

BioSpace25 - Biodiversity insight from Space  
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# Quantifying the functional trait variation across tropical forests with satellite data

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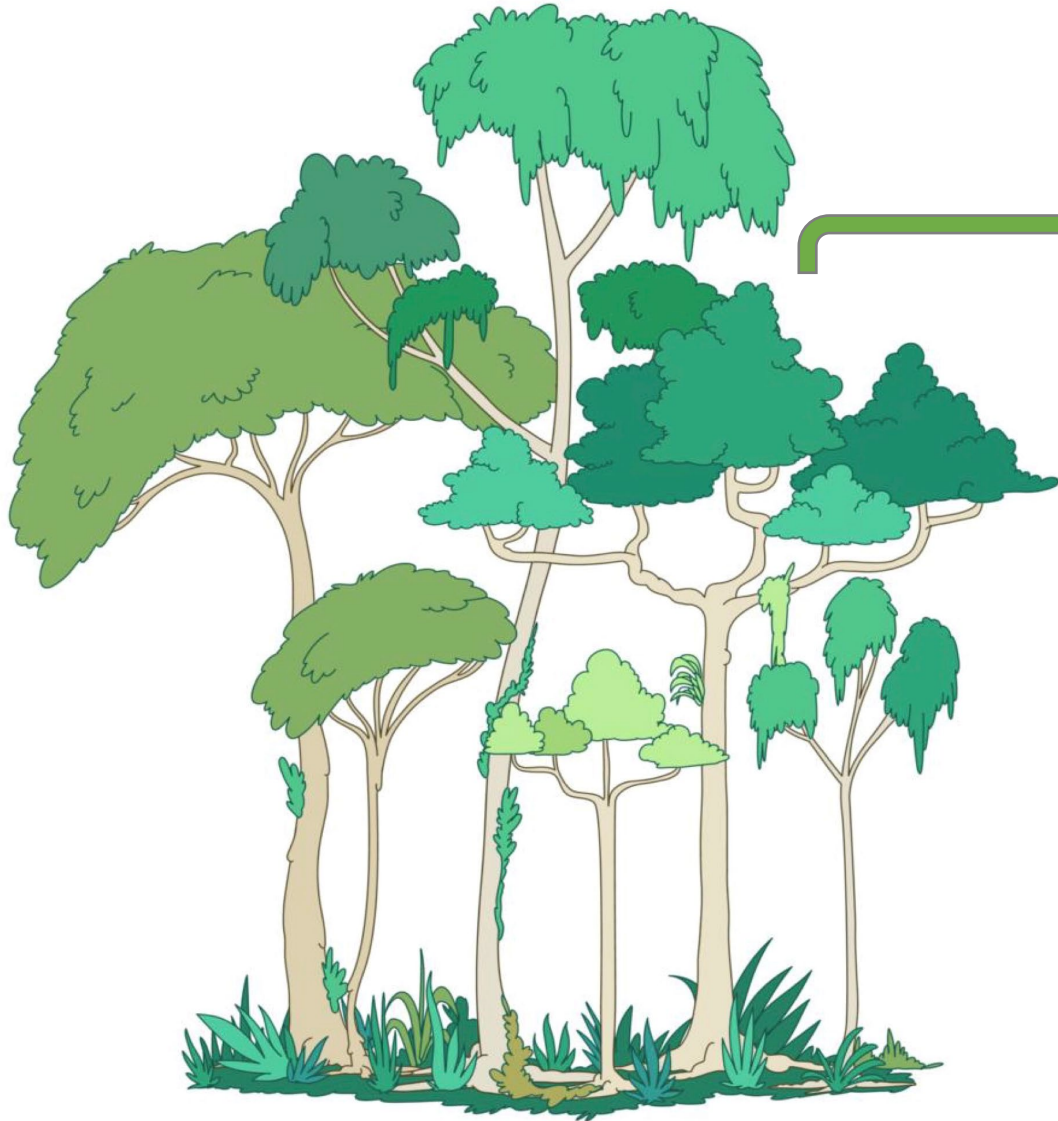
ESA UNCLASSIFIED - For ESA Official Use Only



