



UNIVERSITY  
of SOPRON

FACULTY OF  
FORESTRY



# Overview of Remote Sensing and GIS Applications for Forest Monitoring

Géza Király, Kornél Czimber



# Forest monitoring by Remote Sensing

- Quantity
  - Area, Height, Volume
- Quality
  - Tree species
  - Forest health
- Passive Remote Sensing
  - Satellite images
  - Aerial photographs
    - Manned aircrafts
    - Unmanned aircrafts
- Active Remote Sensing
  - RADAR
  - LiDAR

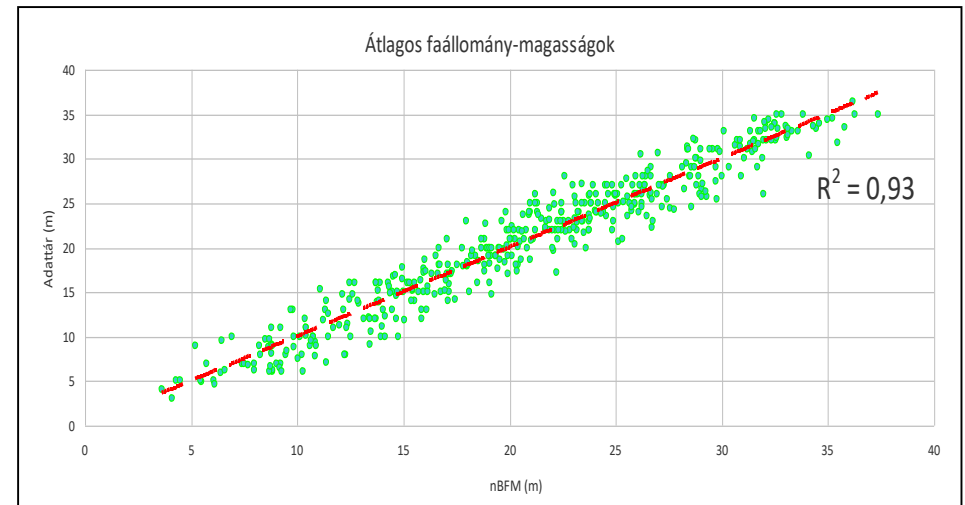
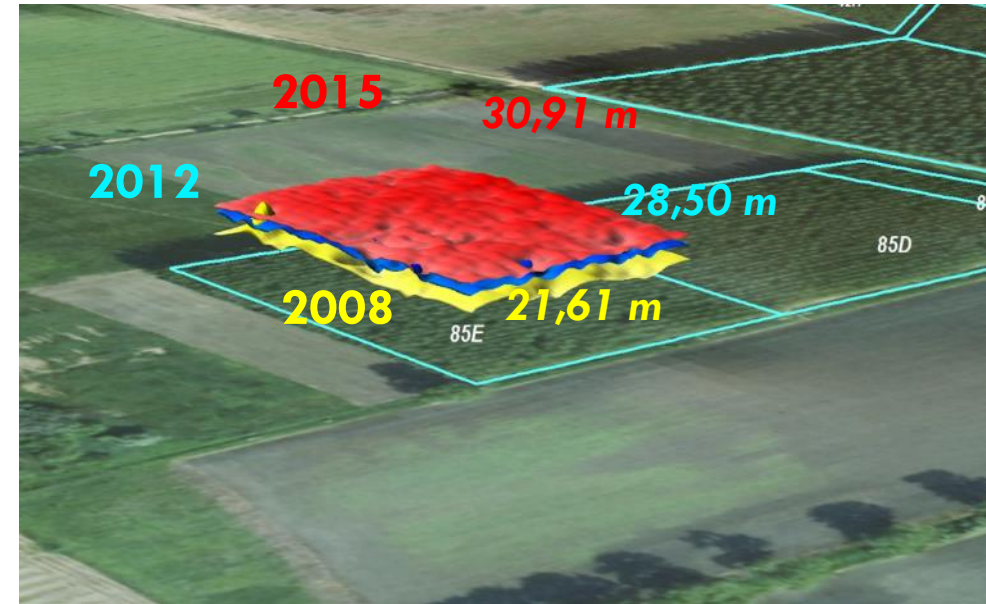
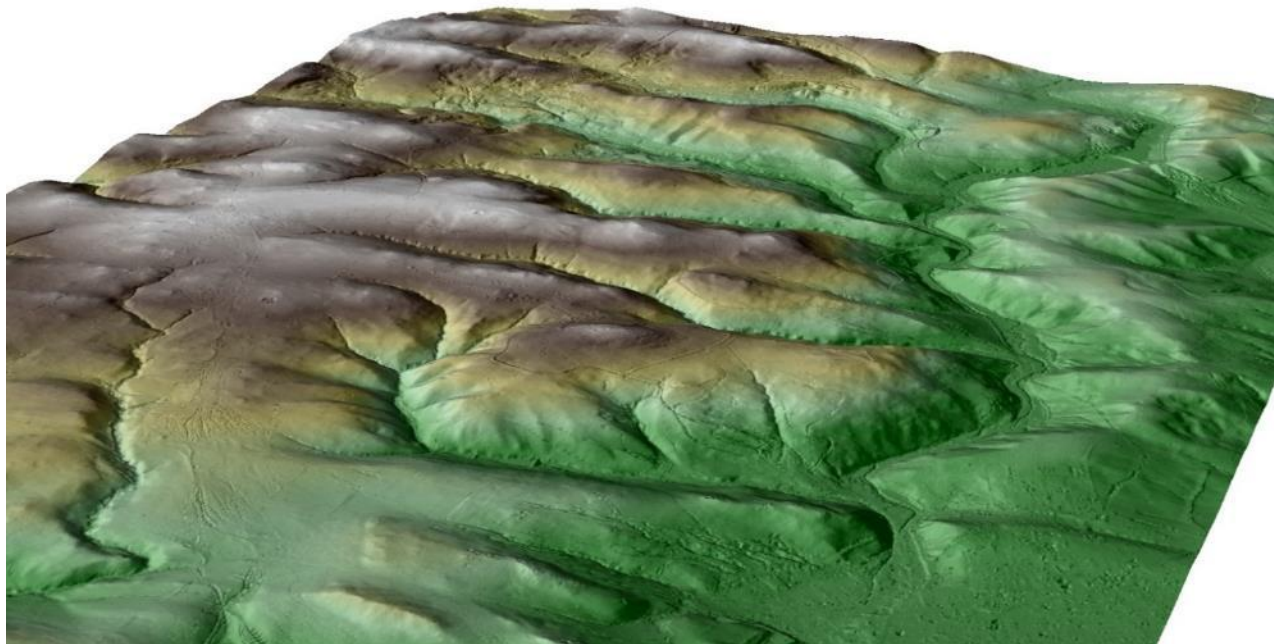


# Forest monitoring – quantity

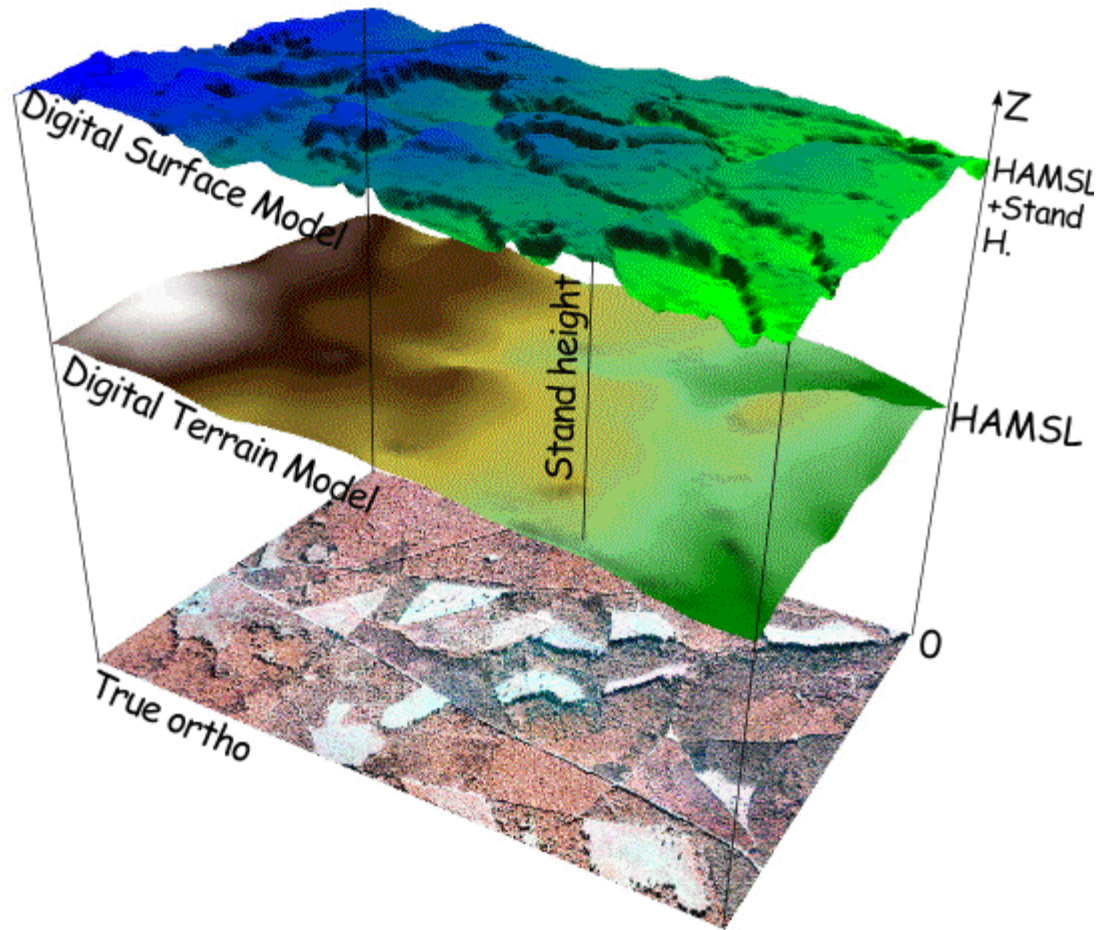
- Passive
  - Photogrammetry
    - Airborne
    - Terrestrial
- Active
  - LiDAR (Laser Scanning)
    - Space-borne
    - Airborne
    - Terrestrial
- Image matching
  - Semi-global matching (SGM) (Hirschmüller, 2005 and 2008)
  - Structure from Motion (SfM) (Snavely, N., 2008)
- Point Cloud-based processing
- Tree detection
  - Inverse watershed
  - Geomorphon
  - Local maxima



