Biodiversity: a Remote Sensing Perspective

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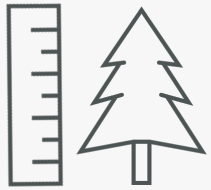
Biodiversity

Biodiversity is a broad concept that can be assessed through various variables such as Essential Biodiversity Variables (EBVs)[1].

Genetic composition

Species population



Species traits

Community composition

Ecosystem functioning

Ecosystem structure

[1] Pereira *et al.* 2013; Navarro *et al.* 2017

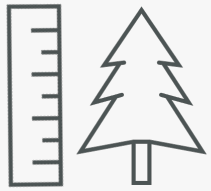
Biodiversity

- Genetic diversity (richness and heterozygosity)
- Genetic differentiation (number of genetic units and genetic distance)
- Effective population size
- Inbreeding

- Community abundance
- Taxonomic/phylogenetic diversity
- Trait diversity
- Interaction diversity

- Species distributions
- Species abundances

- Primary productivity
- Ecosystem phenology
- Ecosystem disturbances



- Morphology
- Physiology
- Phenology
- Movement
- Reproduction

- Land cover fraction
- Ecosystem distribution
- Ecosystem Vertical Profile

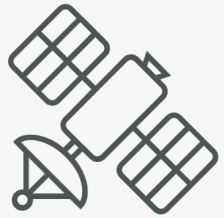
Measuring Biodiversity: Challenges

Wide range of variables to be measured

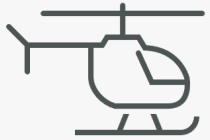
Shift from local to large scale (e.g., national)

Remote Sensing

Many of these variables can be measured directly or indirectly with remote sensing (RS) sensors.



Satellite

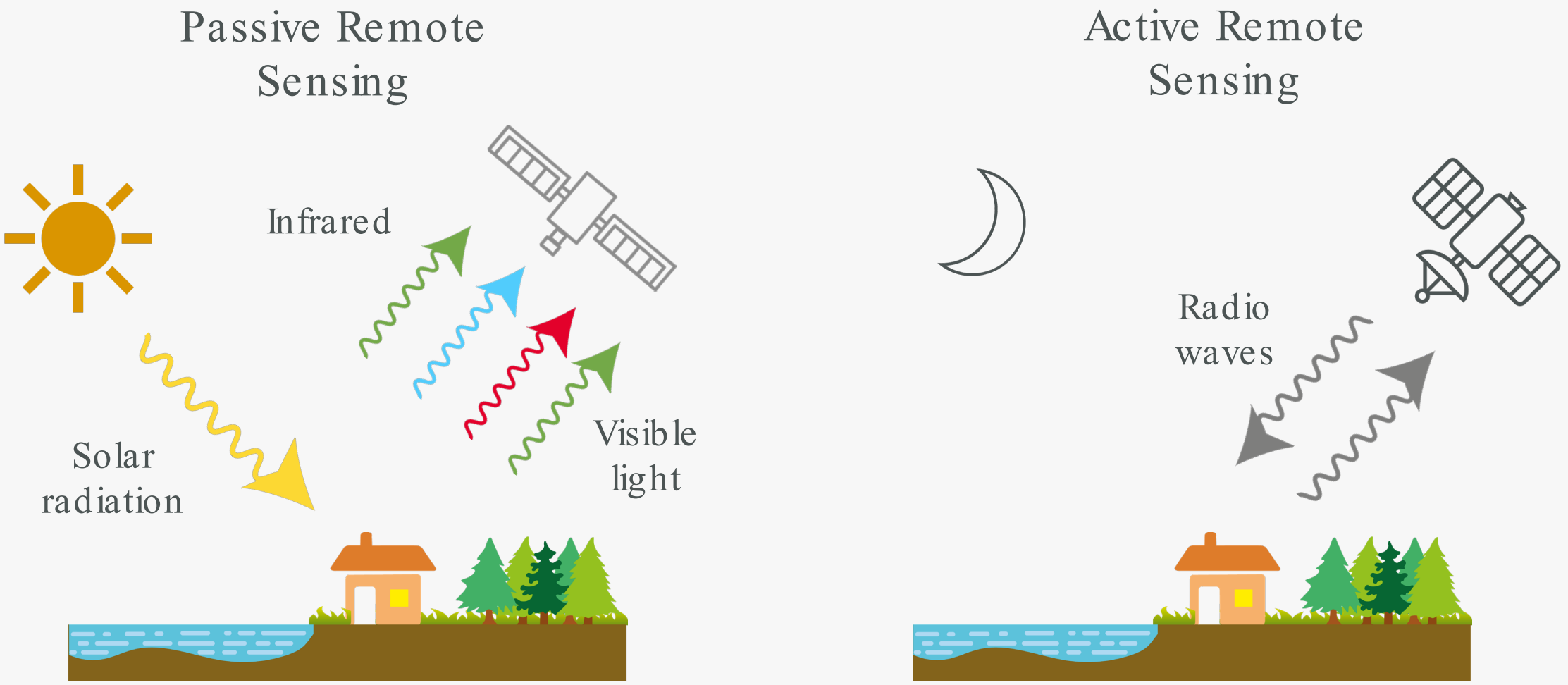


Helicopter/plane

Ground based

UAV

Remote Sensing: Passive and Active



Measuring Biodiversity with RS

- Genetic diversity (richness and heterozygosity)
- Genetic differentiation (number of genetic units and genetic distance)
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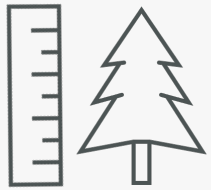

