

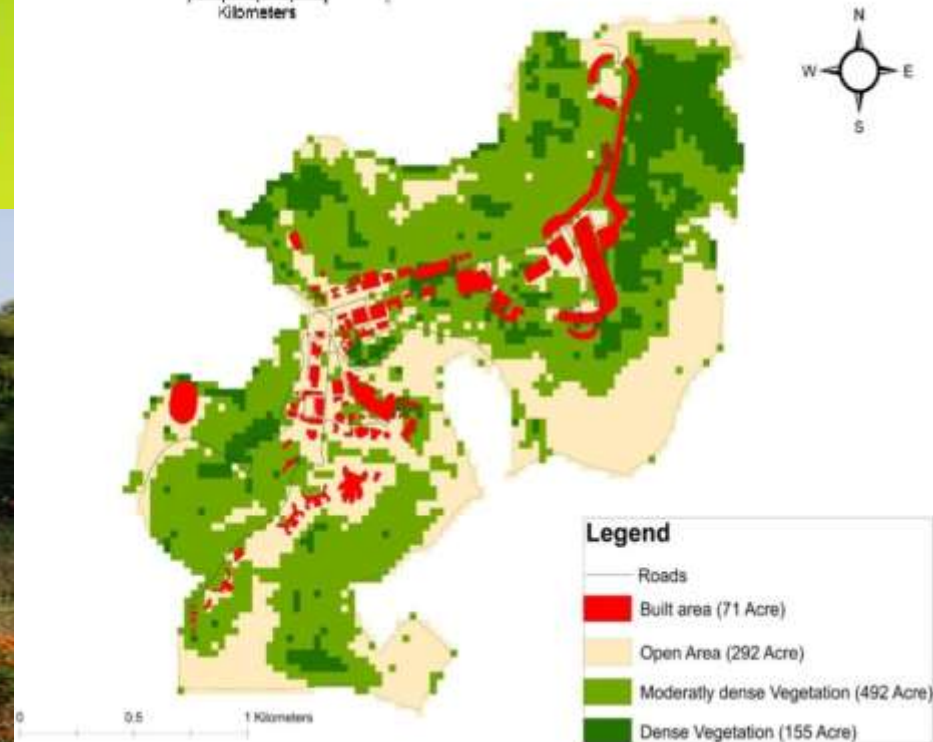
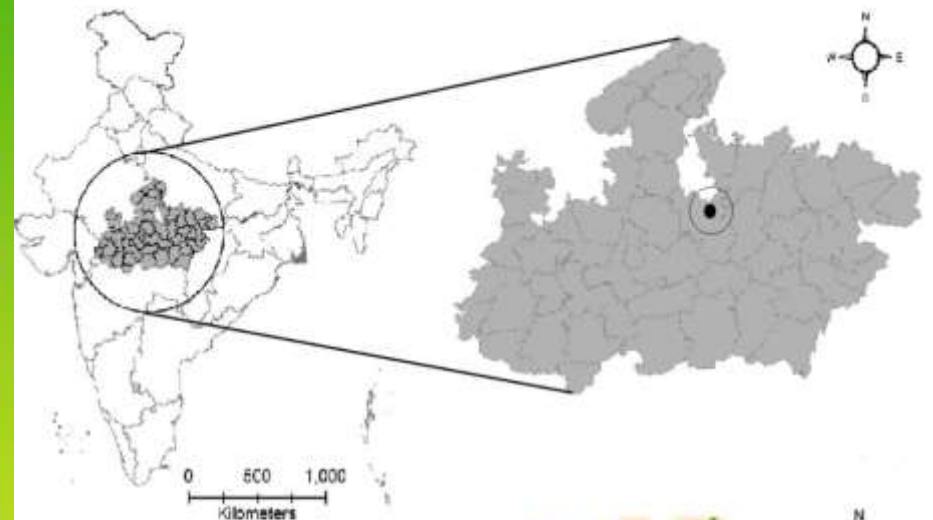
Plant diversity patterns and conservation status of Eastern Himalayan forests in Arunachal Pradesh

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A little about me

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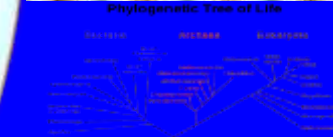


