

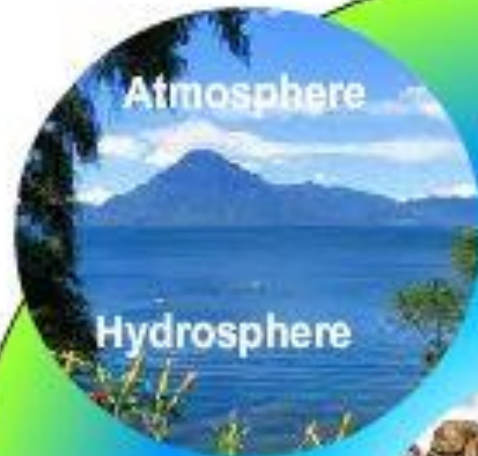
Land Use and Ecosystem Services in Traditional Home Gardens in Sri Lanka



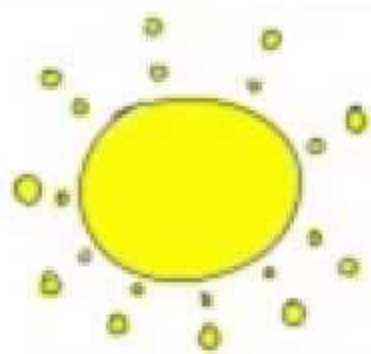
Dr. Ajith Gunawardena

Actg. Director - (Research and Development)

Central Environmental Authority



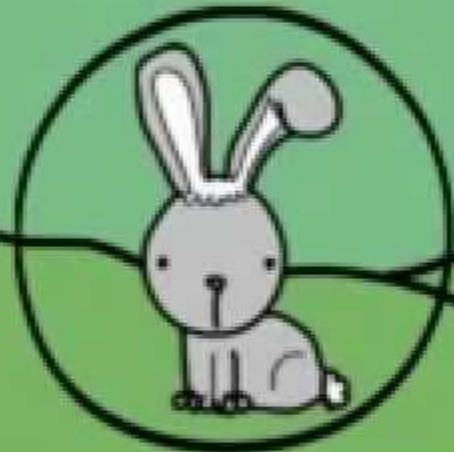
Ecosystem



Ecosystem

Air

Non-living

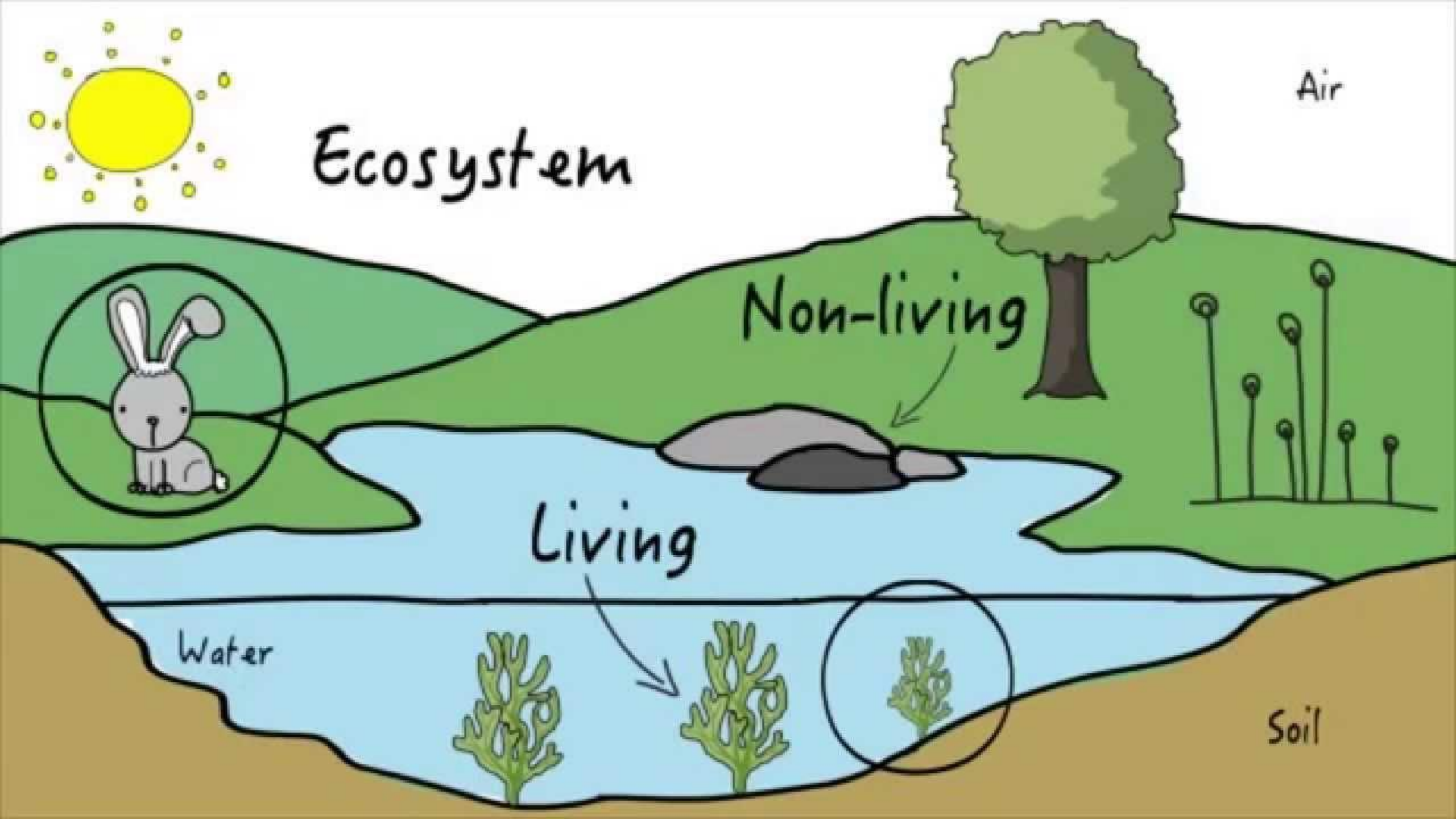


Living

Water



Soil

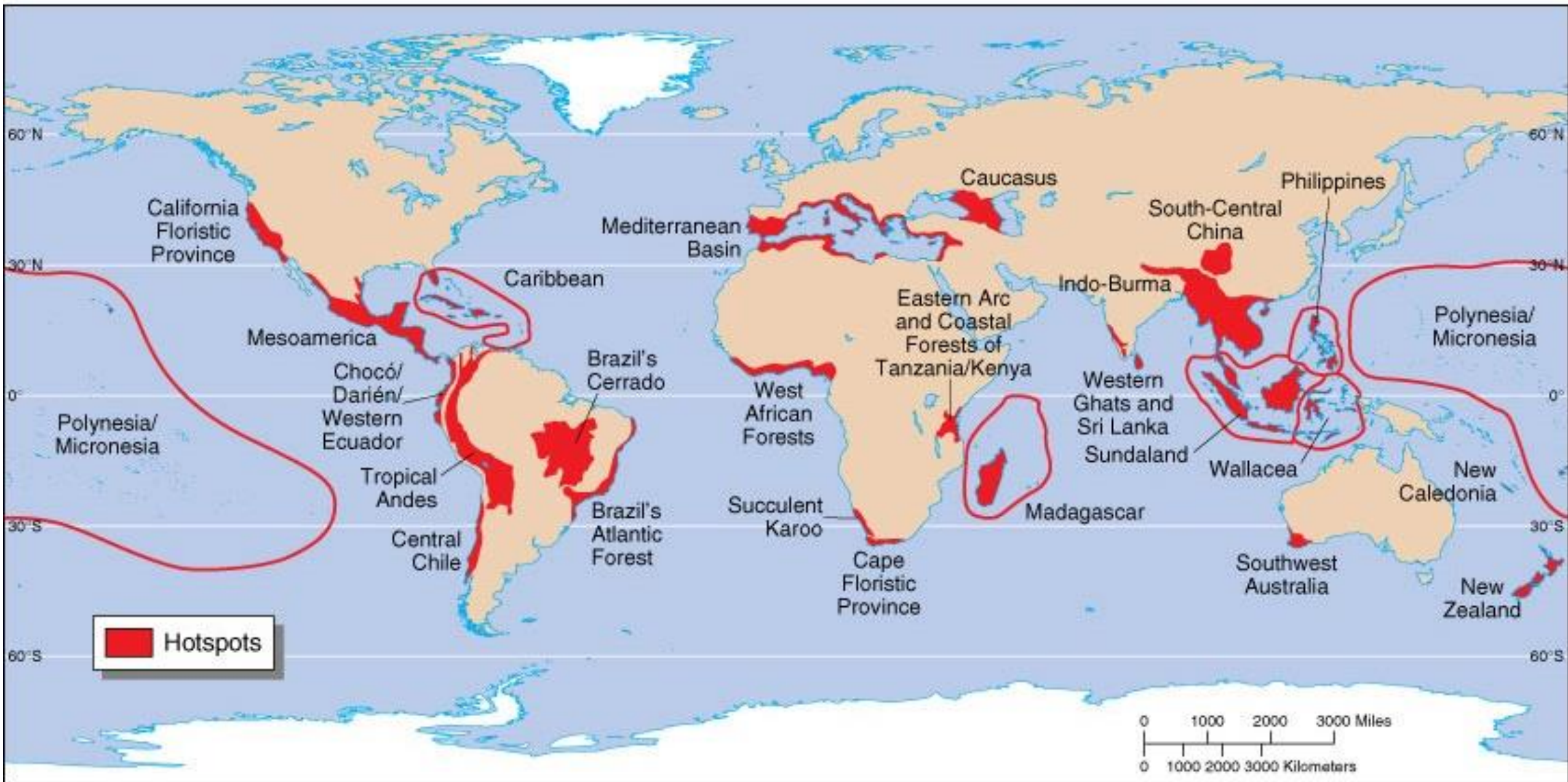


Why Sri Lanka is important ?

