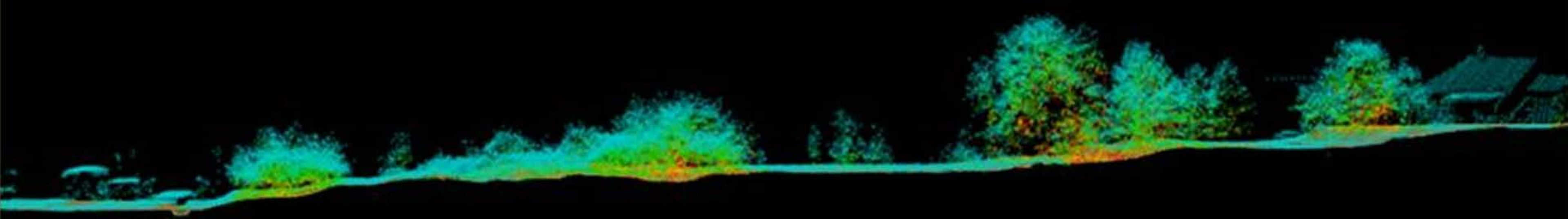

Airborne and Terrestrial Laser Scanning in Forestry

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Overview

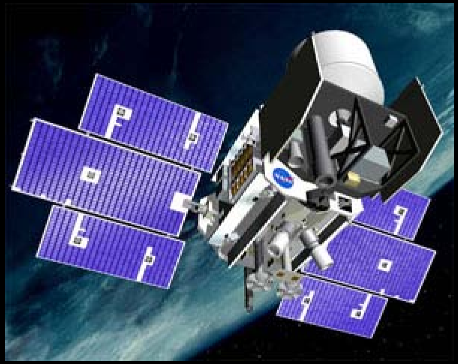
- Introduction
- Laser Scanning
  - Airborne
  - Terrestrial
- Forestry applications
- Ideas for cooperation

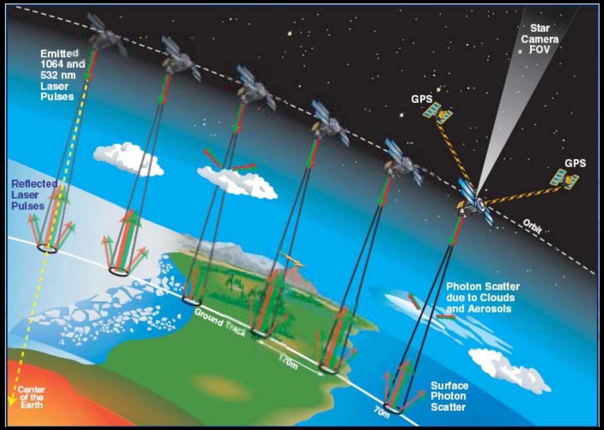
Department positioning

- University of West Hungary
  - Faculty of Forestry
    - Institute of Geomatics and Civil Engineering
      - Department of Surveying and Remote Sensing
      - Department of Forest Opening-Up
      - Department of Water Management
- Traditional surveying, GNSS, Photogrammetry, Remote Sensing and GIS sections
- Firsts
  - ALS in Hungary (Sarród, 2004)
  - TLS in forests in Hungary(ER-46, 2006)
  - Digital metric camera survey in Hungary (Fertő, 2007)

