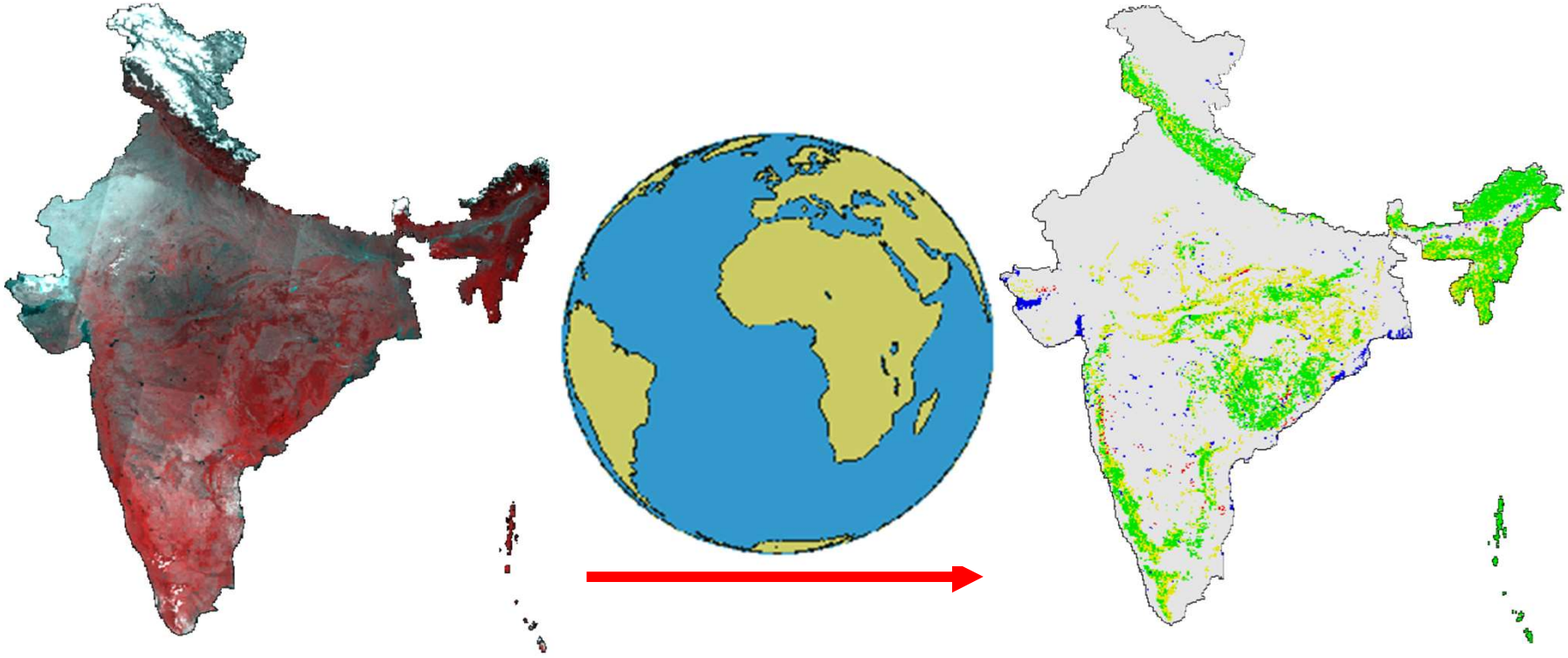
Forest Statistics



Forest Survey of India, Dehradun.

Forest Carbon Inventory for India

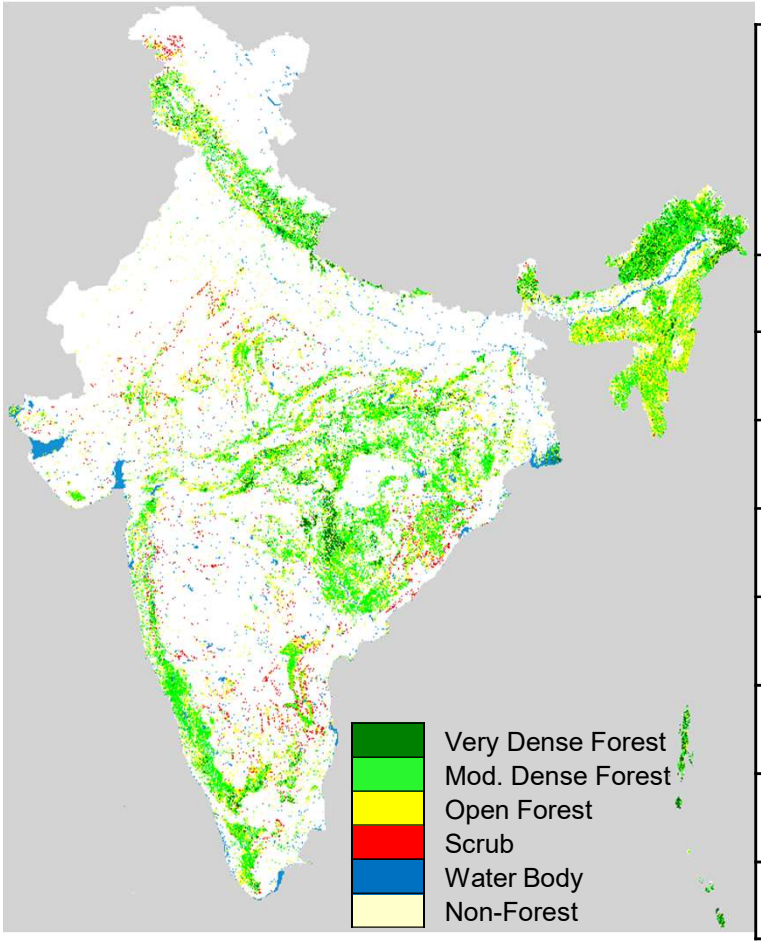
- Forest cover maps,
- Forest types maps,

For estimation and stratification of 'Activity data'

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

For developing 'Emission factors'

Forest Cover in India – ISFR 2015



Class	Area (km^2)	% of Geo. Area
Forest Cover		
a) **VDF** (>70 %)	85,905	2.61
b) MDF (40-70%)	315,374	9.59
c) **OF (10-40%)**	300,395	9.14
Total Forest Cover	**701,673**	**21.34**
Scrub	41,362	1.26
Other Non-forest	2,544,228	77.40
Total Geo. Area	**3,287,263**	**100.00**

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Forest Cover Change Matrix (km^2) depicts

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

Forest Types of India*

MAJOR GROUPS (climate)	TYPE GROUPS (temp. & moisture)
1. Moist Tropical Forests	Group y1.1-Tropical Wet Evergreen Forests Group1.2-Tropical Semi-Evergreen Forests Group 1.3-Tropical Moist Deciduous Forests Group1.4-Littoral And Swamp Forests
2. Dry Tropical Forests	Group 2.5-Tropical Dry Deciduous Forests Group2.6-Tropical thorn Forests Group 2.7-Tropical Dry Evergreen Forests
3. Montane Temperate Forests	Group3. 8-Southern Subtropical Broadleaved Hill Forests Group 3.9-Subtropical Pine Forests Group 3.10- Subtropical Dry Evergreen Forests
4. Montane Subtropical Forests	Group 4.11-Montane Wet Temperate Forests Group 4.12-Himalayan Moist Temperate Forests Group 4.13-Himalayan Dry Temperate Forests
5. Sub Alpine Forests	Group 5.14-Sub Alpine Forests
6. Alpine Scrub	Group 6.15-Moist Alpine Scrub Group 6.16- Dry Alpine Scrub

SUB-GROUPS (location)