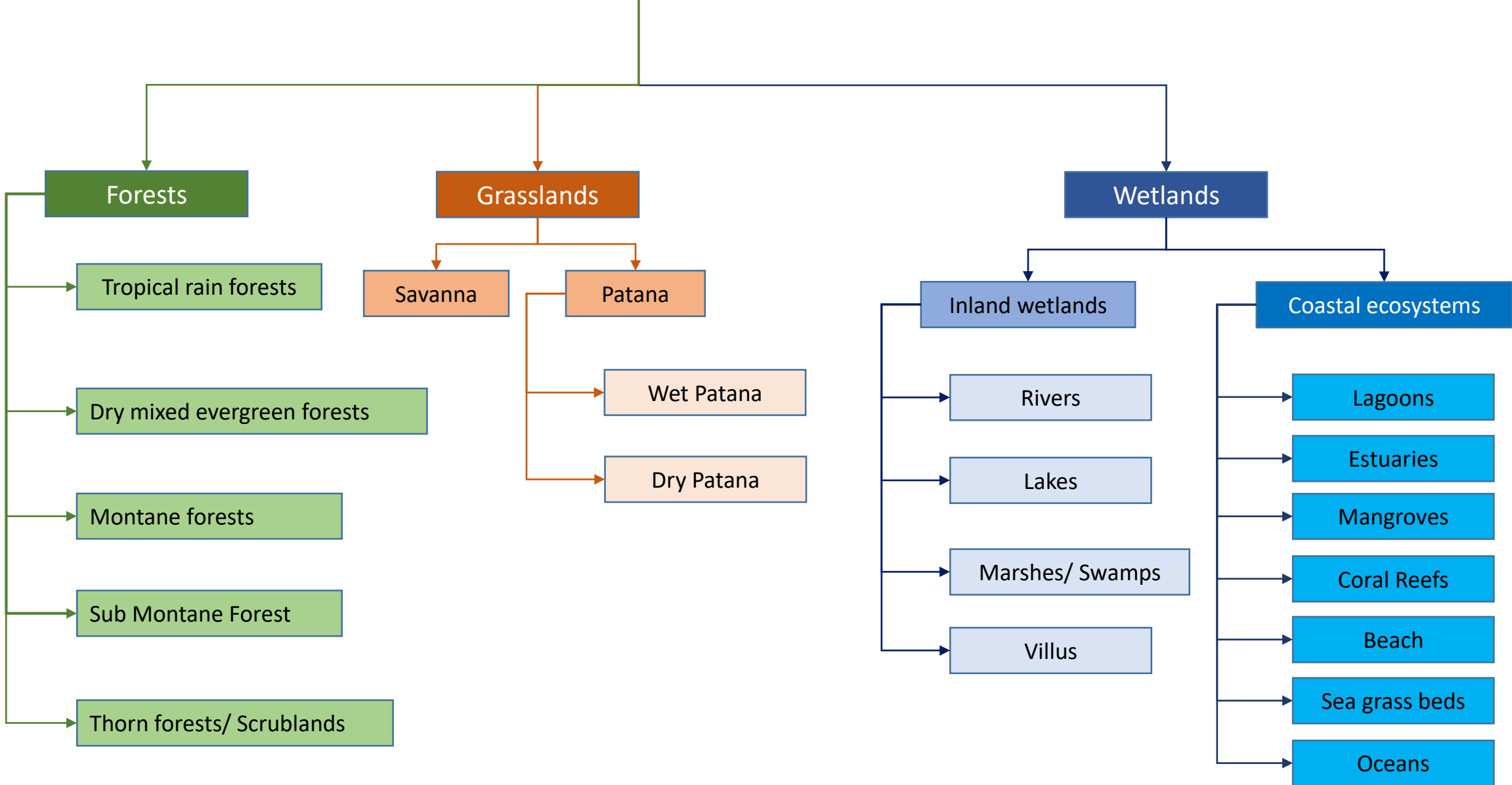


Because Many Ecosystems

Biodiversity Hotspots

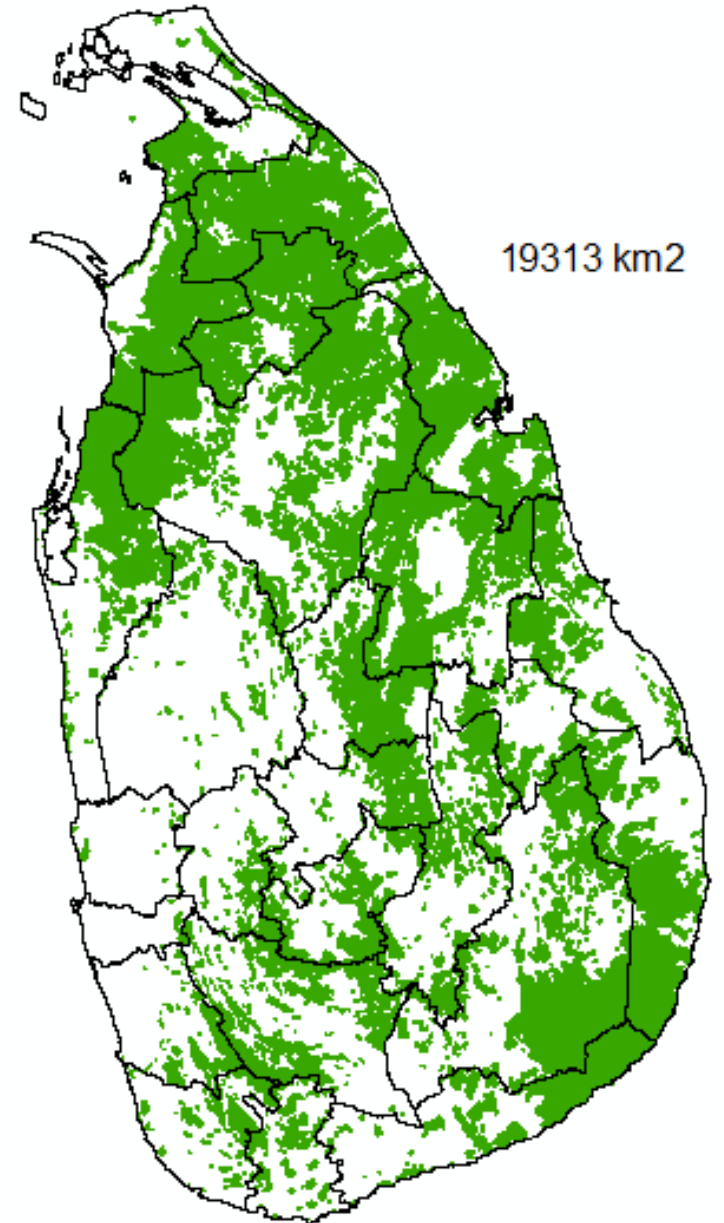


Natural Ecosystems in Sri Lanka

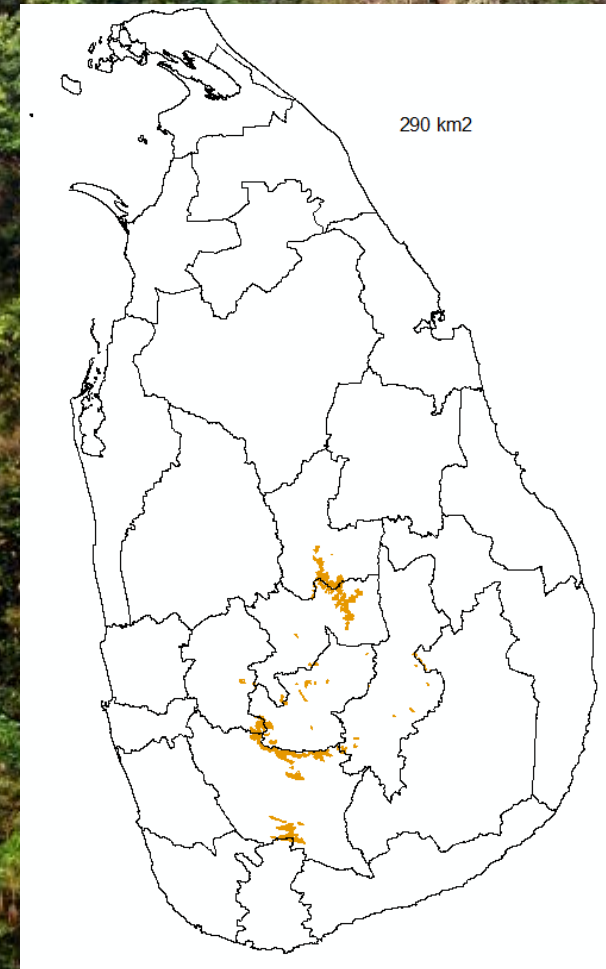




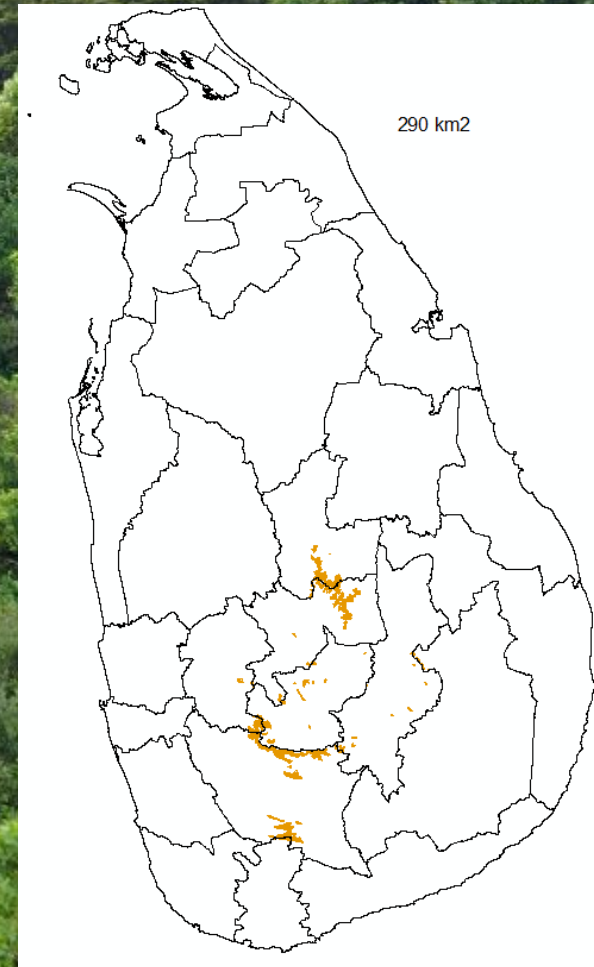
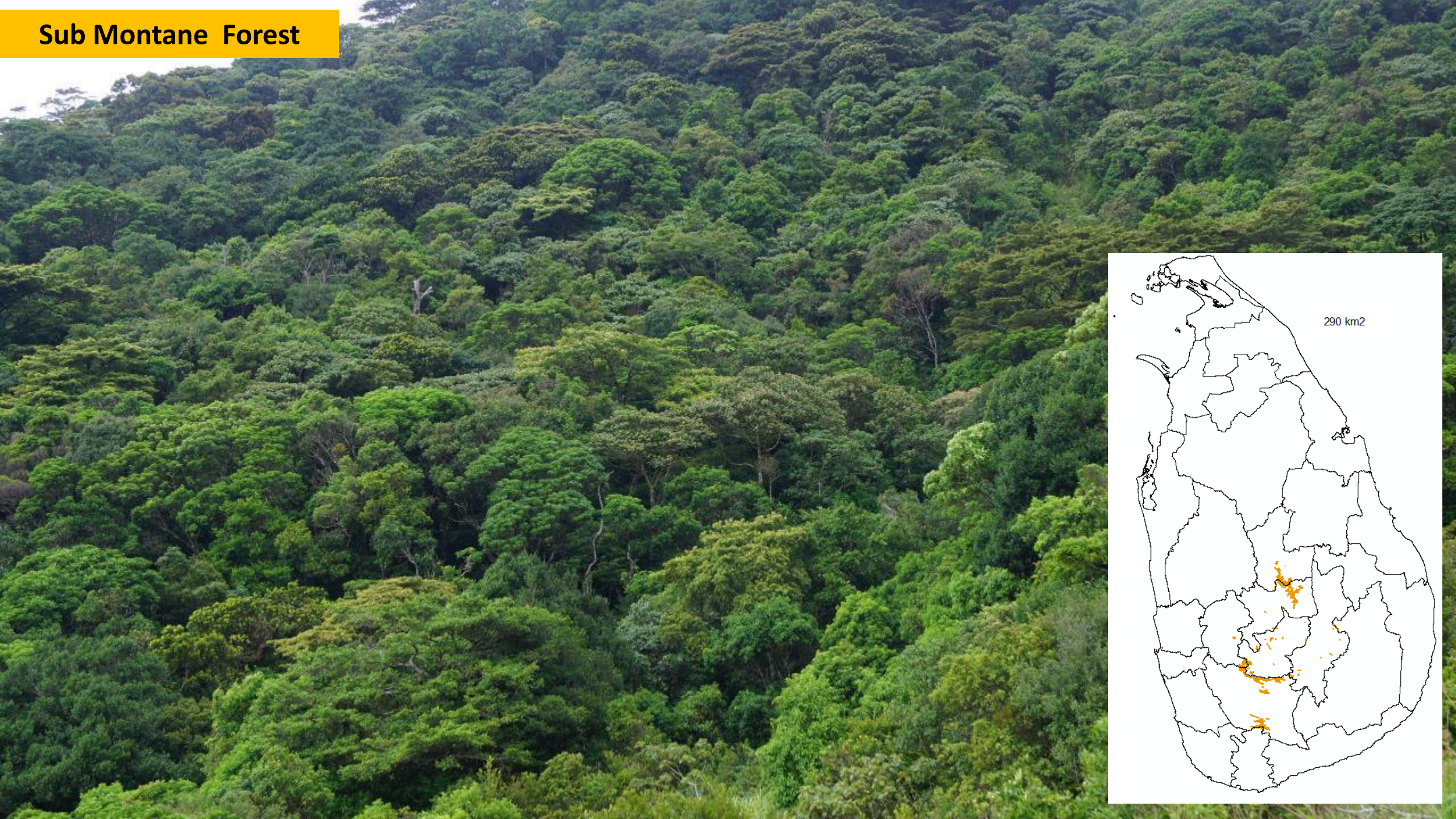
Forest Ecosystems