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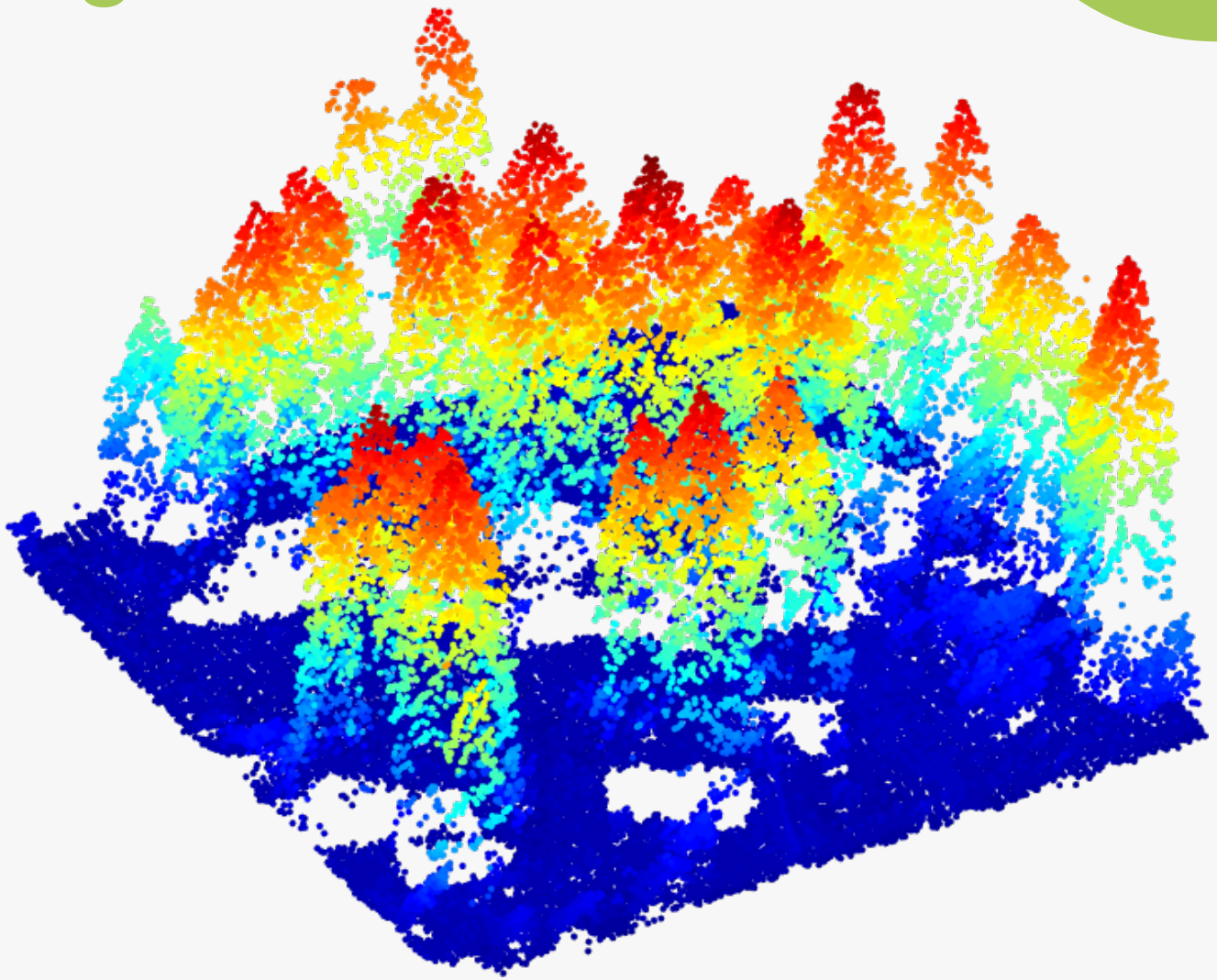
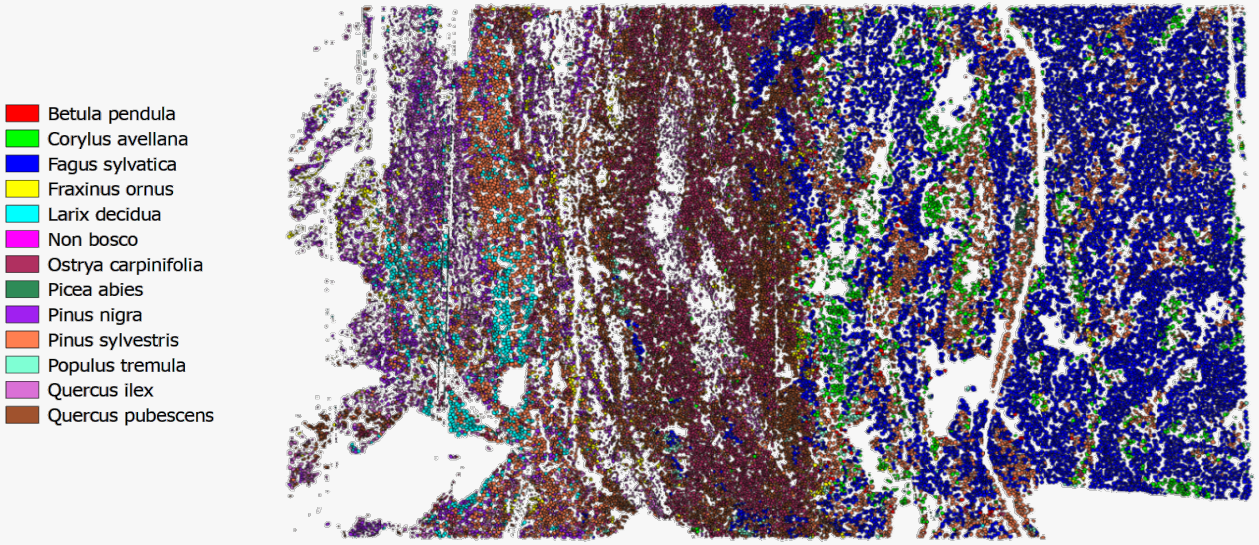
Active Remote Sensing: LiDAR