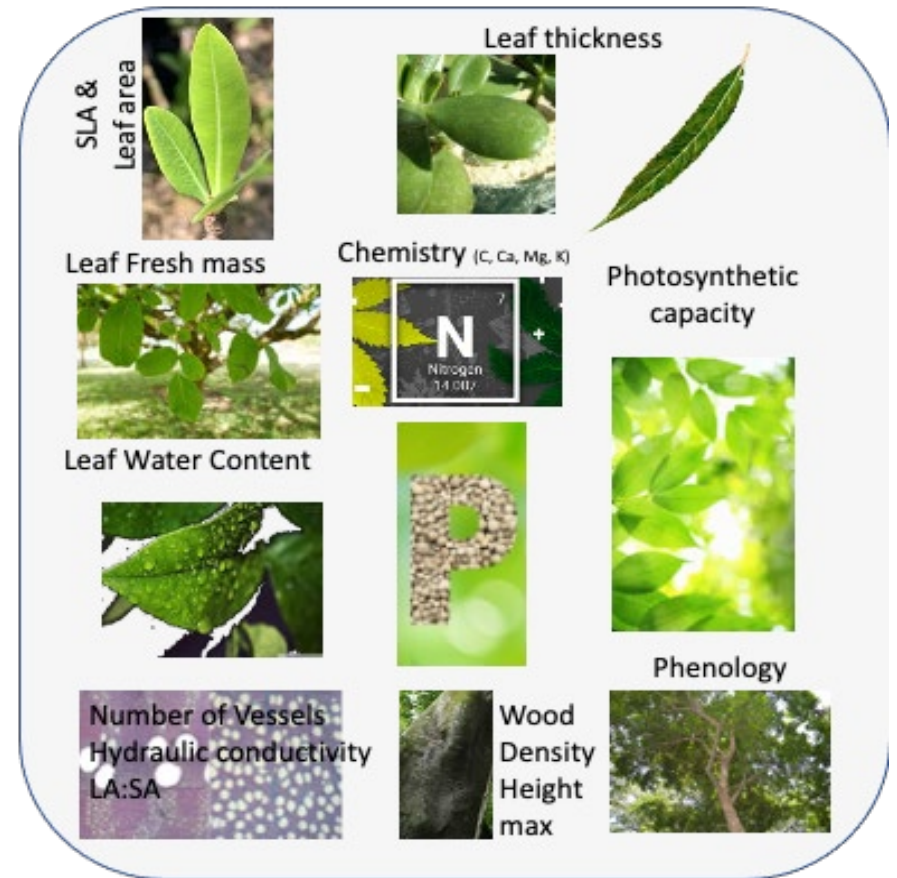
- Most diverse forests on Earth: up to 2/3 of the ~73,000 tree species found on Earth
- 80% of the world's known species found there
- Key ecological functions: carbon exchange, nutrient cycling, and the provision of water and energy
- Contributing to a billion people's livelihoods around the world
- What set of traits do tree species have that allow them to thrive in the current climate ?