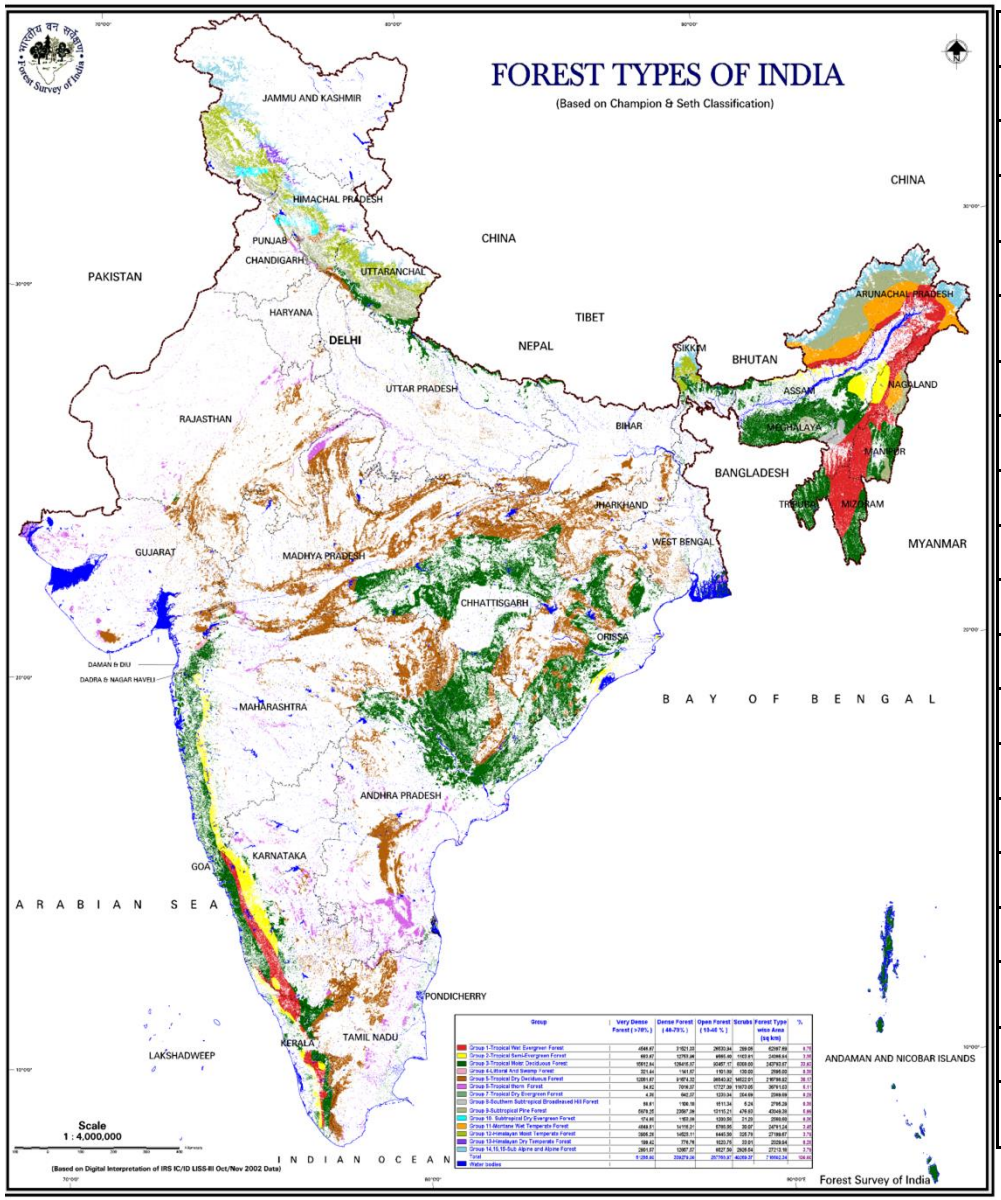
Sub-group- 22 Nos.

TYPES (local edaphic cond.)

Types - 200 Nos.

*As per Champion and Seth classification(1968)

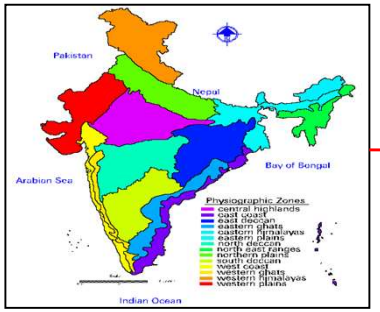
Forest Cover in Different Forest Type Groups



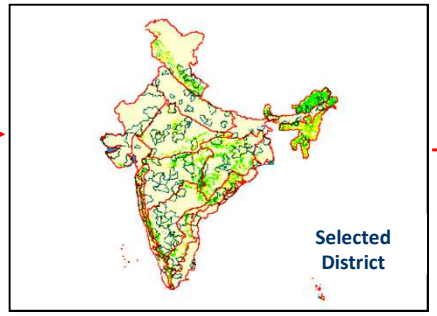
Type Group	%
Group 1 Tropical Wet Evergreen	2.92
Group 2 Tropical Semi-Evergreen	13.79
Group 3 Tropical Moist Deciduous	19.73
Group 4 Littoral & Swamp	0.69
Group 5 Tropical Dry Deciduous	41.87
Group 6 Tropical Thorn	2.25
Group 7 Tropical Dry Evergreen	0.13
Group 8 Subtropical Broadleaved Hill	2.69
Group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

NFI Methodology since 2002

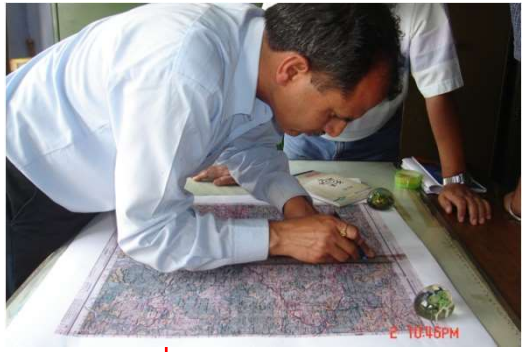
Stratified country into 14 physiographic zones



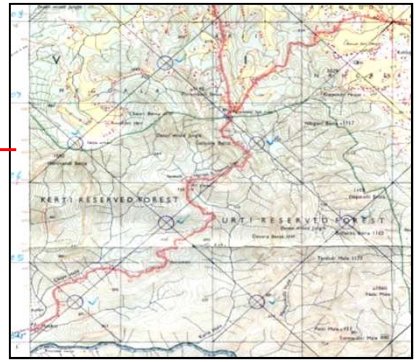
60 districts are selected randomly for inventory in a cycle of 2 yrs



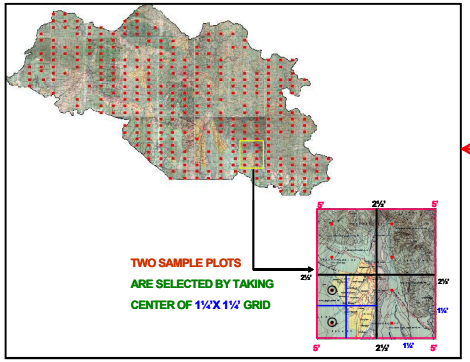
District are divided into grid of **2½′ × 2½′.**



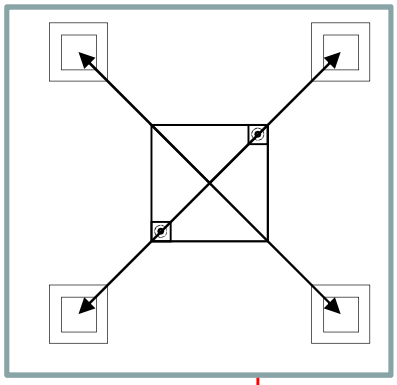
Each grid of 2½′ × 2½′ are divided into four sub-grids of 1¼′ × 1¼′ .



two sub-grids of 1¼′ × 1¼′ are selected randomly.



A square sample plot of size 0.1 ha is laid out at the centre of each selected forest sub-grid.