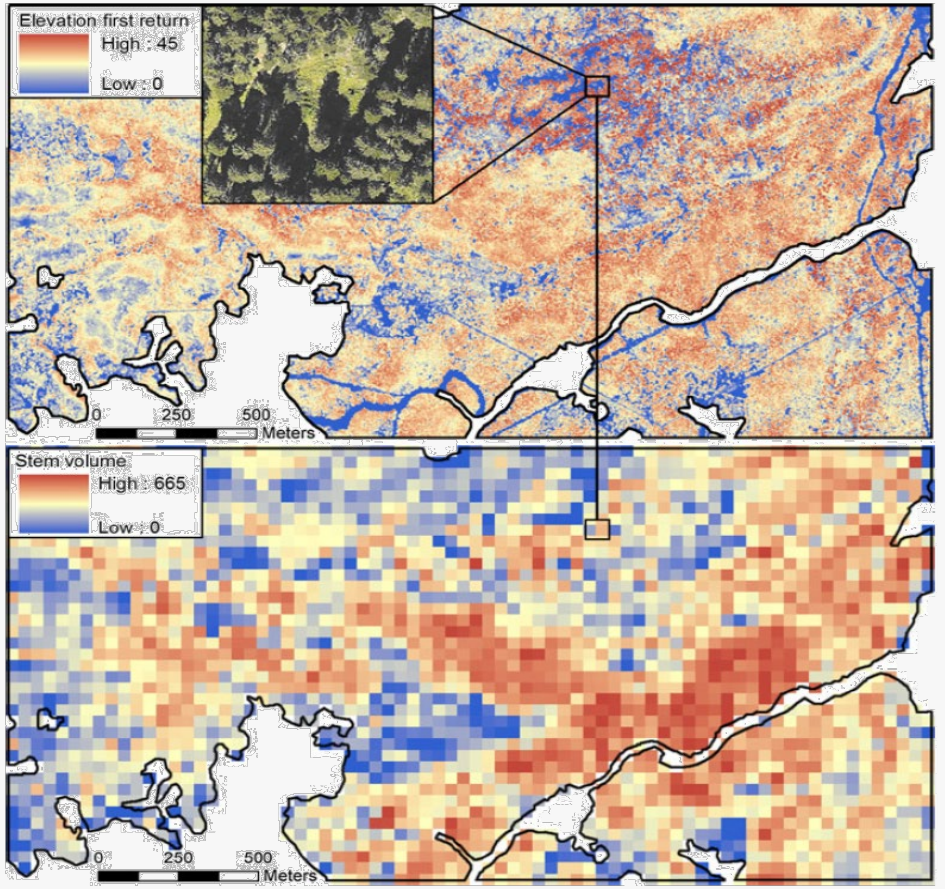
- Acquired from airborne platforms.
- Sensor emits laser pulses (up to 150 Khz) to measure the distance from the target.
- Generates a point cloud representing the 3D structure of the forest.



Tree Species Classification

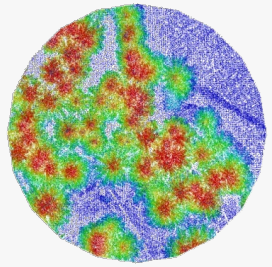
- **Objective** : Prediction of tree species, volume/biomass distribution.
- **Scale**: single tree and plot.
- **Remote sensing data** :
  - airborne hyperspectral
  - LIDAR





