



UNIVERSITY  
*of* SOPRON

FACULTY OF  
FORESTRY

# Overview of Remote Sensing and GIS Applications for Forest Monitoring

Part #2 - Kornél Czimber



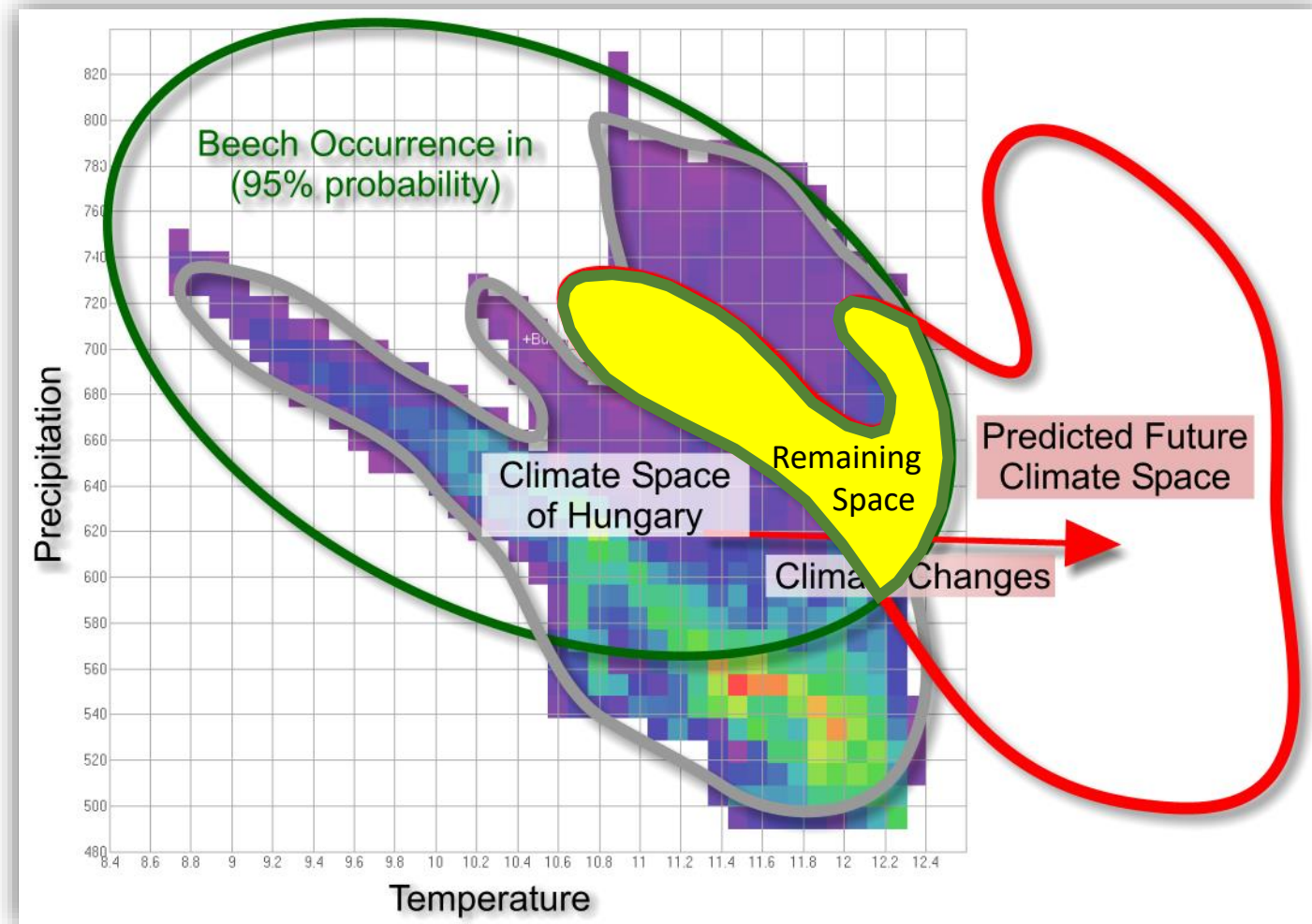
# Content

1. AgroClimate DSS
2. Object based Forest Mapping
3. Tree Species Mapping with CNN
4. IceSAT2 Application
5. Nationwide Airborne Laser Scanning
6. UAV based Forest Survey
7. Close range Photogrammetry Applications
8. SmartForest



# 1. AgroClimate DSS

- Decision Support System
- Spatial Database Integration
  - Past climate datasets
  - Forest database
  - Soil, hydrology datasets
  - 12 Climate Models
- Prediction of Future Forests
  - Tree species and their growth



### Agrárklíma Döntéstámogató Rendszer v2.16.10.20 Beta



**+ Háttér térképek**

**- Klímaterképek**

**Közelmúlt**  
Erdészeti klímazónák 1981-2010  
Adatforrás: OMSZ

**Jelen**  
Erdészeti klímazónák 2011-2040  
Adatforrás: Ensembles EU, A1B

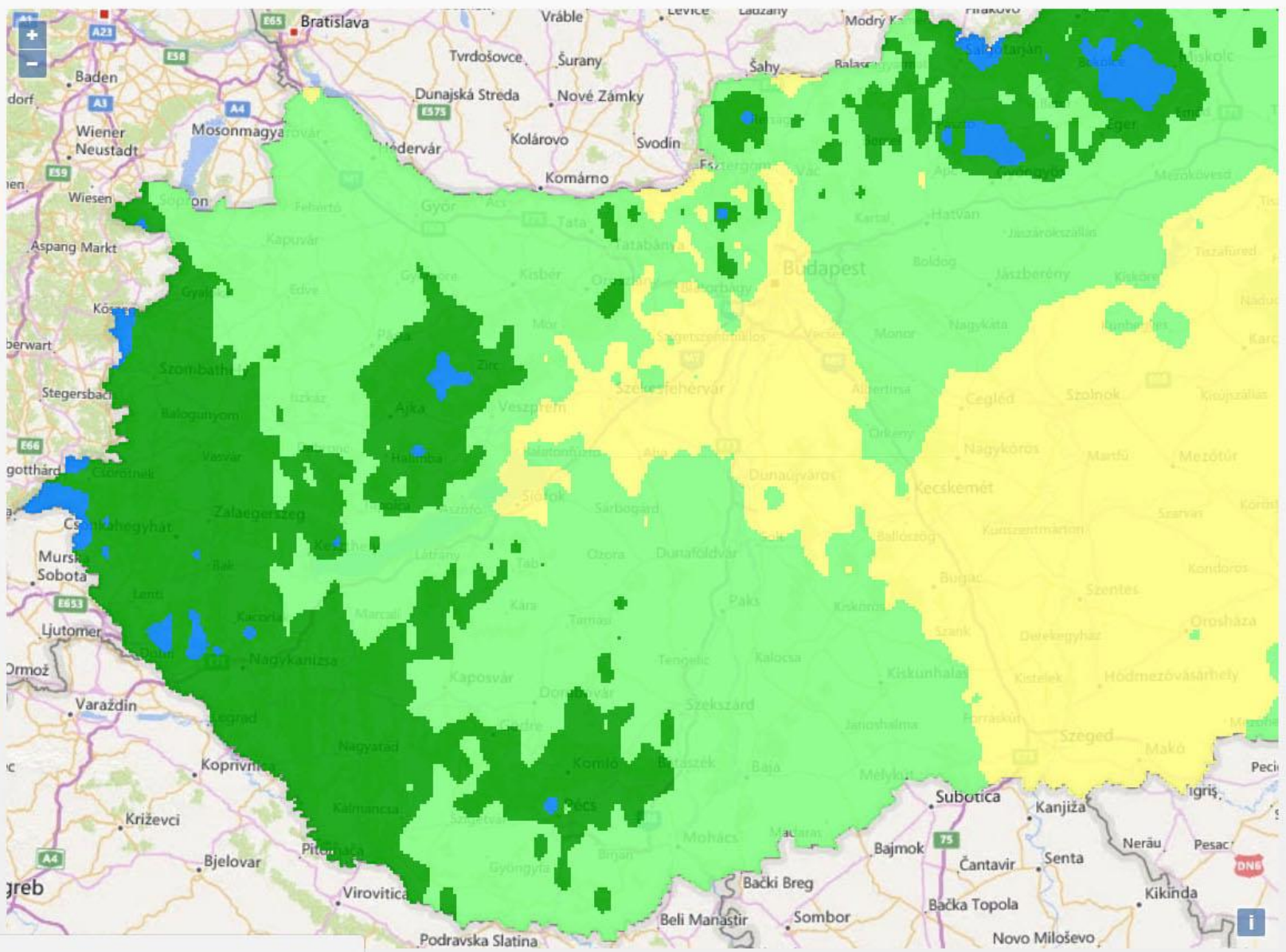
**Közeljövő**  
Erdészeti klímazónák 2041-2070  
Adatforrás: Ensembles EU, A1B