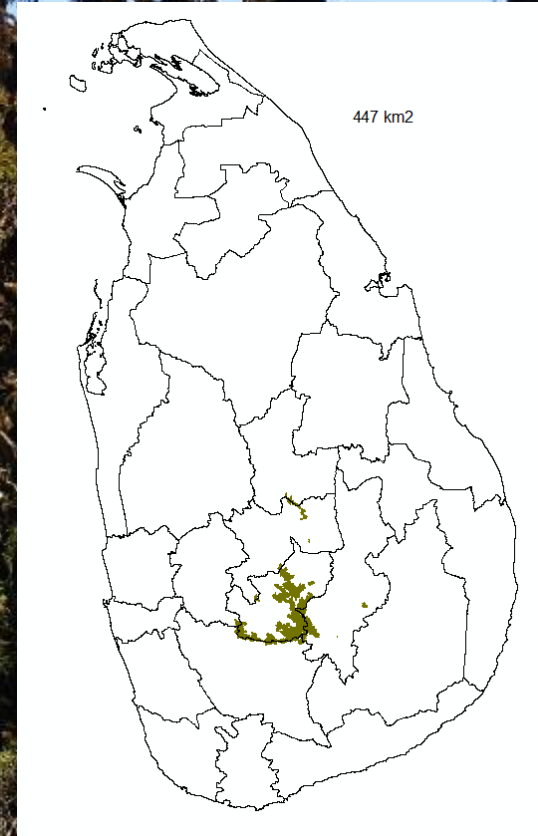
Tropical Rain Forest



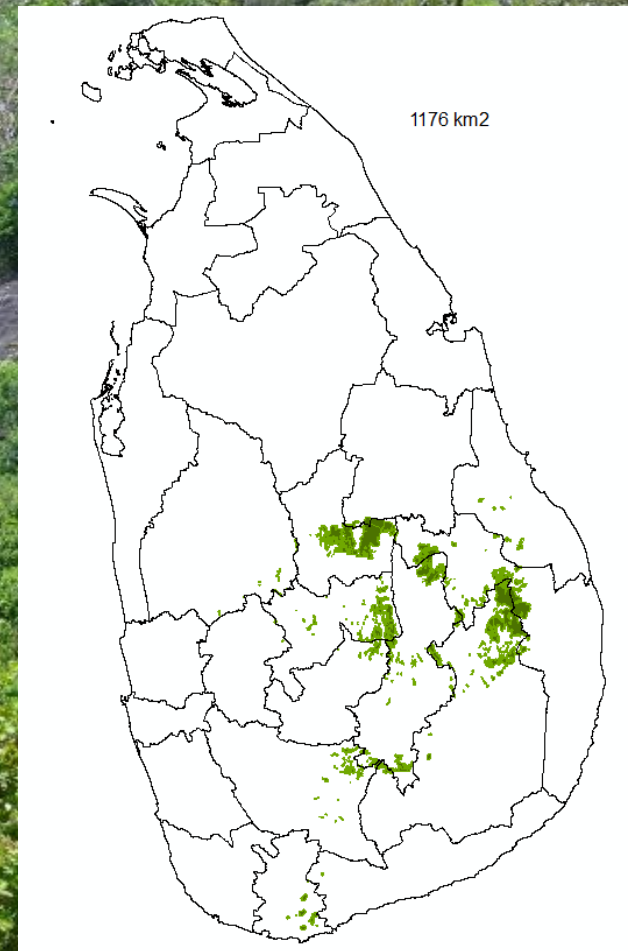
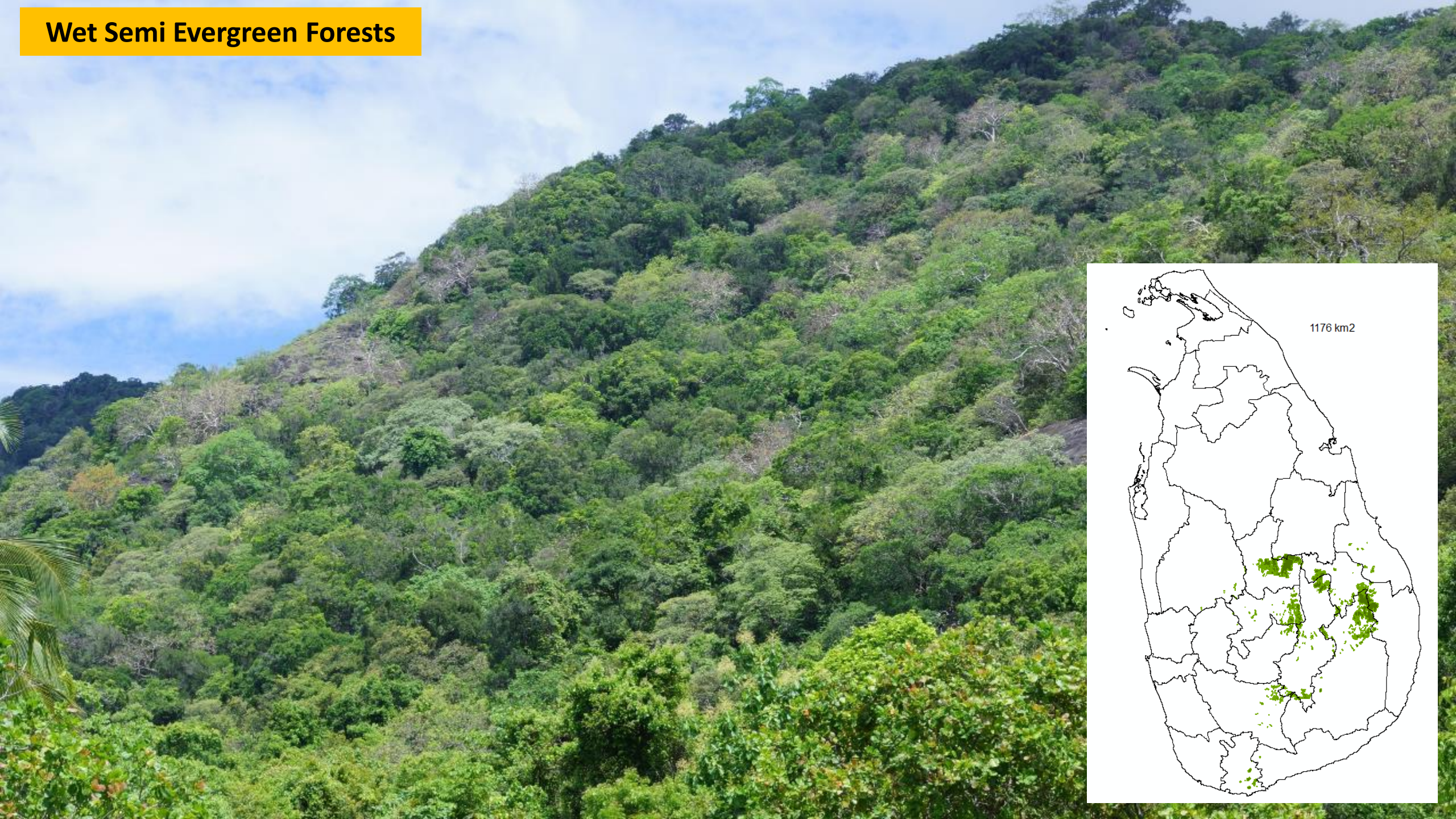
Sub Montane Forest



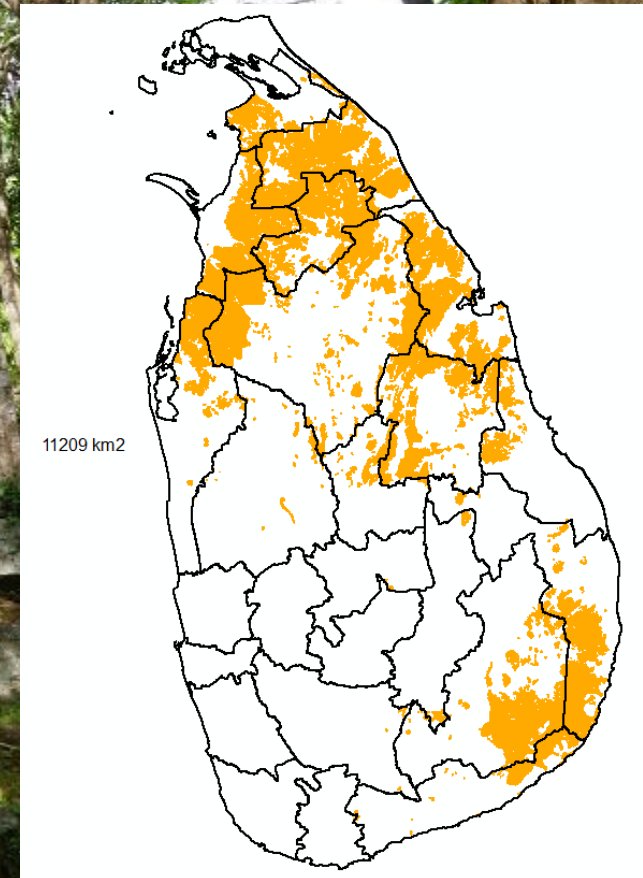
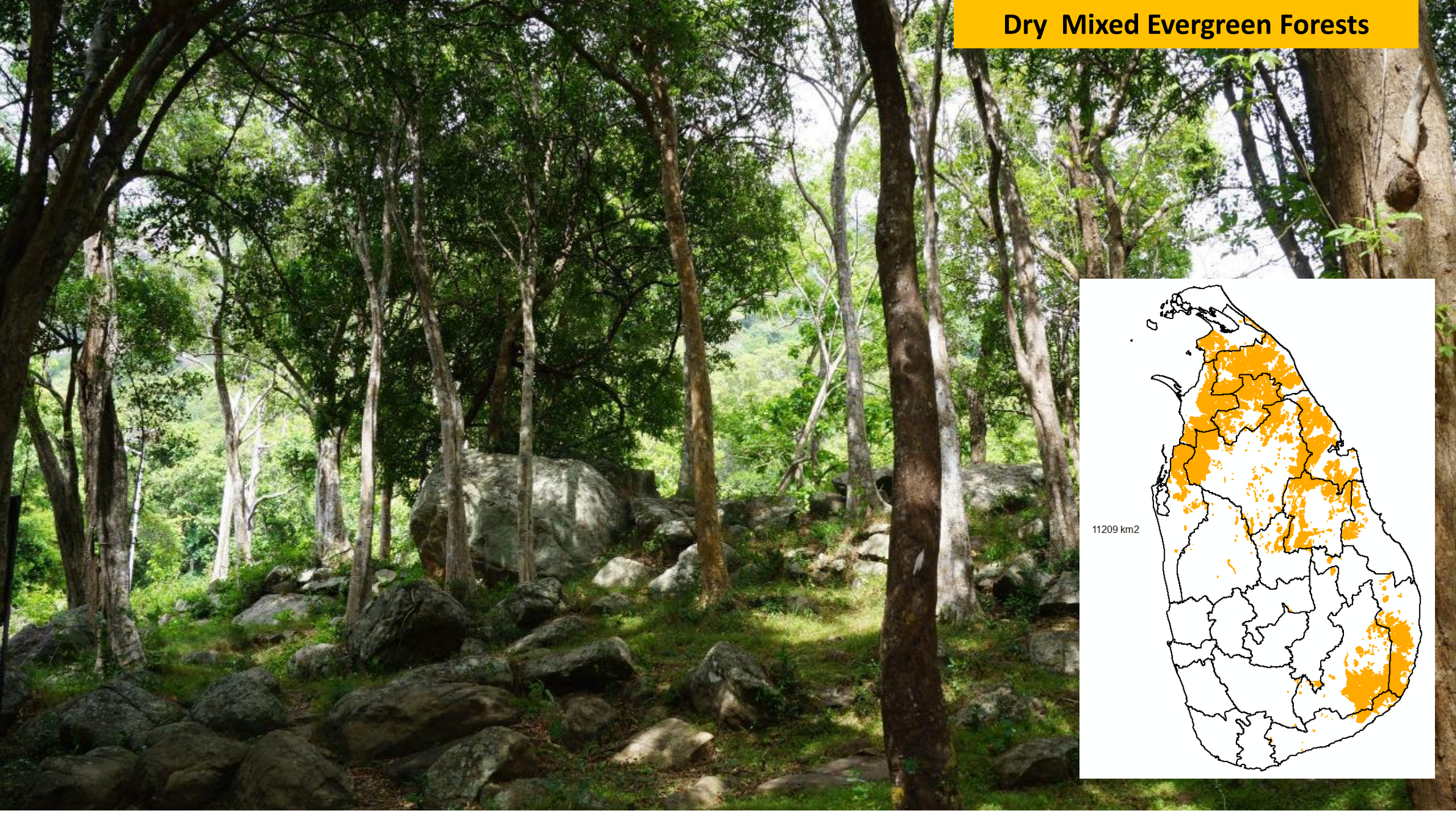
Montane Forest



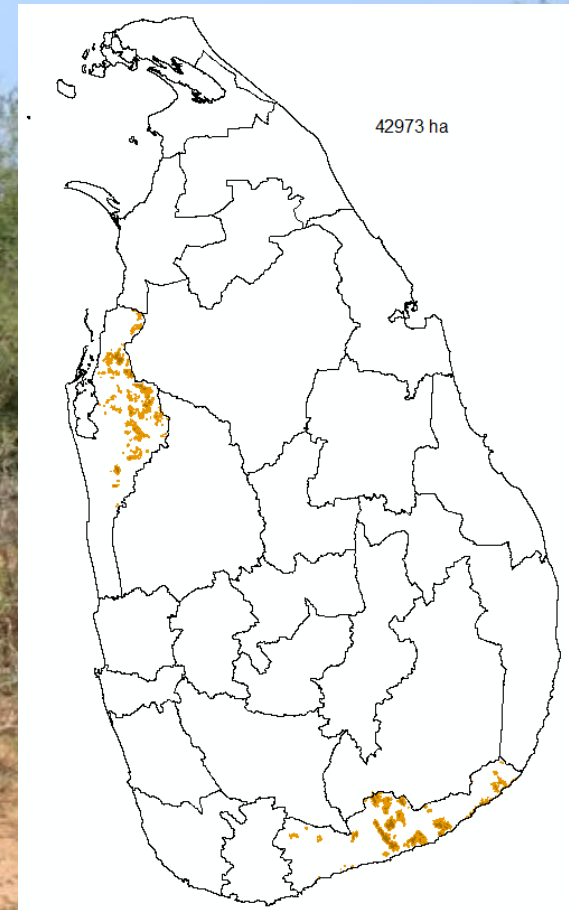
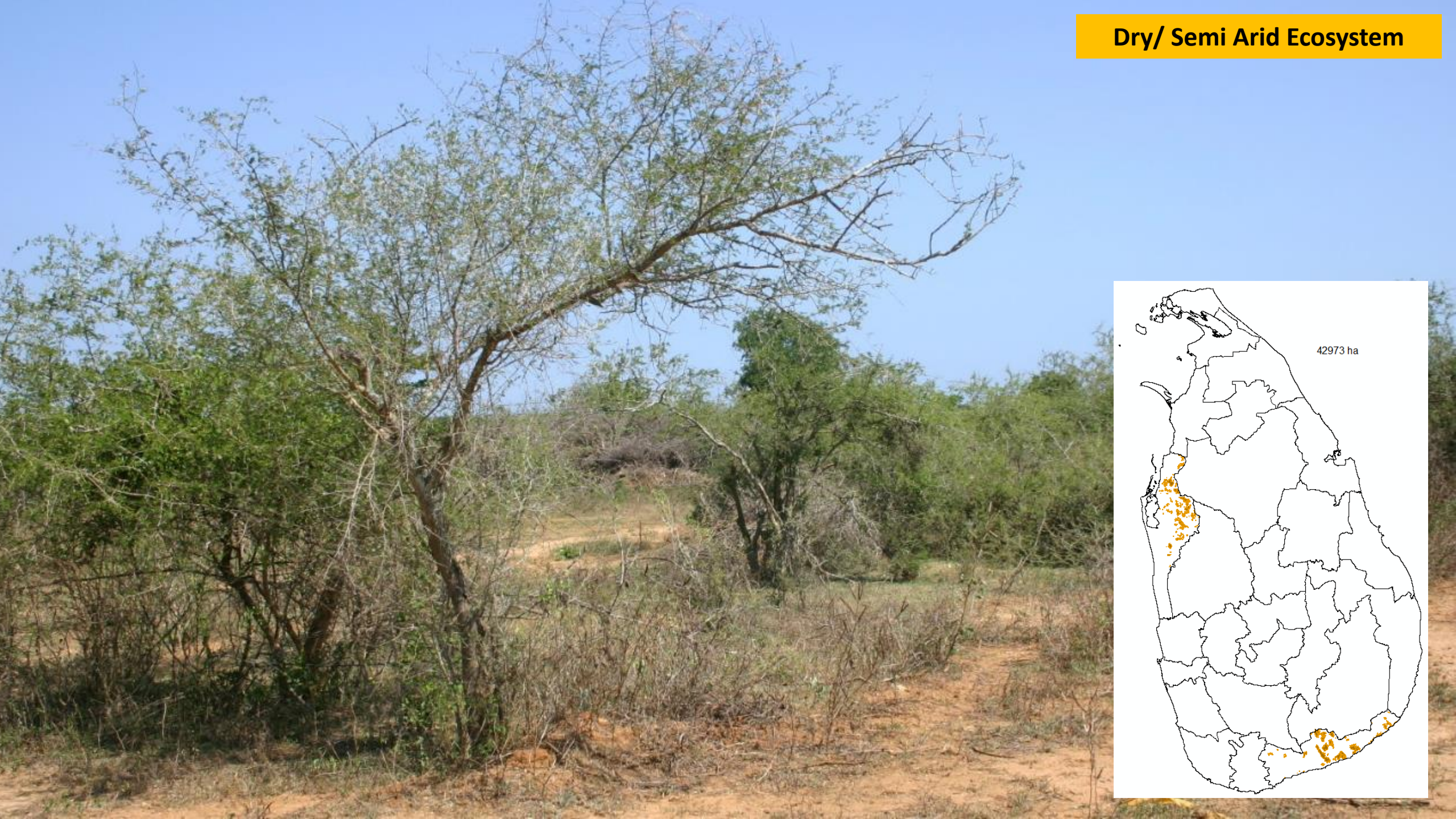
Wet Semi Evergreen Forests