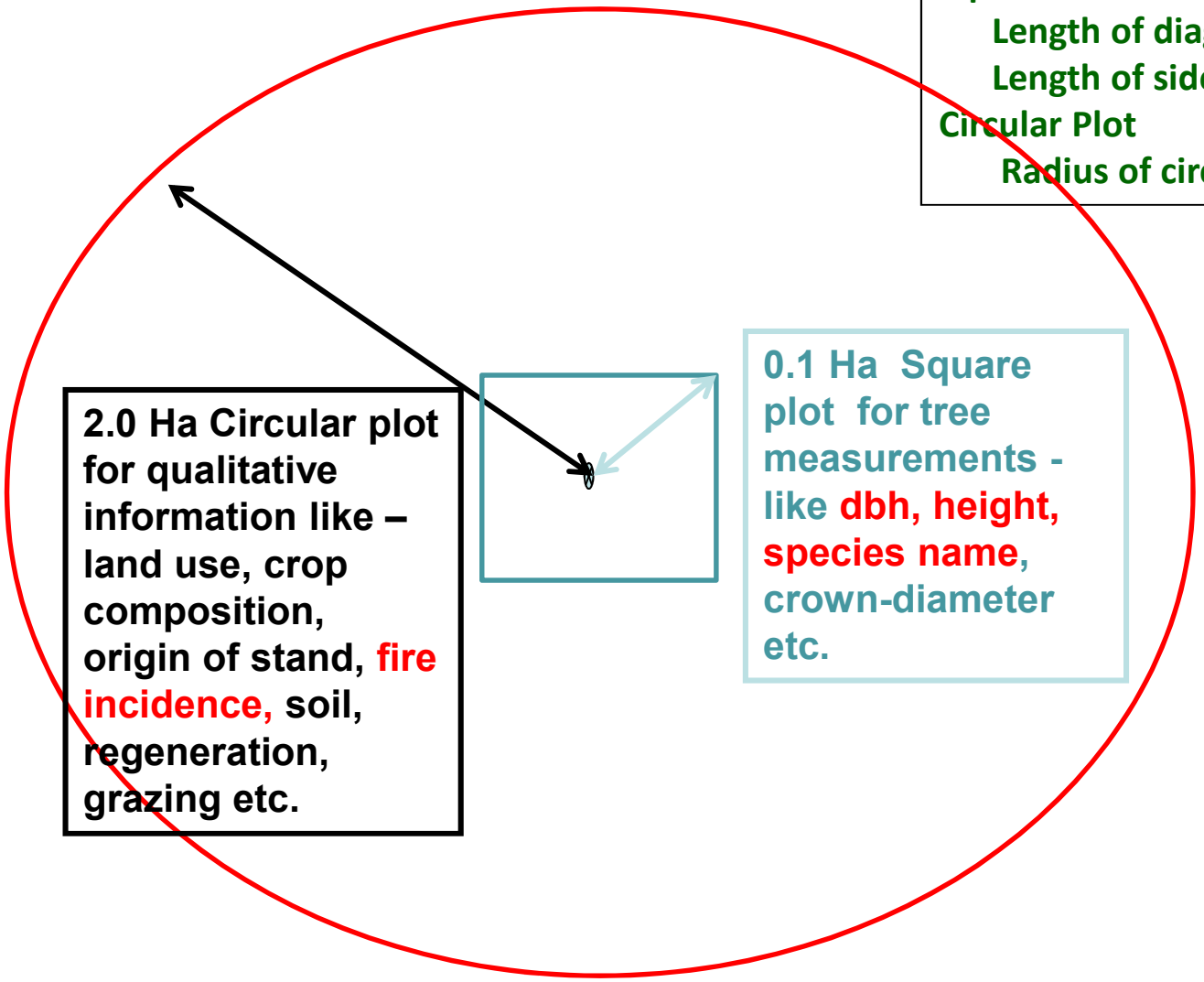
dbh of all tree over 10 cm recorded, litter and soil sample collected, regeneration status, bamboo, land use, legal status, crop composition, etc are recorded.

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**



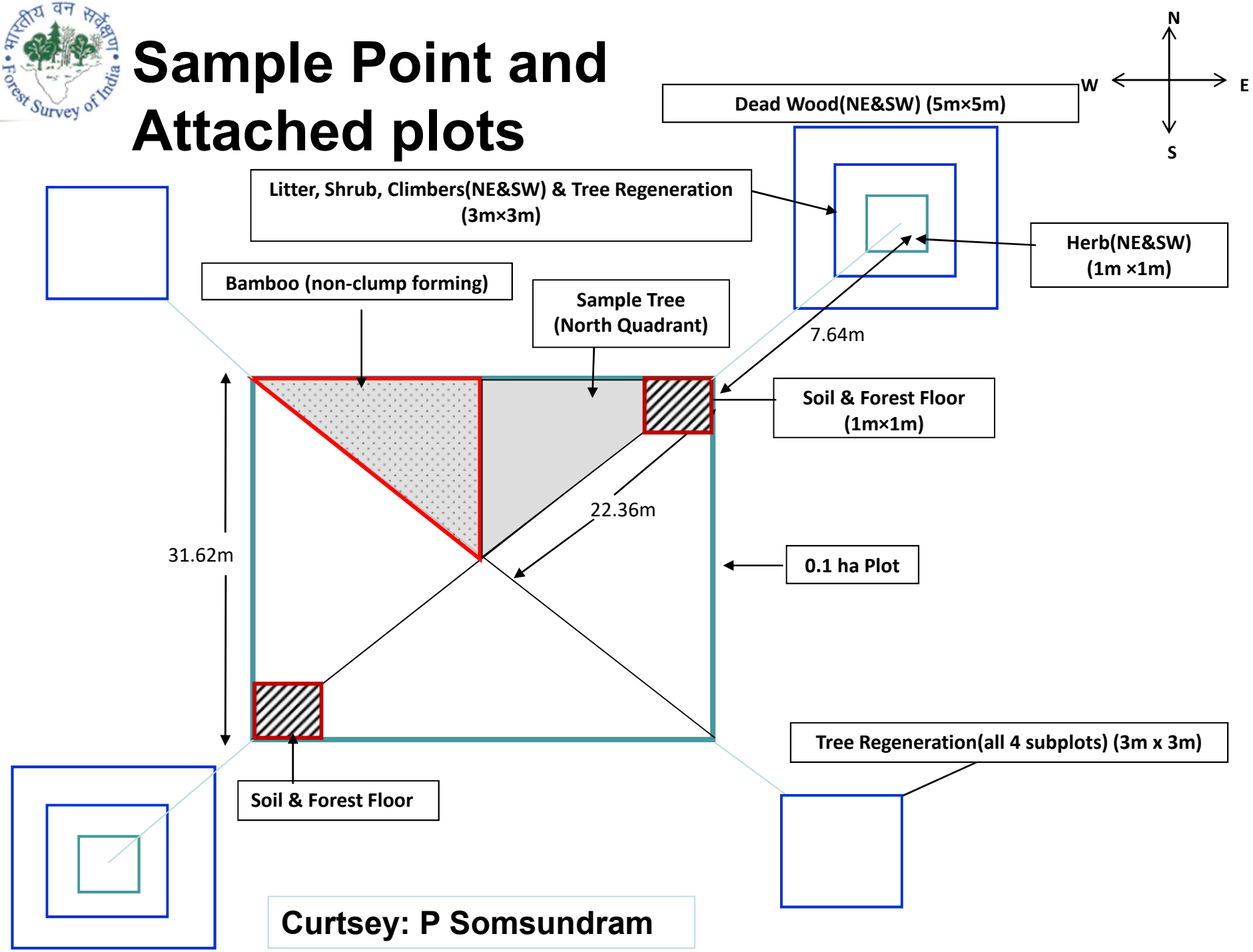
2.0 Ha Circular plot for qualitative information like – land use, crop composition, origin of stand, fire incidence, soil, regeneration, grazing etc.

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

- **Soil depth**
- **Rockiness**
- **Humus**
- **Origin of stand**
- **Crop Composition**
- **Bamboo density**
- **Bamboo quality**
- **Plantation potential**
- **Size class**
- **Biotic influence**