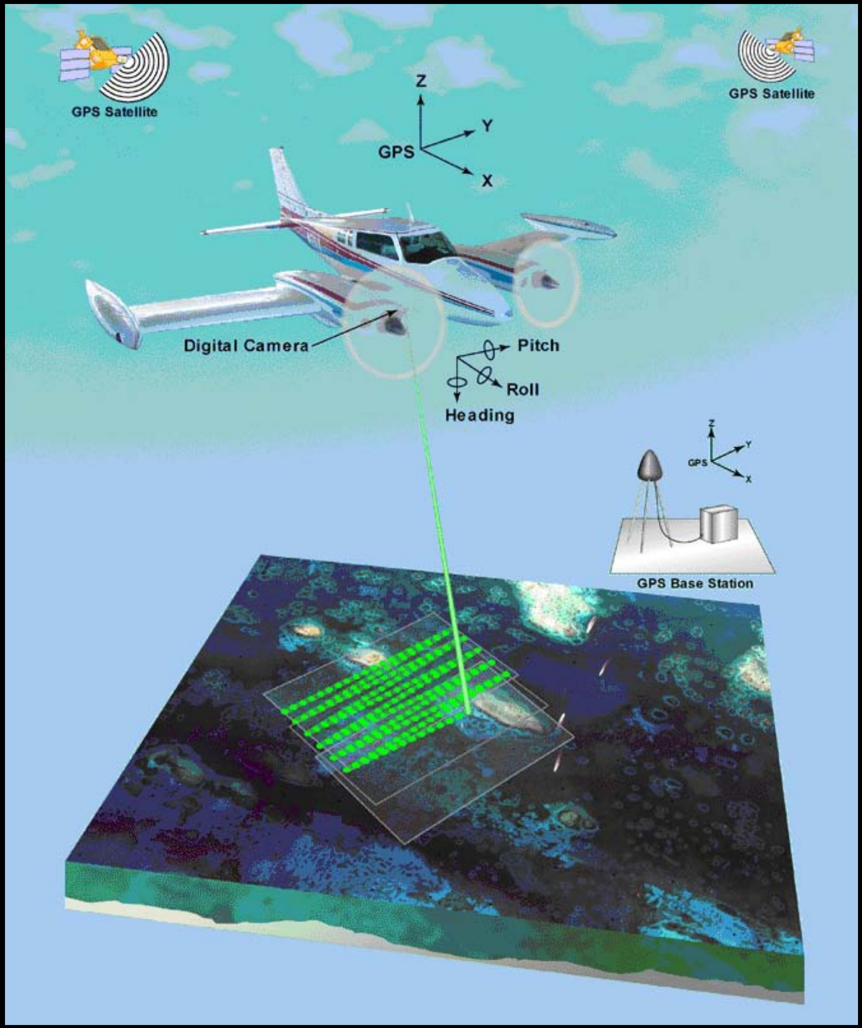
Laser scanning (LiDAR)

- Active RS technic
- Optical wavelength
- Series of distance measurements
- Scanning -> Imaging
- Spaceborne
- Airborne
- Mobile
- Terrestrial