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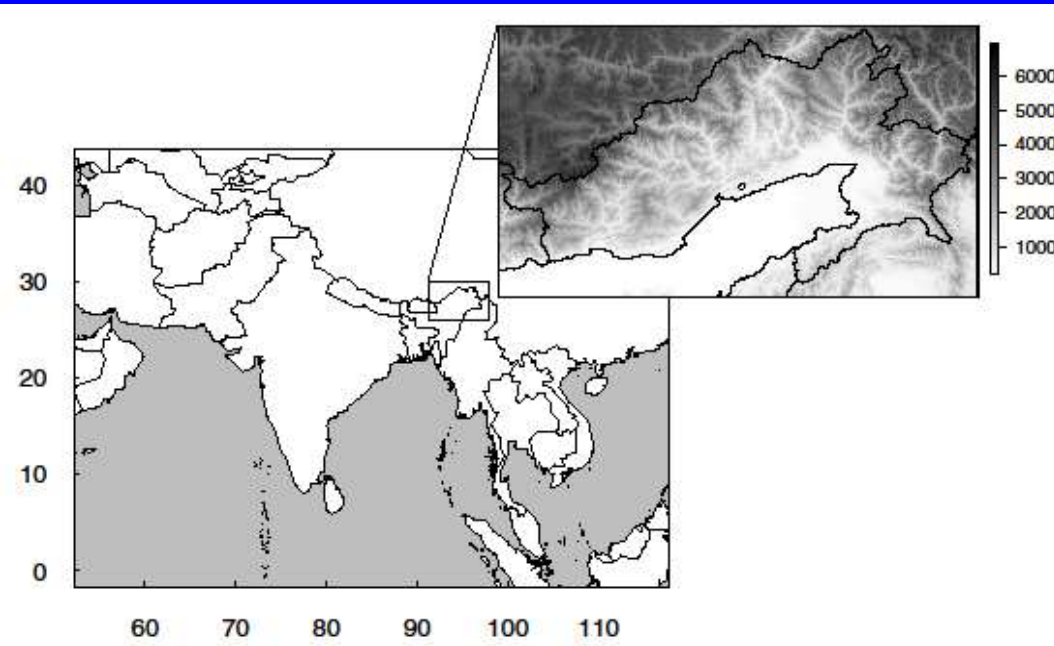


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Eastern Himalayas - Arunachal Pradesh



- India is one of the mega biodiversity nation.
- Sub-continent represent four hotspots e. g. **Himalayas, Indo-Burma, Western Ghats, Srilanka and Sundaland.**

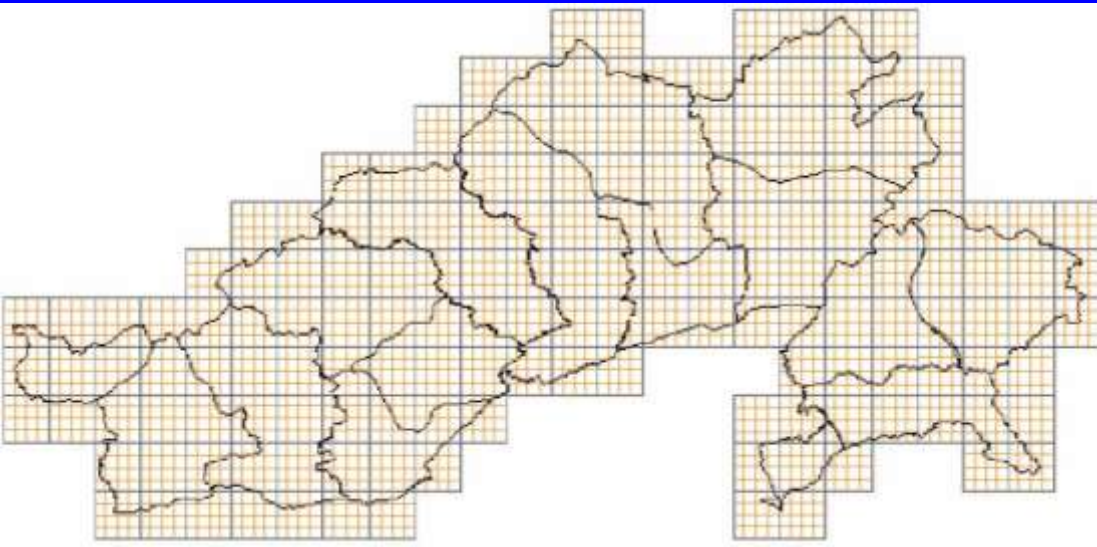
- Arunachal is among 200 globally important eco-regions
- Biodiversity hotspot
- Houses over 5000 species of plants
- High endemism
- Largest elevational gradients in the world
- Ranging from lowland tropical forests to alpine vegetation
- Has 80.30 % forest cover

Cont.