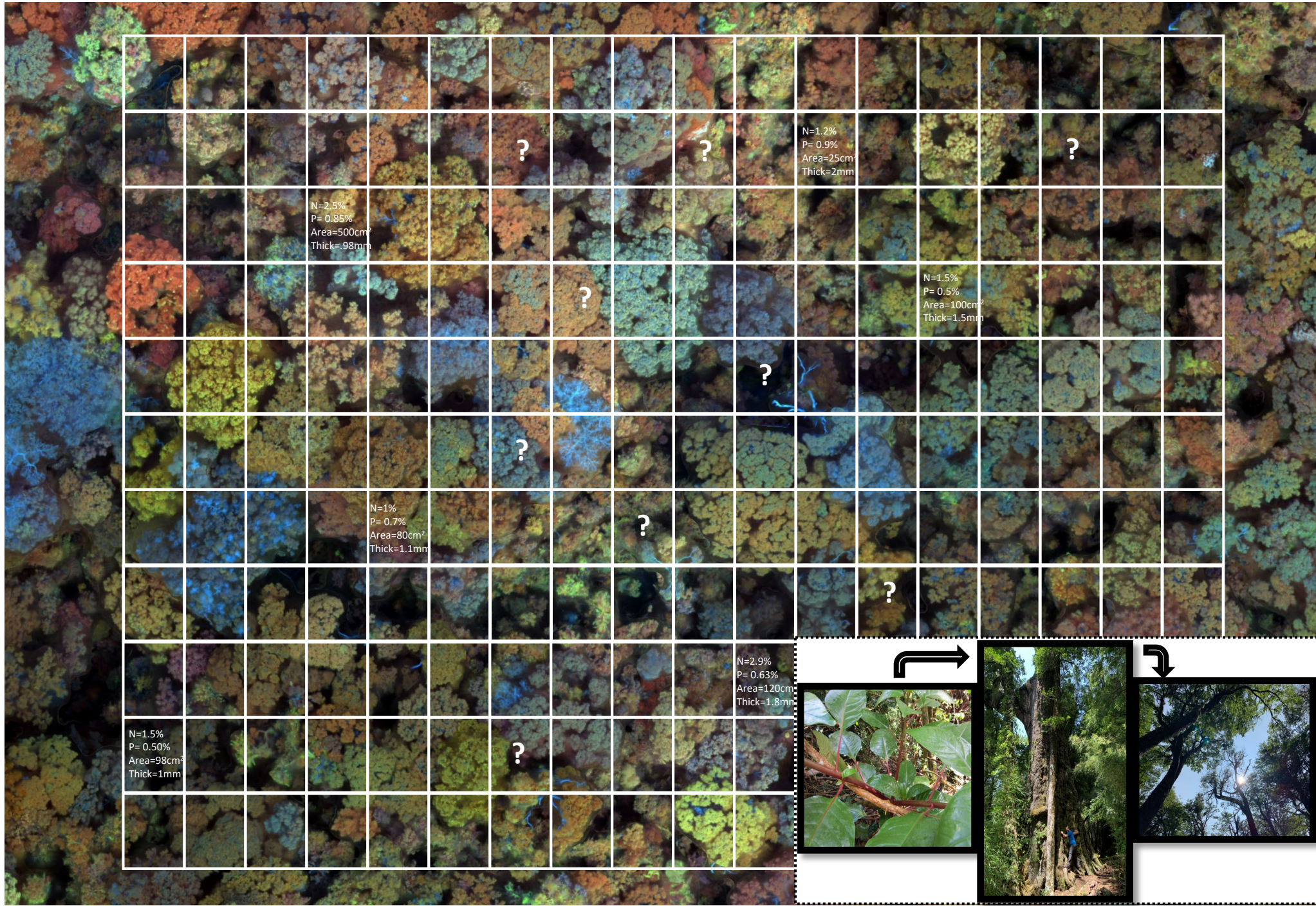
# Tree canopy traits



Functional traits underpin ecosystem functioning and responses to a changing environment



# Remote sensing of functional trait diversity and composition



# Questions



1

Can we map the pantropical distribution of canopy trees functional traits?

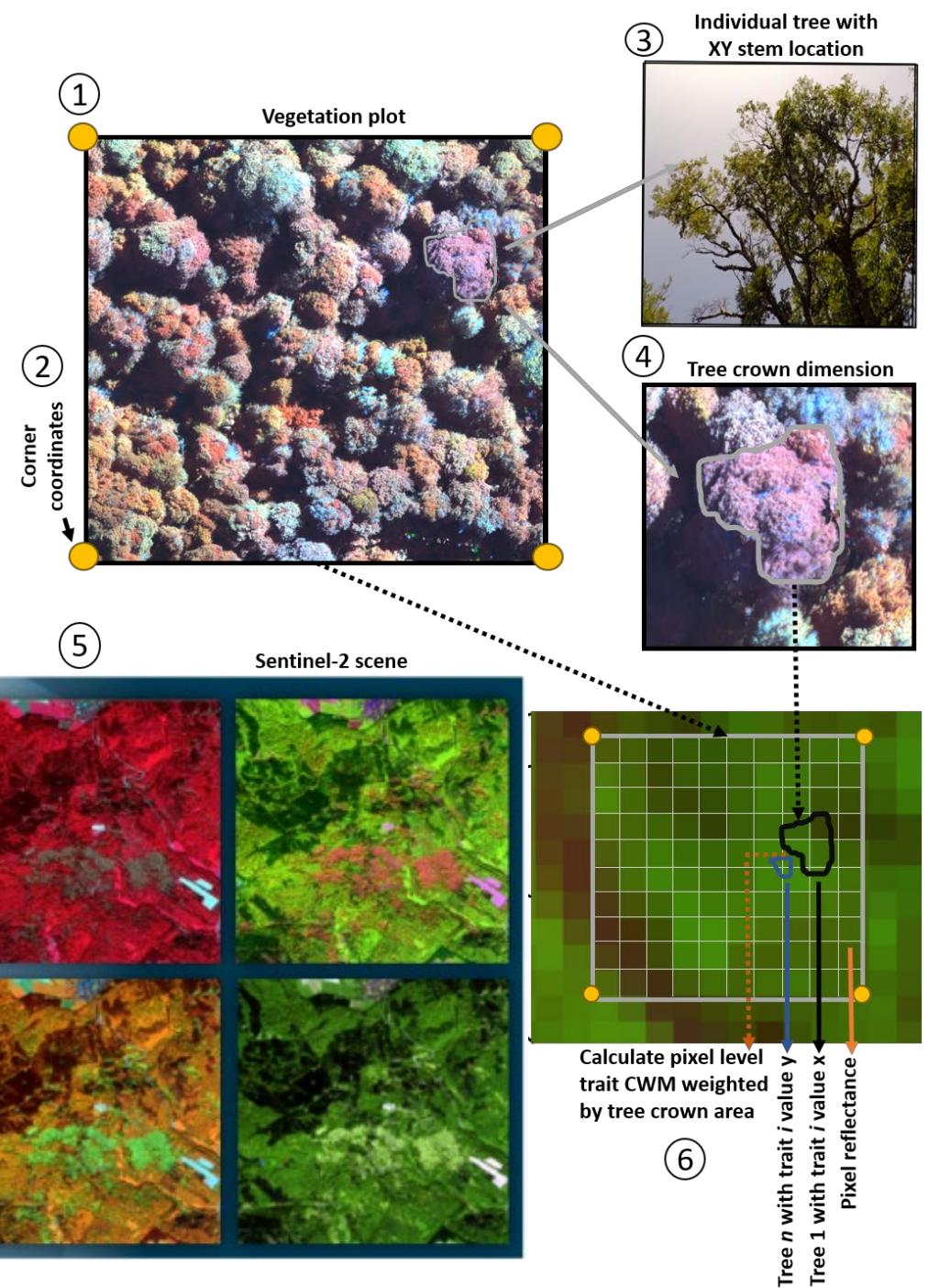
→ Based on optical 'types', nutrients and morphological traits can be mapped with spectral remote sensing at scale