**Távoljövő**  
Erdészeti klímazónák 2071-2100  
Adatforrás: Ensembles EU, A1B

**+ Termőhelyi térképek**

**+ Kiegészítő térképek**

15



**+ Helyszín**

**- Klíma**

Időszak:  
**Közelmúlt 1981-2010**

Klíma:  
**1 B, Bükkös klíma**

Erdőterv:  
B

FAI átlag (optimista, pesszimista becslés):

**+ Hidrológia**

**+ Genetikai talajtípus**

**+ Fizikai talajféleség**

**+ Termőréteg vastagság**

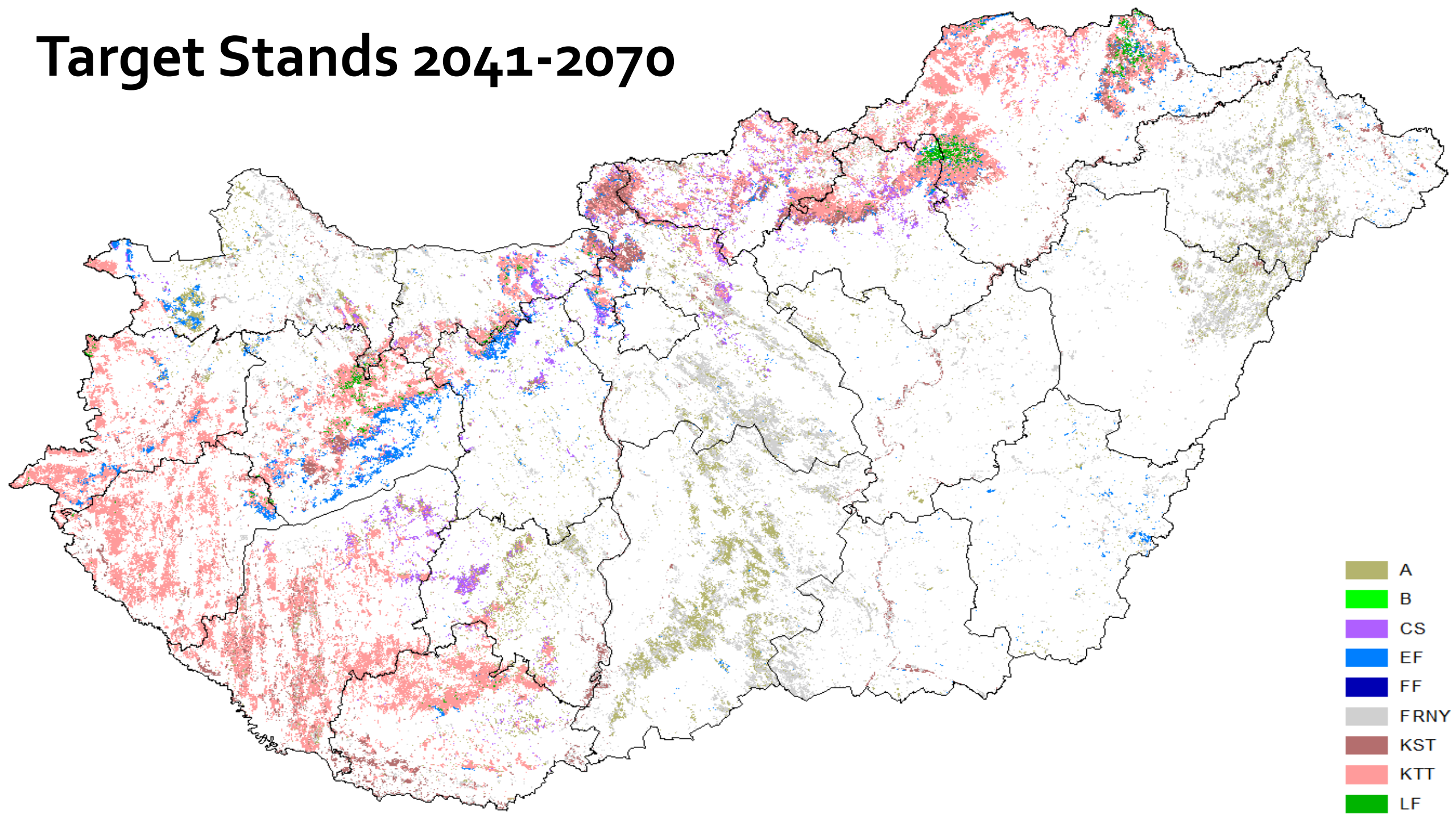
**- Céllállomány**

Főfafaj és növekedése:

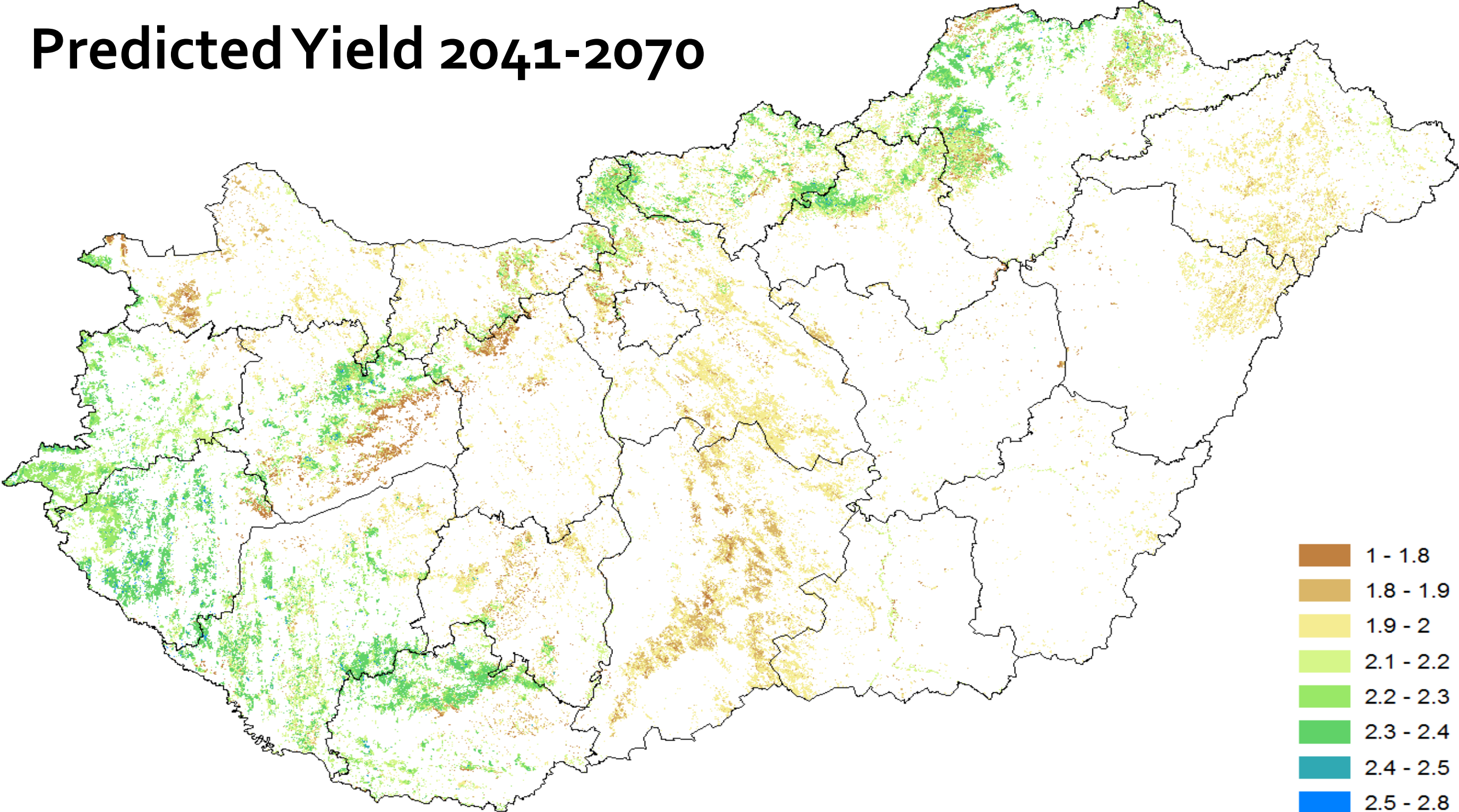
Elegyfafajok:

Termőhelytípus változat:

# Target Stands 2041-2070



# Predicted Yield 2041-2070

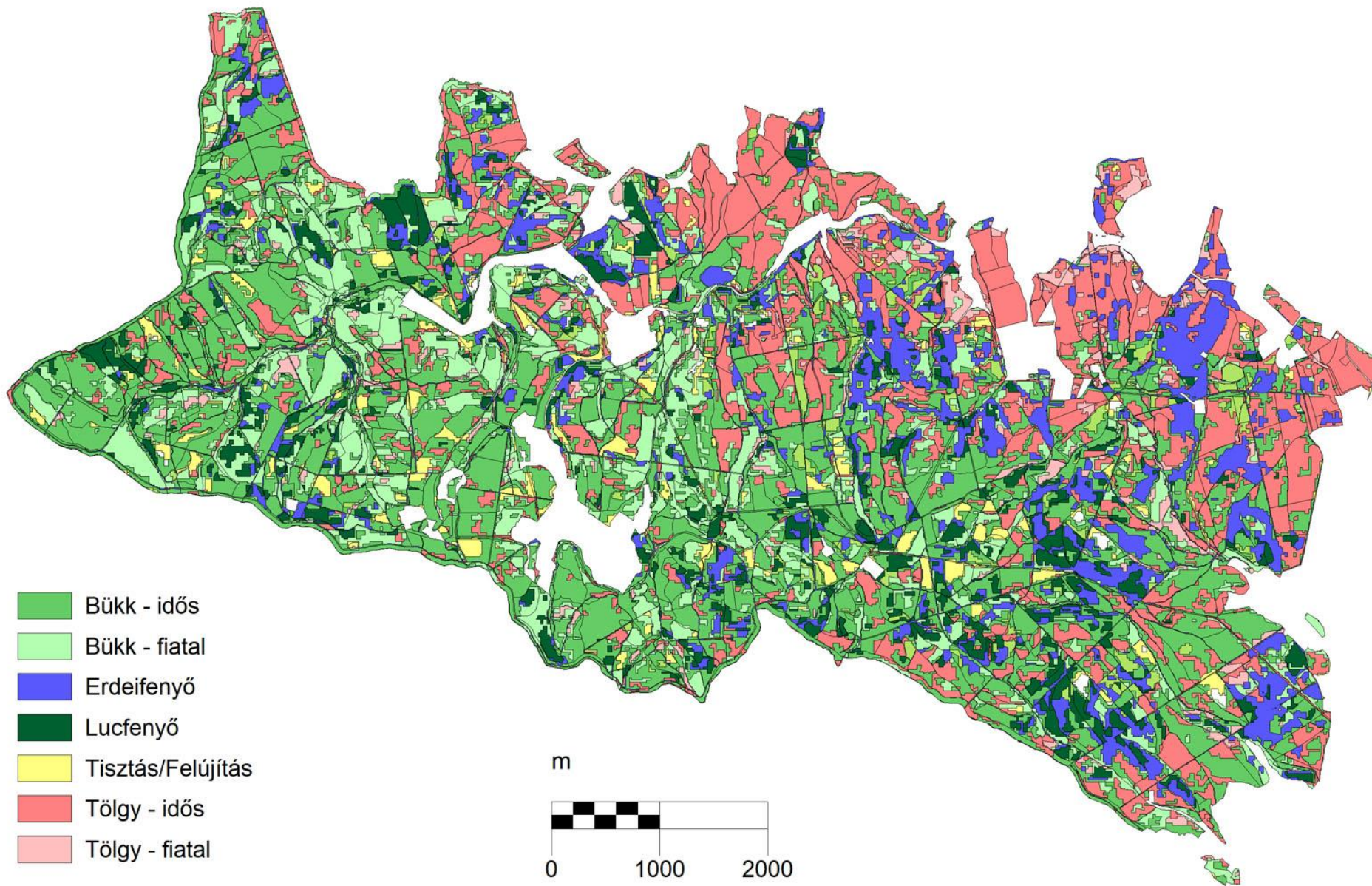


## 2. Object based Forest Mapping

- Sentinel-2 images series
- OBIA: Object based Image Analysis
- Constrained image segmentation
  - Considering sub-compartment borders
- Mapping main tree species
- Young and mature stand separation
- Vector based output