- **Exhibit a mosaic of climatic zones.**
- **Receives heavy rain almost throughout the year**
- **Climate is highly hot and humid at the lower altitudes**
- **Valleys are covered by swampy dense forests**
- **While it becomes exceedingly cold in the higher altitudes**
- **Floristic diversity of these forests is rapidly disappearing due to habitat alteration.**
- **Loss of such forest resources would have great implication on:**
 - **environment**
 - **biological diversity**
 - **and socio-economic setup of the communities**

- **Thus, it is imperative to have an assessment of the current status of the:**
 - forest resources
 - geographic distribution and population structure of plant species
 - to develop working plans for management and conservation of these forest resources
- **The present study attempted to study the plant diversity pattern in Eastern Himalayan forests of Arunachal Pradesh**
 - By mapping 177 hectare area along different altitudinal gradients.

Grid generation and vegetation sampling

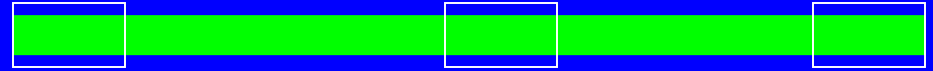


- Toposheets (1:50,000) collected from Survey of India
- Each sheet divided into 16 grids (ArcGIS)

- Area of state - 83743 sq.
- Total no. of topo-sheets - 166
- Each toposheet - 16 grids
- Total no. of grids - 1920
- Grid size - 6.25 km x 6.25km
- Transect - 10m x 500m

Details of grids per district & percentage covered in present study.				
Name of the Districts	Total No. of Grids	No. of grids sampled	No. of transect sampled	% of grid coverage
Anjaw	134	21	21	15.67
Changlang	101	39	40	38.61
Dibang Valley	176	-	-	-
East Kameng	137	16	17	11.68
East Siang	89	18	18	20.22
Kurung Kumey	138	-	-	-
Lohit	110	36	38	32.73
Lower Dibang Valley	142	35	35	24.65
Lower Subansiri	90	21	21	23.33
Papumpare	77	20	21	25.97
Tawang	61	6	6	9.84
Tirap	27	10	10	37.04
Upper Siang	181	20	20	11.05
Upper Subansiri	153	7	7	4.58
West Kameng	121	51	51	42.15
Total	1920	349	354	18.18

Sampling protocol:

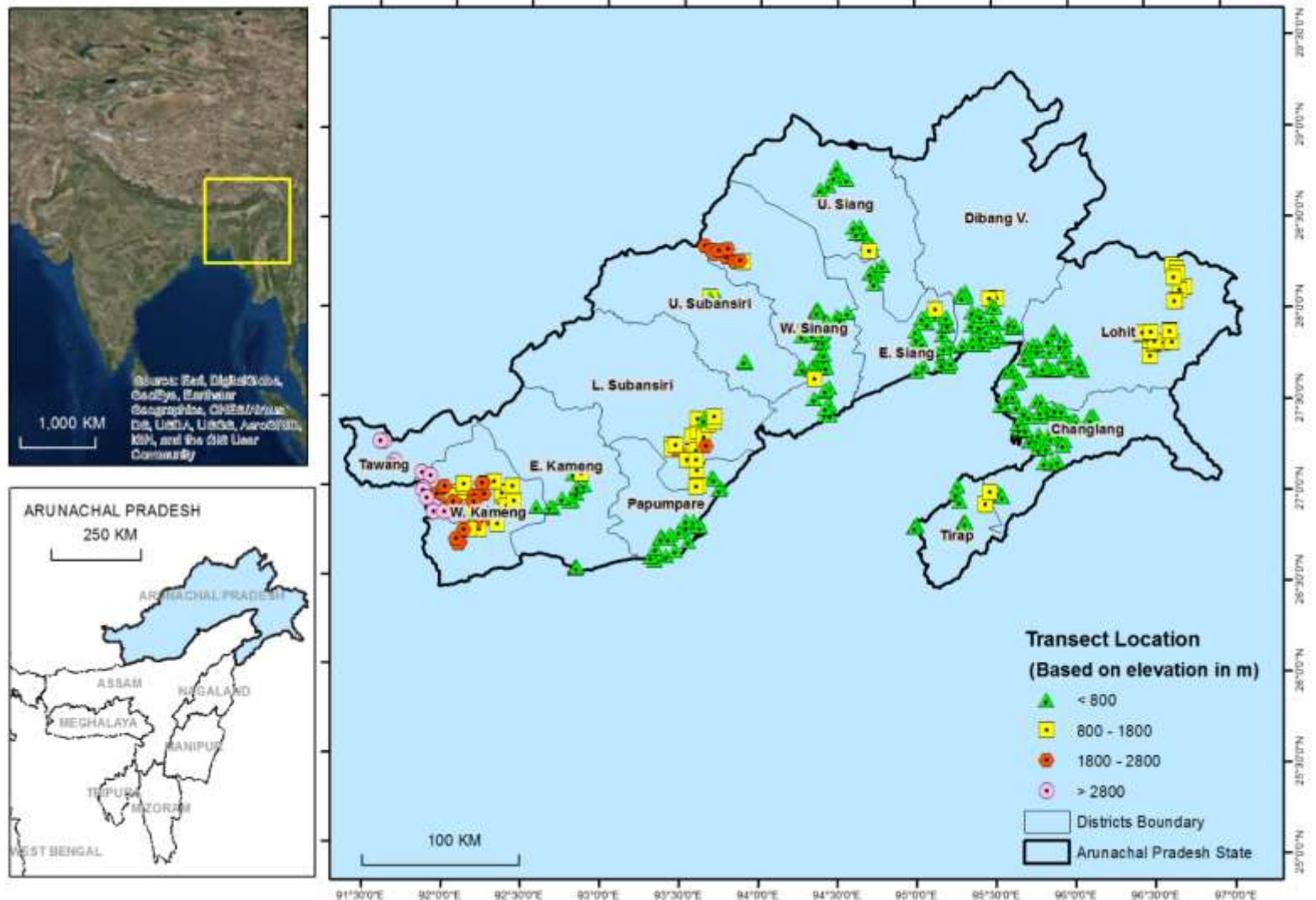


- Transects were laid in 349 selected grids.
- Transects were further divided into a number of quadrats.
- Preferred size of quadrat was 10 x 10 m.
- GBH and visual height of all the plants (≥ 10 cm girth) were recorded.
- Two 1 x 1m quadrats laid within transect for herbs, shrubs & seedlings of trees.

1000 M X 5 M
500 M X 10 M

**Enumerated all
the trees and
shrubs**

**Herbs in 1 X 1m
quadrat (one to
two seasons)**



Map of the study sites showing the locations of studied transects at different altitudinal gradients.

Data analysis

- **Quantitative analysis of vegetation e.g. :**
 - Importance Value Index
 - Species richness
 - The Shannon-Wiener Diversity Index
 - Evenness index
 - The ratio of abundance to frequency to interpret the distribution pattern of the species

The ratio of abundance to frequency indicates regular distribution if below 0.025, random distribution between 0.025 - 0.05 and contagious if >0.05.

Results

- A total of 482 (458 identified, 24 unidentified) plant species including various endemic and non-endemic were recorded in the present study:
 - 153 non-woody herbs and grasses (145 identified) belong to 55 families
 - 329 woody trees and shrubs (313 identified) belong to 74 families.
- The 458 identified species belong to
 - 117 families
 - 251 genera
 - 94.10 % phanerogams
 - Angiosperms: 421 spp. and Gymnosperms: 10 spp.
 - 5.90 % cryptogams
 - Pteridophytes: 27 spp.

- **Maximum diversity of species contributed by the families:**
 - Fabaceae : 27 species
 - Papilionaceae: 10 species
 - Mimosaceae: 09 species
 - Caesalpinaceae: 08 species
 - Poaceae : 21 species
 - Ericaceae : 20 species
 - Asteraceae : 18 species
 - Lauraceae : 17 species
 - Euphorbiaceae : 16 species
 - Urticaceae : 15 species
 - and 49 families were represented by single species.
 - 14 bamboo species were also recorded in the present study.