Principles

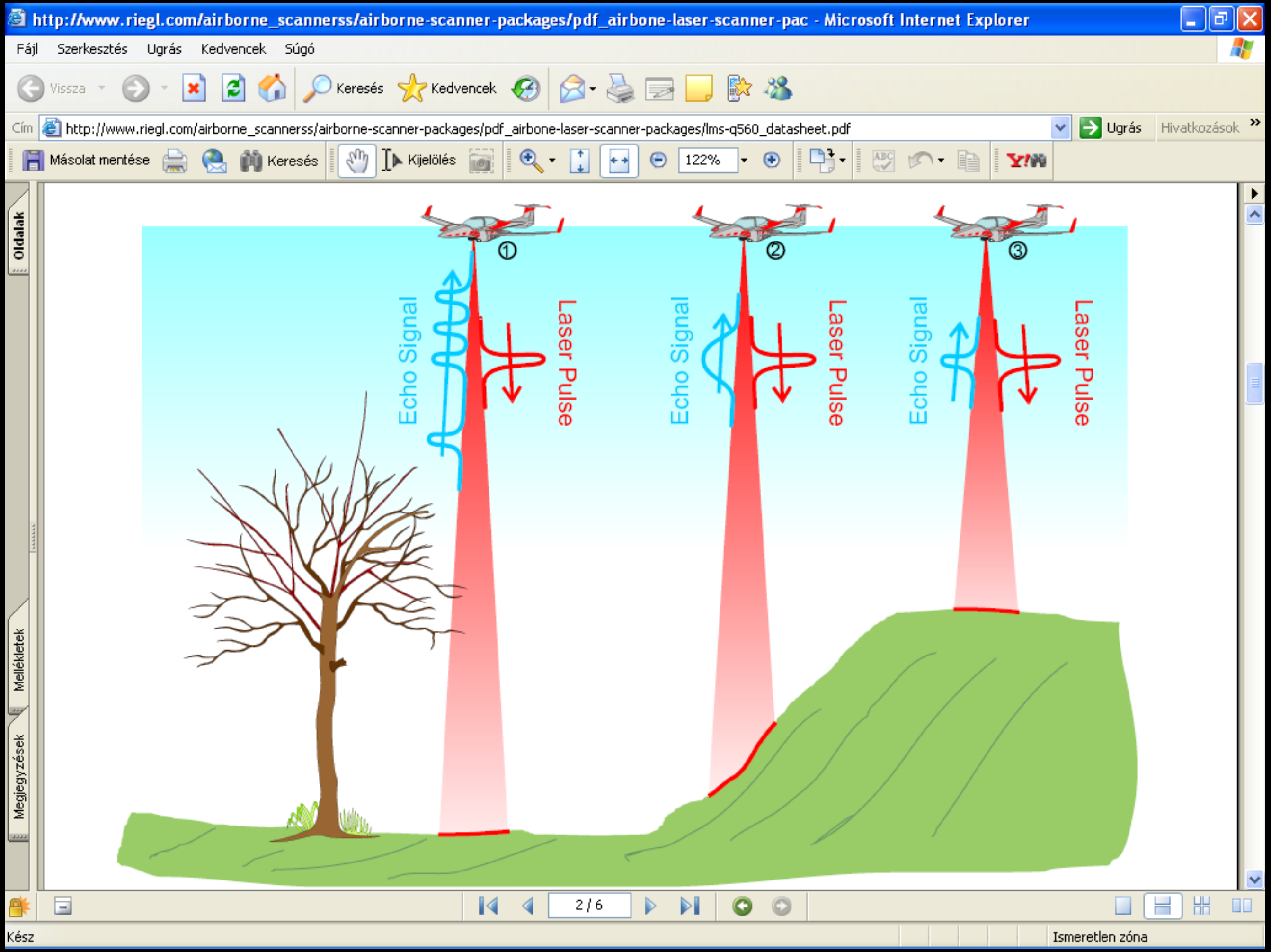


- Ranging
- Directions
- Position by GNSS
- Attitude by IMU

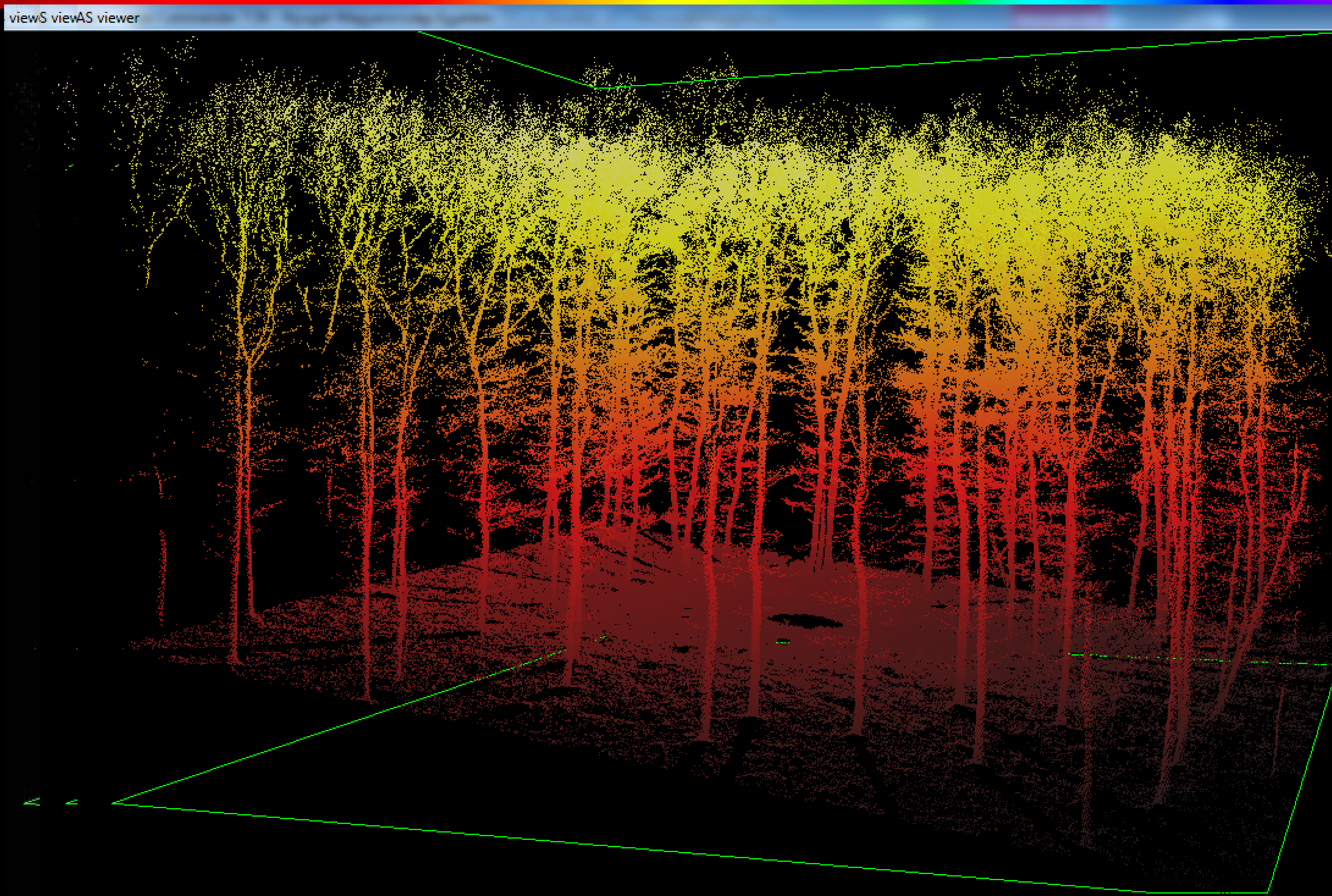
Full waveform

- Single pulse
- First/Last pulse
- 4-6 recorded pulses

- Full Waveform
  - More information
  - Information on the object



The pointcloud (X, Y, Z, I, R, G, B)



- Monitoring the forest in Danube floodplain area influenced