2

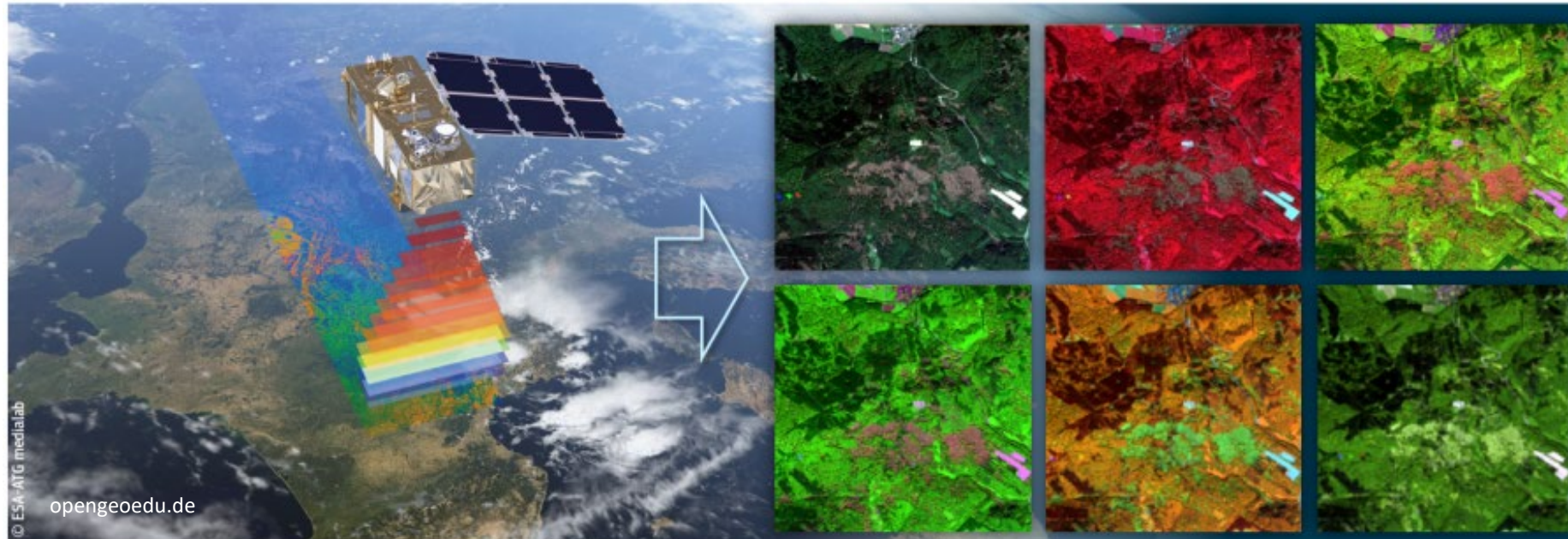
Do tropical American, African and Asian forest share the same Functional Richness and Divergence?

→ We expect tropical American forests to be functionally richer given to their higher species diversity and wide range of environmental conditions followed by African and Asian tropical forests

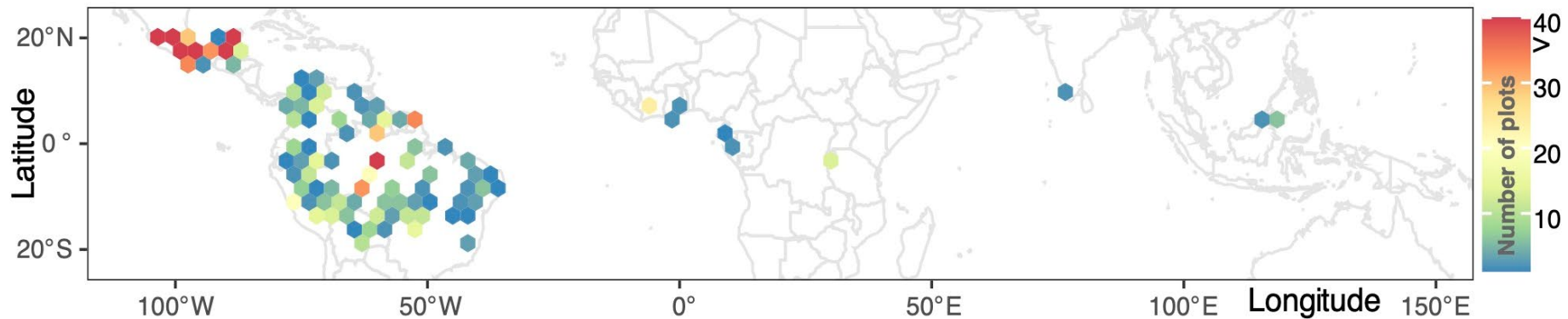
# Big data from the field and Satellites to map tree traits across tropical forests