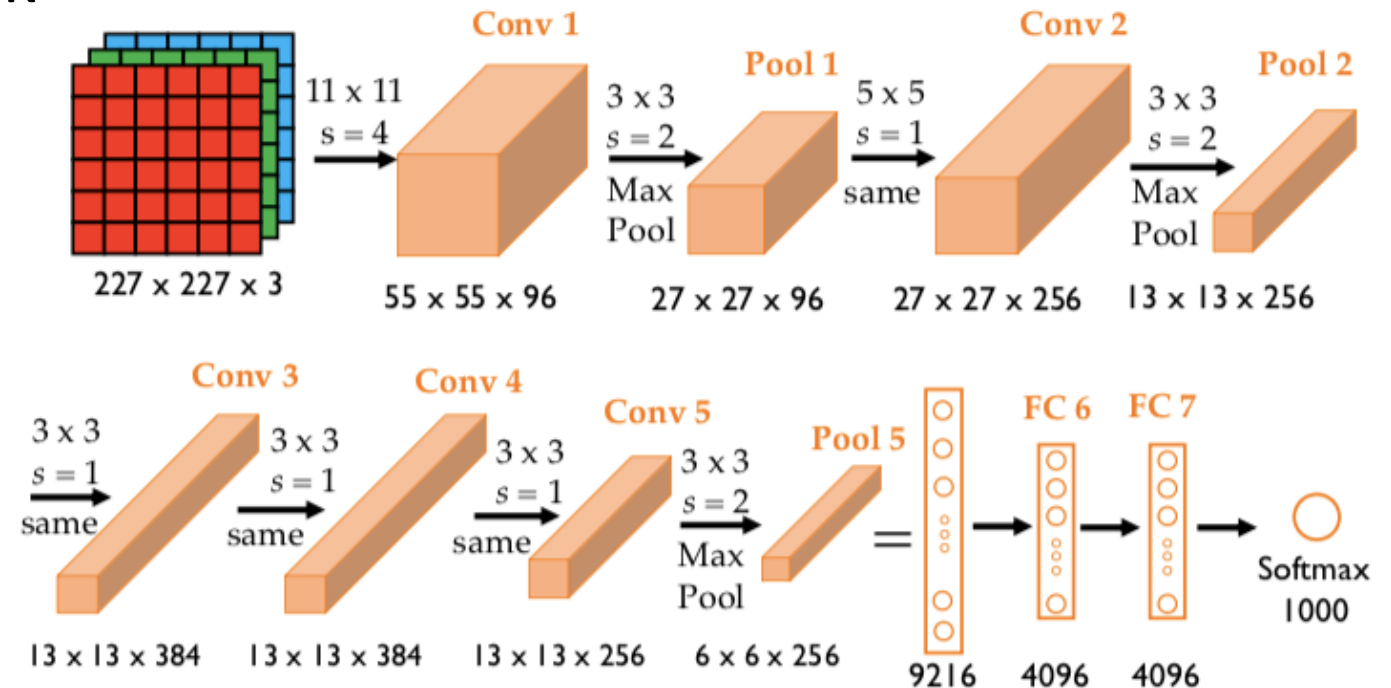
# Object based Forest Mapping

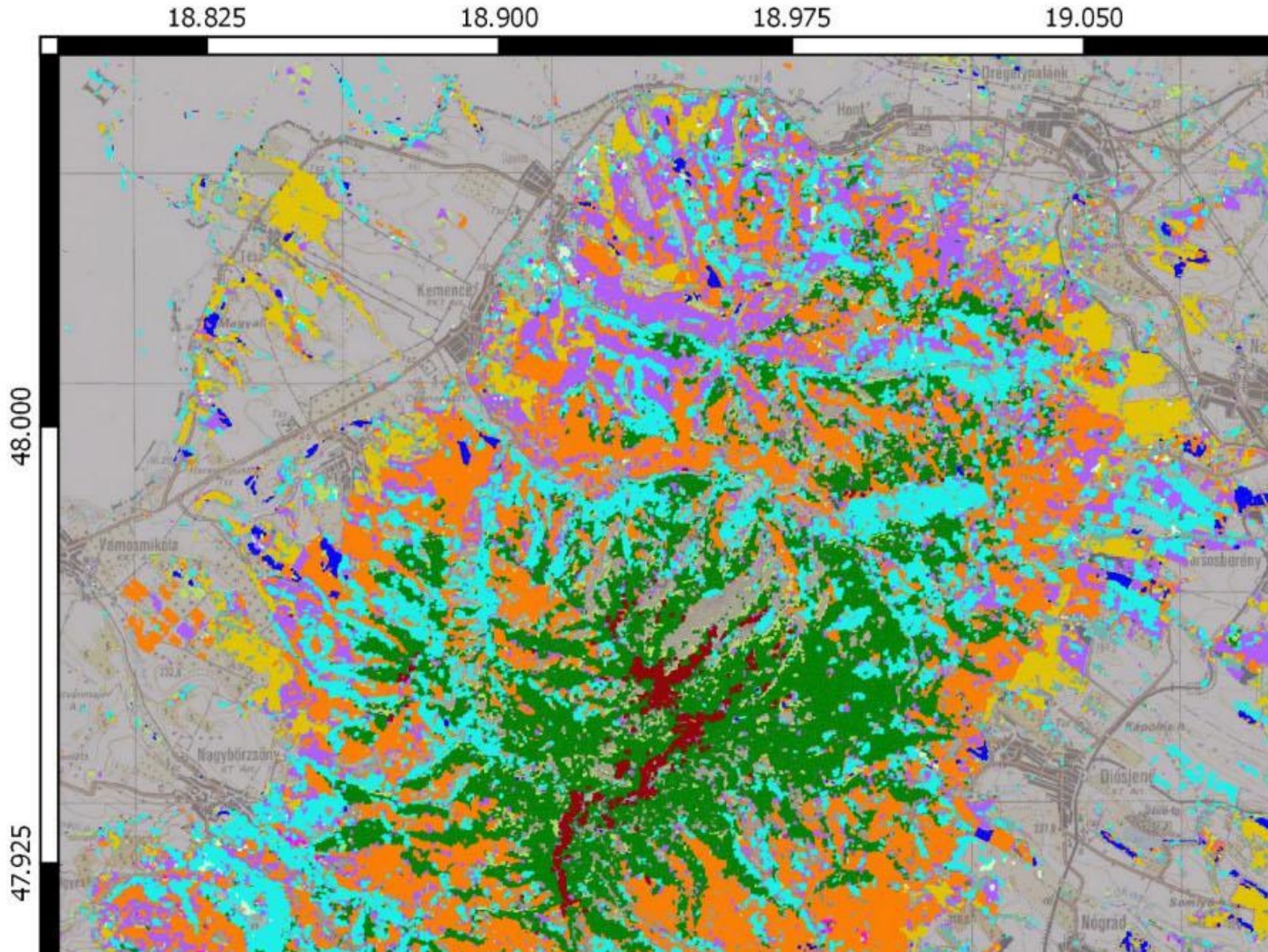




### 3. Tree Species Mapping with CNN

- Large area, 13 tree species
- Convolutional Neural Network
- Architecture: CNN, AlexNET
- Software: TensorFlow
- Training on supercomputer
- Accuracy: 88% (94%)