by the hydro-power plant at Bős/Gabcikovo according to mutual obligatory cross-border commitments of Hungary and Slovakia

- Construction of hydro-power plant 1977-1992
- Complex monitoring since 1992

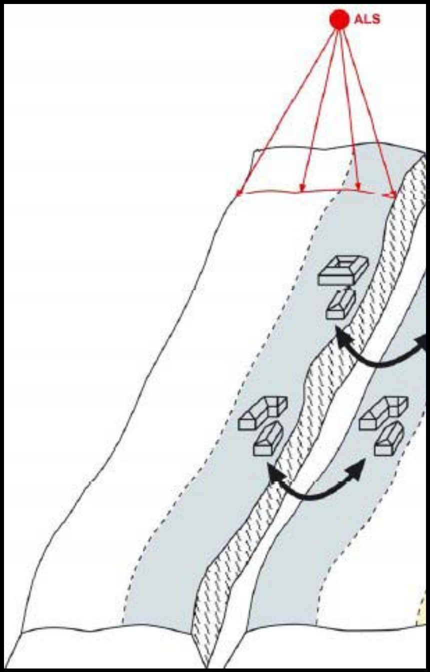
- 3D remote sensing technology
  - Airborne Laser Scanning – ALS or LiDAR
  - Very High Resolution Stereo Photogrammetry
  - Leaves-on and leaves-off flights