## Sentinel-2 satellite data



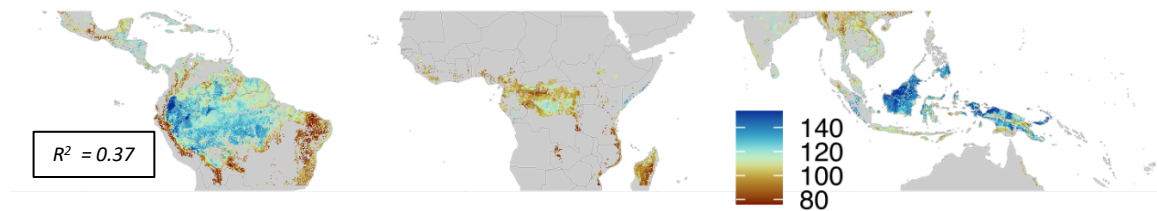
# Sampling locations



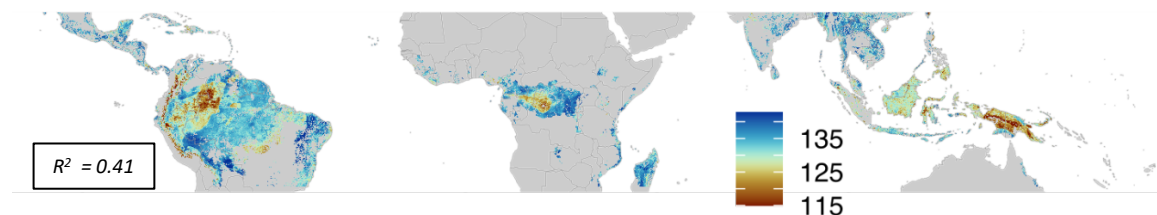
- 1814 permanent vegetation plots across
  - Spatially geo-located tree individuals
  - 18 countries in the four tropical continents
  - Coverage: 799.5 ha
- 
- Sentinel-2 Raw bands + Vegetation indices + Canopy Texture
  - Slope - Soil - Climate
  - Random Forest

## Leaf morphology and structure

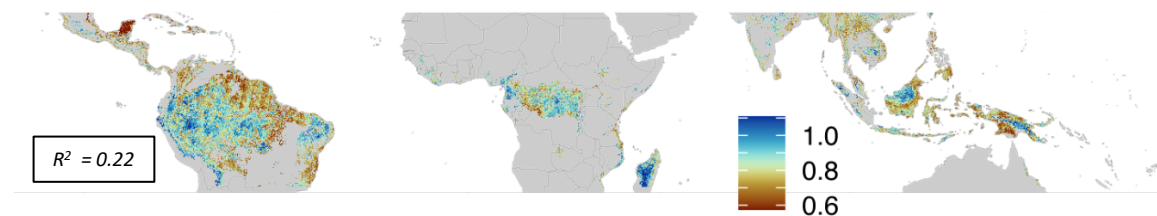
Area<sub>L</sub> (cm<sup>2</sup>)



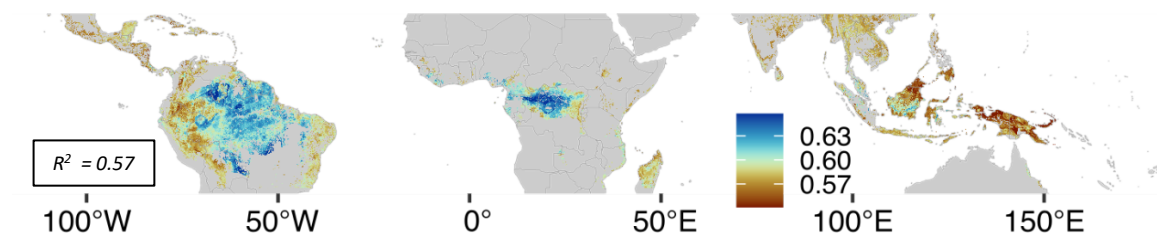
SLA (cm<sup>2</sup> g<sup>-1</sup>)



Thickness<sub>L</sub> (mm)

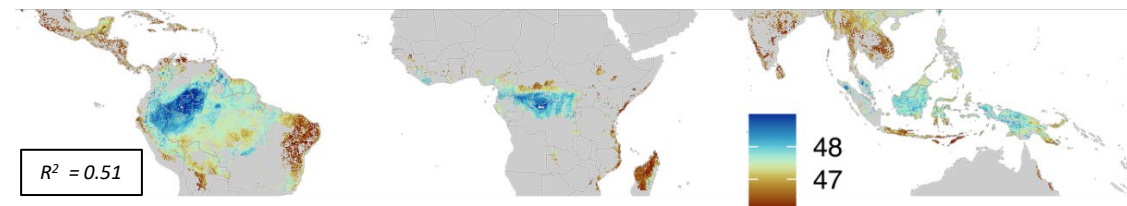


WD (g cm<sup>3</sup>)