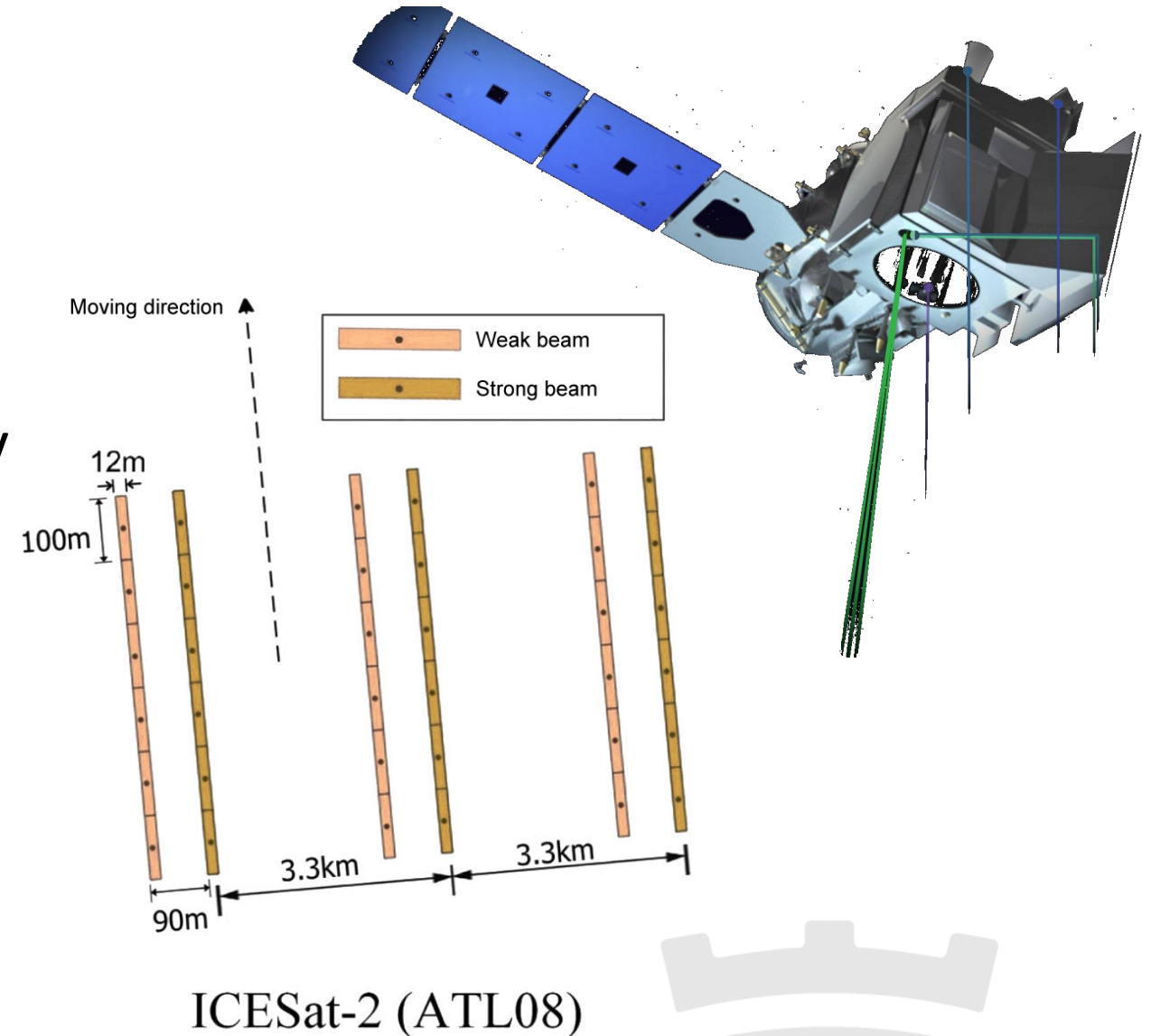
# CNN, AlexNET classification result

Source: Barton

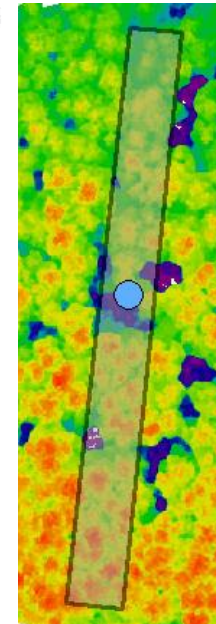
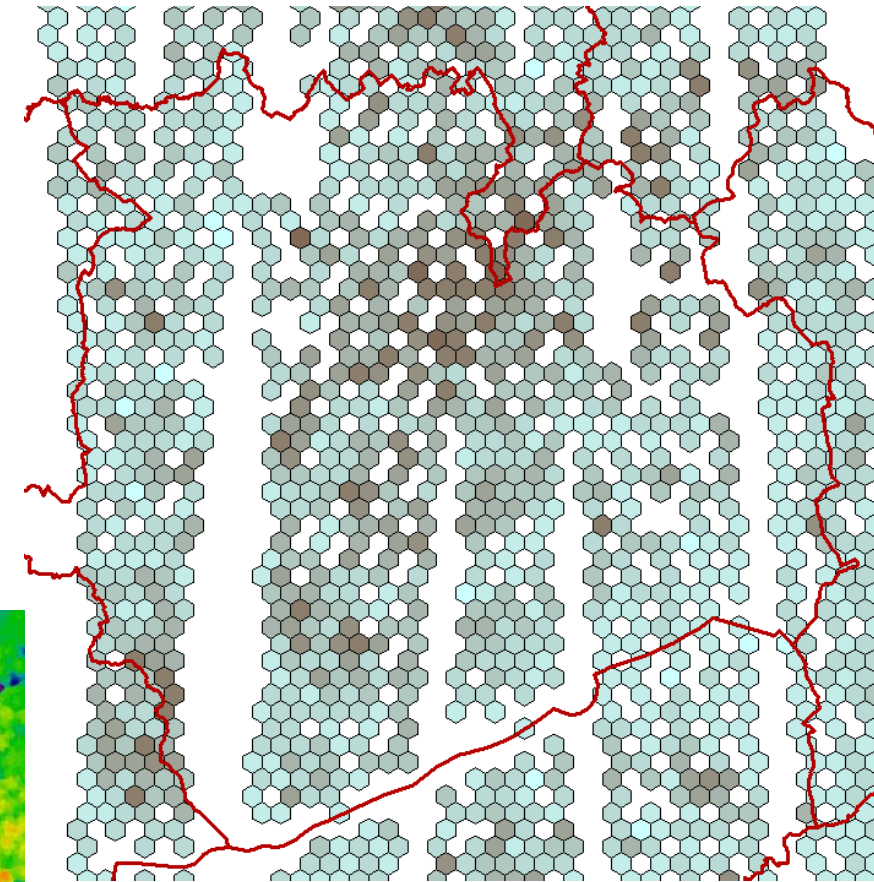
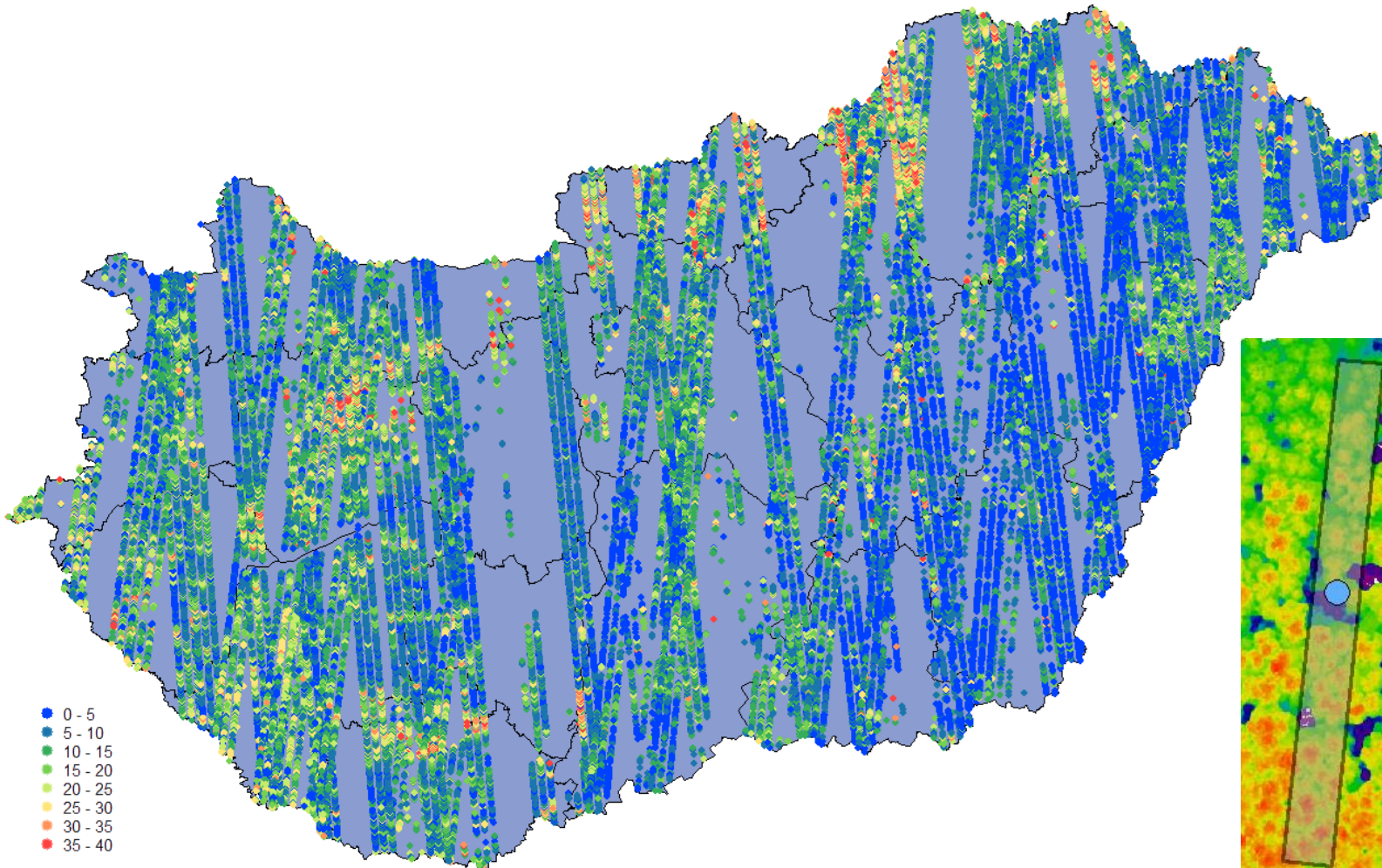


## 4. IceSAT2 application

- Satellite based LiDAR sampling
- Ice, Cloud, Land Elevation survey
- Suitable for tree height based large-scale forest inventory
- Tree height growth monitoring
- Crown closure detection
- Vertical structure analysis
- Volume calculation