- 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



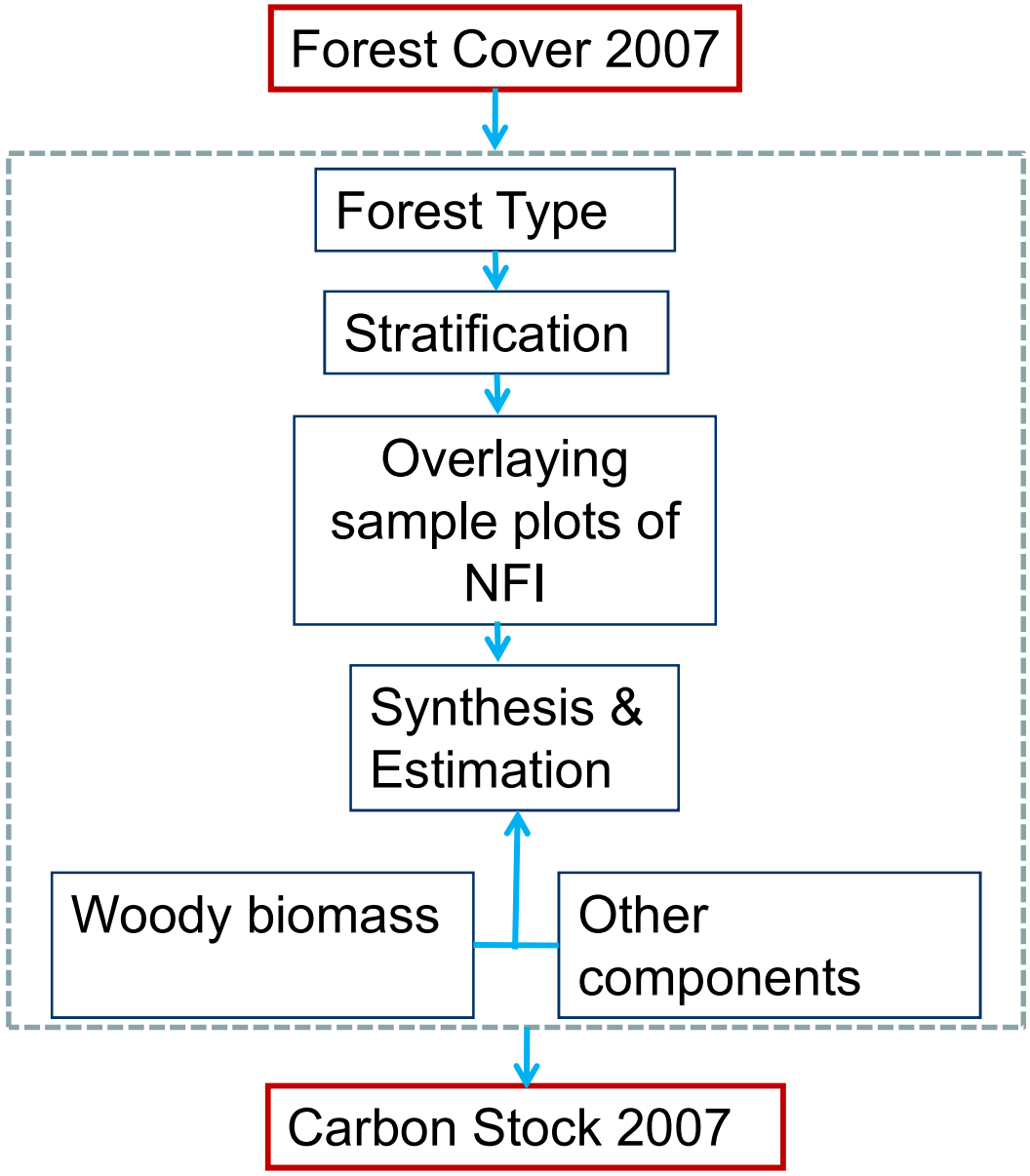
Curtsey: P Somsundram

Remaining Components of Forest Biomass

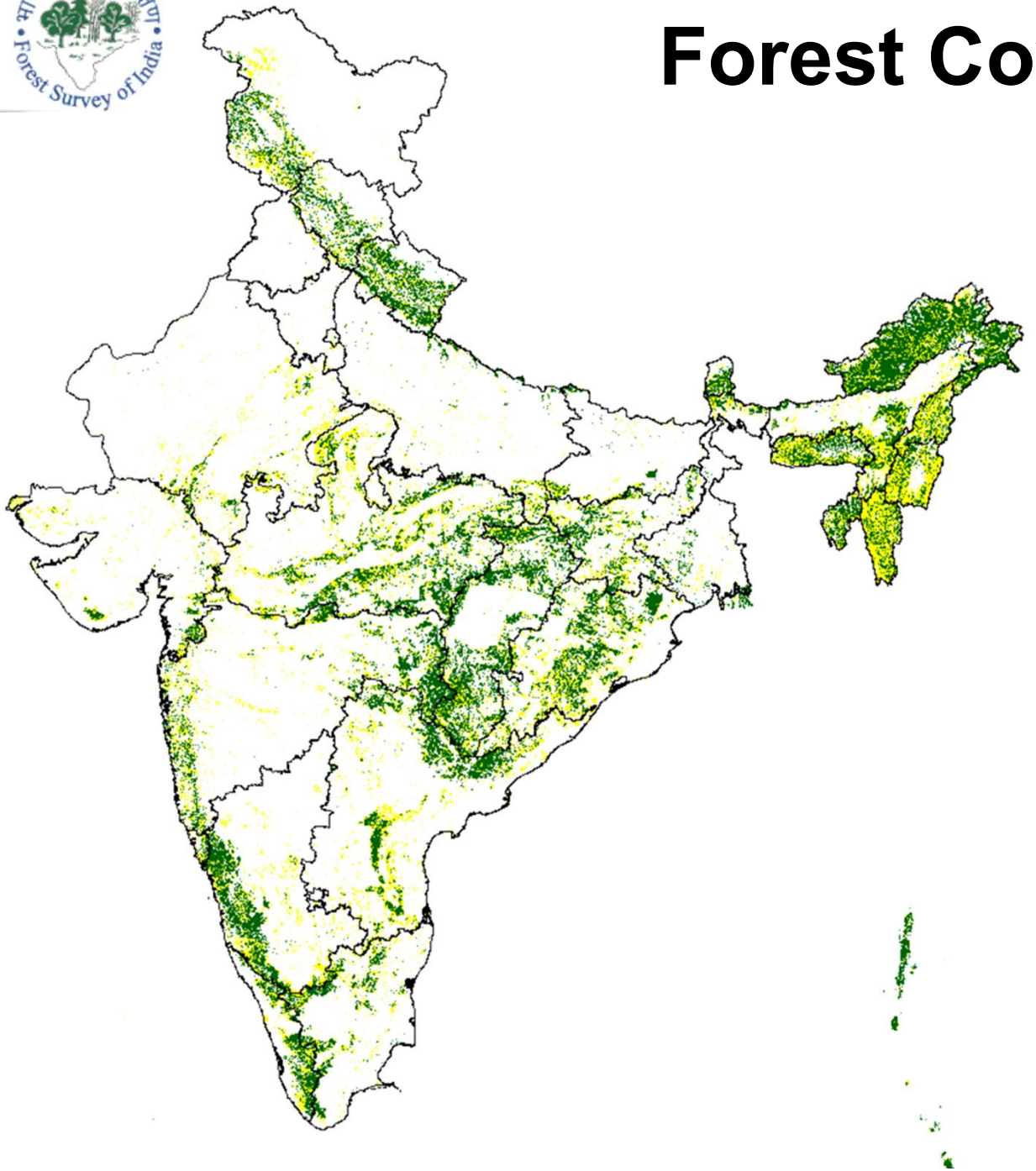
The following biomass components are not generally measured under NFI

- **Biomass of stem below 10 cm dia, branches below 5 cm, foliage etc of NFI trees**
- **Biomass of all tress 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**