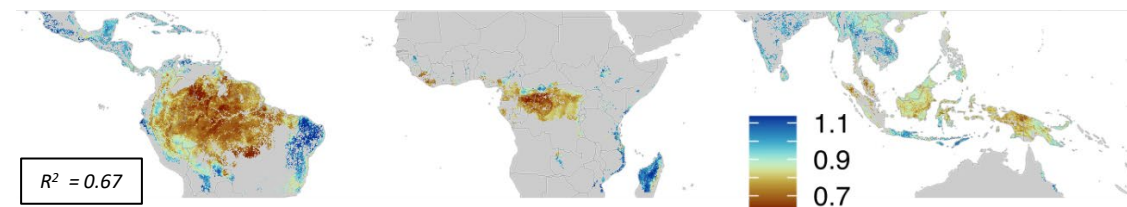


## Leaf chemistry

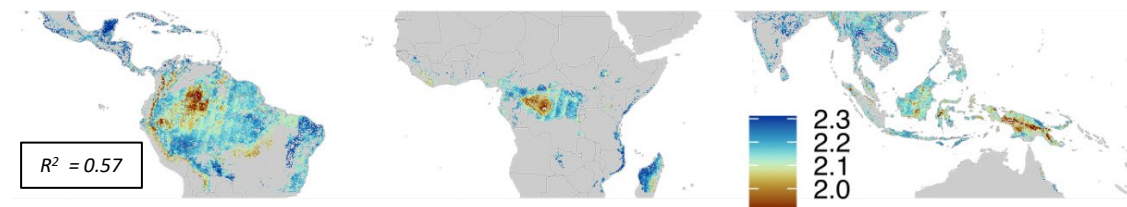
C<sub>L</sub> (%)



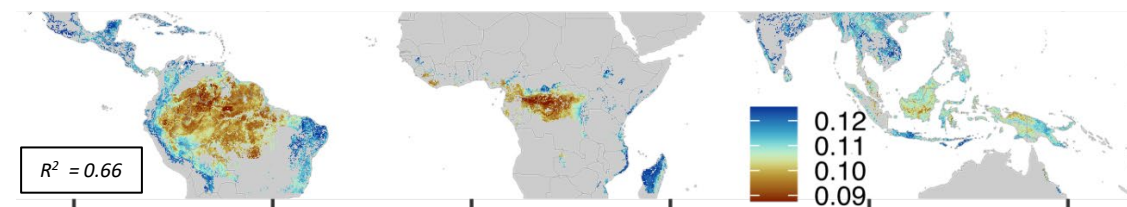
Ca<sub>L</sub> (%)



N<sub>L</sub> (%)