Dry Mixed Evergreen Forests



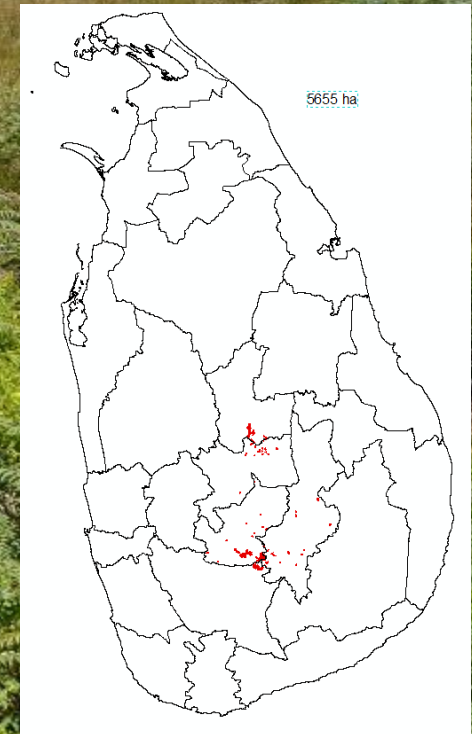
Dry/ Semi Arid Ecosystem



Grassland Ecosystems



Wet Patana Grassland

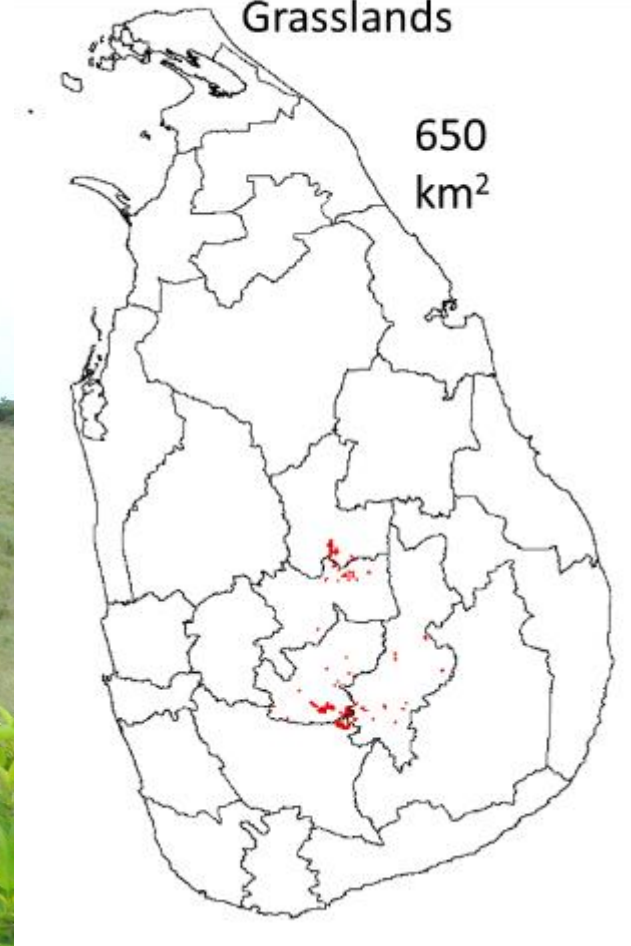


Dry Patna Grassland

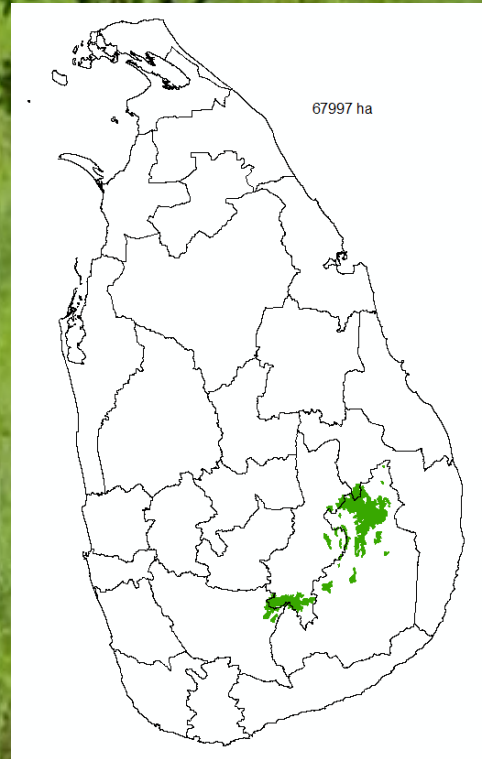


Montane
Grasslands

650
km²



Dry Savana Forest/ Grasslands



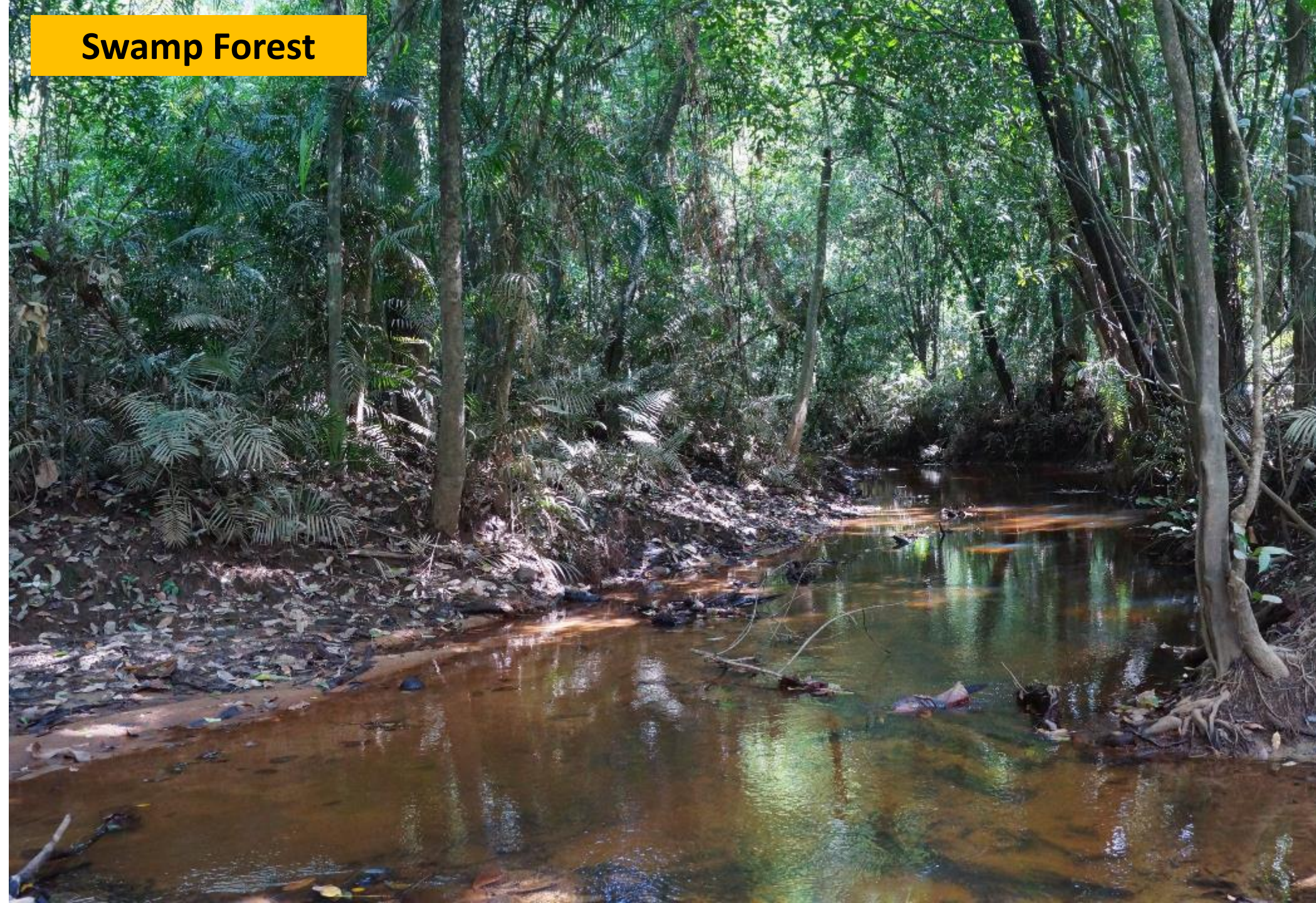
Wetland Ecosystems

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graph TD; A[Wetland Ecosystems] --> B[Inland Ecosystems]; A --> C[Coastal Ecosystems];
```

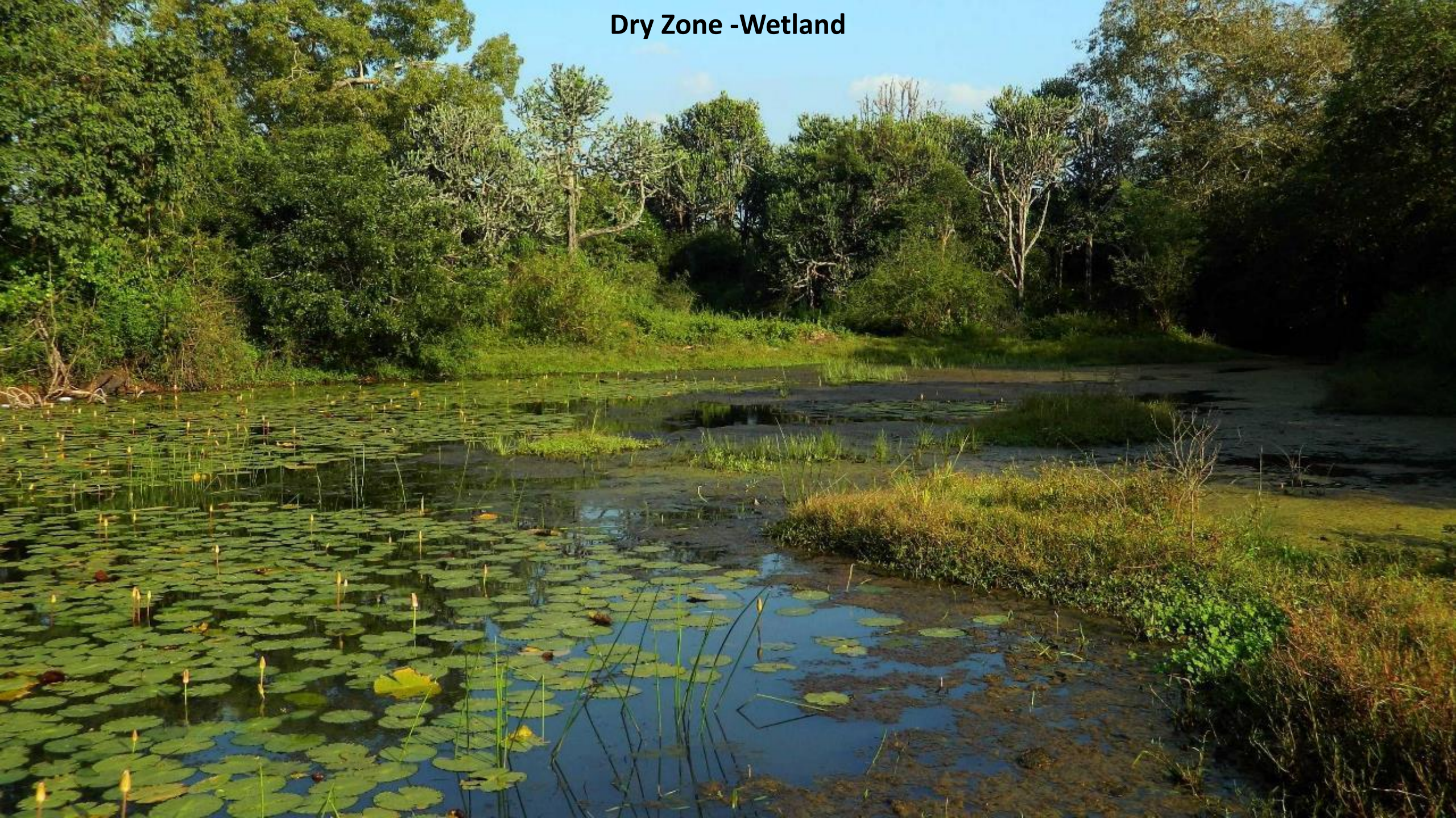
Inland Ecosystems

Coastal Ecosystems

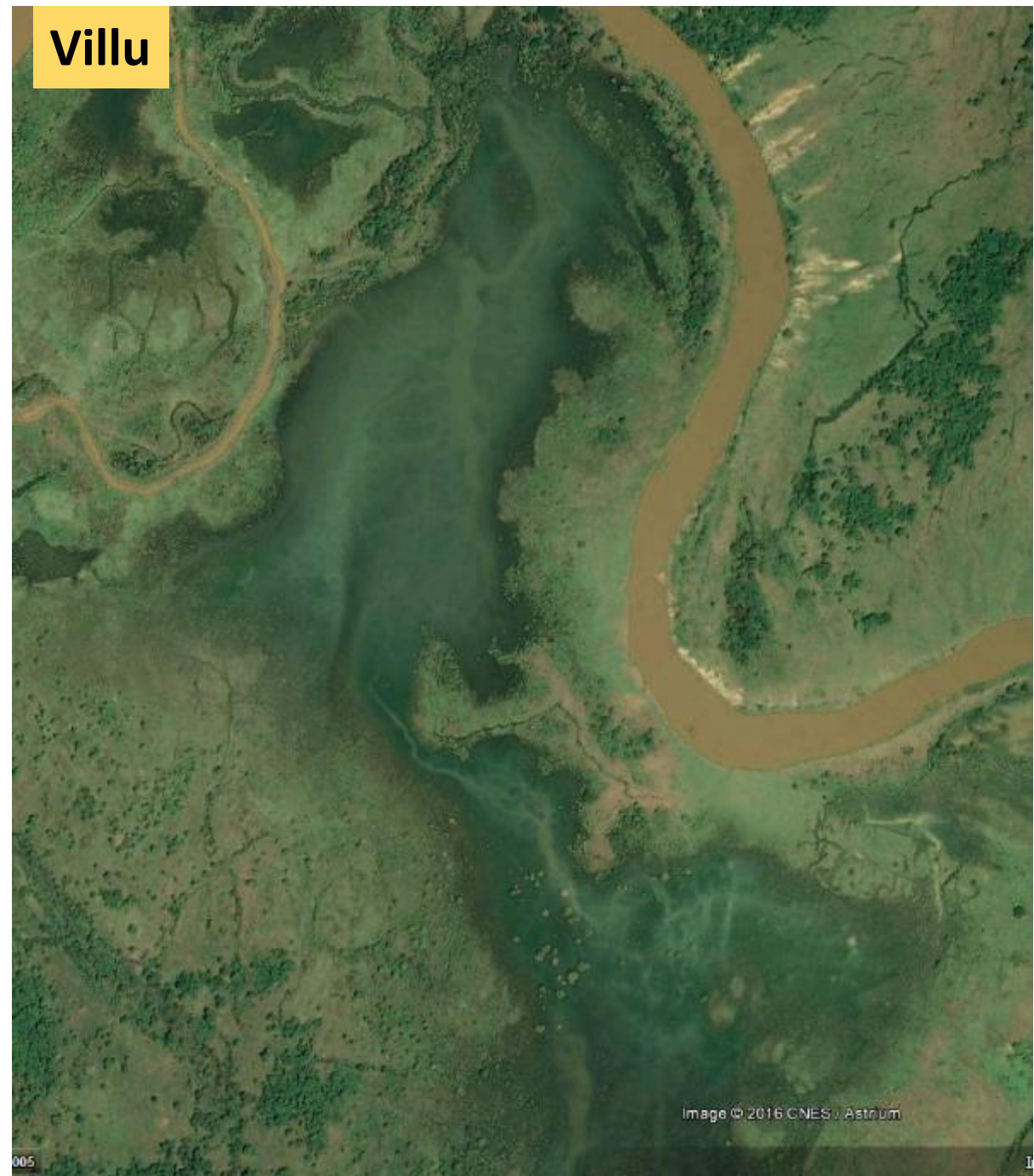
Swamp Forest



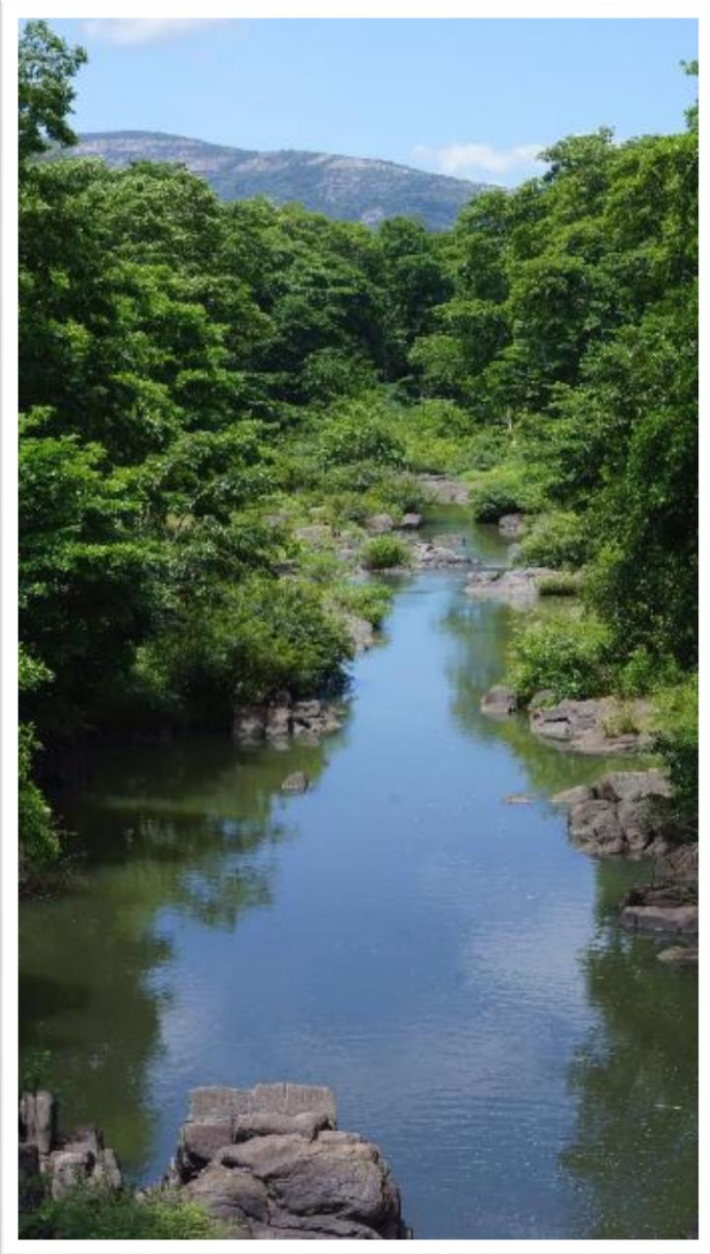
Dry Zone -Wetland



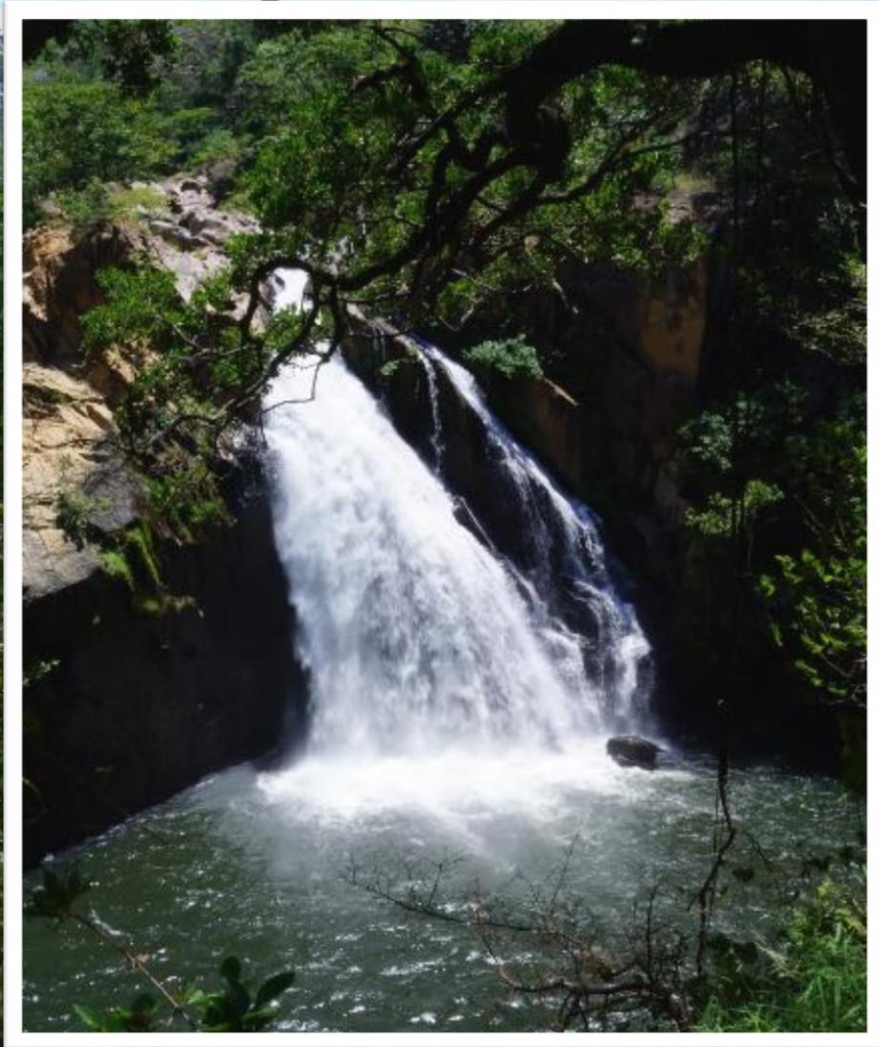
Villu



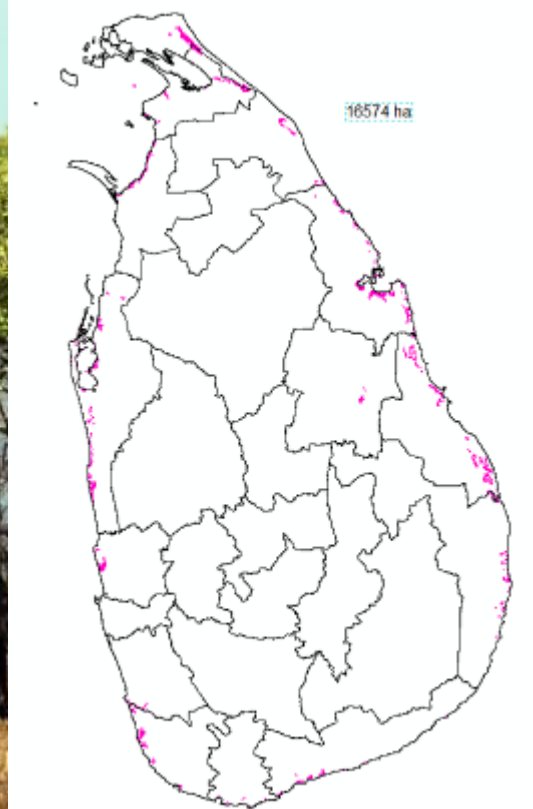
Riverine Ecosystems



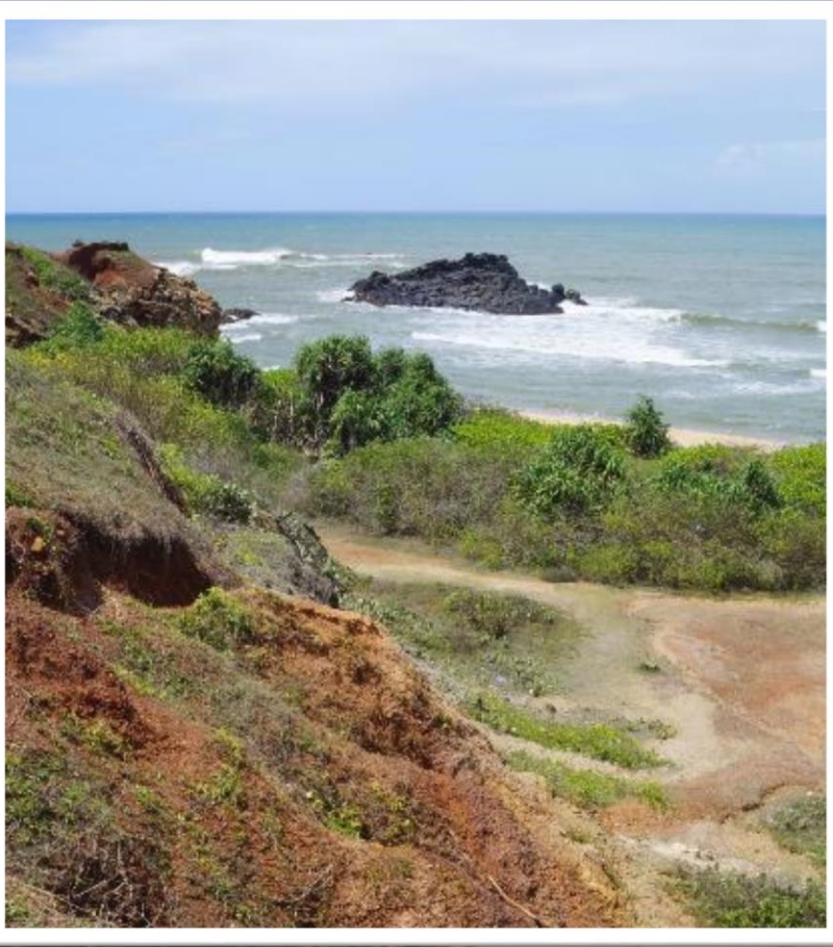
Rivers / Waterfalls



Mangroves



Beaches



Prickly Pear (*Opuntia dillenii*)

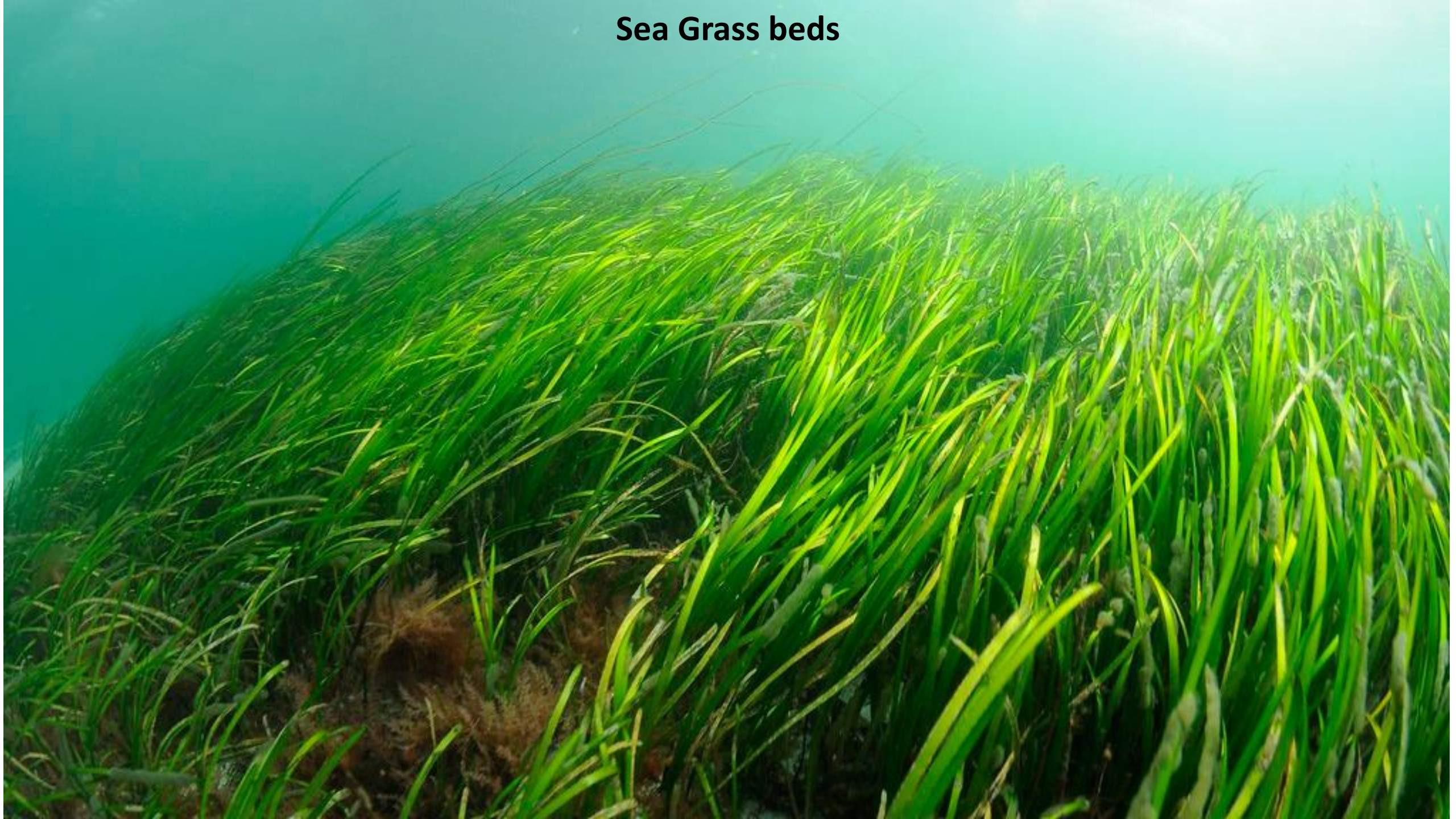


Maha rawana reula
(*Spinifex littoreus*)



Yellow-wattled lapwing
(*Vanellus malabaricus*)

Sea Grass beds



Corel Reef



Sand Dunes



Lagoon



Wewa



Paddy Lands



Forest Plantation



Traditional Home Gardens of Sri Lanka



Kandyan Home Gardens (KHG)

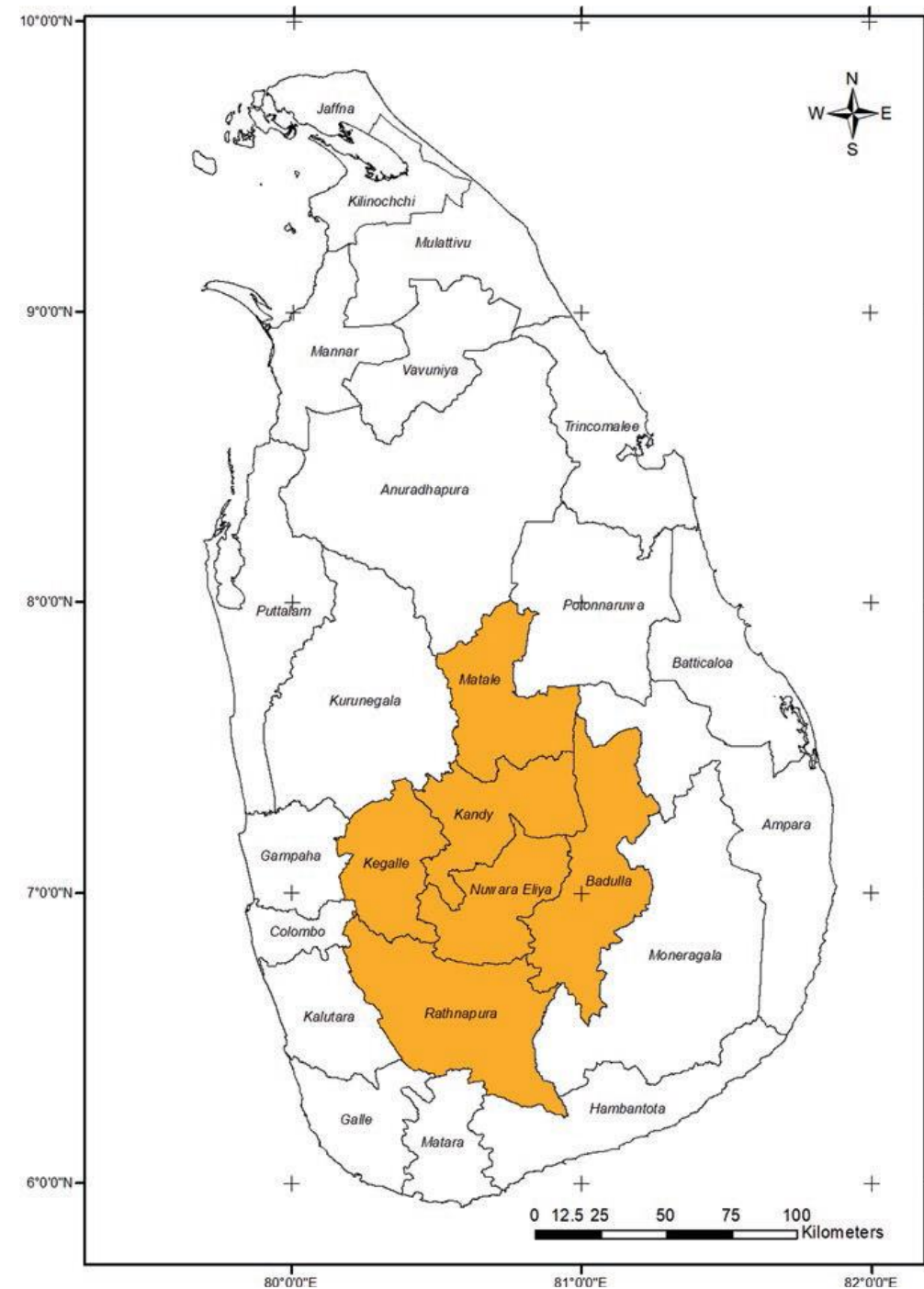