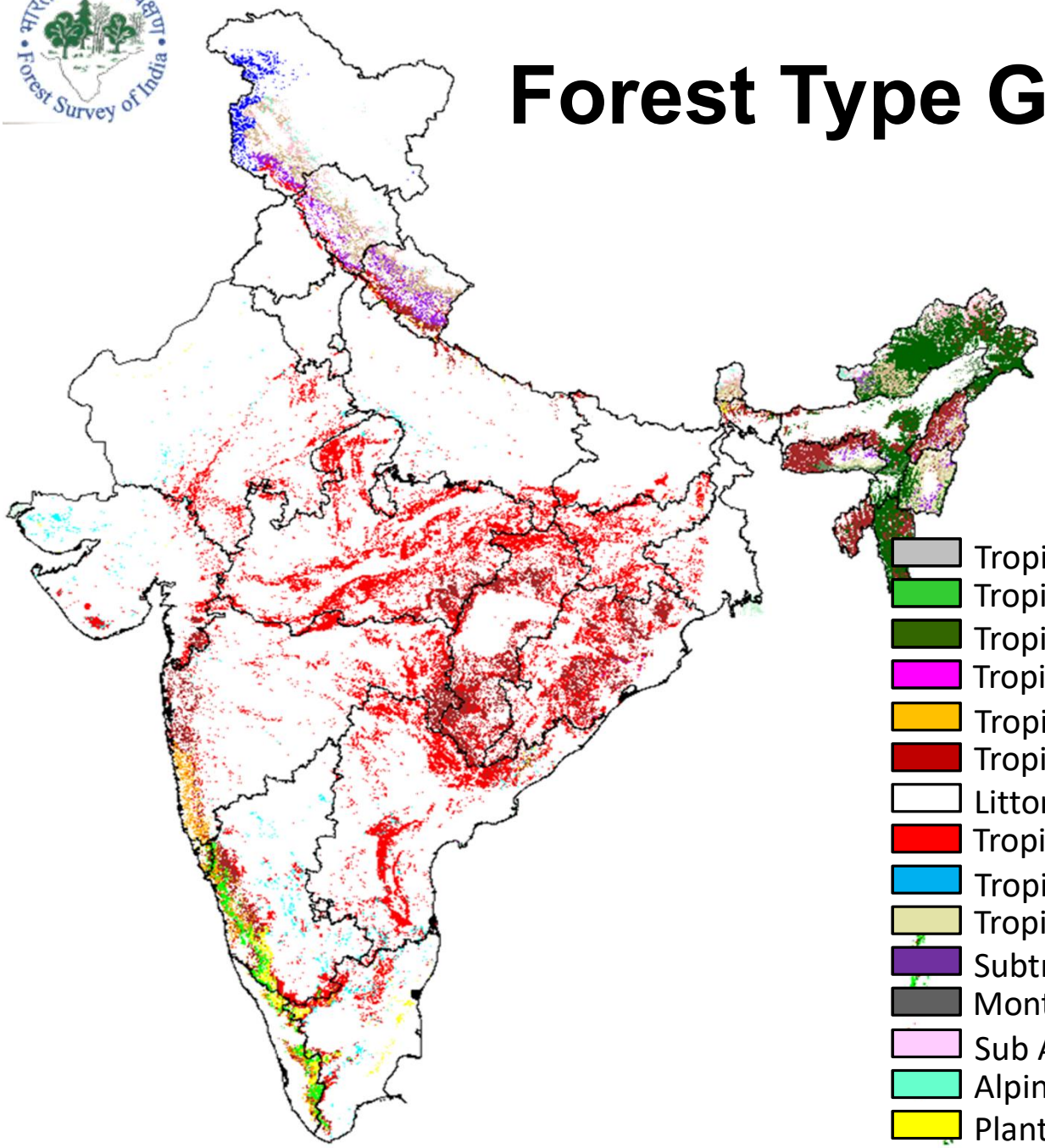
Approach


Forest Cover 2007
Forest Type
Stratification
Overlaying sample plots of NFI
Synthesis & Estimation
Woody biomass
Other components
Carbon Stock 2007