# Forest stand height



## normalised Digital Surface Model, Canopy Height Model (nDSM – CHM)



$$nDSM = DSM - DTM$$

$$V = F_c \cdot G_c \cdot H$$

where:

V: Volume (m<sup>3</sup>)

F<sub>c</sub>: Form factor of the Crown projection

G<sub>c</sub>: Sum of Crown projection (m<sup>2</sup>)

H: Average Stand Height (m)

# Forest monitoring – quality

- Passive
  - Satellite images
    - Free (e.g. Landsat, Sentinel)
    - Services (e.g. Planet, Maxar)
  - Airborne
- Active
  - RADAR
- Image classification
  - Unsupervised, Supervised
  - Subpixel-, Pixel-, Segment-based
- NDVI



# FIR – Forest Monitoring Technical System

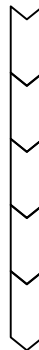
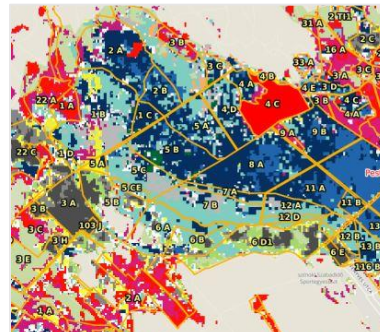
## Image processing



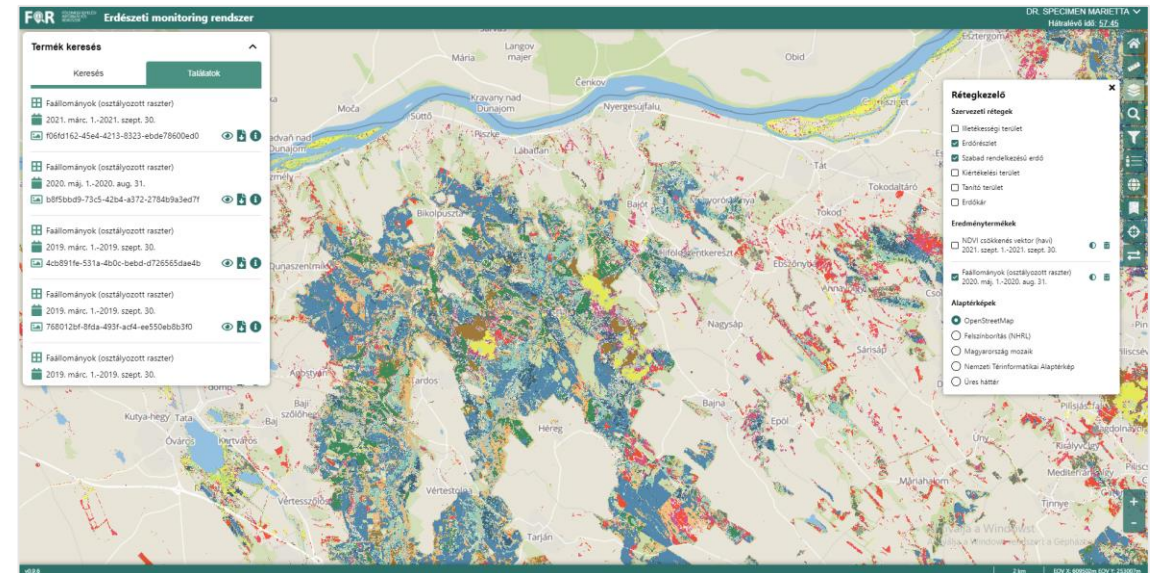
NDVI-based  
processing



Machine learning  
Training areas



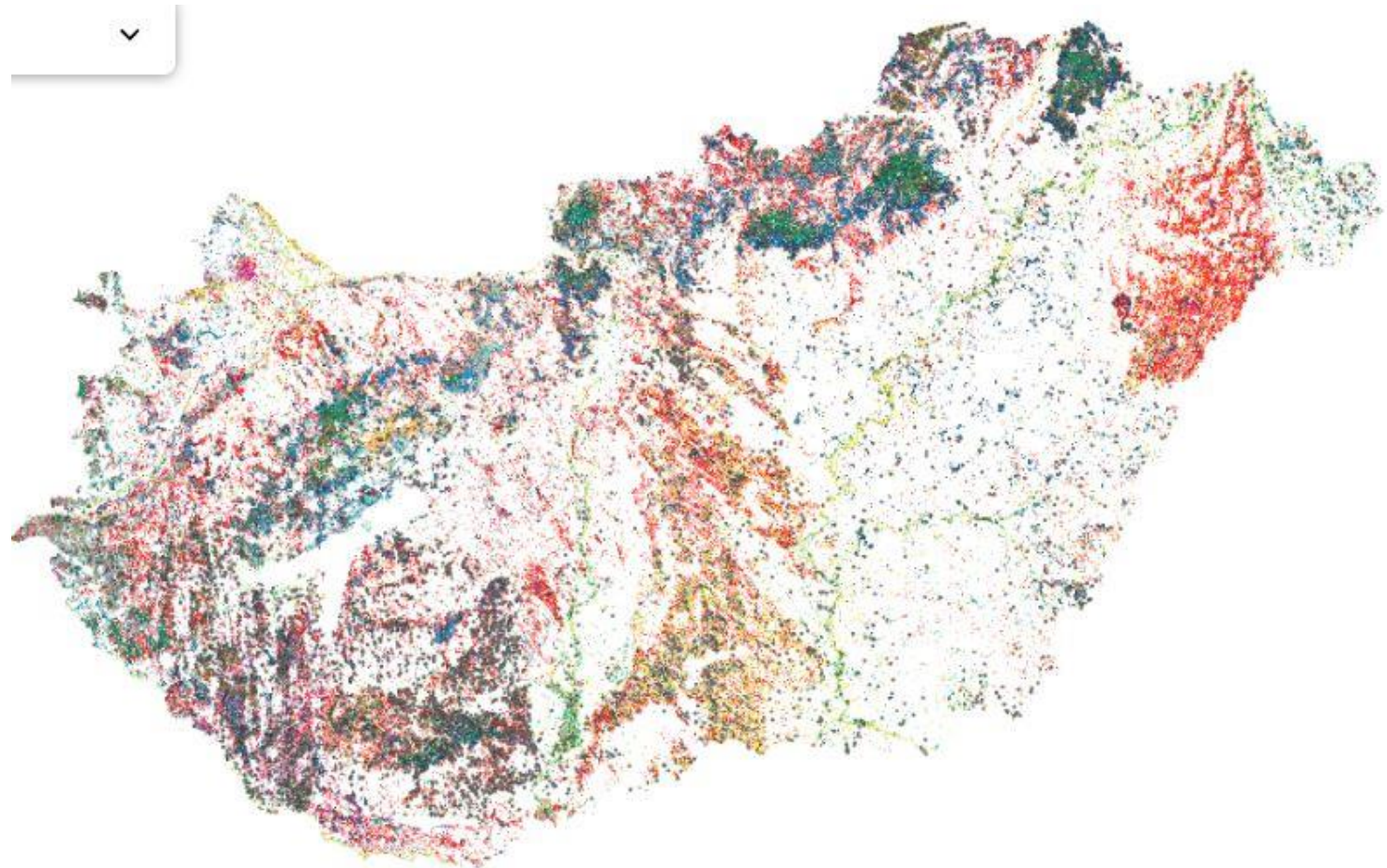
## Visualisation



<https://efold.gov.hu/>

# Checking and improving the forest stand classification algorithm

- Checking the classification
- Optimization of training areas
- Rationalization of processing units
- Surveying the possible application field