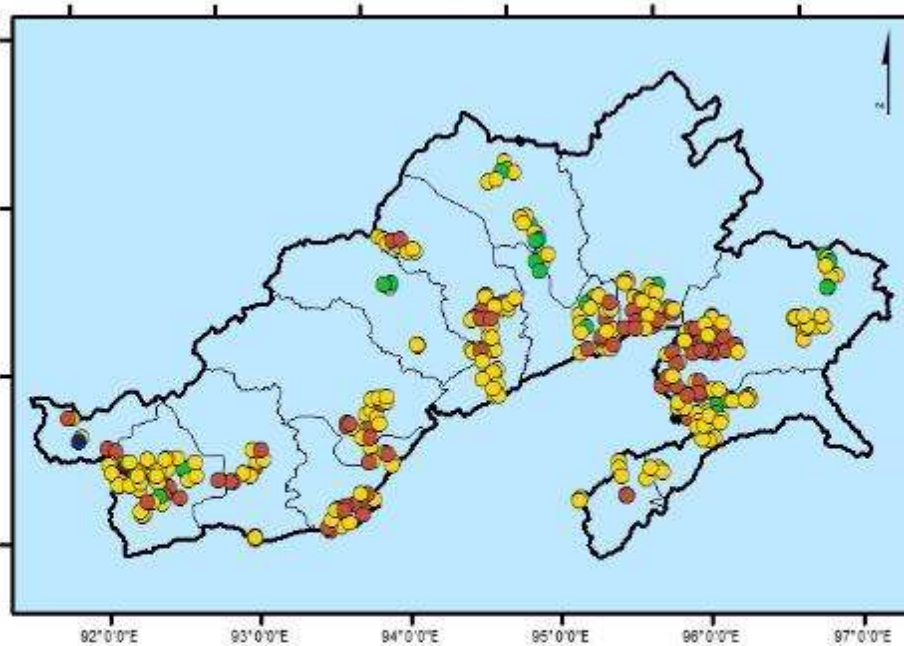
- Species richness ranges from 0 to 64 (mean 22 ± 0.65 SE) per transect.
- Tree (≥ 10 cm GBH) density per transect ranges from 0 to 1220 individuals ha^{-1} (374 ± 8.88 SE).
- Highest density as well as species richness recorded in tropical broad leaf semi evergreen forests.
- Maximum diversity had been recorded from Lohit, Changlang and Tirap districts.
- High diversity in these regions may be due to the higher rainfall as compared to other parts of the state.
- However, these forests are exposed to various levels of disturbances.



Various disturbances in natural forest of Arunachal Pradesh.

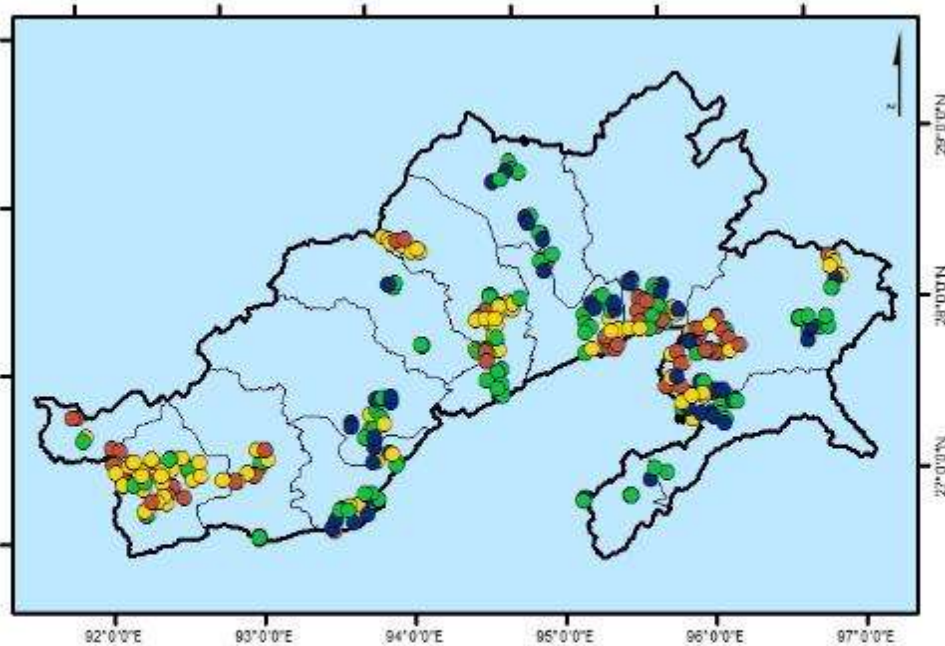
- A total of **82,383** individuals of woody species recorded in **354** studied transects
 - with stand density of 465 individuals ha⁻¹.
- In general, tree density varies with –
 - forest type
 - forest age
 - tree species & size
 - site history
 - site condition
 - and other factors
- The most dominant trees were:
 - *Castanopsis indica* (24 individuals ha⁻¹),
 - *Quercus semicarpifolia* (12 individuals ha⁻¹)
 - *Pinus roxburghii* (12 individuals ha⁻¹)
 - Some bamboos (*Dendrocalamus strictus*: 69 individuals ha⁻¹; *Bambusa pallida*: 16 individuals ha⁻¹)

Total Individual & Species Diversity



Total individuals (numbers)

● < 200 ● 200 - 400 ● 400 - 600 ● > 600



Species Diversity

● < 10 ● 10 - 20 ● 20 - 30 ● > 30

□ Districts Boundary □ Arunachal Pradesh State

100 KM



- The majority of transects have 200 - 400 numbers of individuals followed by < 200 individuals.
- The majority of transects have species diversity ranging from 20 – 30 species followed by 10 - 20 species.