Forest Biodiversity at Individual Tree Level

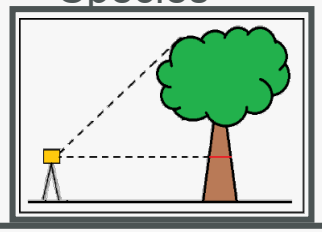
LiDAR data



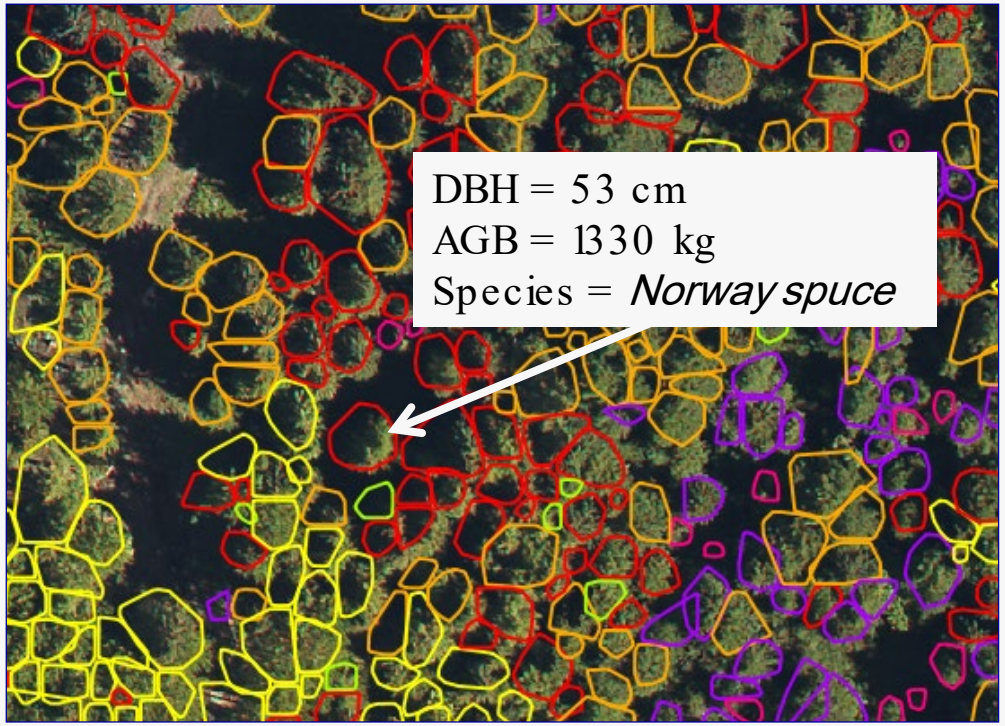
Sentinel-2 data

Field measurments

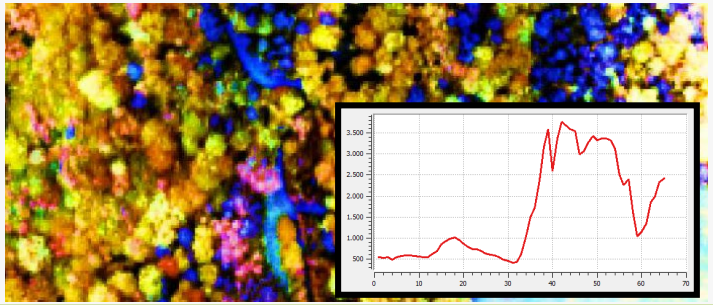
- Height
- DBH
- AGB
- Species

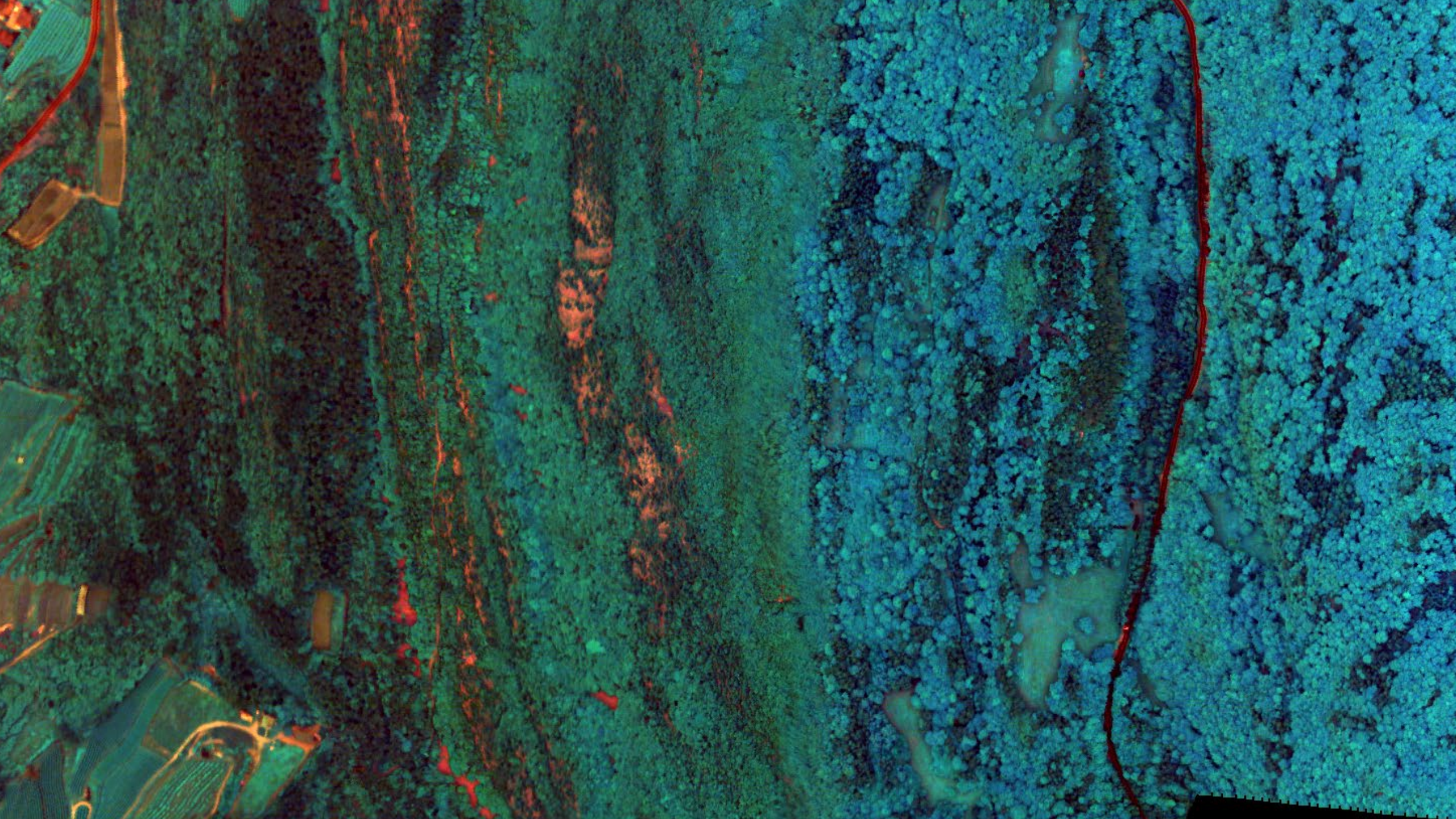


Definition of models based on machine learning to predict DBH, AGB, and species.