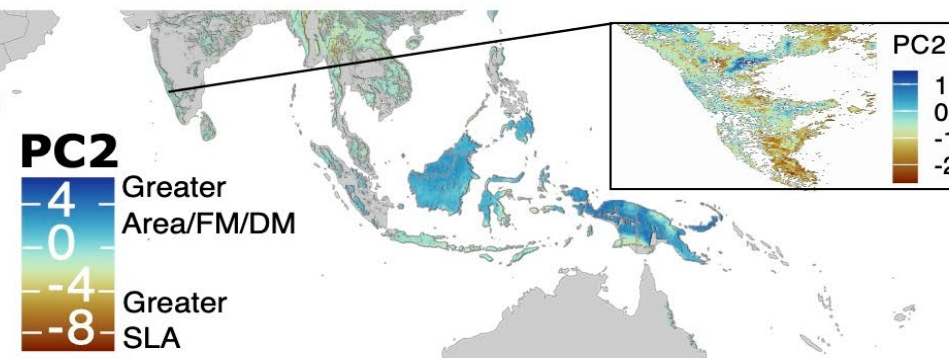
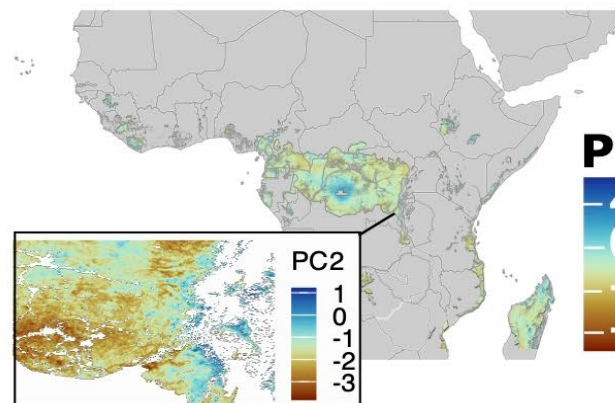
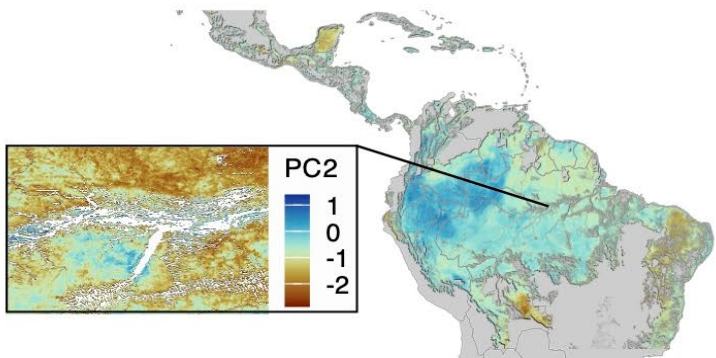
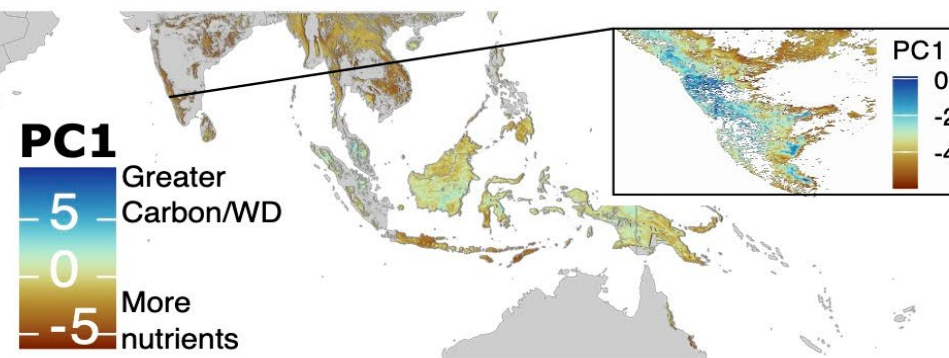
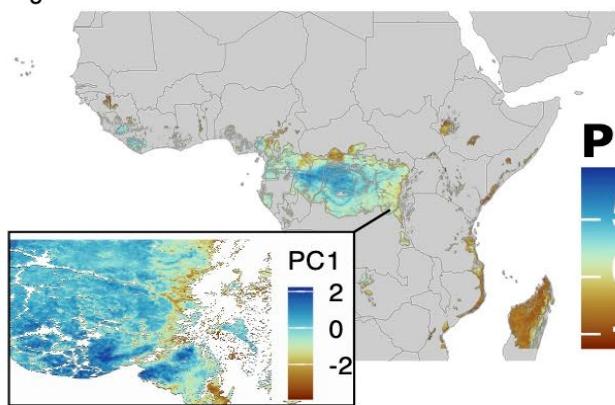
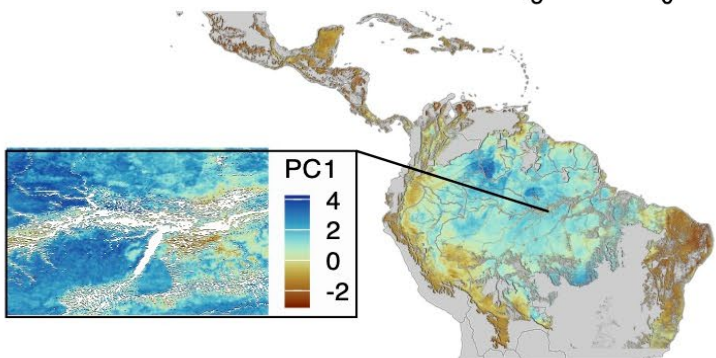
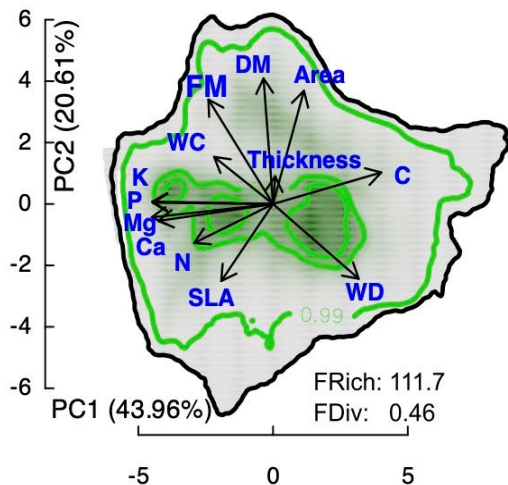
P<sub>L</sub> (%)