Forest Cover

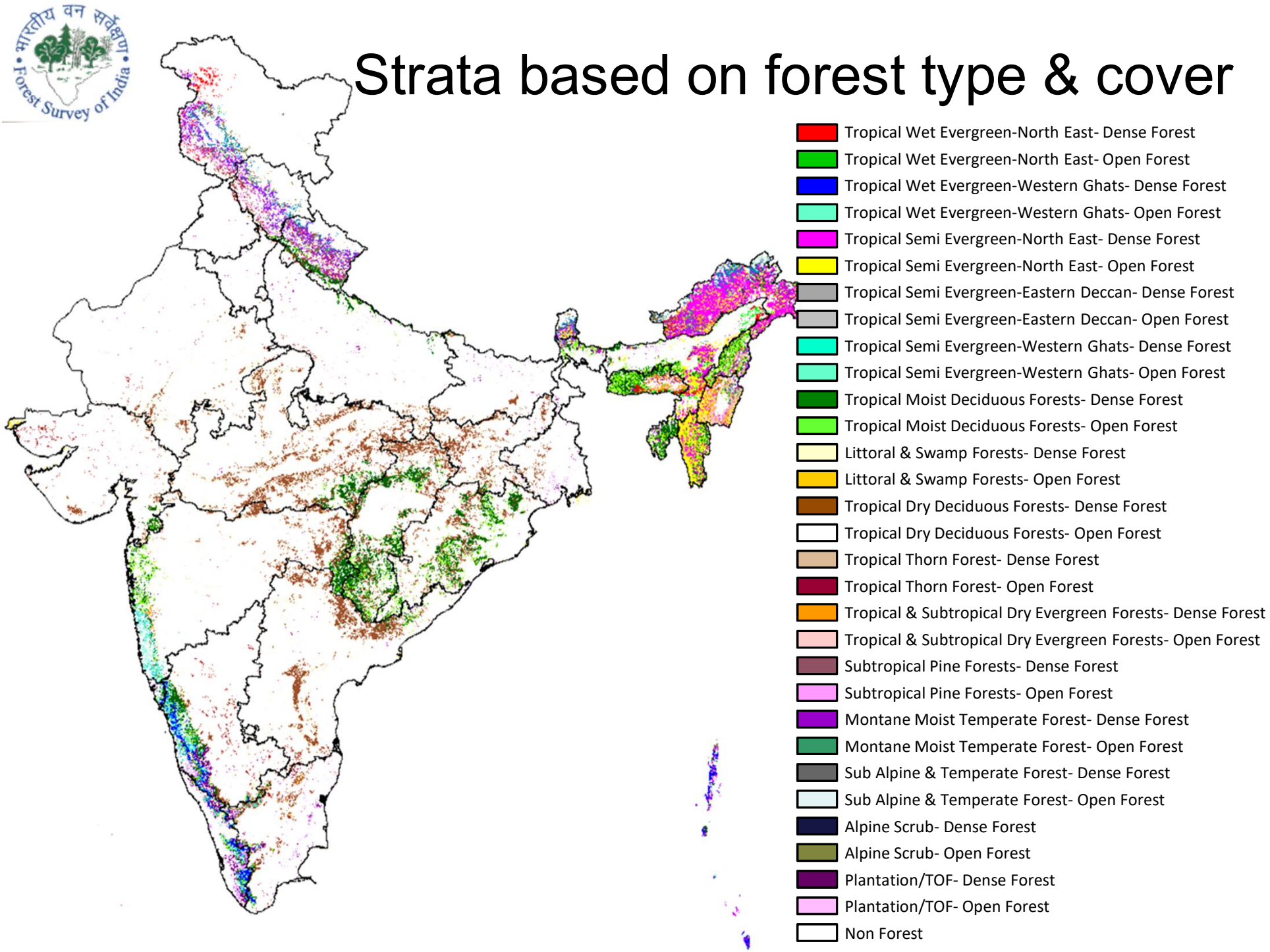


Forest Type Groups

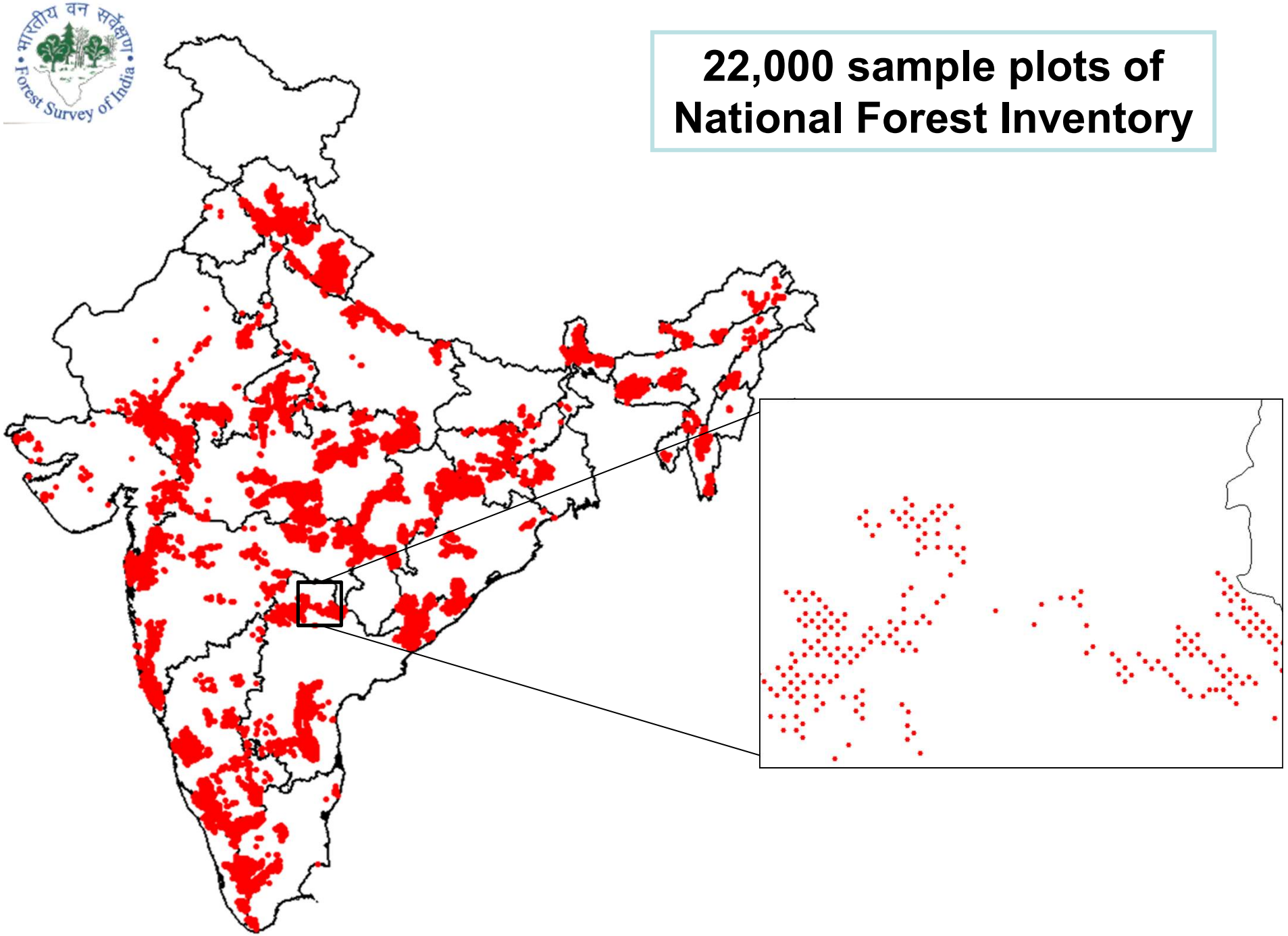


- Tropical Wet Evergreen-North East
- Tropical Wet Evergreen-Western Ghats
- Tropical Semi Evergreen-North East
- Tropical Semi Evergreen-Eastern Deccan
- Tropical Semi Evergreen-Western Ghats
- Tropical Moist Deciduous Forests
- Littoral & Swamp Forests
- Tropical Dry Deciduous Forests
- Tropical Thorn Forest
- Tropical & Subtropical Dry Evergreen Forests
- Subtropical Pine Forests
- Montane Moist Temperate Forest
- Sub Alpine & Temperate Forest
- Alpine Scrub
- Plantation/TOF
- Non Forest

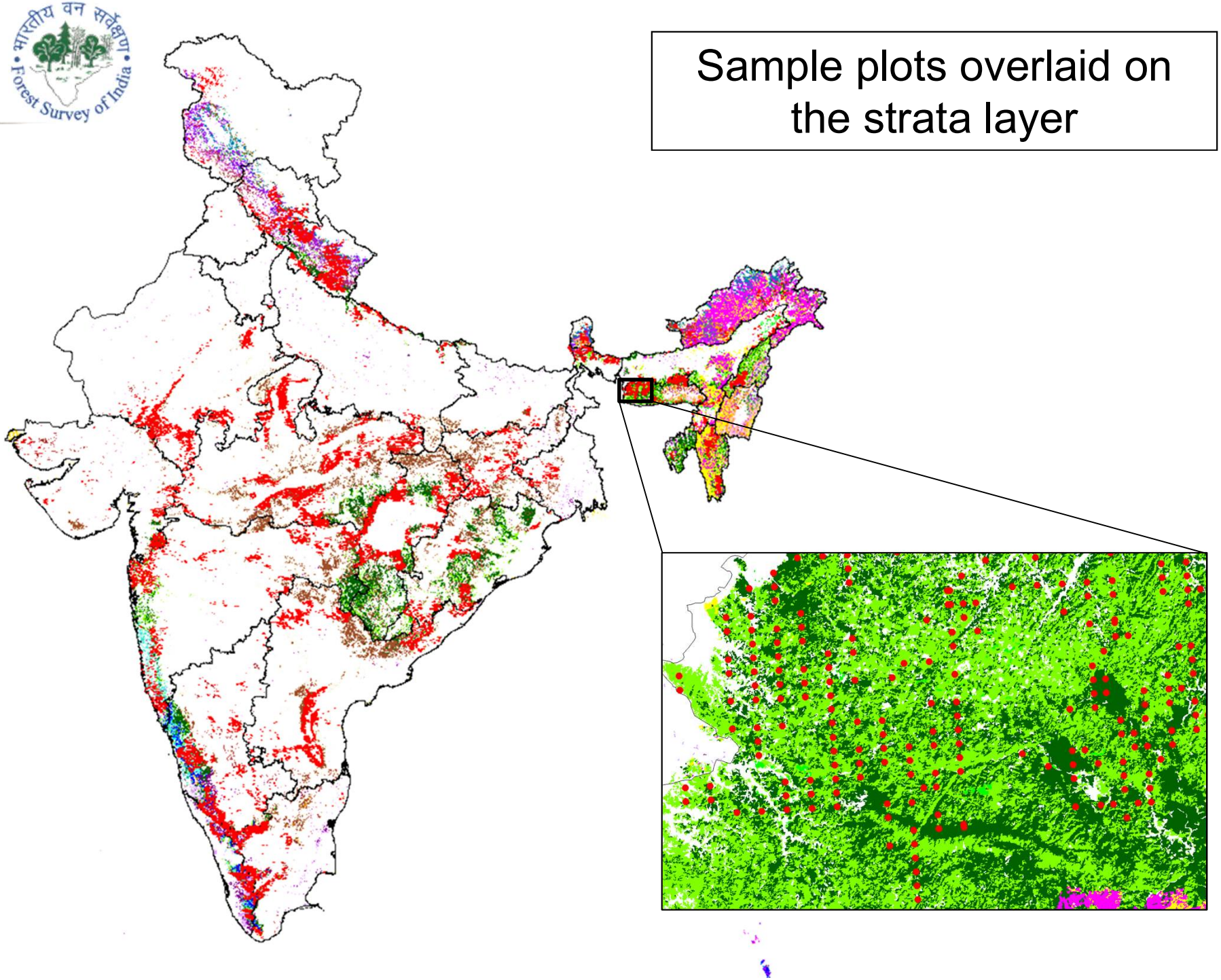
Strata based on forest type & cover



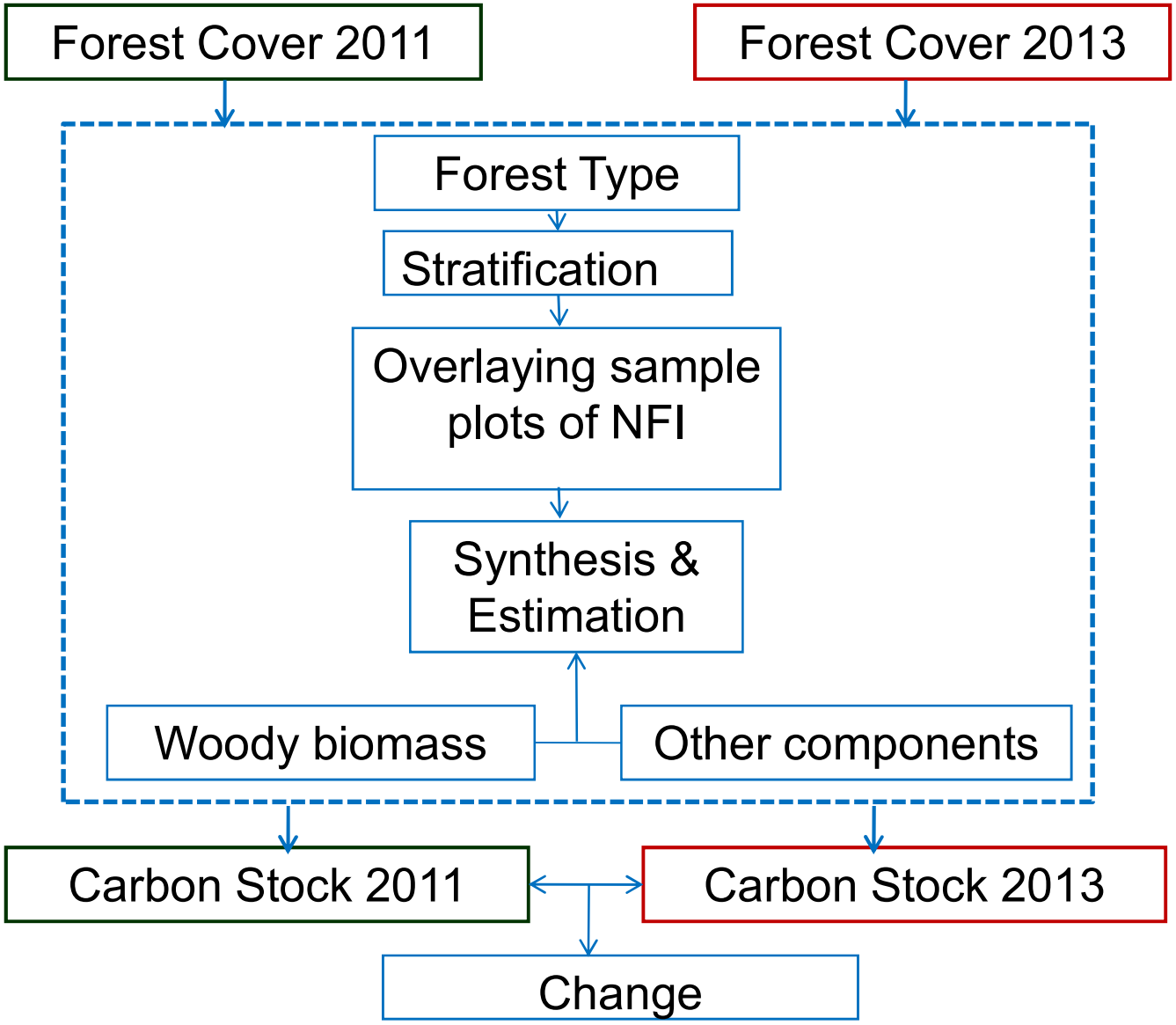
22,000 sample plots of National Forest Inventory