Number of Individuals (per Transect)	Species diversity				Total
	<10	10-20	20-30	>30	
<200	37	35	12	10	94
200-400	18	61	83	74	236
400-600	1	4	3	12	20
>600	0	2	1	1	4
Total	56	102	99	97	354

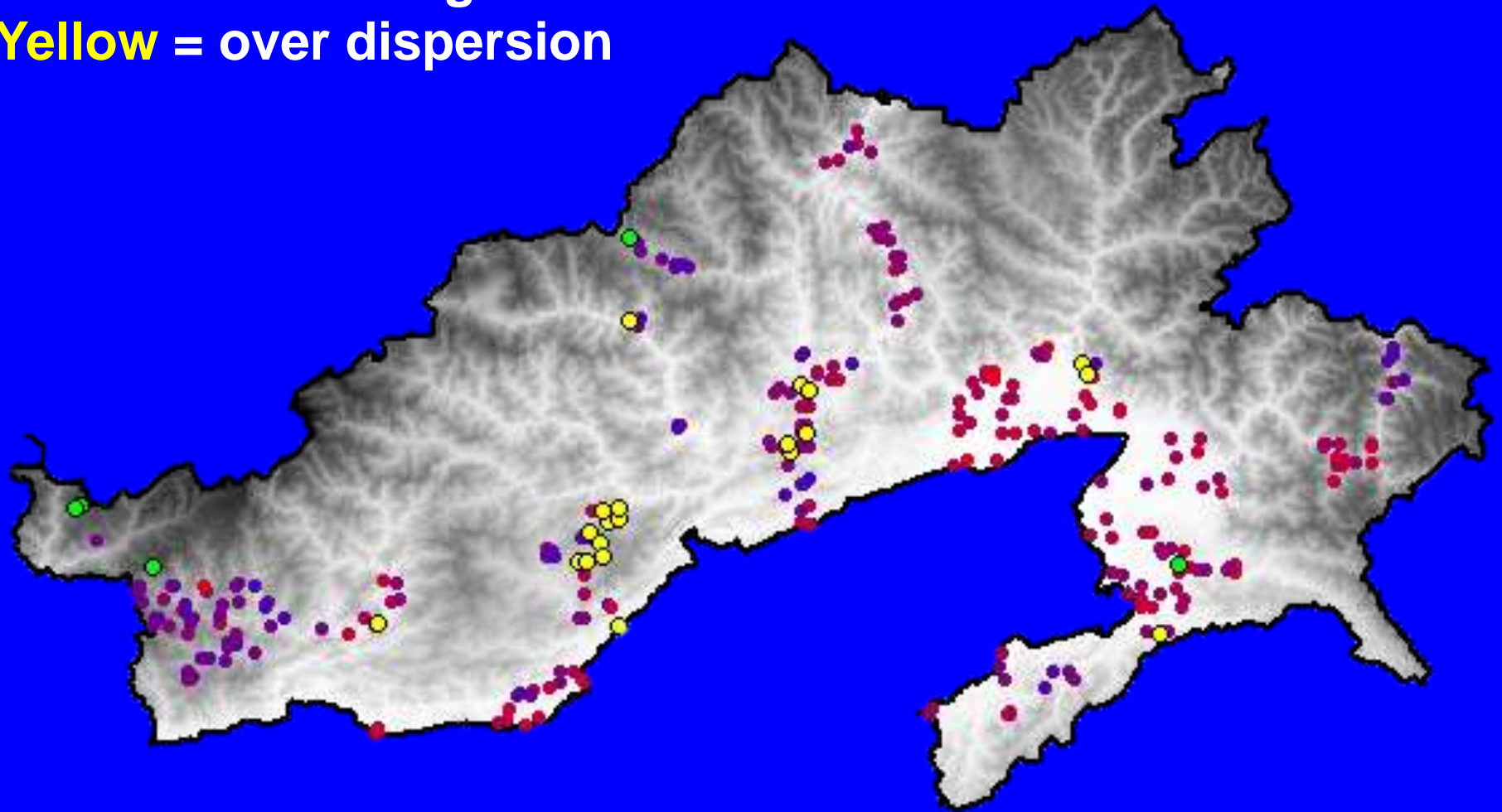
- **Shannon-Wiener diversity index is generally high for tropical forests of Indian subcontinent and ranged from 0.81 to 4.1.**
- **Shannon–Wiener diversity values for:**
 - Trees was 4.64
 - Herbs was 4.12
- **Concentration of dominance were:**
 - Tree - 0.02
 - Herbs 0.03
- **The values of species diversity showed the trend tree > herb**
- **While concentration of dominance showed the opposite trend herb > tree.**
- **High diversity and low concentration dominance in the studied forests may be due to different levels of anthropogenic pressure.**