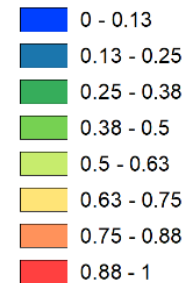




# Subpixel-based classification

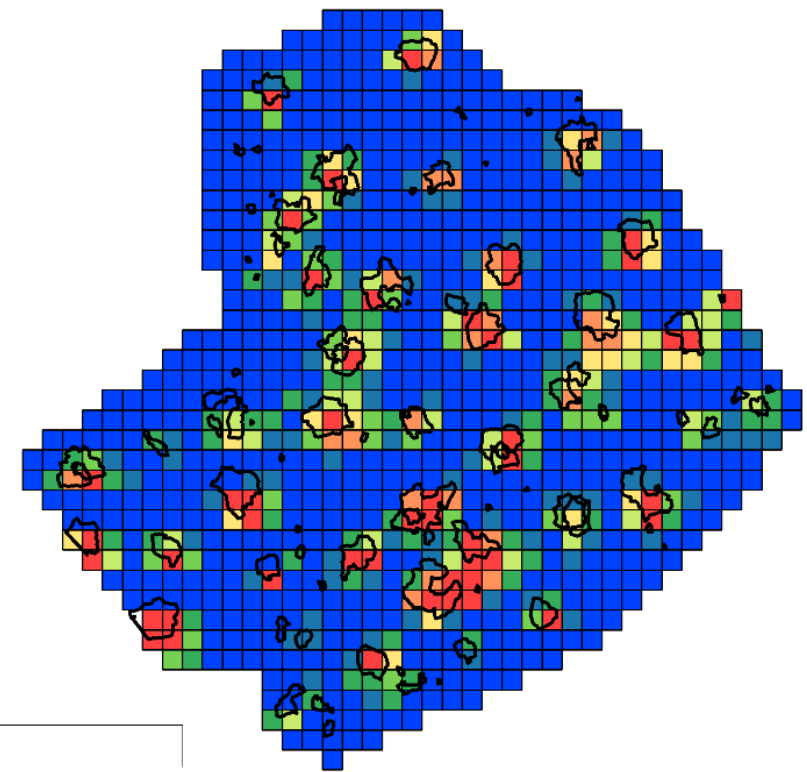
- Selecting endmembers
- Spectral Unmixing

$$R_b = \sum_{i=1}^N f_i \cdot R_{i,b} + \varepsilon_b$$



meter

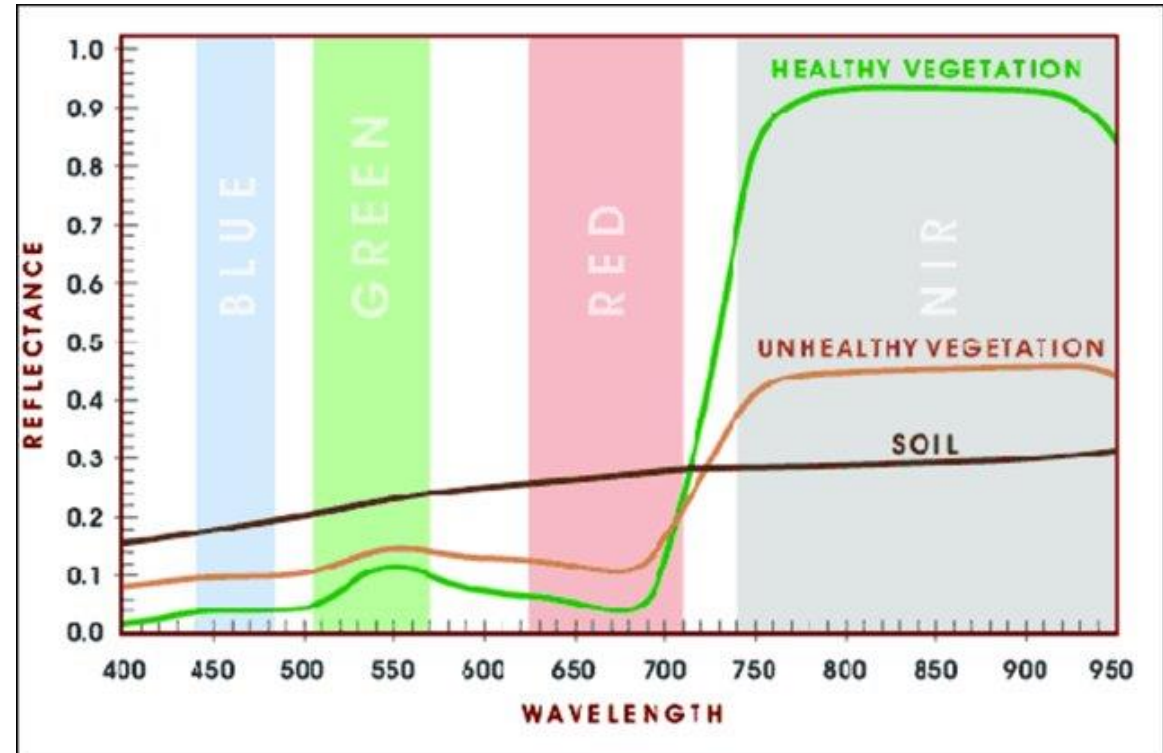
0 100 200



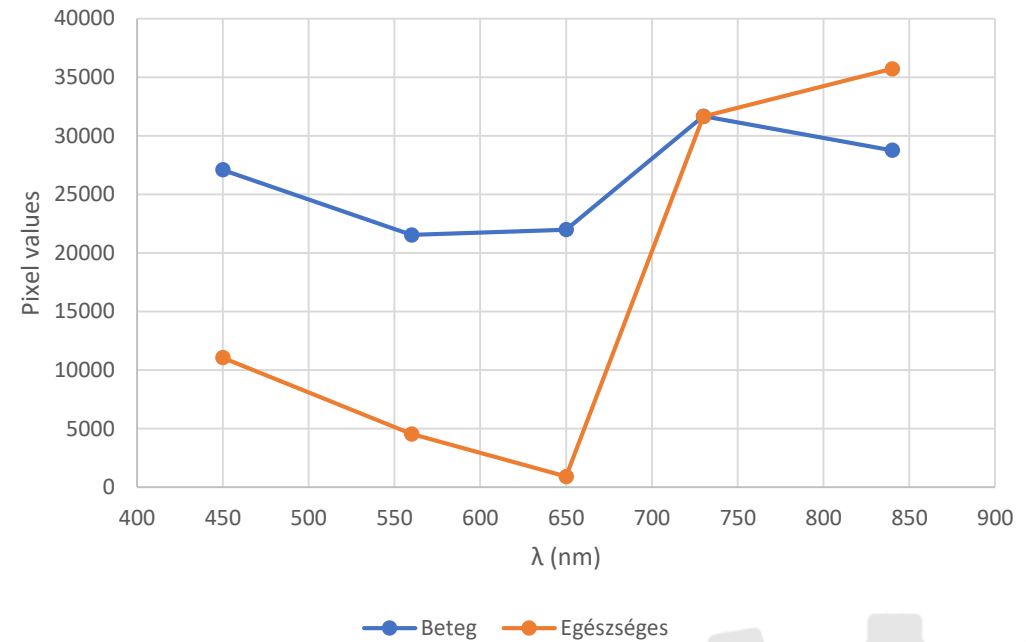
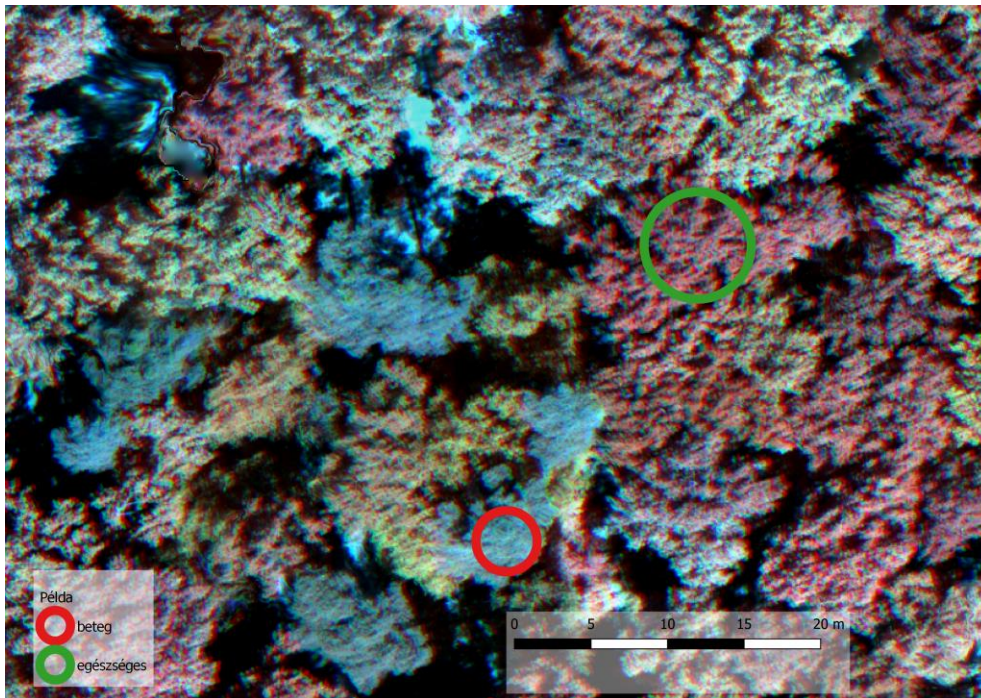
Barton (2018)