The unique home garden system in the central region was called Kandyan Home Gardens (KHG), named based on the **ancient**

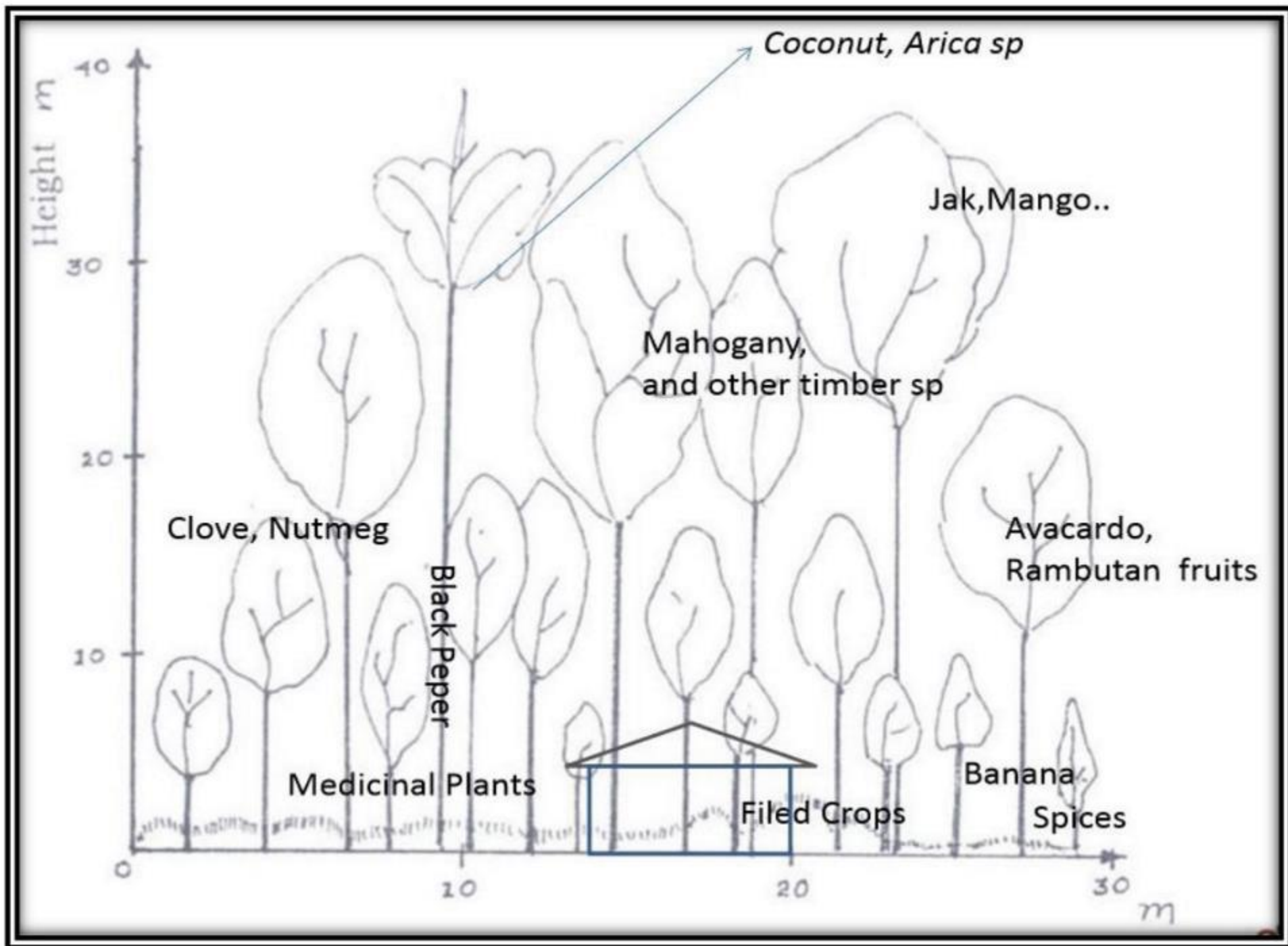
Kandyan Kingdom

Kandy and adjacent districts

- Badulla
- Kegalle
- Kurunegala
- Matale
- Nuwara Eliya
- Rathnapura

Elevation 400 to 1,050 msl.

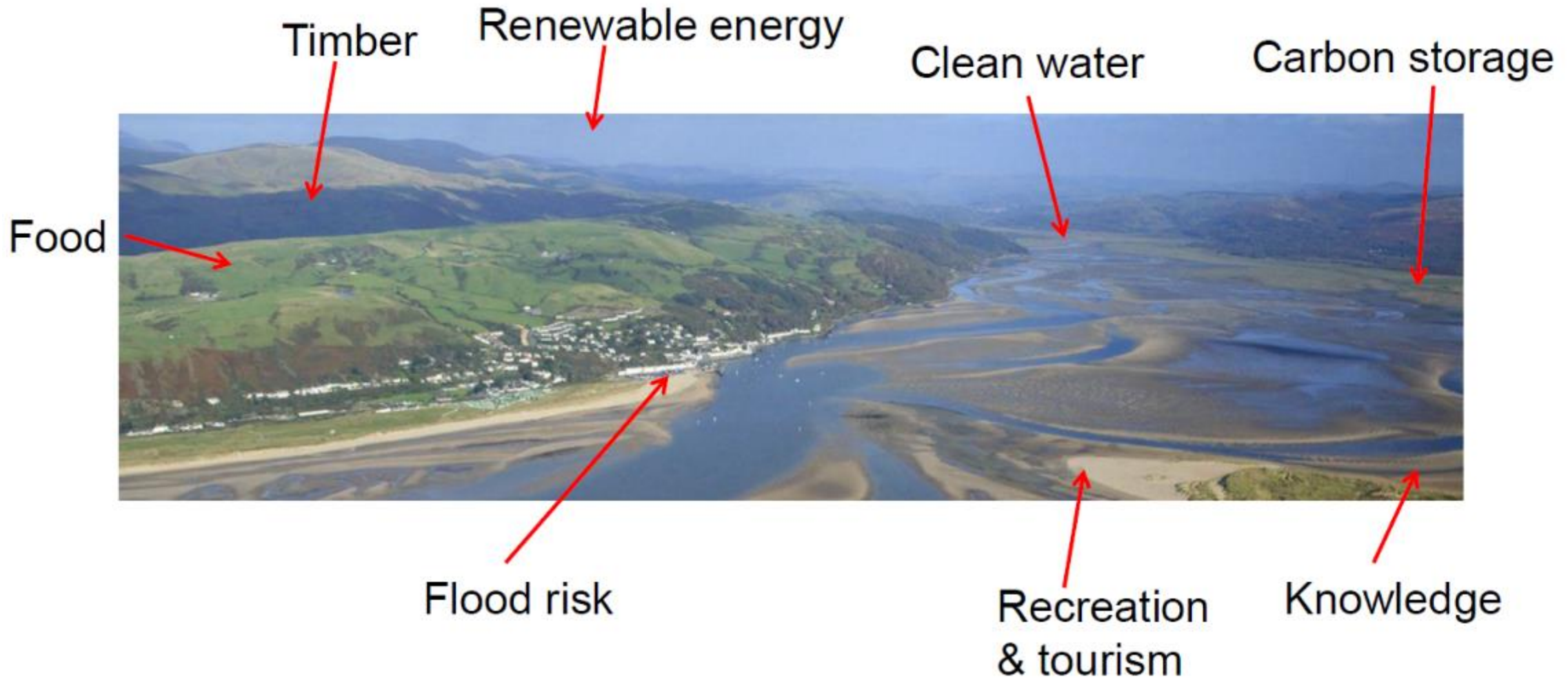




Floral Description/characteristics	
No. of flora species (trees, shrubs, vines, herbs)	147
No. of species occurrence of more than 90% of home gardens	10
Tree density (No. trees/ ha, including tree saplings)	301.75
Average tree height (in meters)	23.2
Average Cumulative DBH (>10cm) per home gardens	22.6m
No. of canopy layers	4-5
No. of fruit species	16
No. of cash crop species	21
No. of medicinal plants species	92
No. of plants which have ornamental values	21
No. of vegetable species (including green vegetables)	24
No. of timber (major)	18
No. of spices species	13
No. of multi-purpose tree species	07
No. of species used to prepare live fences	03

Ecosystem services

Defined as services provided by the natural environment that benefit people



ECOSYSTEM SERVICES

Provisioning

- FOOD
- FRESH WATER
- WOOD AND FIBER
- FUEL
- ...

Supporting

- NUTRIENT CYCLING
- SOIL FORMATION
- PRIMARY PRODUCTION