Out of the total 354 transects:

- **Alpine vegetation (>2800 m altitude) - 15 transects**
 - Species richness ranges from 02 to 21 (mean 9 ± 1.57 SE)
- **Temperate forests - 35 transects**
 - Species richness ranges from 05 to 44 (mean 16 ± 1.21 SE).
- **Sub-tropical forests – 70 transects**
 - Species richness ranges from 05 to 53 (mean 24 ± 1.27 SE)
- **Tropical forests – 232 transects**
 - Species richness ranges from 0 to 64 (mean 23 ± 0.84 SE).

- **Elevational gradients are ideally suited for examining biodiversity drivers -**
 - **as elevation is correlated with several environmental variables including competition, mutualism, ecotone effects, temperature and rainfall that determine energy availability and ecosystem productivity.**
- **Differences in species diversity among communities generally resulted from variations in site specificity.**
- **It is often correlated with rainfall and nutrient status of the site.**
- **Dispersal limitation is an important ecological factor for controlling species distribution pattern.**
- **Contagious distribution has been accepted as a characteristic pattern of plant occurrence in nature and it is an indication of clusteredness.**

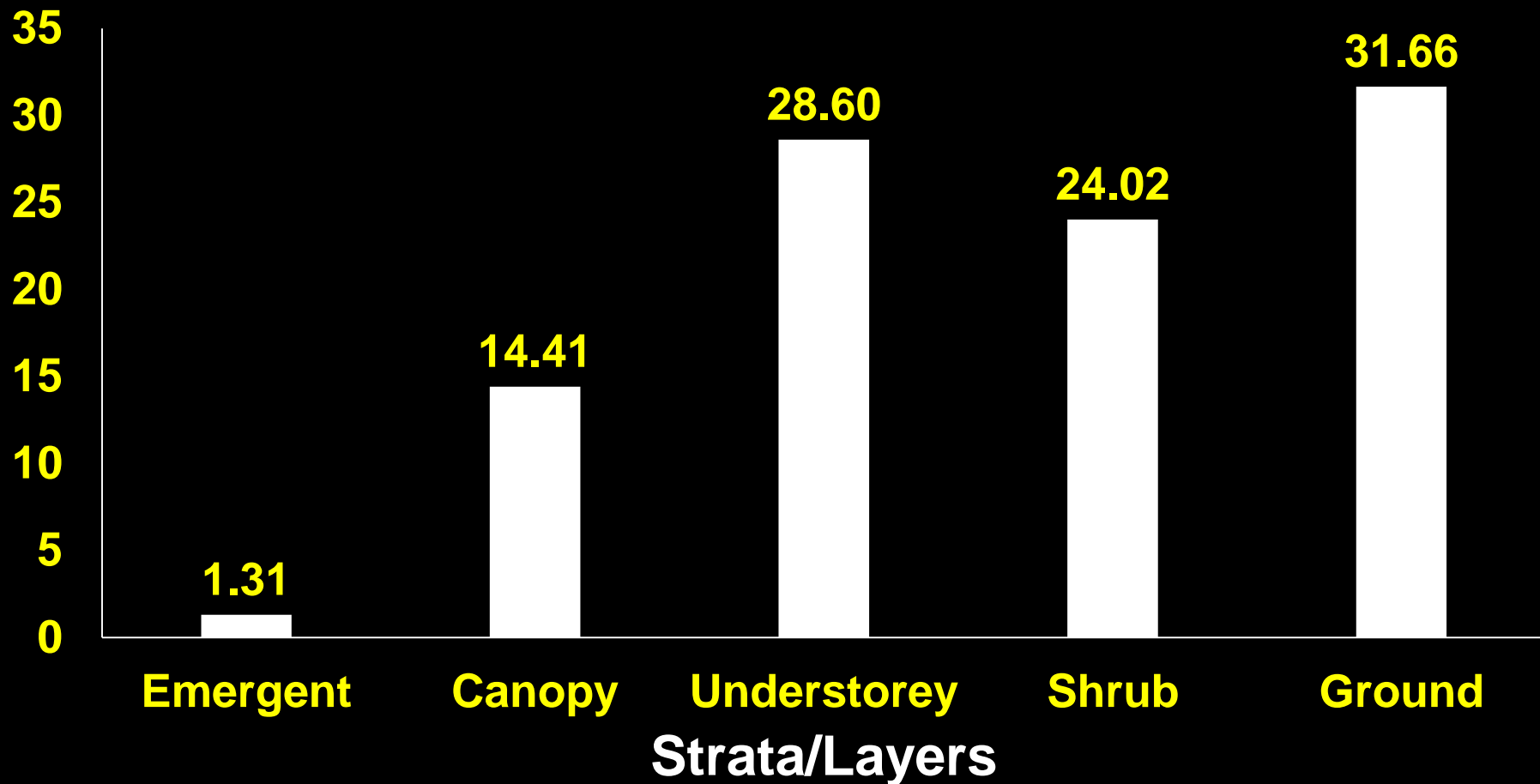
Green = clustering
Yellow = over dispersion