# NDVI

- $NDVI = (NIR - R) / (NIR + R)$



# Healthy and unhealthy single trees



# DJI MATRICE600Pro



- Hexacopter
  - ~2 kg payload
  - ~30 min flying time
  - Redundancy (GPS, INS, battery)
- Sony A7R camera
  - 36 MP
  - Full Frame
  - 35 mm optics
- Sequoia multispectral camera
  - 1.2 MP
  - 4 bands
  - 3,98 mm (30 mm)

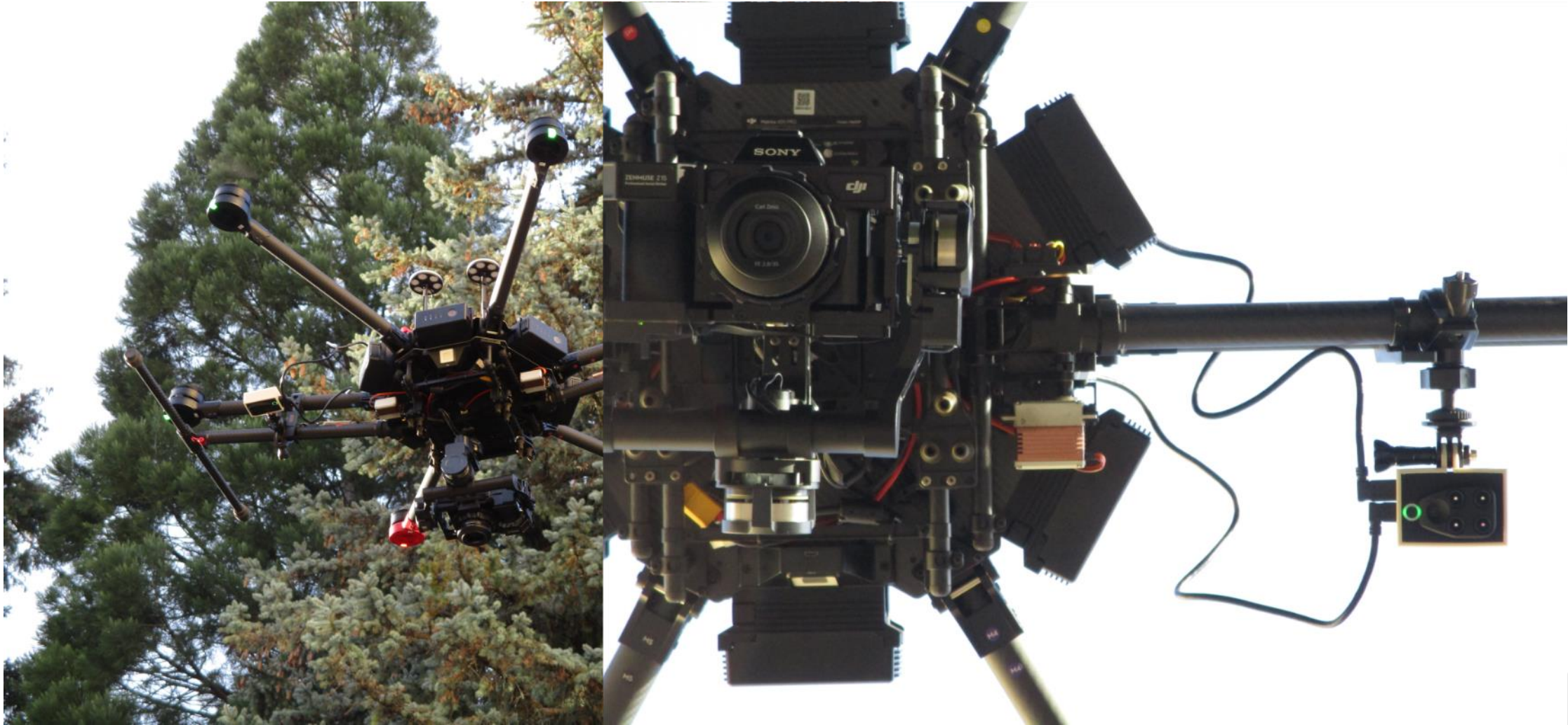


# DJI MATRICE600Pro

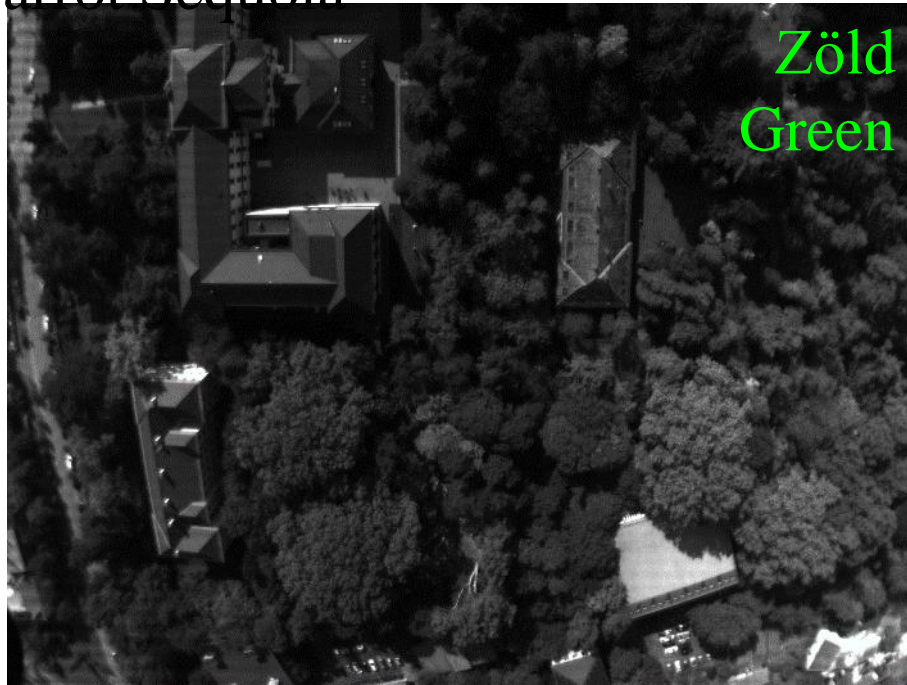


# DJI MATRICE600Pro

Sony A7R kamera  
Parrot Sequoia



# Parrot Sequoia



Parrot Sequoia

VZK  
RGB





# Soproni Egyetem Botanikus Kert

- 2018.06.10
- ~180 m flying height
- 124 photos
- ~2,5 cm ground resolution
- Products
  - Ortophoto-mosaic
  - Digital Surface Model

## Survey Data

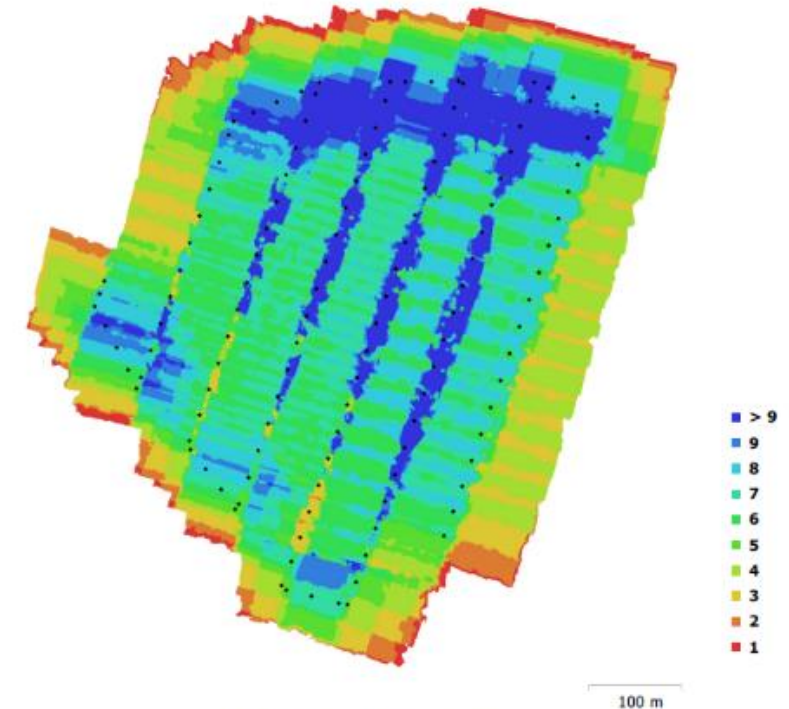


Fig. 1. Camera locations and image overlap.