Sample plots overlaid on the strata layer



Approach for change



Change in forest carbon stock During 2011 - 2013

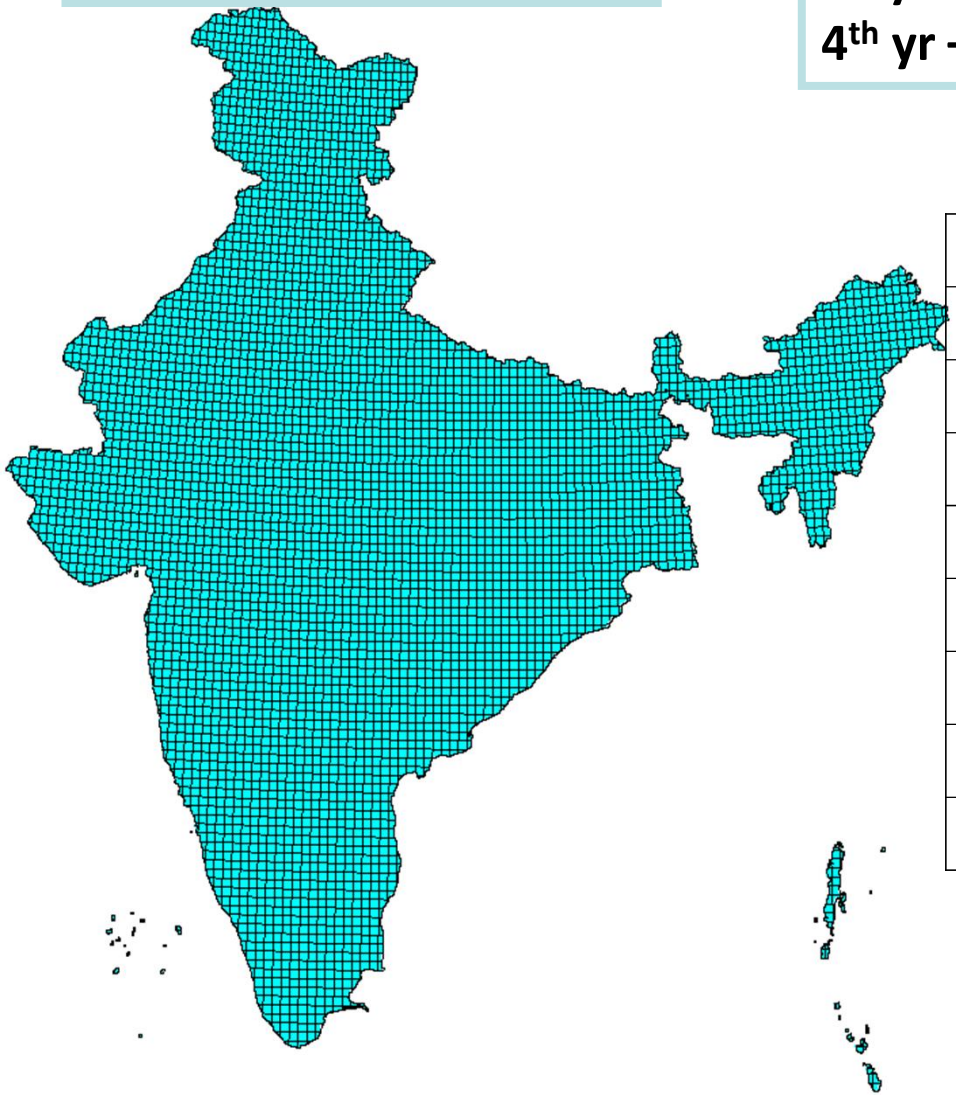
Carbon Pools	C Stock in 2011 (million tons) ISFR 2013	C Stock in 2013 (million tons) ISFR 2015	Net Change in C Stock (million tons)
Above Ground biomass	2,192	2,220	28
Below ground biomass	694	695	1
Dead wood	27	29	2
Litter	130	131	1
Soil	3,898	3,969	71
Total	6,941	7,044	103

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

5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	
2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	
3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	
4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	
5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	
2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	
3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	

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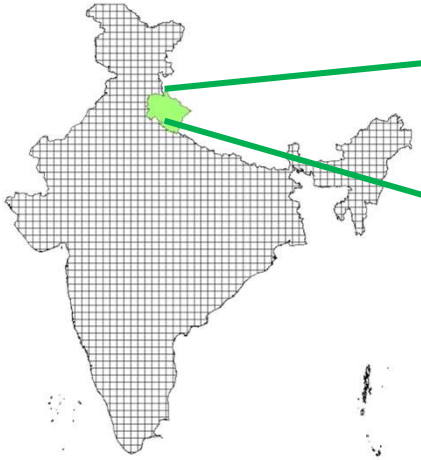
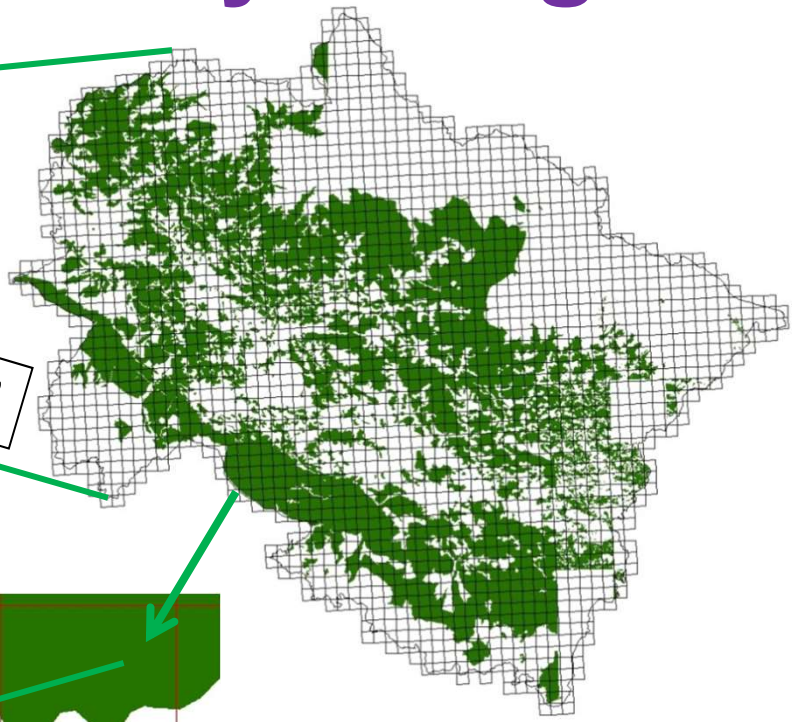
National Forest Inventory Design