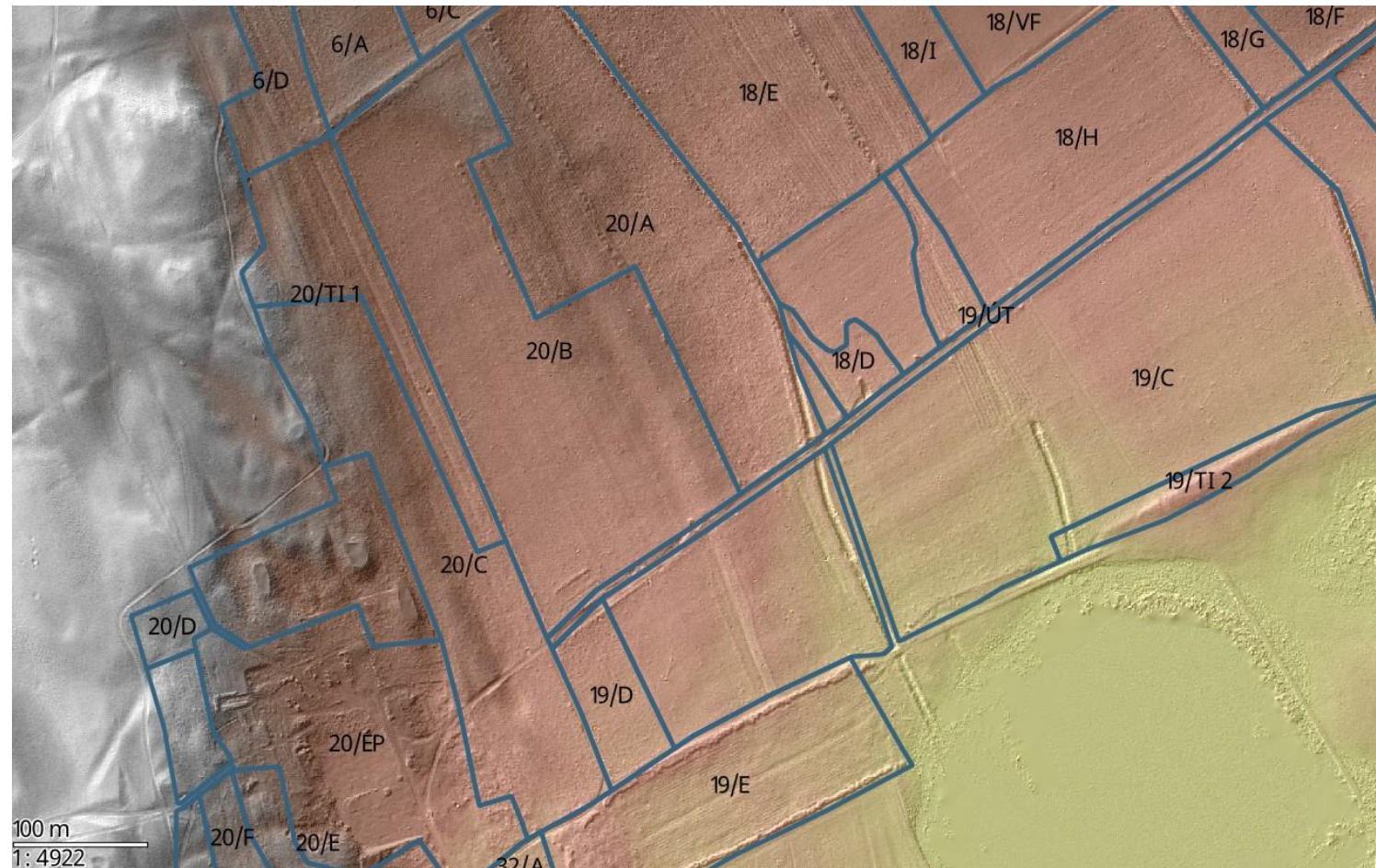


## 4. IceSAT2 application



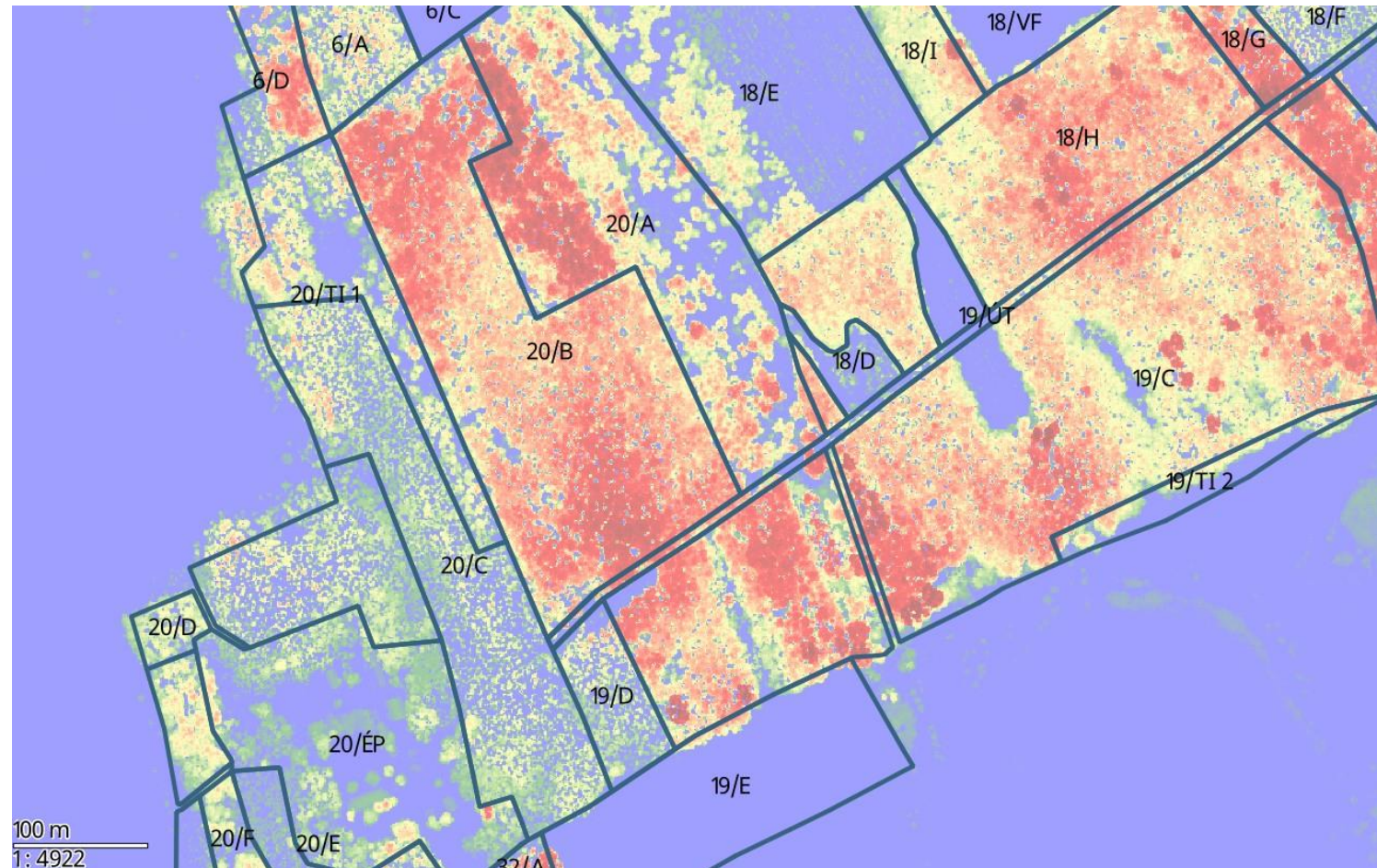
## 5. Nationwide Airborne Laser Scanning

- Density: 5 points/m<sup>2</sup>
- Detailed DEM creation >>
- Detailed CHM creation
- Single Tree Parameters
  - Position, Height
  - Crown Diameter
  - DBH, Volume
- More than 50% finished



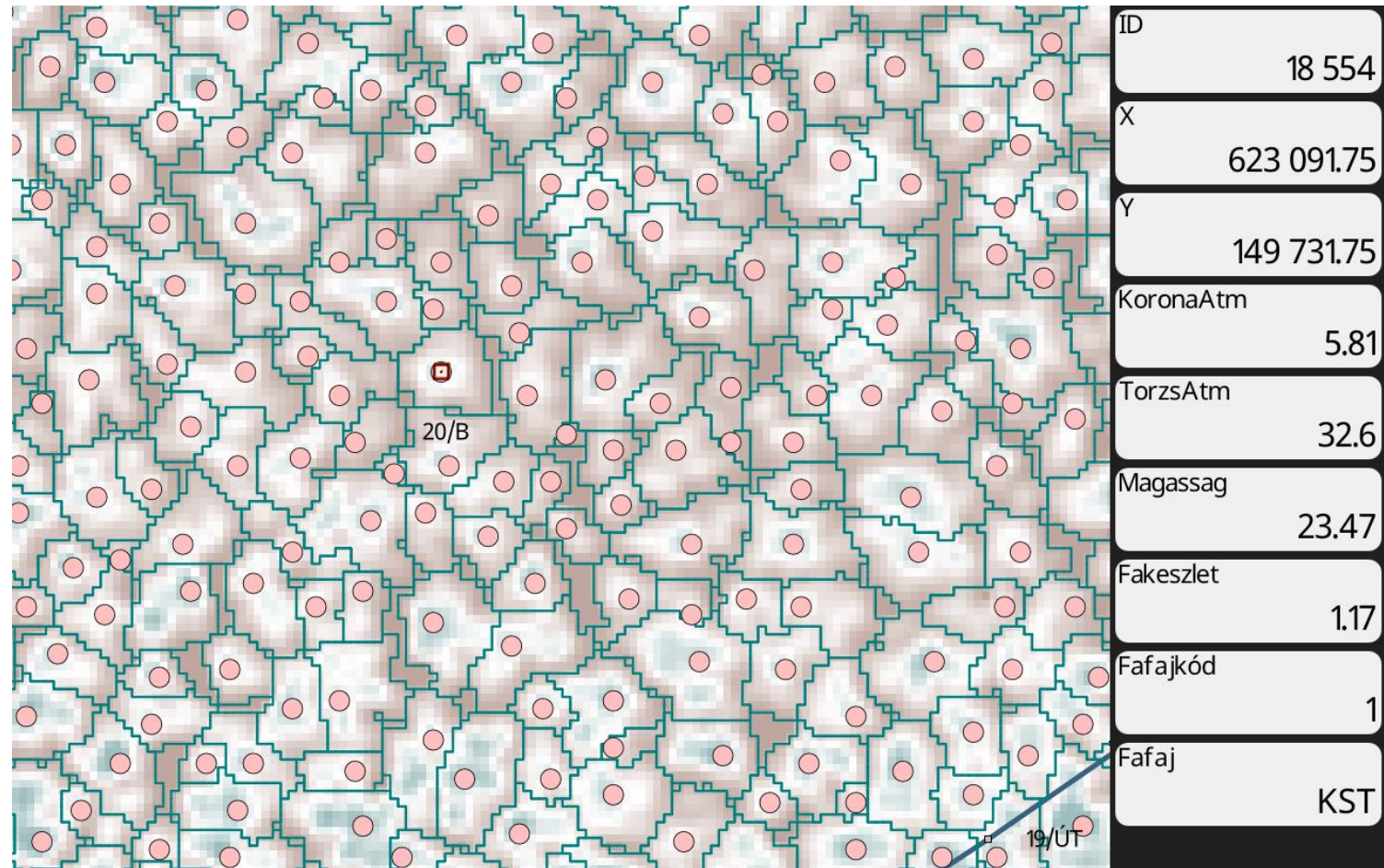
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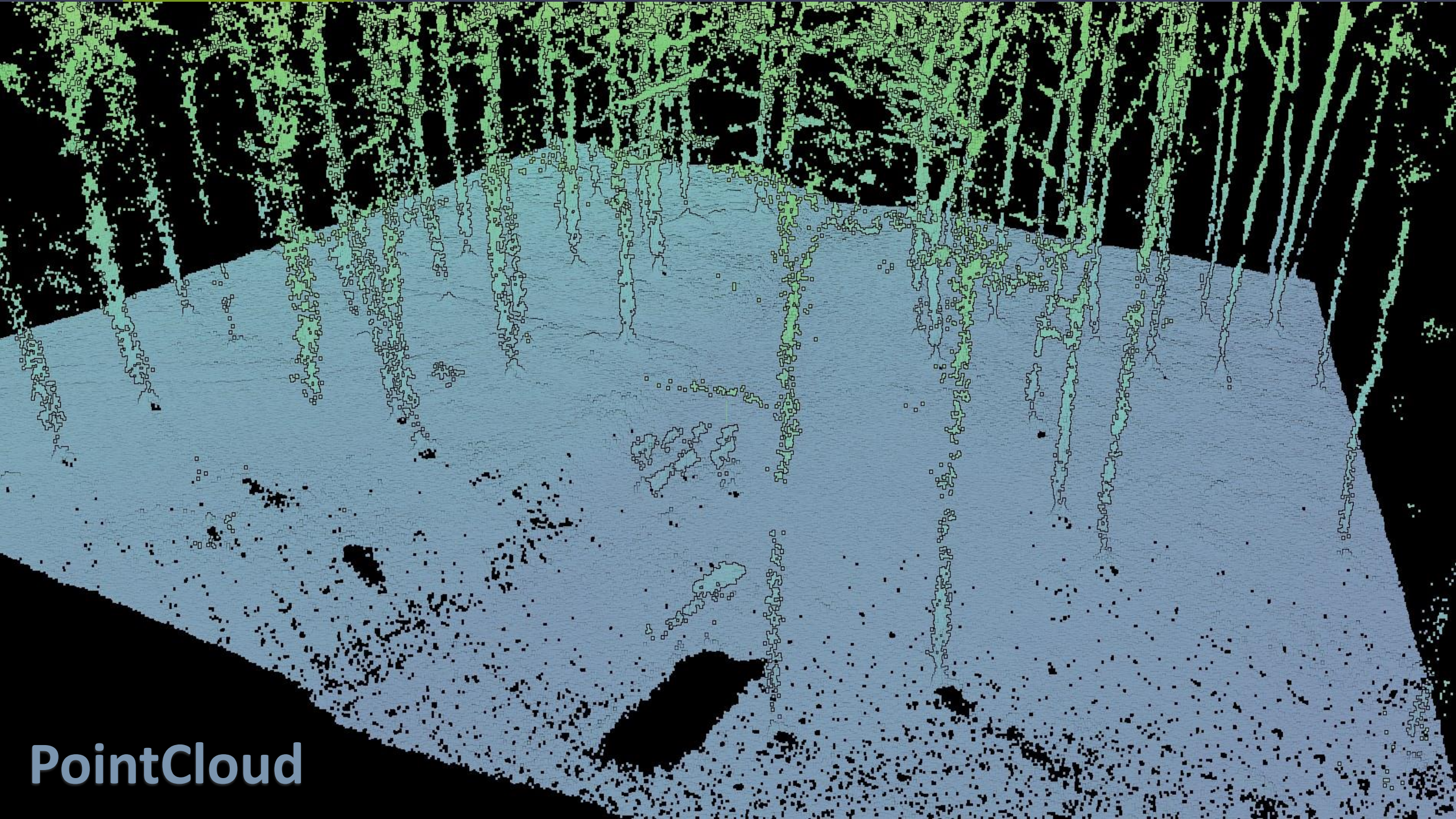