Number of images:	124	Camera stations:	124
Flying altitude:	171 m	Tie points:	154,243
Ground resolution:	2.19 cm/pix	Projections:	379,361
Coverage area:	0.328 km <sup>2</sup>	Reprojection error:	0.504 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
ILCE-7R (35 mm)	7360 x 4912	35 mm	4.89 x 4.89 $\mu$ m	No

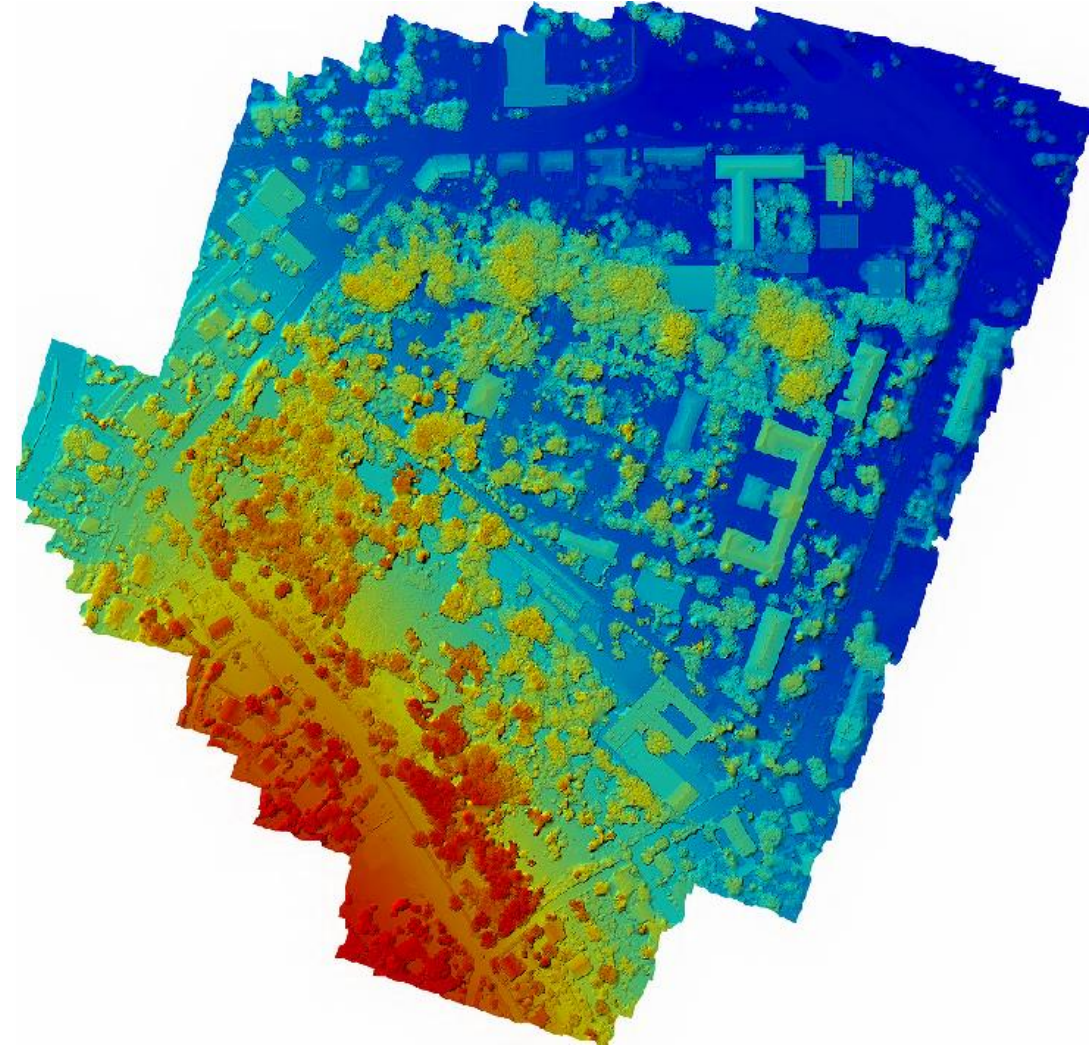
Table 1. Cameras.

# Soproni Egyetem Botanikus Kert

## Ortophoto



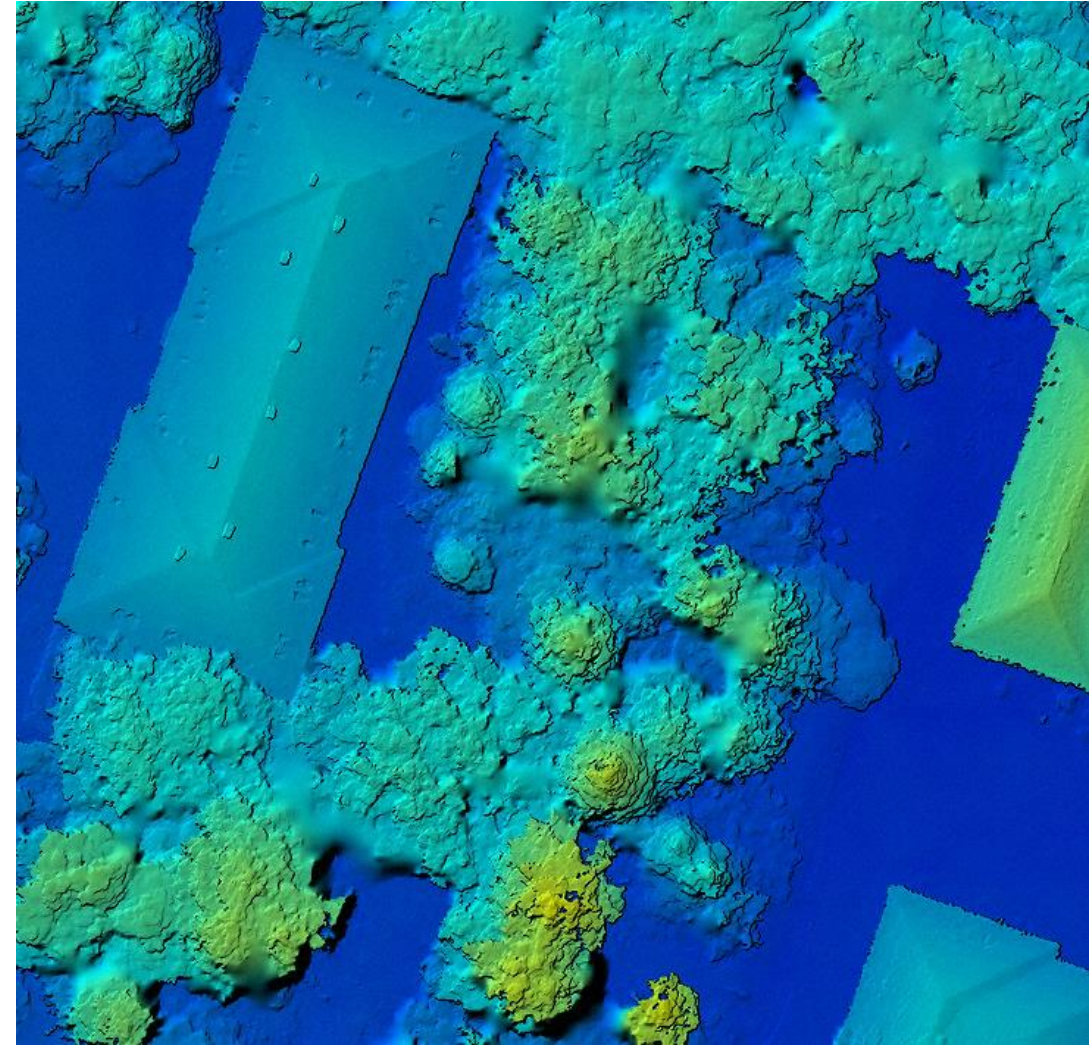
## DSM



# Soproni Egyetem Botanikus Kert Ortophoto



# DSM

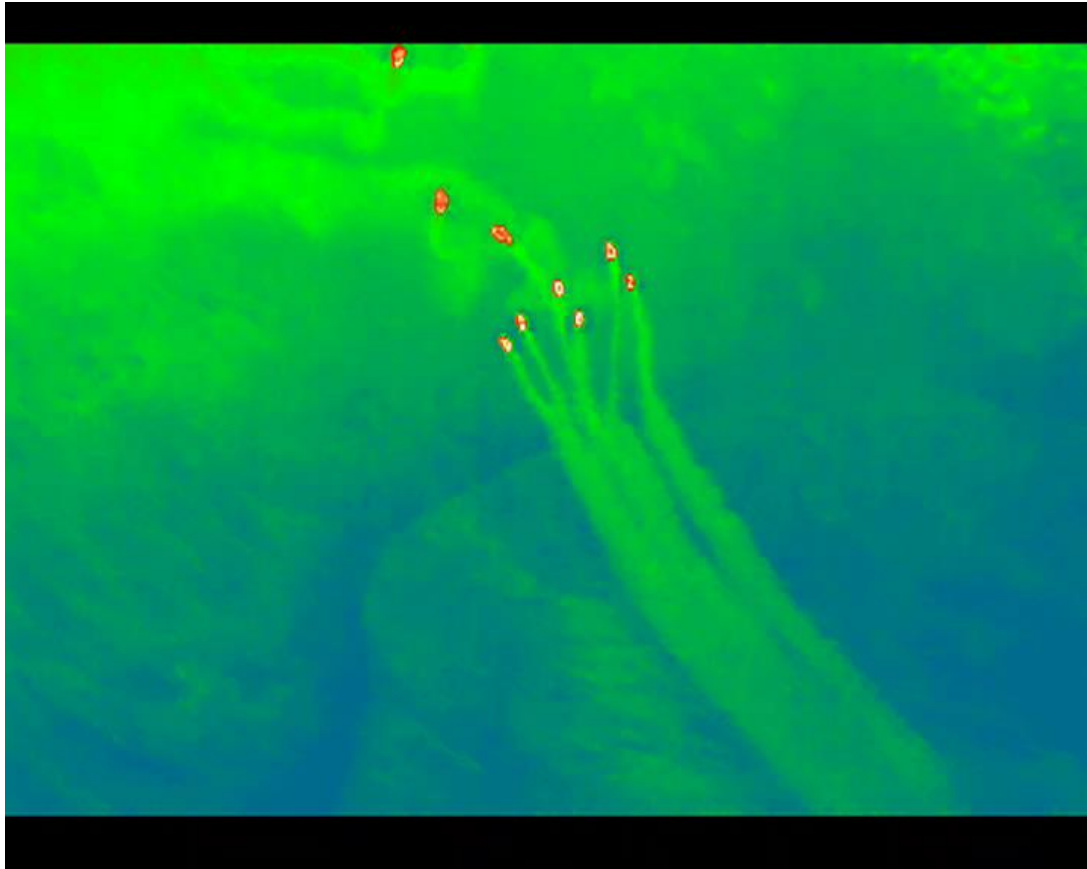


# DJI Matrice 100



- Quadrocopter
- ~20 min. flying time
- X3 camera
  - 12 MP,
  - 3,61 mm (20 mm)
- XT thermal camera,
  - 336\*256,
  - 19 mm (~114 mm)