- ...

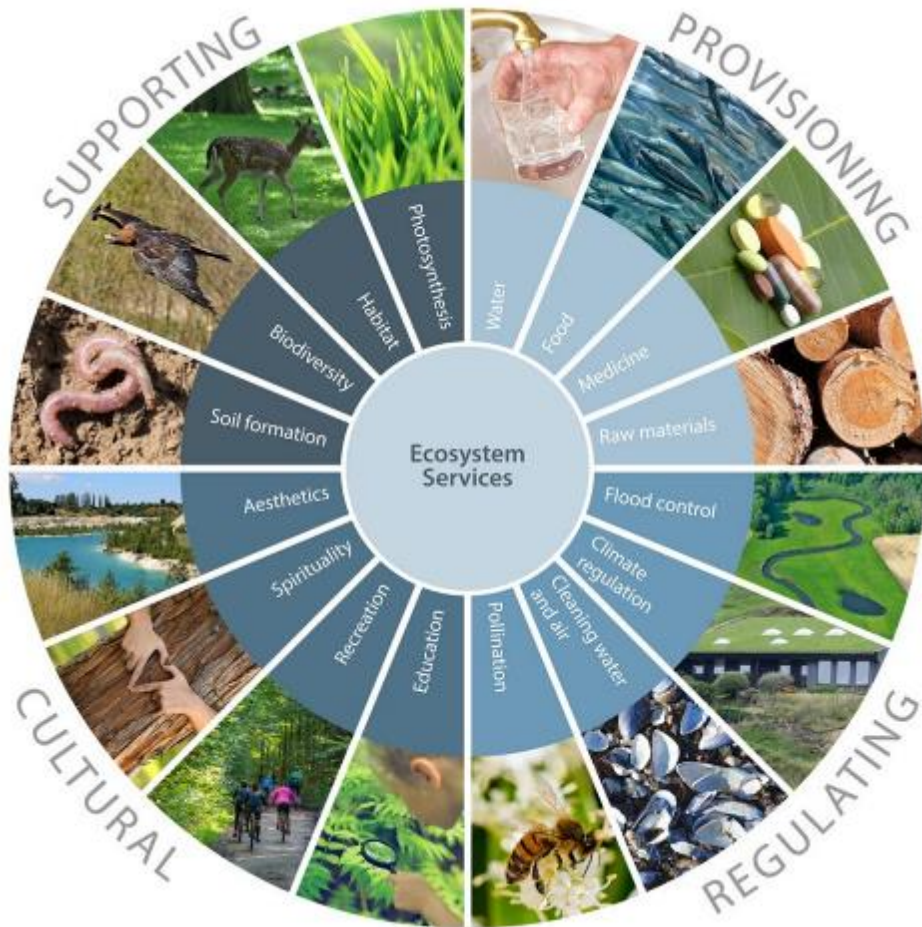
Regulating

- CLIMATE REGULATION
- FLOOD REGULATION
- DISEASE REGULATION
- WATER PURIFICATION
- ...

Cultural

- AESTHETIC
- SPIRITUAL
- EDUCATIONAL
- RECREATIONAL
- ...

Ecosystem Services



- Balance Nature
- Biological Productivity
- Regulation Climate
- Degradation of Waste
- Cleaning of Nutrients
- Control Potential Pest and Disease
- Detoxification of soil and sediments
- Stabilization land against degradation
- Carbon sequestration & Global Climate change
- Maintain soil fertility

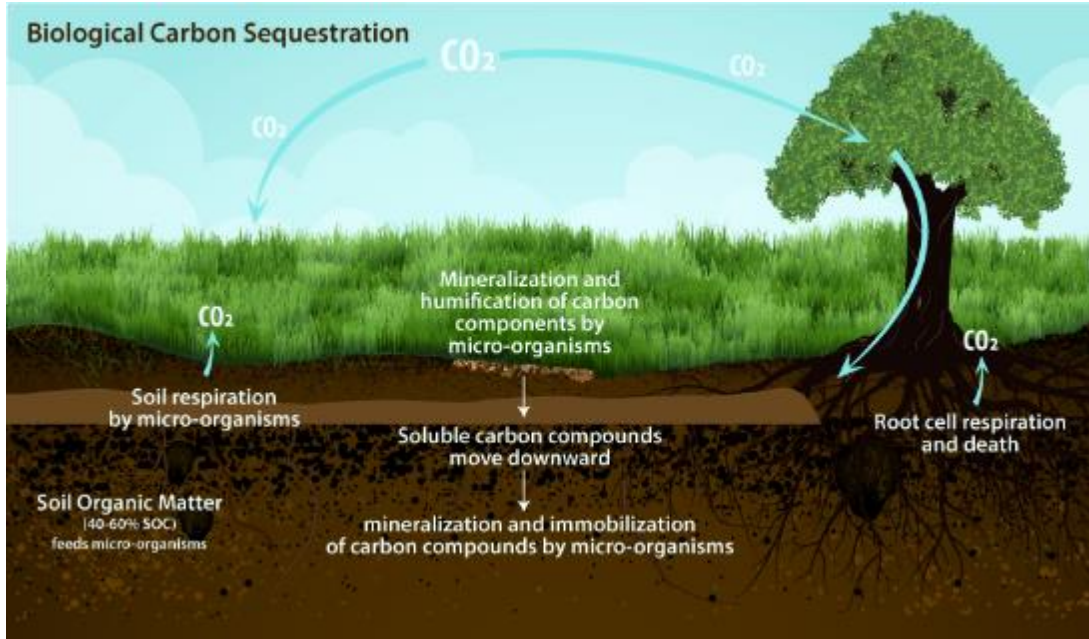
Ecosystem Services of KHG

Provisioning Services	Regulating Services	Cultural Services	Supporting Services
Fruit & Vegetable	Carbon- sequestration	Benefit Sharing	Habitat for Flora and Fauna
Spices	Flood Control	Sacrifices	Nutrient Cycling
Medicine	Micro Climate Regulation	Pride & Pleasure	Nutrient Dispersal
Staple Food	Maintaining Water Quality	Aesthetic	Seed Dispersal
Timber	Reduction of Soil Erosion	Employment	
Fodder	Pest and Disease Control	Marinating Social Status	
Livestock Products			

Provisioning Services from KHG



Regulating Services



Cultural Services

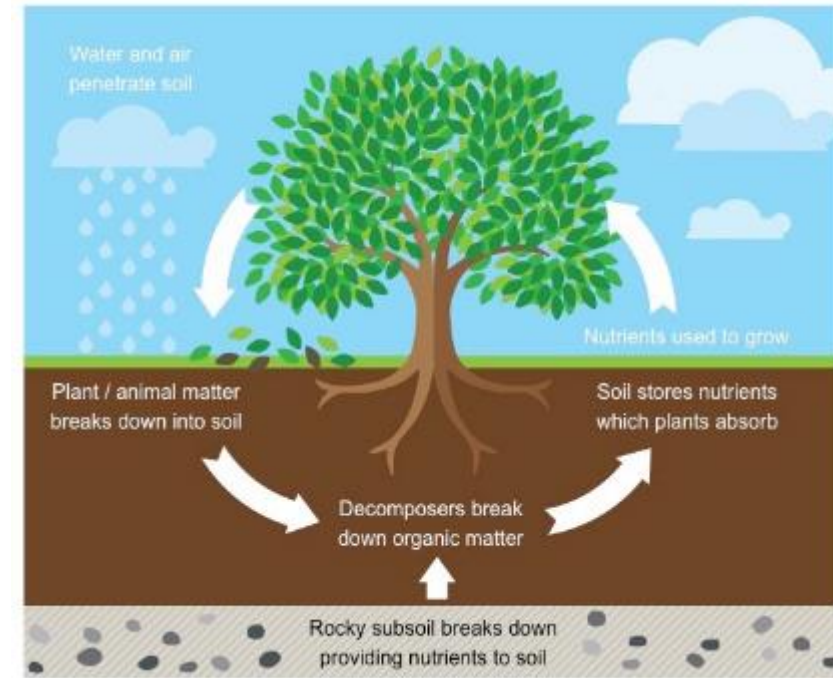


Supporting Services

Habitat for Flora and Fauna



Nutrient Cycling



Seed Dispersal