## 6. UAV based Forest Survey

- 1000 points/m<sup>2</sup>
- 15 hectares
- Leaf-off condition
- Relative flight height 60 m



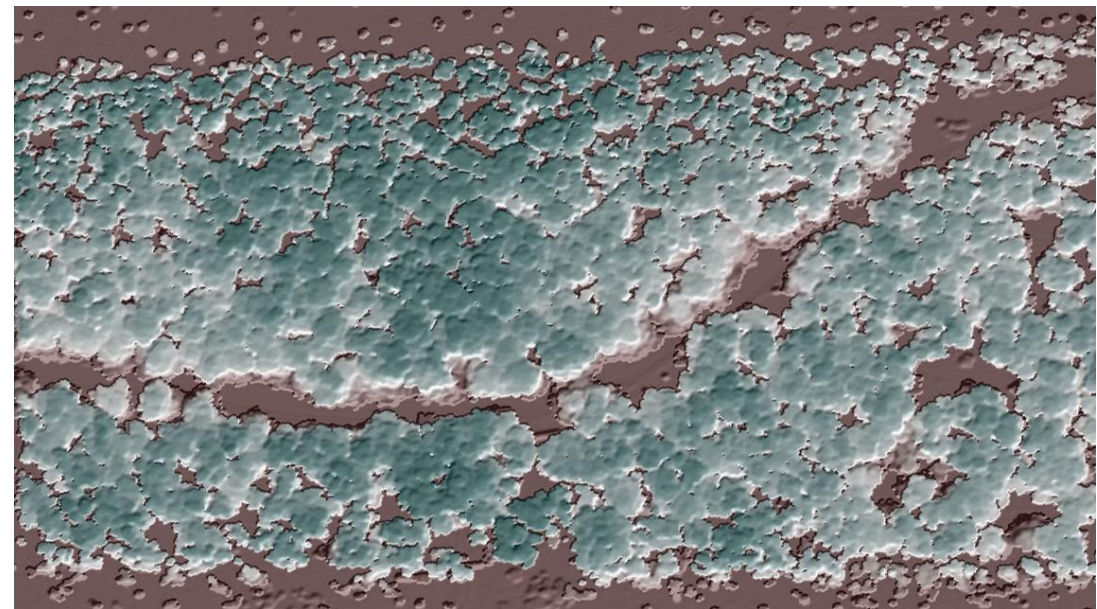
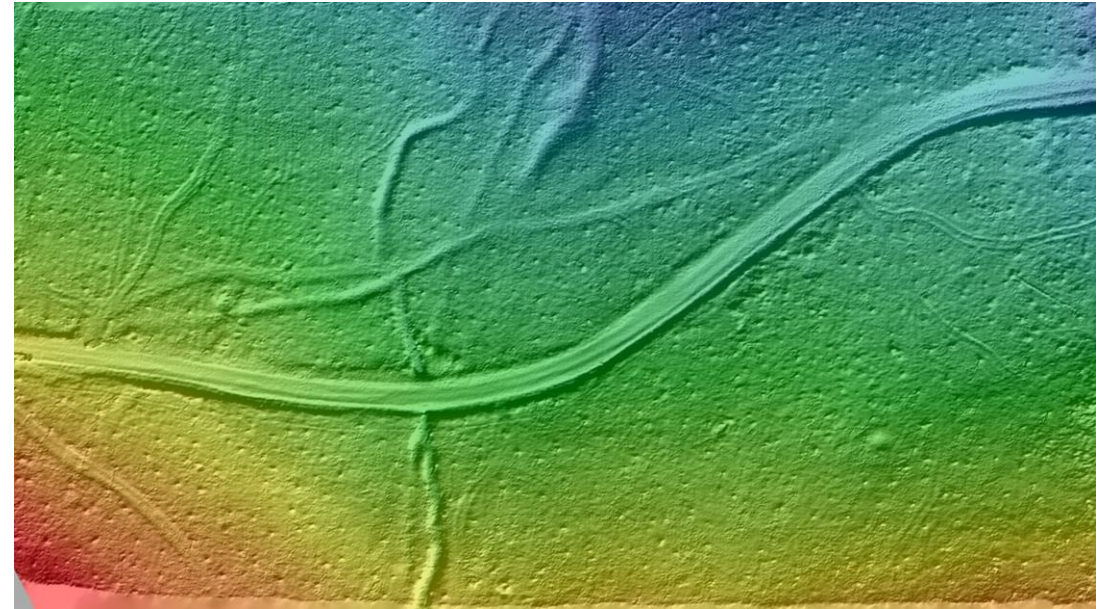




PointCloud

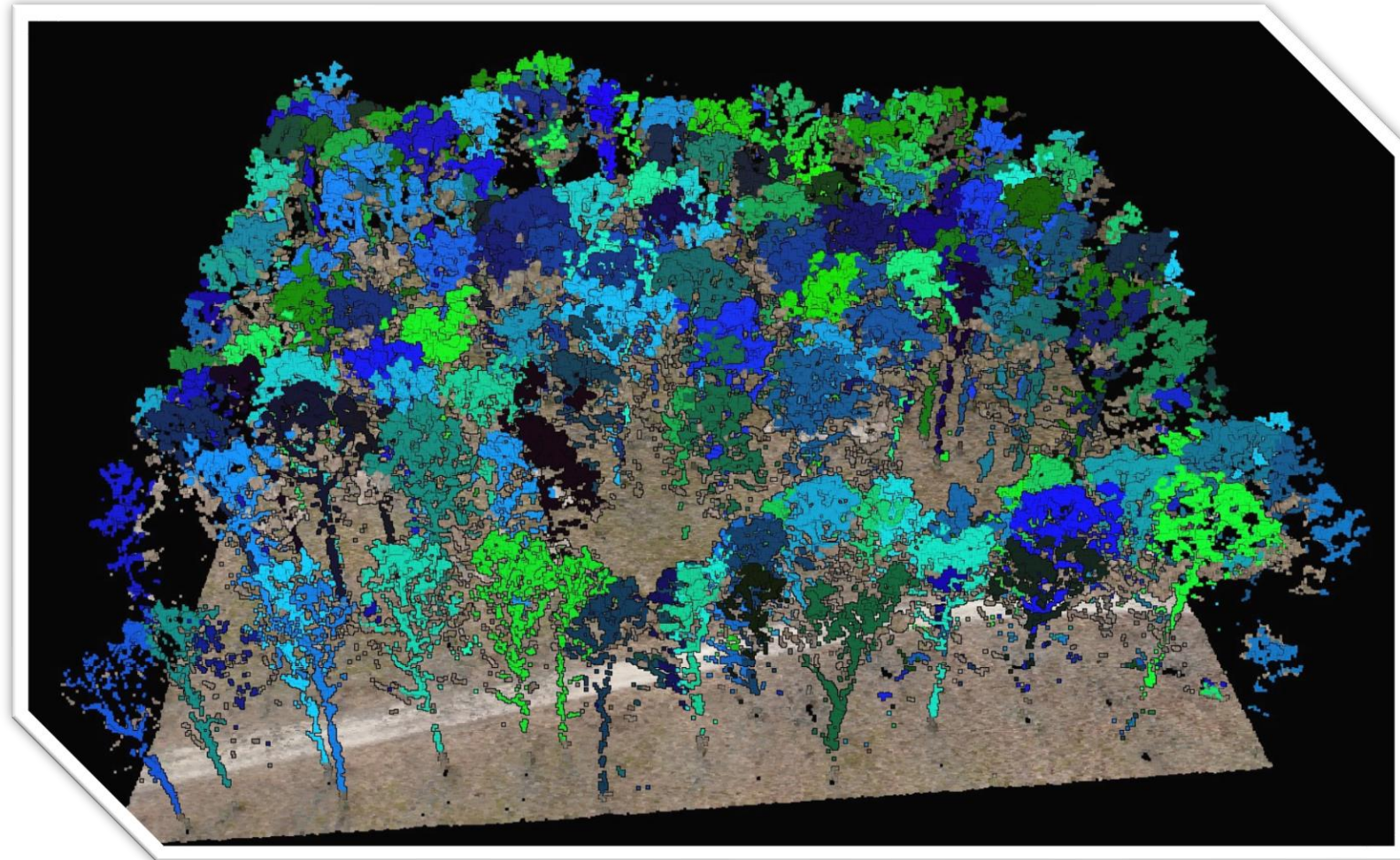
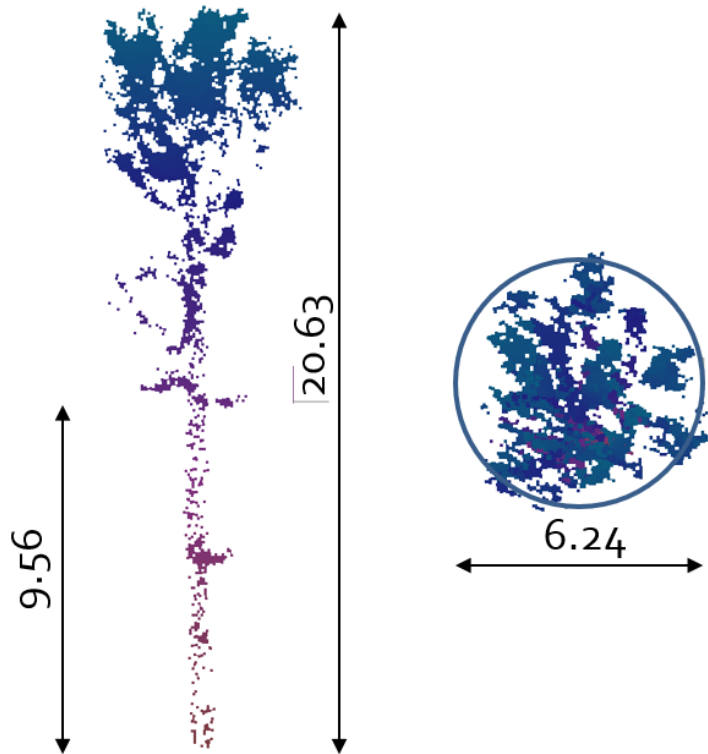
## 6. UAV based Forest Survey