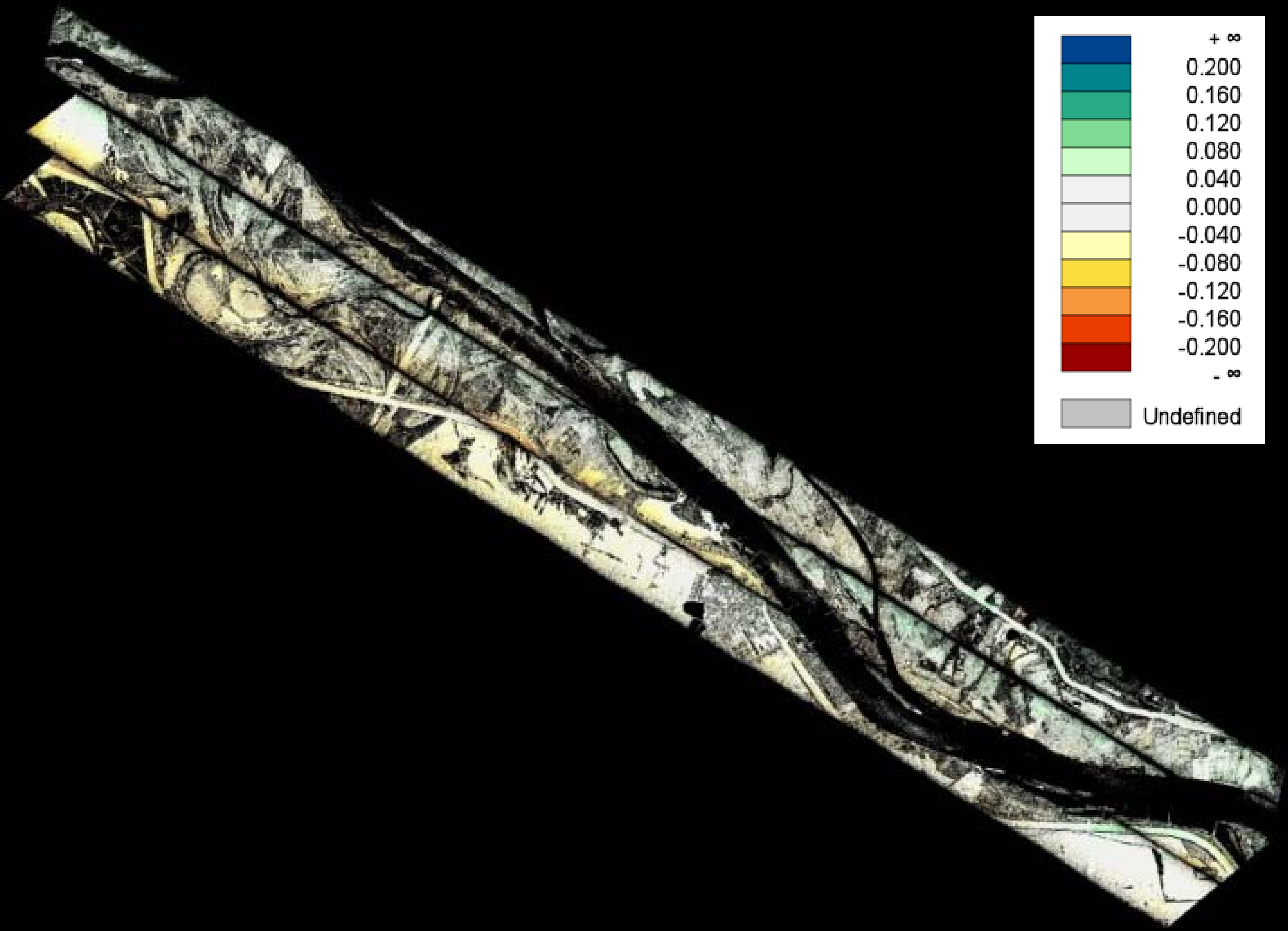
Methodology

- Planning the survey and getting the permission
- Execution of the survey
- Pre-processing
  - Filtering
  - Relative orientation
  - Absolute orientation
- Processing
  - Digital Surface Model (DSM)
  - Digital Terrain Model (DTM)
  - normalised Digital Surface Model (nDSM)
- Forest parameters extraction
  - Area-based methods
    - Stand heights
    - Crown closure
    - Stem density
  - Individual tree based methods
    - Single tree heights
    - Crown projection area

INMEIN project (HUSK/1101/1.2.1/0141)
Execution of the survey: 2013.09.08.

