm dia, branches below 5 cm, foliage etc of NFI trees
- Biomass of all trees below 10 cm dbh,
- Biomass of Shrubs, herbs, climbers etc.
- Biomass of dead wood
- Litter (branches only)
- Biomass of tree bark
- Below ground root biomass
Approach

**Forest Cover 2007**

**Forest Type**

**Stratification**

**Overlaying sample plots of NFI**

**Synthesis & Estimation**

**Woody biomass**

**Other components**

**Carbon Stock 2007**
Forest Cover

Dense Forest
Open Forest
Forest Type Groups

- Tropical Wet Evergreen-North East
- Tropical Wet Evergreen-Western Ghats
- Tropical Semi Evergreen-North East
- Tropical Semi Evergreen-Eastern Deccan
- Tropical Semi Evergreen-Western Ghats
- Tropical Moist Deciduous Forests
- Littoral & Swamp Forests
- Tropical Dry Deciduous Forests
- Tropical Thorn Forest
- Tropical & Subtropical Dry Evergreen Forests
- Subtropical Pine Forests
- Montane Moist Temperate Forest
- Sub Alpine & Temperate Forest
- Alpine Scrub
- Plantation/TOF
- Non Forest
22,000 sample plots of National Forest Inventory
Sample plots overlaid on the strata layer
Approach for change

Forest Cover 2011

Forest Type

Stratification

Overlaying sample plots of NFI

Synthesis & Estimation

Woody biomass

Other components

Carbon Stock 2011

Change

Carbon Stock 2013
### Change in forest carbon stock During 2011 - 2013

<table>
<thead>
<tr>
<th>Carbon Pools</th>
<th>C Stock in 2011 (million tons) ISFR 2013</th>
<th>C Stock in 2013 (million tons) ISFR 2015</th>
<th>Net Change in C Stock (million tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above Ground biomass</td>
<td>2,192</td>
<td>2,220</td>
<td>28</td>
</tr>
<tr>
<td>Below ground biomass</td>
<td>694</td>
<td>695</td>
<td>1</td>
</tr>
<tr>
<td>Dead wood</td>
<td>27</td>
<td>29</td>
<td>2</td>
</tr>
<tr>
<td>Litter</td>
<td>130</td>
<td>131</td>
<td>1</td>
</tr>
<tr>
<td>Soil</td>
<td>3,898</td>
<td>3,969</td>
<td>71</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6,941</strong></td>
<td><strong>7,044</strong></td>
<td><strong>103</strong></td>
</tr>
</tbody>
</table>
FSI’s Role beyond NATCOM 2
Coverage of NFI

India map
5x5km grids

Sampling of grids on 5 yr cycle
1st yr – all 1s  2nd yr – all 3s  3rd yr – all 5s
4th yr – all 2s  5th yr – all 4s  6th yr – all 1s
National Forest Inventory Design

Uttarakhand 5Km x 5km grid overlaid on Forest Boundary

INDIA GRID 5Km x 5Km

Single Grid of 5Kmx 5Km

<table>
<thead>
<tr>
<th>Subplot</th>
<th>8.0 m radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annular plot</td>
<td>20 m radius</td>
</tr>
<tr>
<td>Lichens plot</td>
<td>40 m radius</td>
</tr>
<tr>
<td>Description plot</td>
<td>60 m radius</td>
</tr>
<tr>
<td>Hub vegetation plot</td>
<td>0.6 m radius</td>
</tr>
<tr>
<td>Shrub regeneration litter plot</td>
<td>1.7 m radius</td>
</tr>
<tr>
<td>Deadwood plot</td>
<td>2.8 m radius</td>
</tr>
<tr>
<td>Soil and forest floor sample plot</td>
<td>1m X 1m at mid point between subplots</td>
</tr>
<tr>
<td>Non clump forming bamboo plot</td>
<td></td>
</tr>
</tbody>
</table>
Additional Parameters

- Availability of water source in vicinity of plot
- Invasive spps
- Incidence of Disease (tree)
- Incidence of Insect (tree)
- Mortality
- Inventory of important NTFPs
- Dead standing tree
- Rotten/missing cull
- Compacted crown ratio
- Decay Class
- Bark void
Permanent Observational Plots

- In each Forest Type Group (16)
- 60 m circular plot (1.13 ha)
- Mapping of all trees
- Climate change indicators (lichen, ozone bio-indicators).
- Repeat measurements.

It will provide:
- Biodiversity and its other characteristics
- Forest structure (diversity of tree locations, dimensions & species)
- Change in biodiversity and structure.
- Species change, if any.
National Forest Monitoring System
- A Dynamic System

National/Sub-National different ‘inventory estimates’- GHG/NTFP etc

Policies & Measures

Monitoring function: To track Policies and Measure

RS based Land Monitoring System: to estimate Activity data

National Forest Inventory: to have ‘factor per unit area’
## Journey through Natcoms

<table>
<thead>
<tr>
<th>Natcom</th>
<th>Approach</th>
<th>Tiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>INC</td>
<td>II</td>
<td>Tier II - AGB(timber), SOC Tier I - all others</td>
</tr>
<tr>
<td>SNC</td>
<td>III</td>
<td>Tier II – all but BGB</td>
</tr>
<tr>
<td>TNC</td>
<td>III</td>
<td>Tier III – all pools (proposed)</td>
</tr>
</tbody>
</table>

**TNC provides opportunity to improve**

- Wood density data – more spps.
- Carbon content data – more spps.
- Spps wise BGB
- Soil density at more plots.
- Repeated measurements etc.
Road ahead

- Developing a manual /template for economic valuation and green accounting of natural resources in India with an intent to make SEEA framework understandable for India

- Documenting cases for economics of biodiversity conservation

- Linking outcomes of valuation and green accounting with policy and economic instruments to attain sustainable development,
Thanks

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