How Seeds Travel

by the wind



by animals



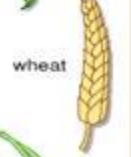
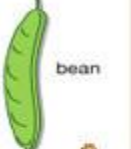
by water



by bursting



by humans



Fauna in KHG



Flora



Butterflies

- 245 species of butterflies in Sri Lanka
 - 21 are critically endangered
 - 38 are endangered and 40 are vulnerable.



Above ground Carbon Estimation in Kandyan Home Gardens Using Remote Sensing



Satellite Data

- Landsat ETM+ (2001), Landsat OLI (2013-2015)
- Geo-Eye (2012)
- SRTM DEM of 30m (digital elevation model)

Classification KHGs

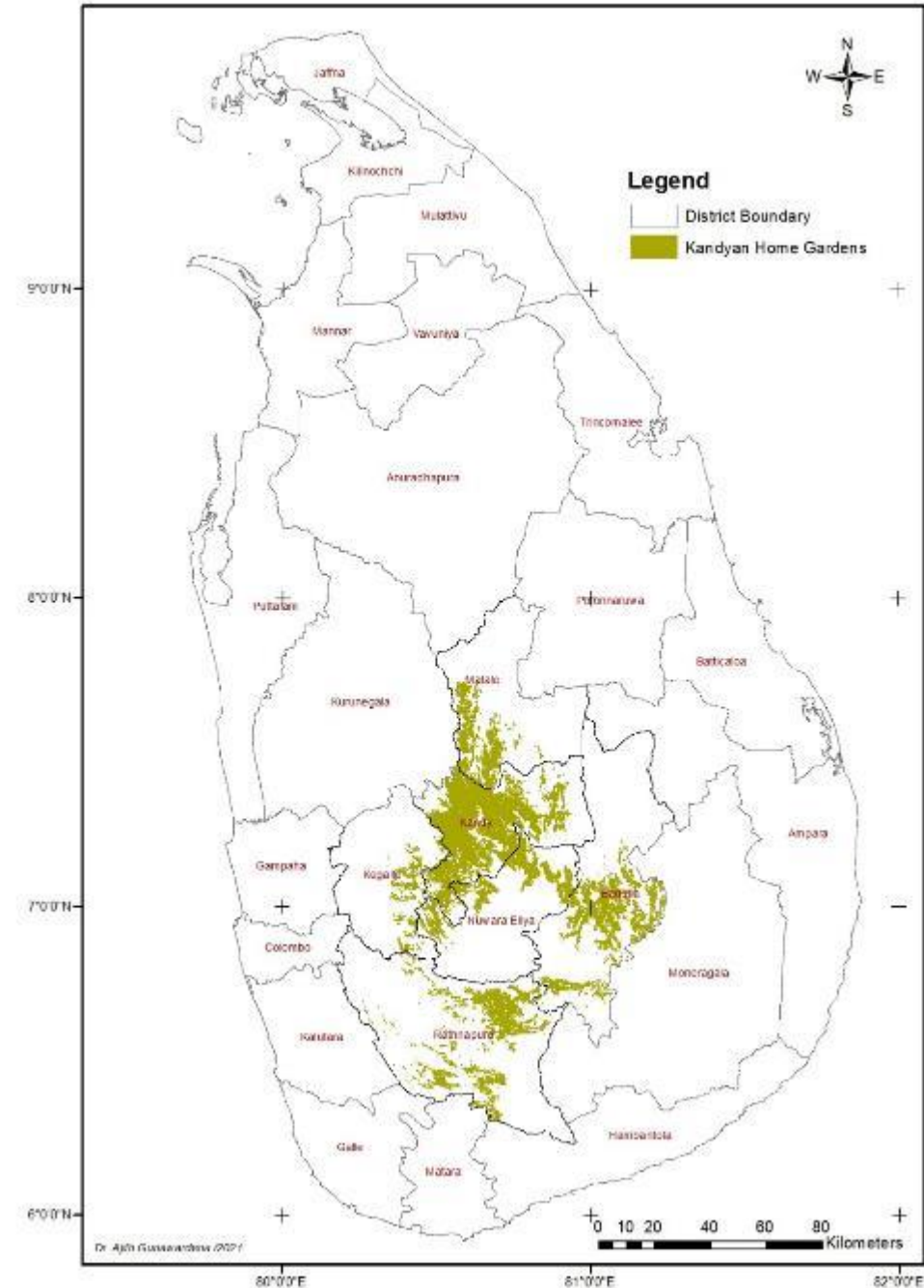
Landsat 8 OLI-derived NDVI has been used to classify the KHG 3 different strata as

- moderately dense
- dense
- high dense canopies.
- The overall accuracy of around 81 %
- 155 sampling locations through high-resolution
- Google Earth imageries.

Tree stand parameters

180 Sampling locations home gardens
in the Kandy and Kegalle Districts.

- The number of trees
- Canopy density
- DBH (Diameter of Brest Height)
- Total Tree Height
- Basal Area



Nine Allometric equations were derived to estimating of AGB in this study.

$$\text{AGB} = 13.2579 - 4.8945(\text{DBH}) + 0.6713(\text{DBH})^2 \text{ (Brown, 1989)}$$

$$\text{AGB} = 21.297022 - 6.952649 * (\text{DBH}) + 0.7403 * (\text{DBH})^2 \text{ (Brown \& Iverson, 1992)}$$