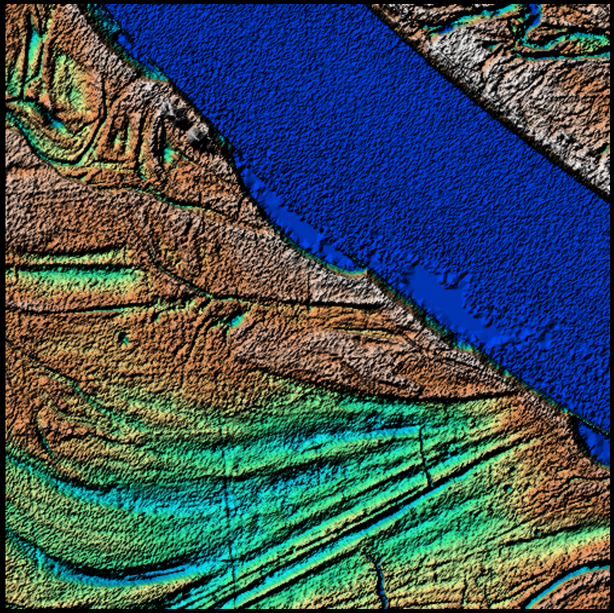
Relative orientation





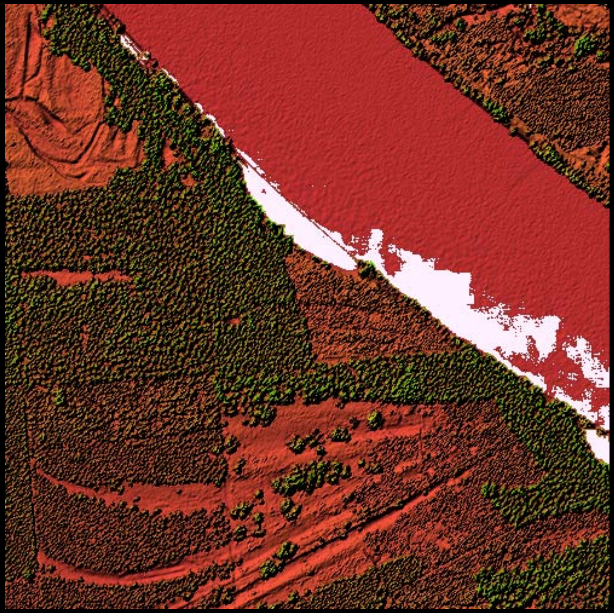
Digital Elevation Models

Digital Terrain Model DTM