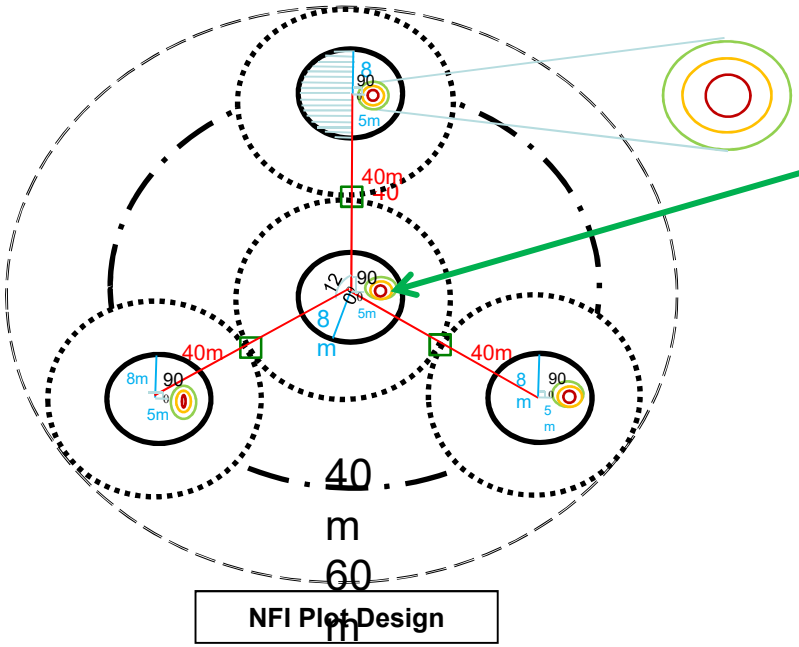


INDIA GRID 5Km x 5Km

Uttarakhand 5Km x 5km grid overlaid on Forest Boundary



Single Grid of 5Kmx 5Km



NFI Plot Design

	Subplot	8.0 m radius
	Annular plot	20 m radius
	Lichens plot	40 m radius
	Description plot	60 m radius
	Hub vegetation plot	0.6 m radius
	Shrub regeneration litter plot	1.7 m radius
	Deadwood plot	2.8 m radius
	Soil and forest floor sample plot	1m X 1m at mid point between subplots
	Non clump forming bamboo plot	

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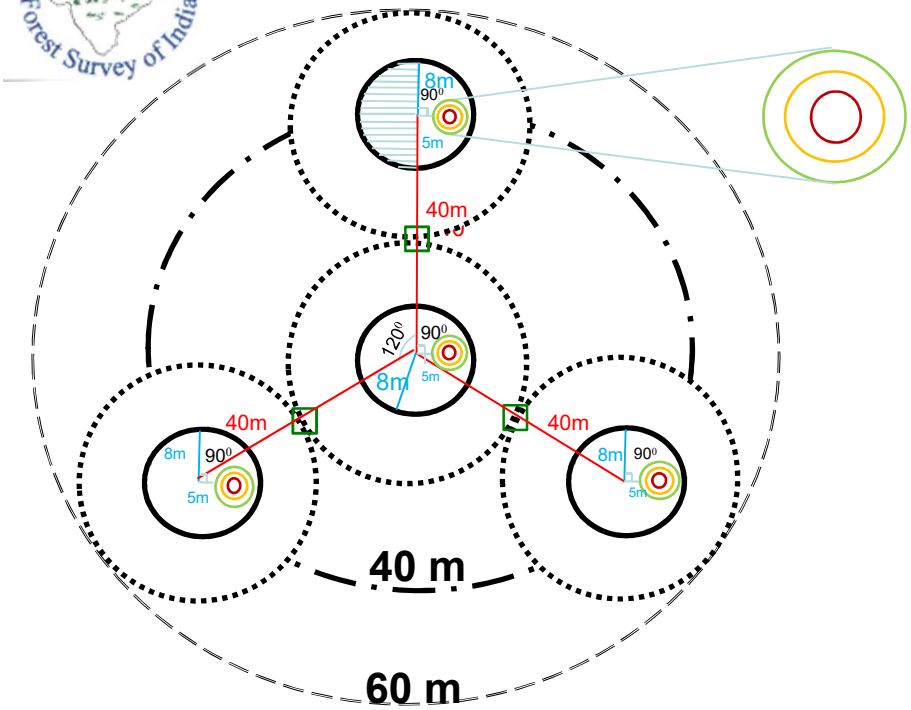
Additional Parameters

- 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



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	Deadwood plot	2.8 m radius
	Soil and forest floor sample plot	1m X 1m at mid point between subplots
	Non clump forming bamboo plot	

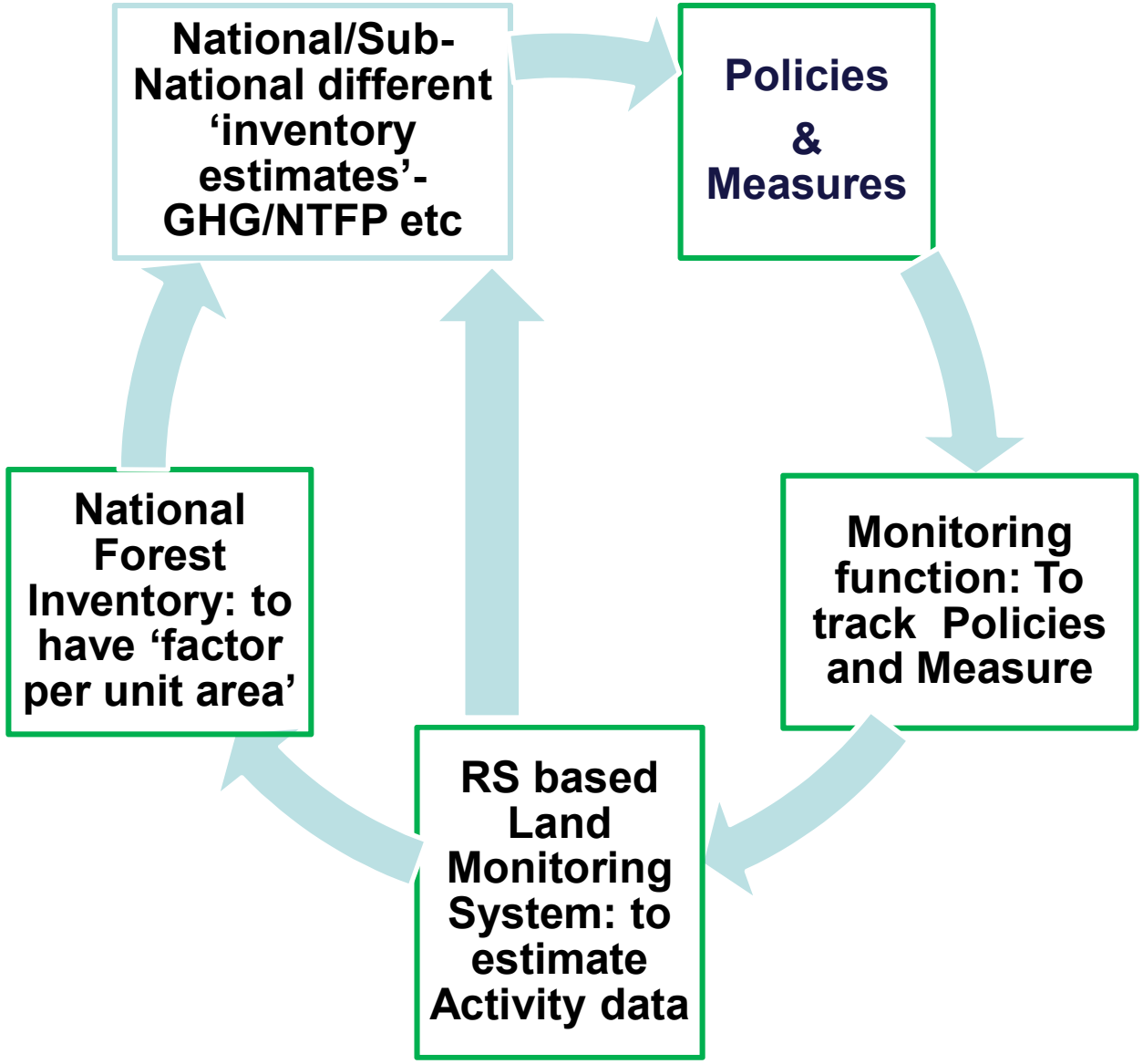
Permanent Observational Plots

- 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



Journey through Natcoms

Natcom	Approach	Tiers
INC	II	Tier II - AGB(timber), SOC Tier I - all others
SNC	III	Tier II – all but BGB
TNC	III	Tier III – all pools (proposed)

TNC provides opportunity to improve

a. **Wood density data – more spps.**
b. **Carbon content data – more spps.**
c. **Spps wise BGB**
d. **Soil density at more plots.**
e. **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,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