# Damages caused by games



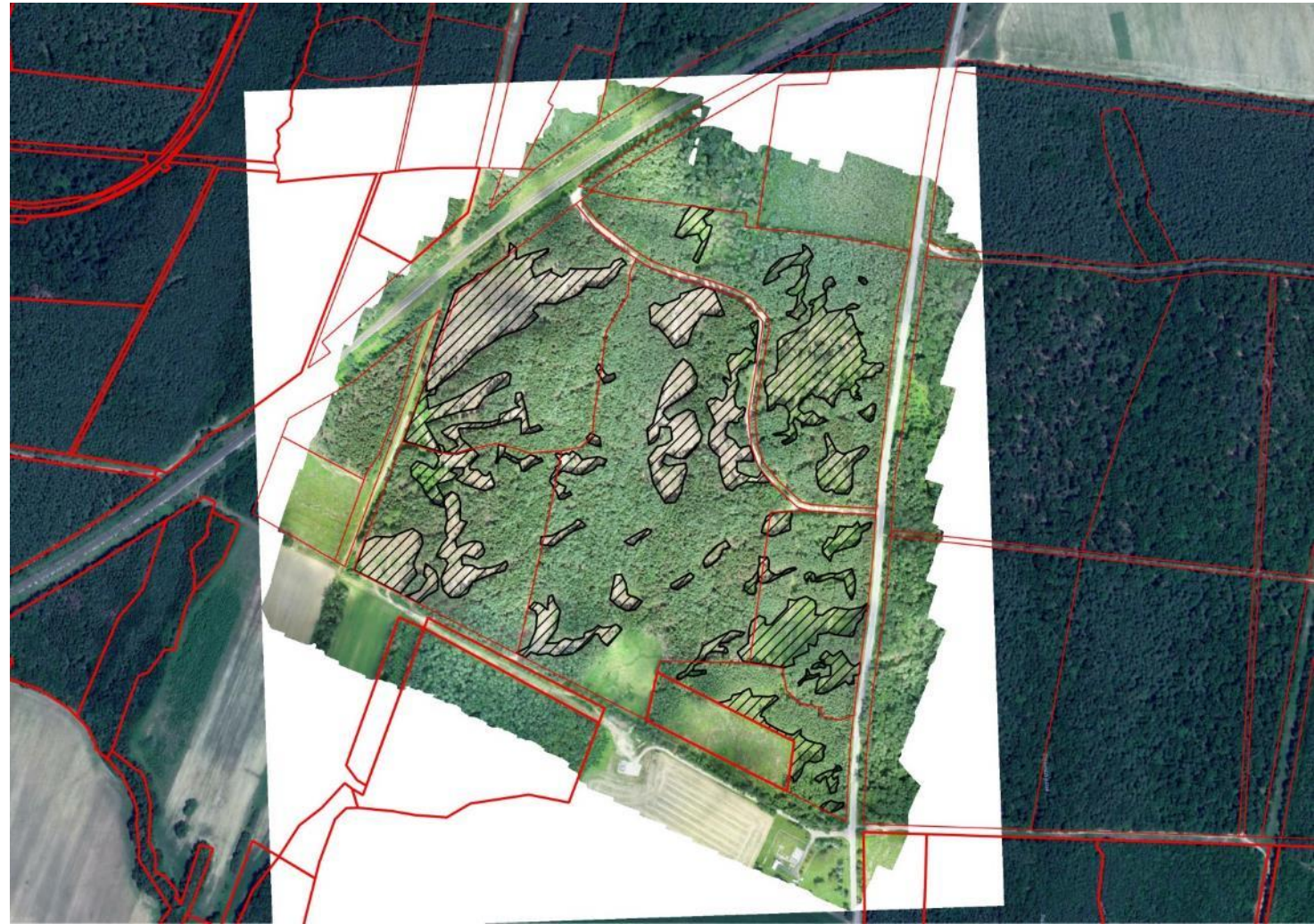
Thermal camera



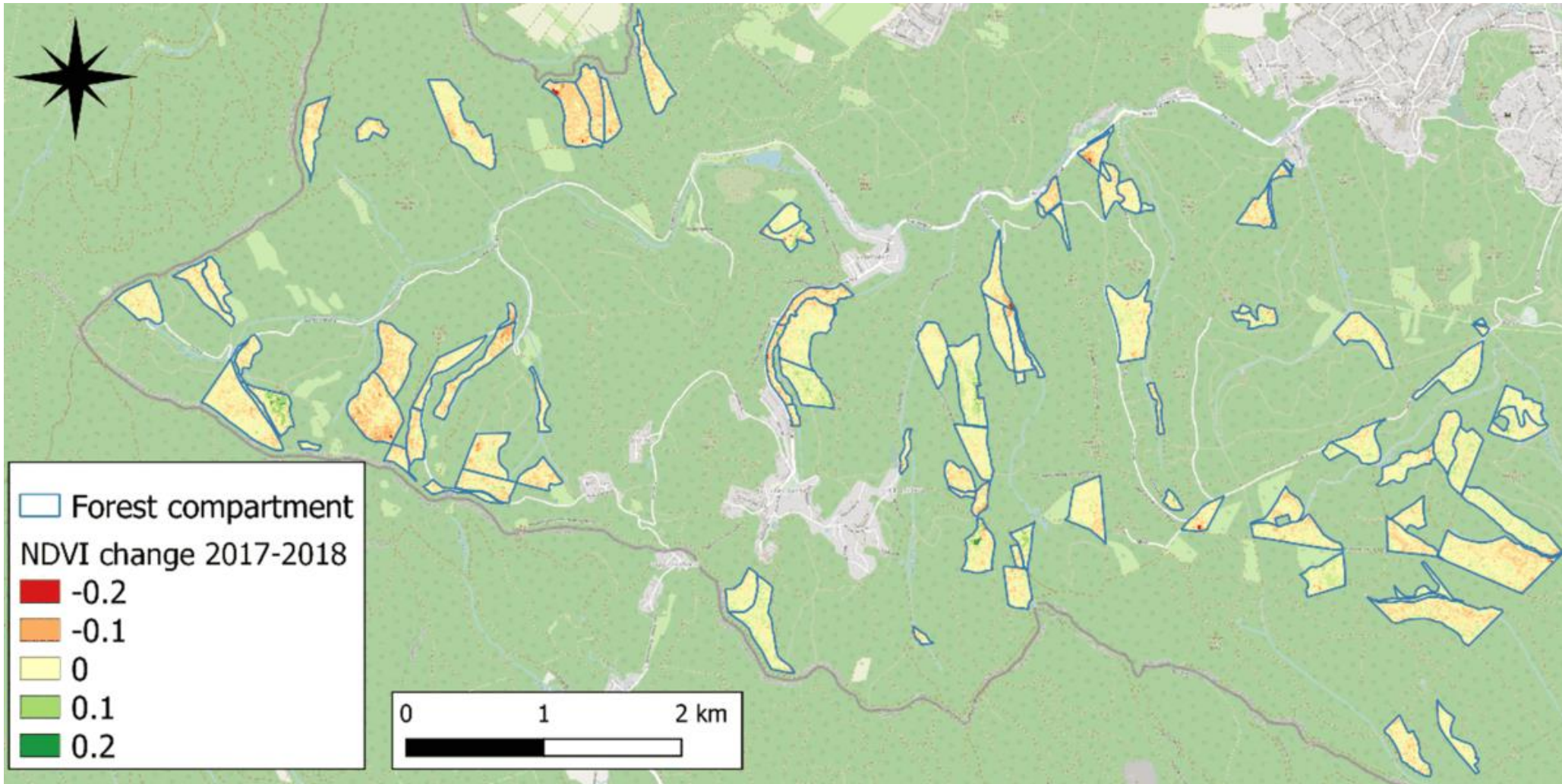
RGB camera

# Health issues of the Norway spruce (*Picea abies*)

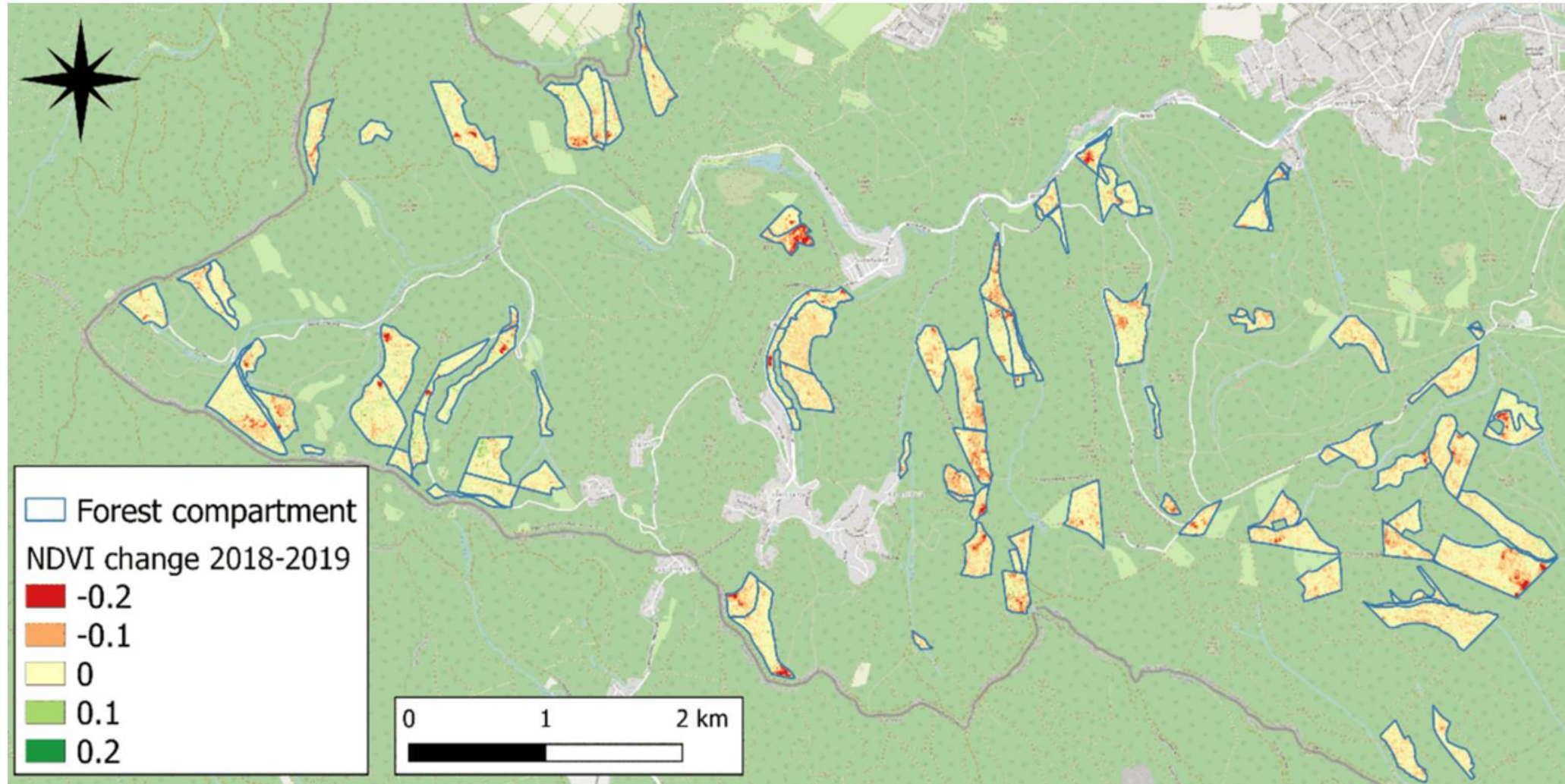
- More and more health problem of Norway spruce
- Planning the felling
- Determination of the area