- All the 483 plant species (out of total 484 spp.) were distributed contagiously in all the studied forest stand with A/F ratio > 0.05
 - whereas, *Phoebe cooperiana* showed a regular distribution with 0.004 A/F ratio.
- A heterogeneous canopy structure is a relevant attribute of tropical forests in physiognomic terms.
- In addition, the degree of vertical stratification is an important factor for maintaining higher woody species diversity in natural forests.

Present study showed distinct stratification (five different strata) on the basis of mean height of the species *viz.*

- emergent (>20 m),**
- canopy (>10-20 m),**
- understorey (>5-10 m),**
- shrub (<5 m including sapling of the tree species) and ground (<1 m including the saplings of both tree and shrub species).**



- Emergent and Canopy layers were occupied by different timber trees and bamboos.
- Understory was occupied by mainly *Rhododendron* spp., small timber and fruit trees.
- Out of the total 329 woody plants -
 - only 48 species were recorded in seedling stage
 - which signify that only 14.59 % woody species were regenerating in the 177 ha studied plots (354 transects).
- This may be due to the uneven timing of sampling.
- Seedling recruitment was poorer in the higher altitude forests (thick ground cover of leaf litter, mainly in coniferous forests hinder the regeneration).

- Landslides in the hills and flood in plain areas during rainy seasons were recurrent ecological disturbances experienced throughout the state.
- Different types of biotic interferences such as:
 - fire,
 - grazing
 - slash and burn agriculture
 - NTFPs collection (firewood, resins, wild vegetables, fruits, toko leaves, fodder, medicinal plants etc.)
 - hunting
 - timber felling, etc.

were encountered and recorded in the present study which directly or indirectly impacts on the composition of the forests and regeneration.

- NTFPs collection by the local people is the main livelihood source for them.

Eastern Himalayan forests have also been invaded by species e. g.

- *Ageratum conyzoides*
 - *Chromolaena odorata*
 - *Cyperus rotundus*
 - *Eichhornia crassipes*
 - *Imperata cylindrica*
 - *Mikania micrantha*
 - *Mimosa invisia*
 - *Mimosa pudica*
 - *Eupatorium* spp.
 - *Parthenium hysterophorus*
 - *Lantana camara*,
 - *Chromolena odorata*
- *Ageratum conyzoides* was the most dominant herb with 12,274 individuals ha⁻¹.





Gymnocladus assamica

Gymnocladus chinensis

Gledetsia assamica



Livistona jenkinsiana

Rhododendron fulgens

Rhododendron meddenii

Some threatened species of Arunachal Pradesh

Various IUCN red listed species are found in the region e. g. :

- *Aquilaria malaccensis*
- *Begonia tessaricarpa*
- *Gledetsia assamica*
- *Gymnocladus assamicus*
- *Livistona jenkinsiana*
- *Rhododendron meddenii*
- *Rhododendron thomsonii*

Conclusion

- The results show that species richness decreases with the increasing elevation.
- Species richness and distribution patterns of plants are largely regulated by the altitude and environmental factors.
- Our study confirms that the Eastern Himalayan forests are highly rich in endemic as well as non endemic species.
- And need intensive monitoring to conserve the fragile ecosystems from ever increasing anthropogenic pressure and changing climatic conditions.

What should be done ?

- **Protect the areas of high endemism.**
- **Create environmental awareness among the people especially young generation.**





Research team which carried out this study

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Research team to carry out following study

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Thank you