- Digital Elevation Model (DEM)
  
  
  
  
  
  
  
  
  
  
- Canopy Height Model (CHM)



## 6. UAV based Forest Survey

- Single Tree segmentation



# 7. Close-range Photogrammetry Applications

- Application #1
- Basal area survey
- From a single image
- Tree stems detection
- Basal condition test
- Summarize by species



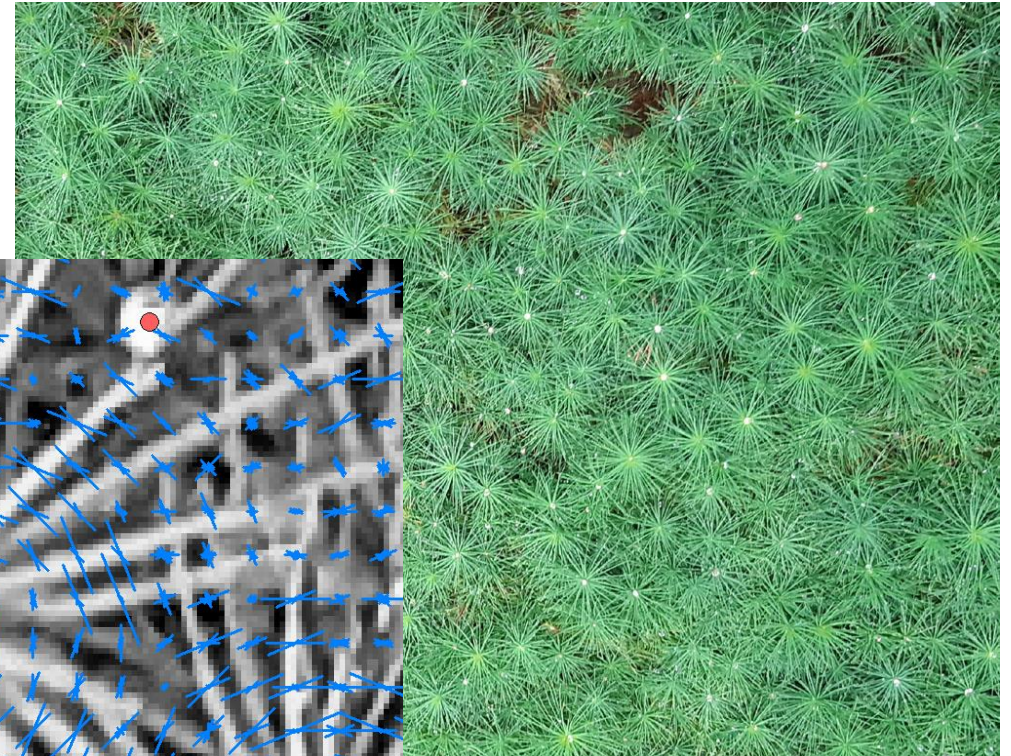
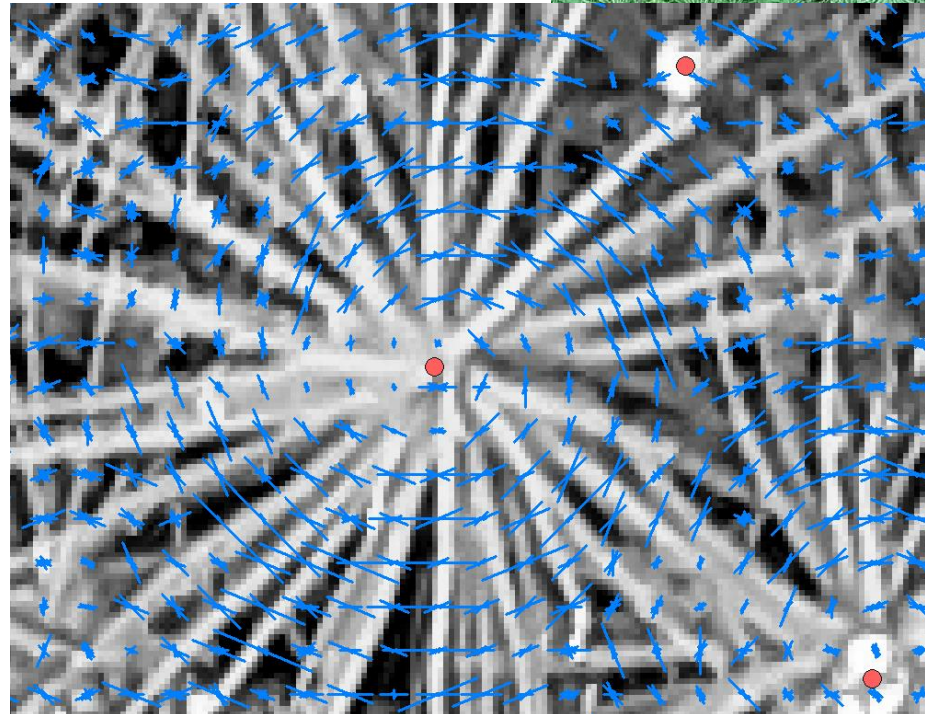
## 7. Close-range Photogrammetry Applications

- Application #2
- Wood pile survey
- Image calibration
- Log detection
- Volume calculation



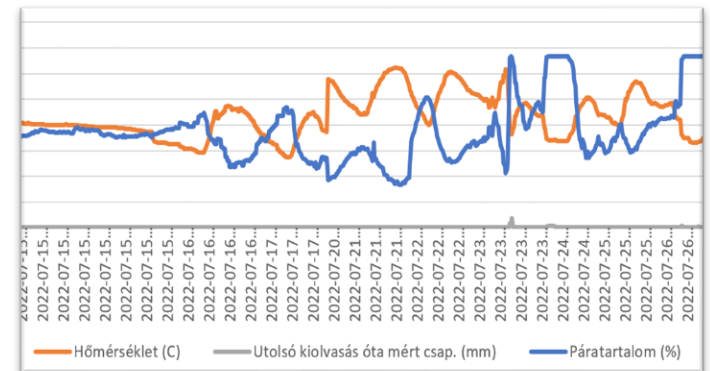
# 7. Close-range Photogrammetry Applications

- Application #3
- Sapling counter
- HOG filter
- Center point detection
- Counting



## 8. SmartForest

- NB IoT sensor network
- Direct feedback from forest
- Cloud database
- Cloud processing
- Measuring climatic, proximity, growth, soil moisture parameters
- Short-term alarm system
- Long-term climate, site and growth response analysis





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**Thank You for Your Attention!**

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