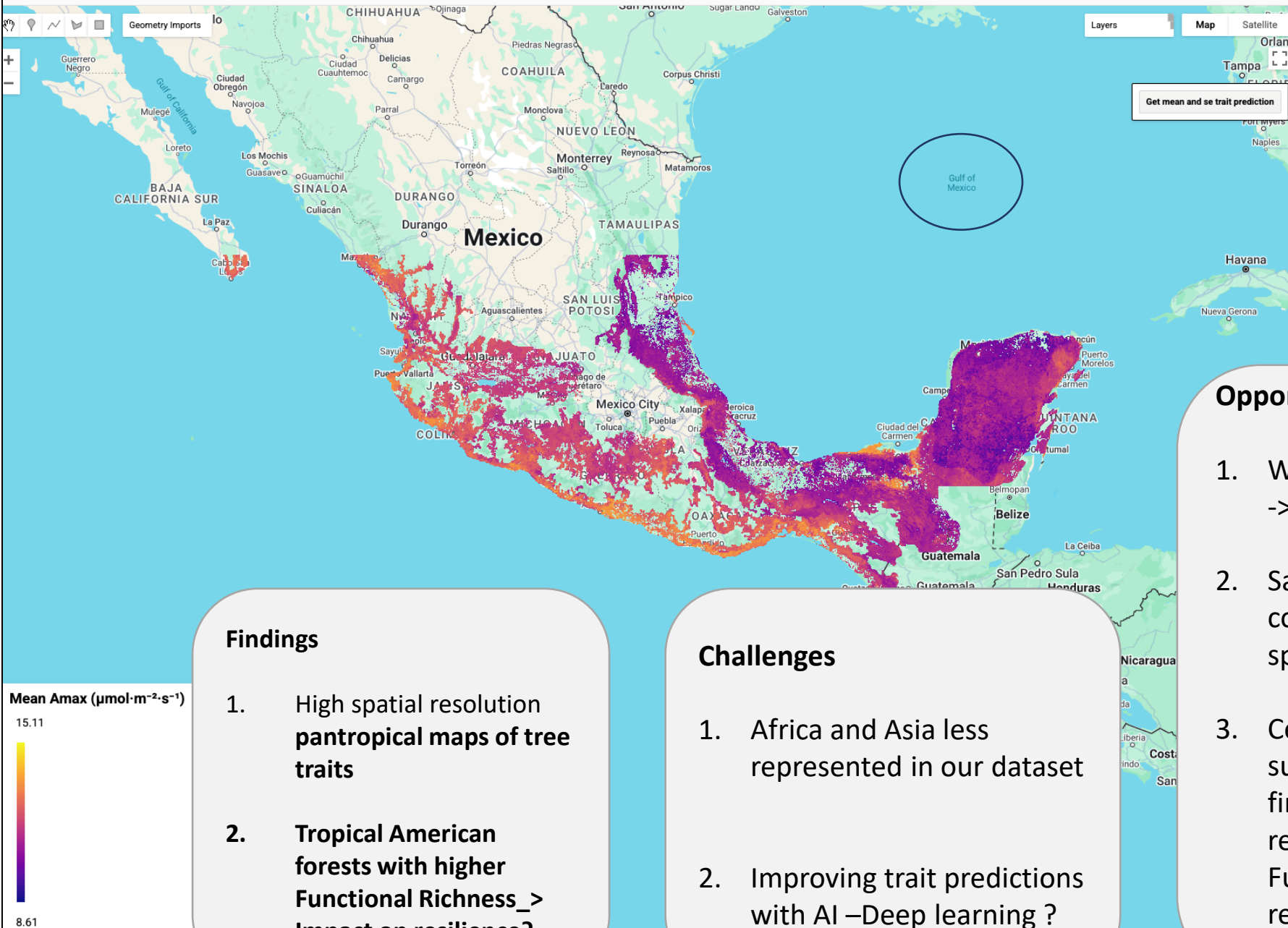


# Functional trait syndromes at scale

## Pantropical



Search places



**Canopy functional trait variation across Earth's tropical forest biome**

Published by Jesús Aguirre-Gutiérrez, Sami Rifai, Xiongjie Deng et al.

This Google Earth Engine application allows users to visualise and export functional trait maps from tropical forest biomes worldwide. It provides an interactive interface for selecting specific functional traits including morphology, nutrients, and photosynthesis. Users can define their region of interest, select desired traits, and adjust export settings including resolution and projection for customised raster outputs. After configuring the export parameters, users can click the 'Generate trait download link' button, and a blue download link will appear below the button. By clicking this link, users can download a .zip file named Trait\_full.zip to their computer. After unzipping, the folder will contain two .tif files: Trait\_full.b1.tif and Trait\_full.b2.tif, corresponding to the mean trait map and the standard error map, respectively.

**Region of interest selection:**

Mexico

**Trait selection:**

Amax (µmol·m<sup>-2</sup>·s<sup>-1</sup>)

**Projection selection (type into the projection):**

Get mean and se trait prediction

**Findings**

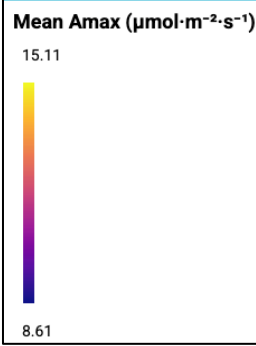
1. High spatial resolution pantropical maps of tree traits
2. Tropical American forests with higher Functional Richness\_> Impact on resilience?

**Challenges**

1. Africa and Asia less represented in our dataset
2. Improving trait predictions with AI –Deep learning ?

**Opportunities**

1. We need more trait field data -> Africa and Asia
2. Satellite sensors that combine higher spatial and spectral resolution
3. Central platforms that support depositing and 'easy' finding of 'Biodiversity' related spatial products (e.g. Functional diversity maps) resulting from remote sensing approaches





Get in touch

Thank you!



John Fell Fund



Leverhulme Centre  
for Nature Recovery