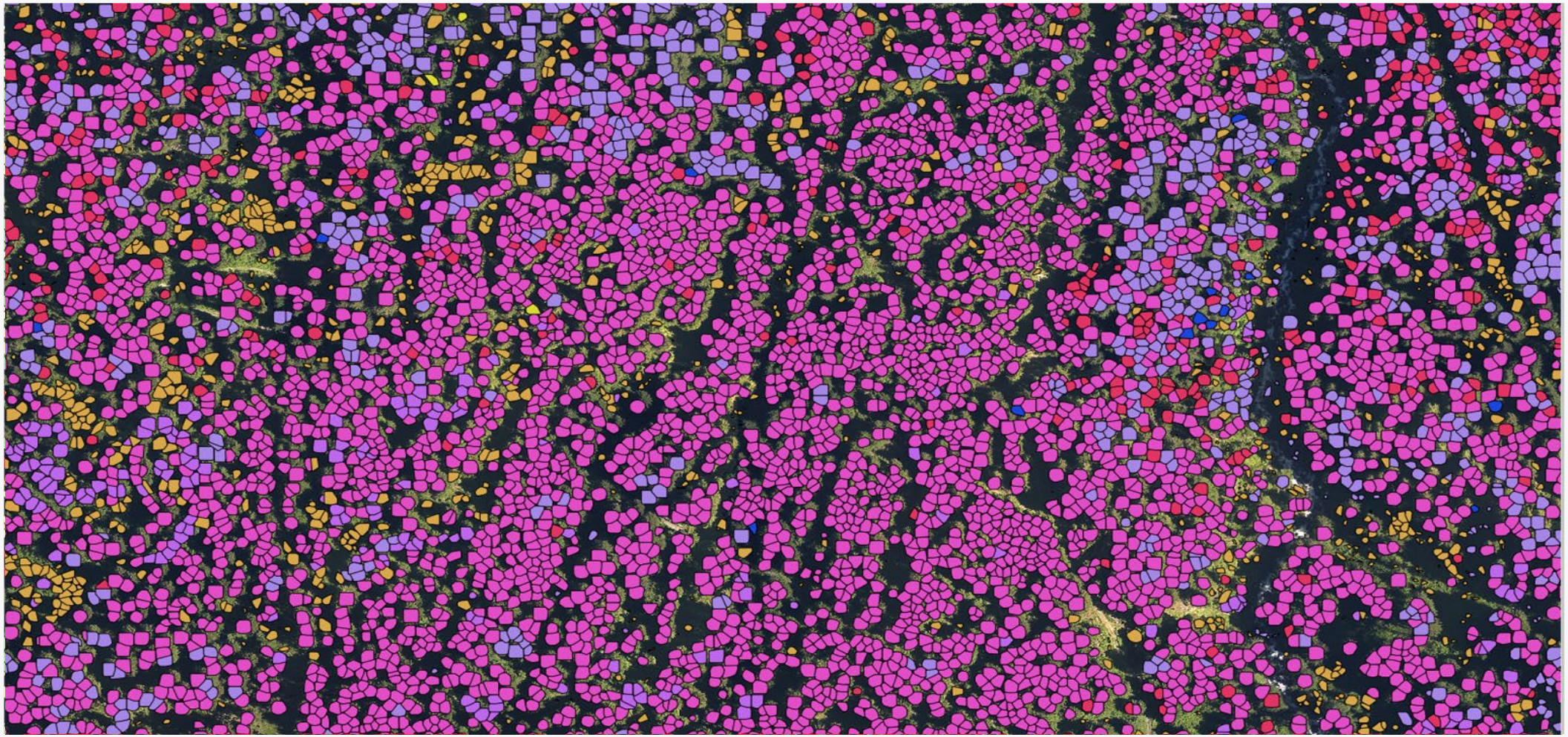
Hyperspectral data

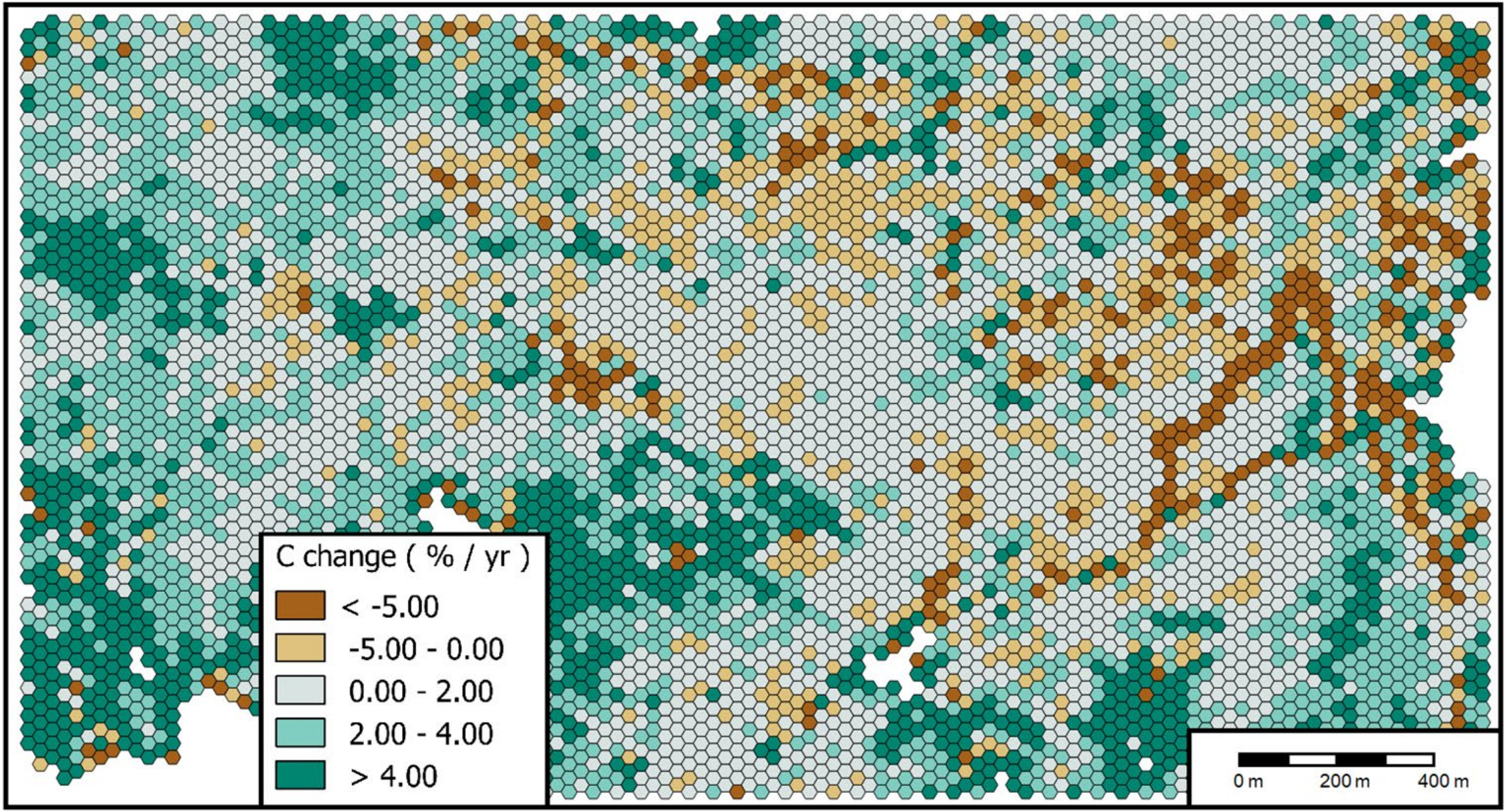