# NDVI changes in Sopron Mountains 2017-2020

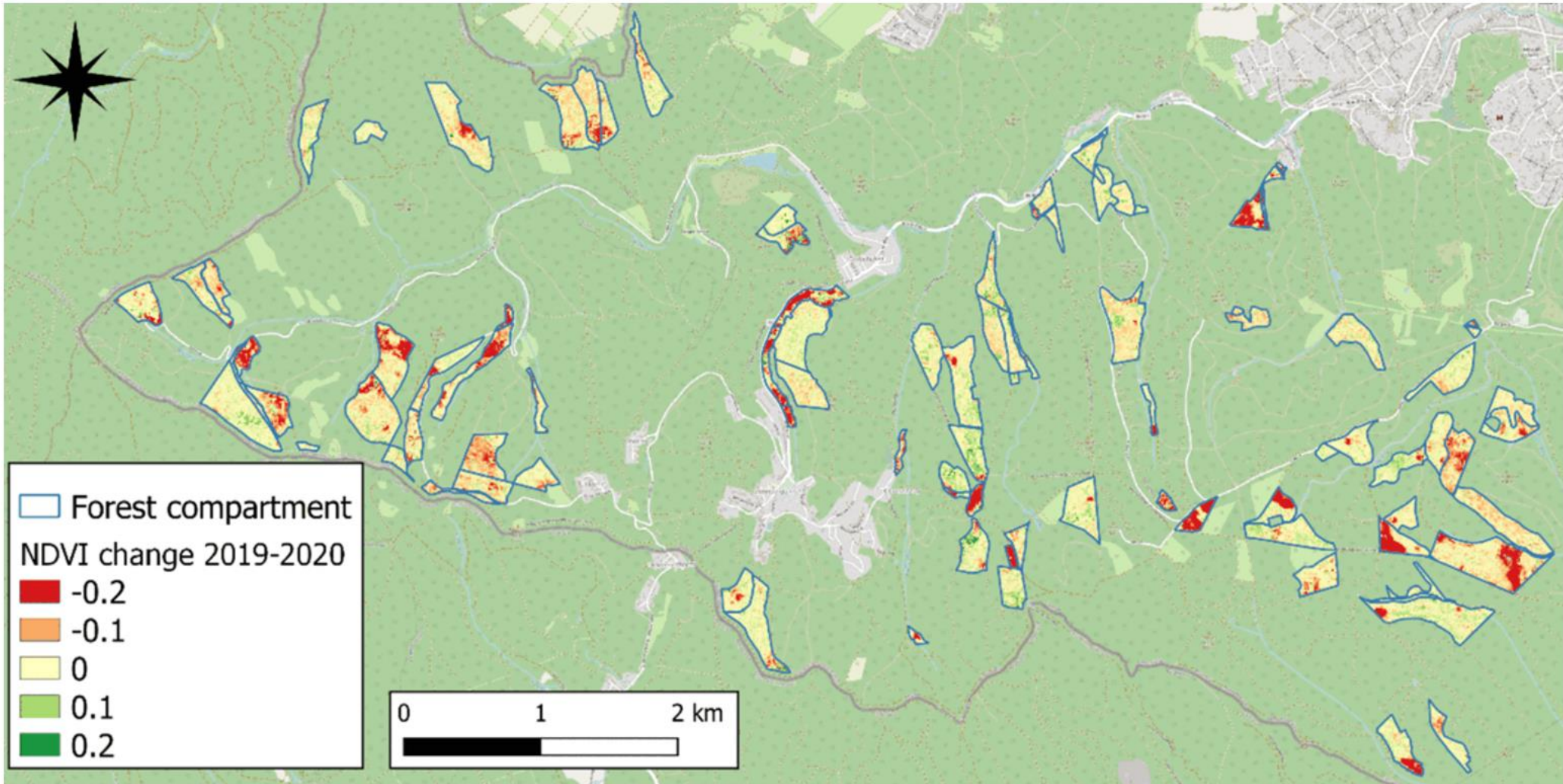


# NDVI changes in Sopron Mountains 2017-2020

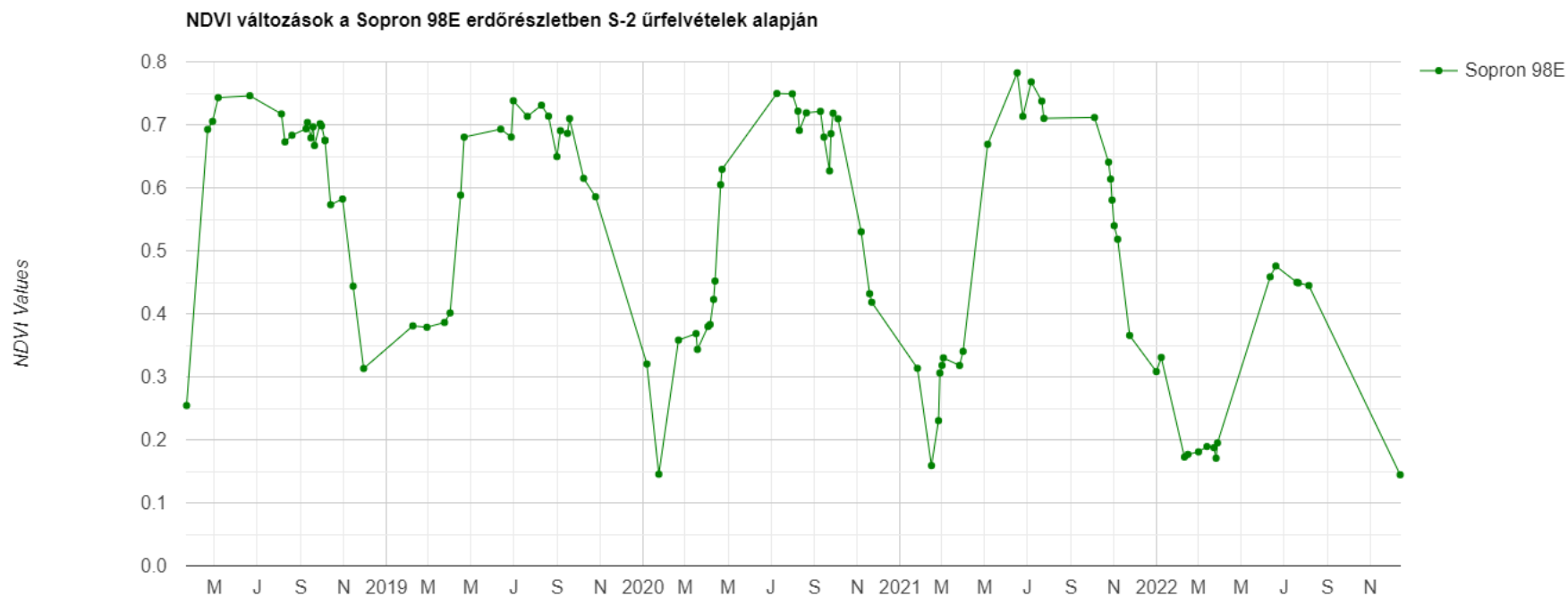




# NDVI changes in Sopron Mountains 2017-2020



# NDVI changes in Sopron 98F compartment 2018-2022



# Health issues of the Scots pine (*Pinus sylvestris*)

- Detected on Sentinel-2
- Surveyed by UAS