$$\text{AGB} = \exp(-2.23927 + 2.49596 * \ln(\text{DBH})) \text{ (Bao HUY et al., 2012)}$$

Observations, Results and Discussion

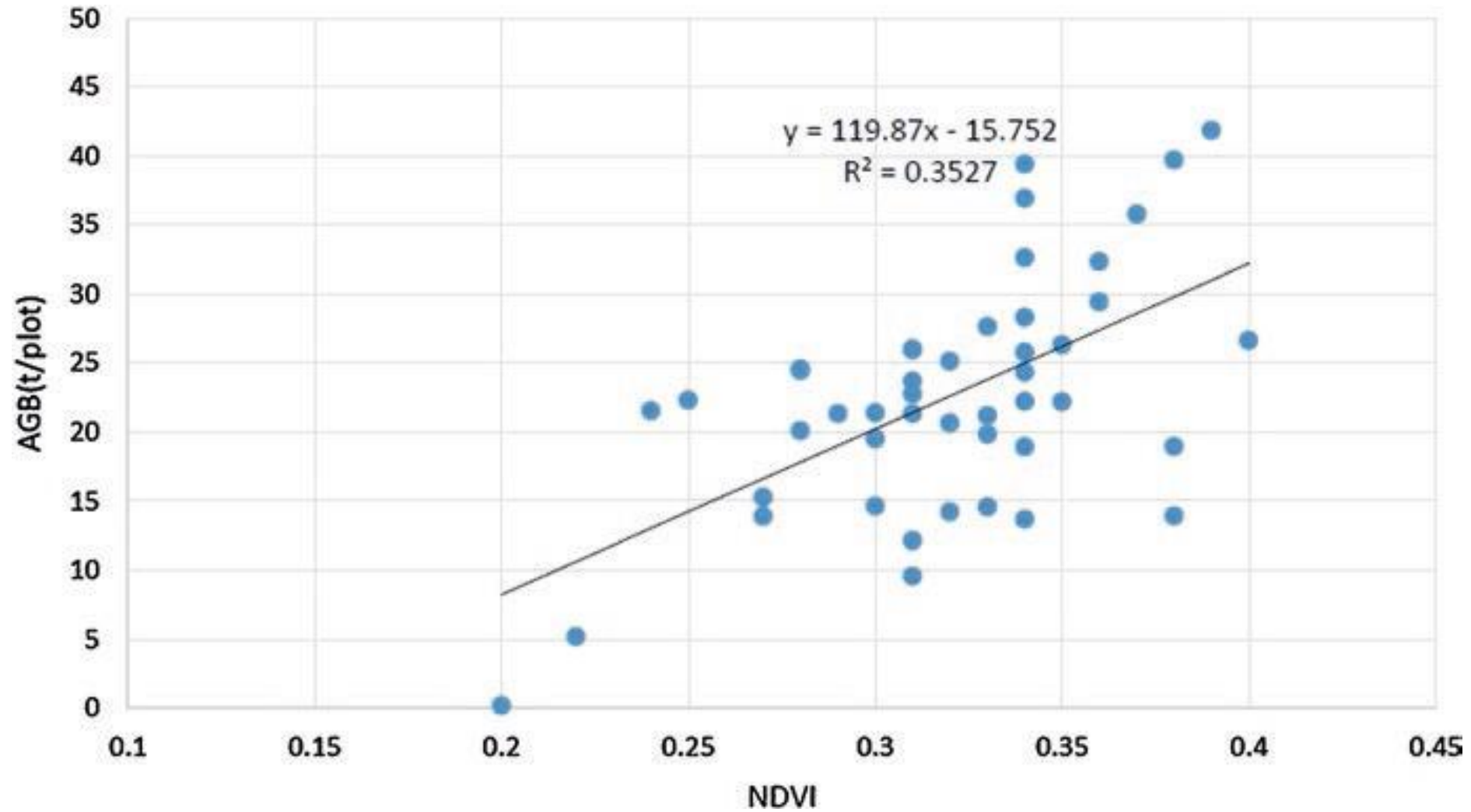
Spatial Distribution

- The extent (138,009 ha) and spatial distribution of the KHGS were identified
- The KFG system is practiced on various soil types

Soil

- Mainly in strong to weak lateritic soils
- Maintaining a high litter layer generated from the tree cover.
- Preventing surface runoff and minimize soil erosion
- The litter layer provides ideal habitats for microbes and small fauna

Relationship Between Biomass and the NDVI Derived with Landsat OLI Images

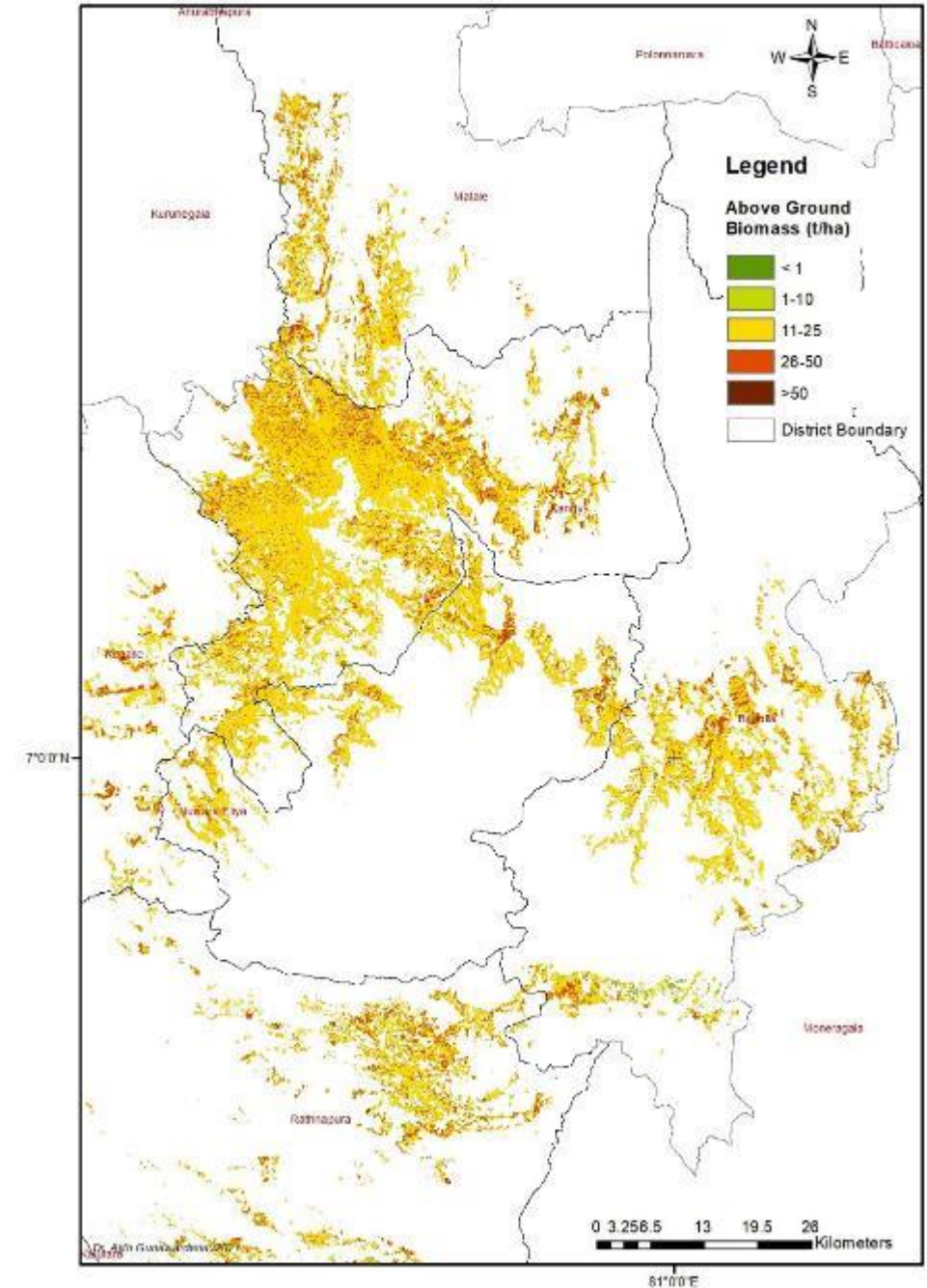


Estimated AGB of KHGs system in the Sri Lanka using Landsat OLI data

- A strong correlation was noted with NDVI in the KHG using the equation

$$AGB = 119.87 * NDVI - 15.752$$

- The average biomass through NDVI in average values of **48.6t/ ha**
- It is closer to the **field-based estimation** values of **52.2t/ha** in the study area.



Conclusions

- Very high biomass production and high Carbon sequestration
- Many Ecosystem Services
- Very Rich biodiversity
- Unique Cultural Values
- Proposal is process to “Declare KHG as World Heritage”

Thank You