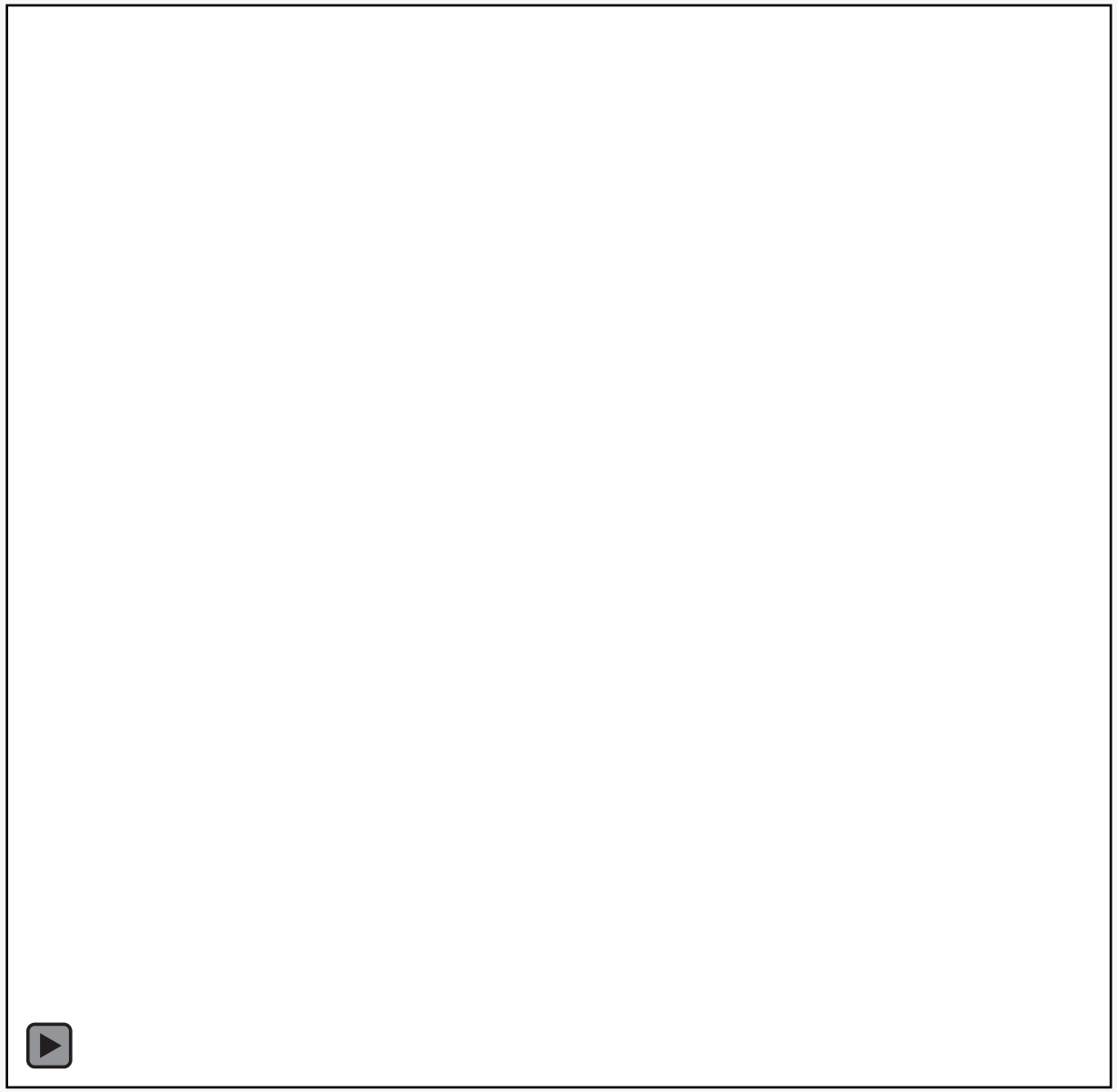
Tree Crown Level Forest Inventory

Aerial image classification

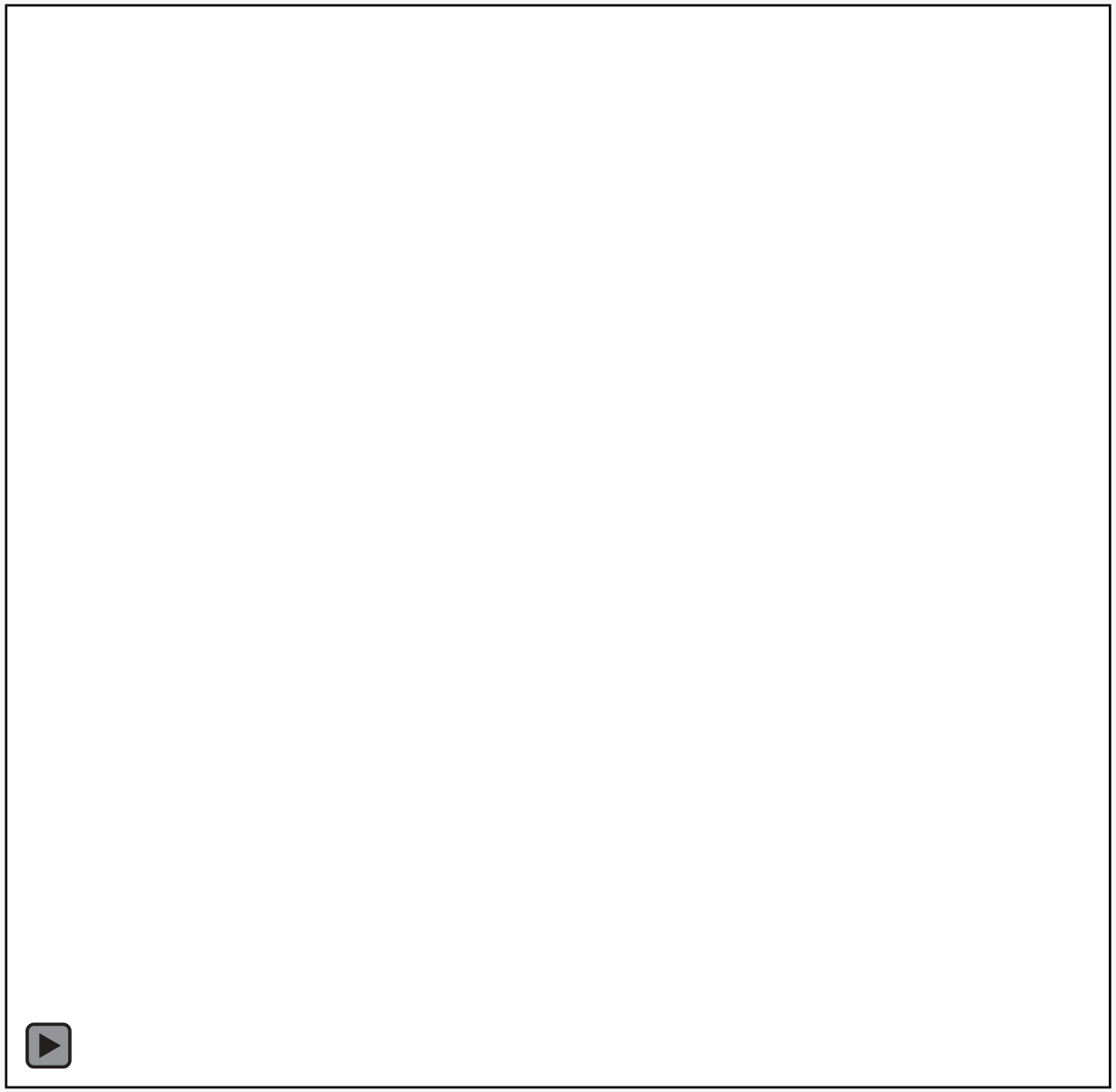