- Field sampled

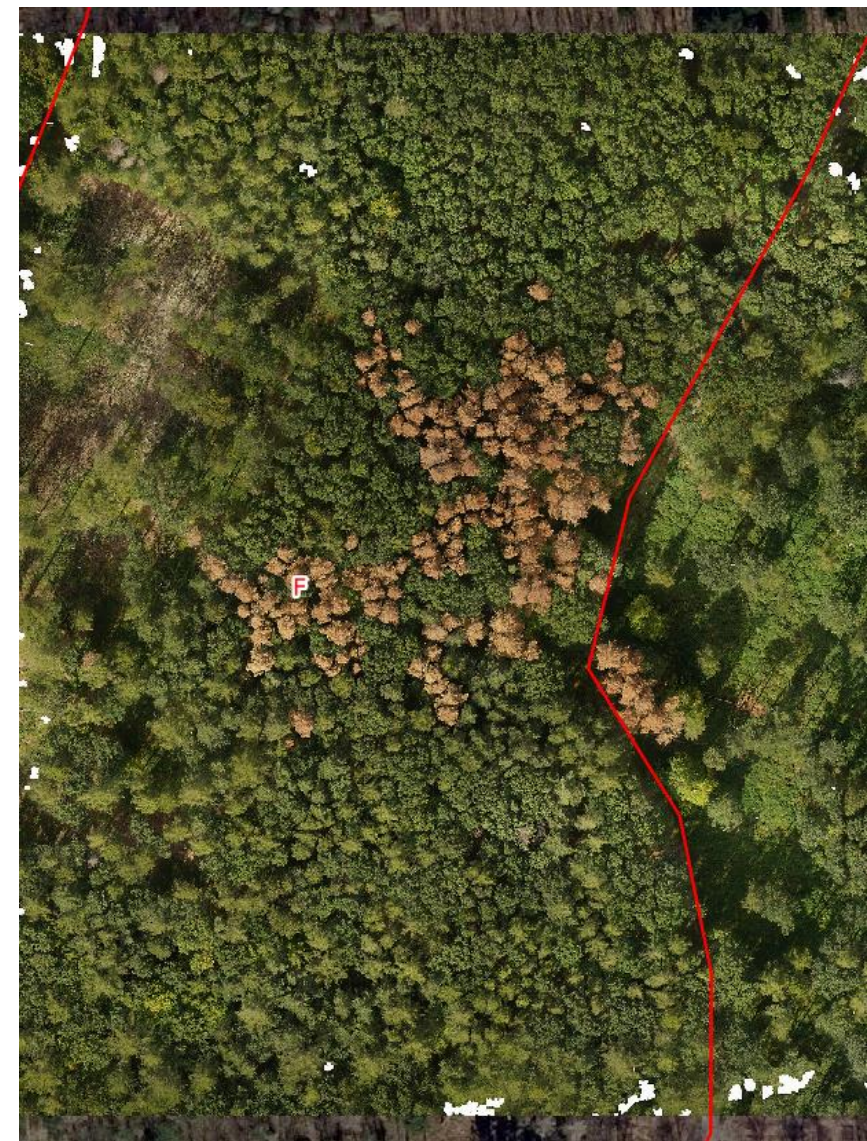




2020.03.20



2021.09.18



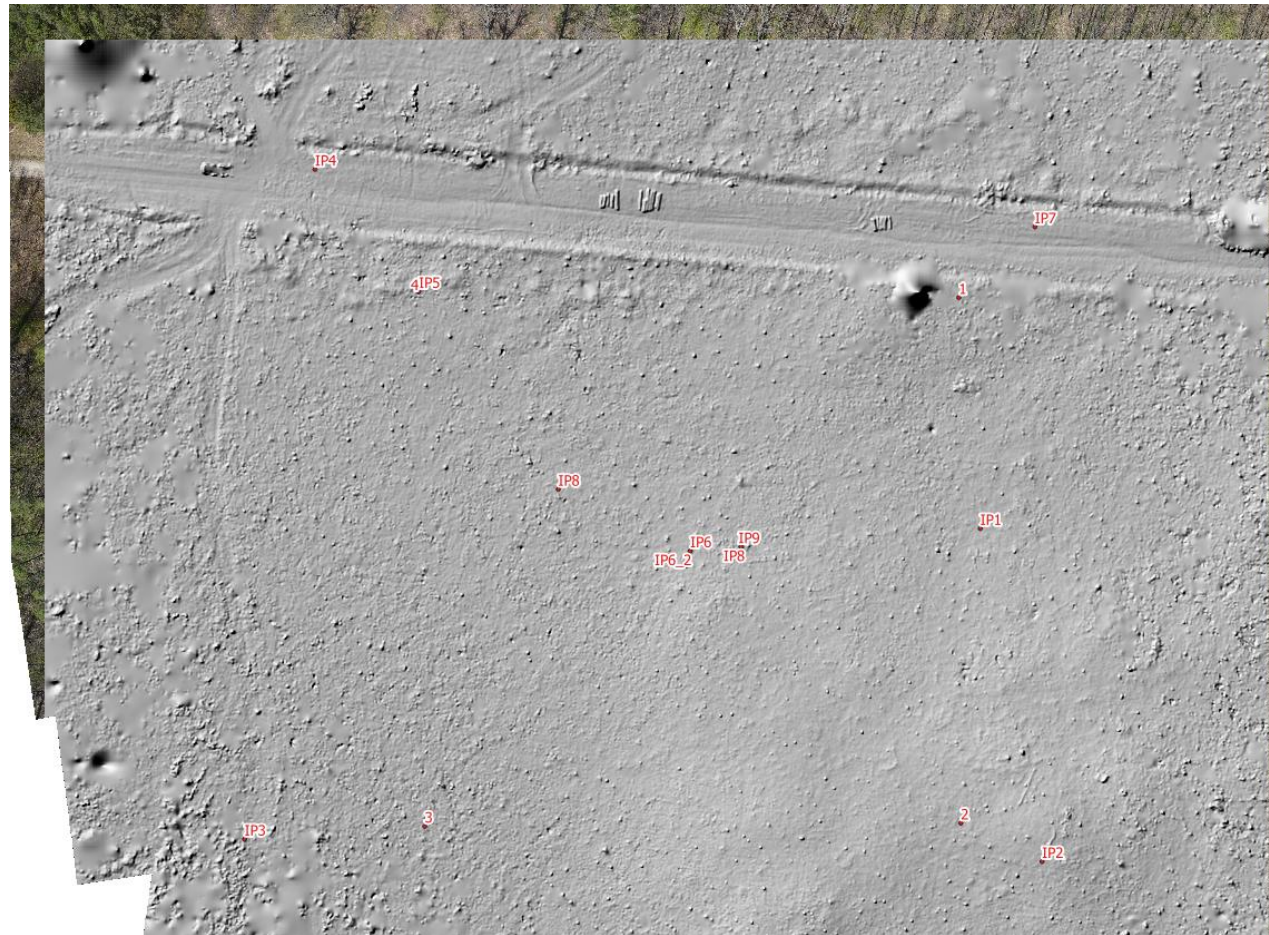
2021.09.18



- Sopron 98E: 11 trees
- Sopron 98F: 78 trees



# Sopron 105 M Marteloscope





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**Thank You for Your Attention!**

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