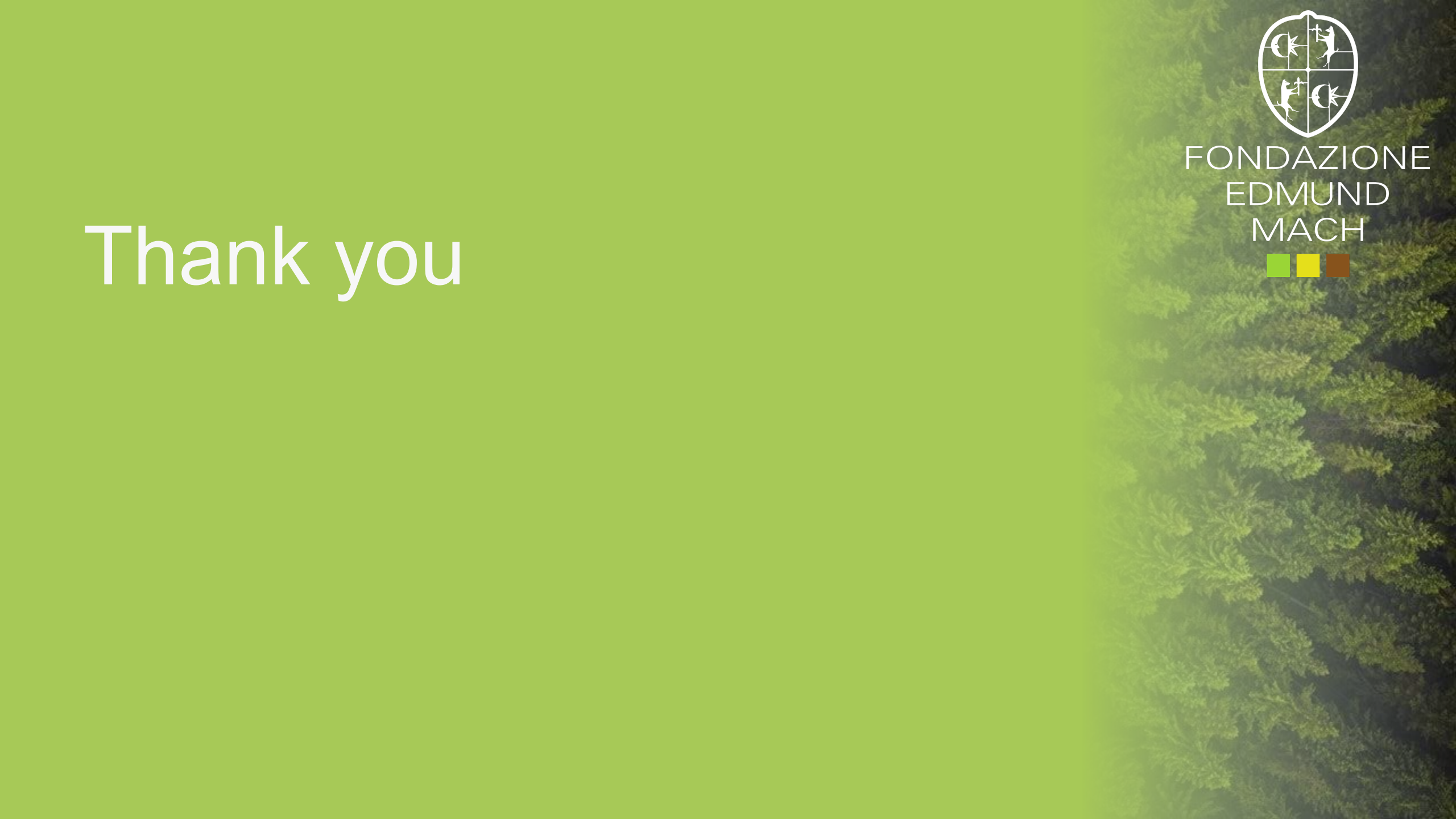
Carbon density change



Sentinel-2 RGB
Predazzo, TN (2020-2022)



Sentinel-2 Moisture Index
Low High

Thank you

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