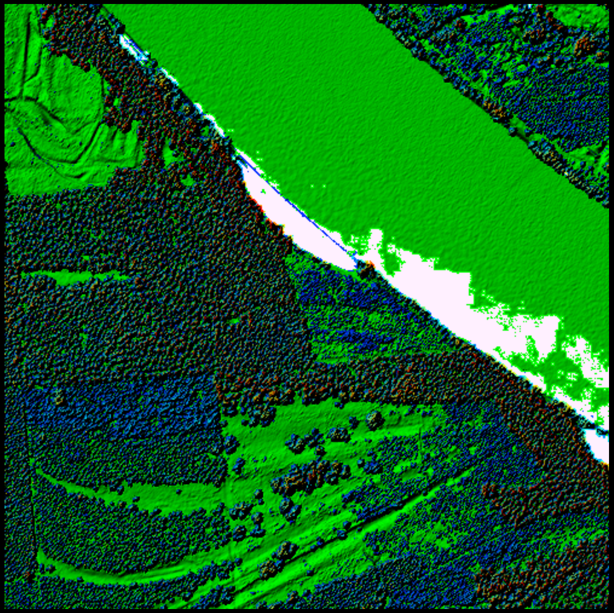
- Adaptive TIN method

Digital Surface Model DSM



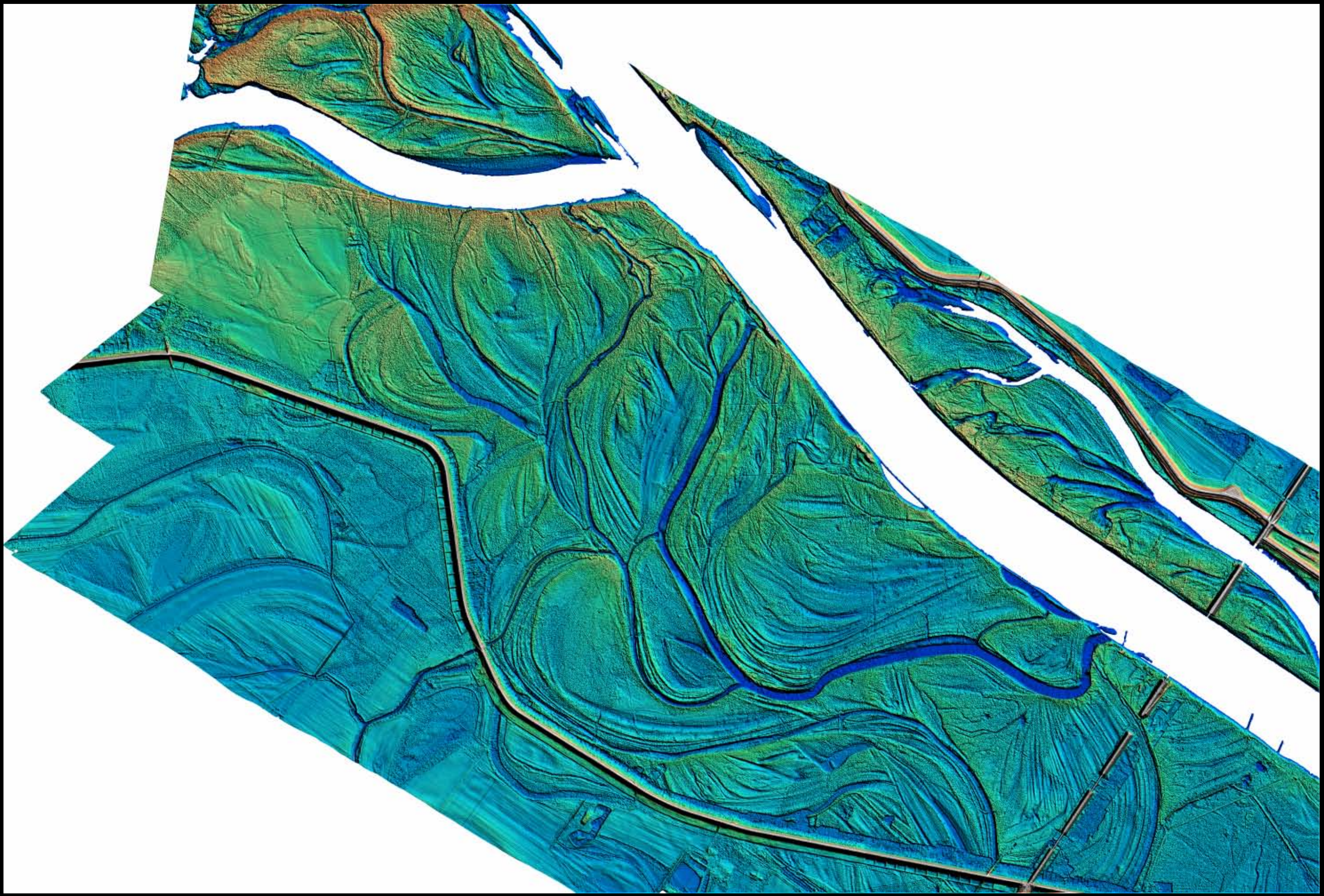
- Fitting parabola method

Normalised Digital Surface Model – nDSM

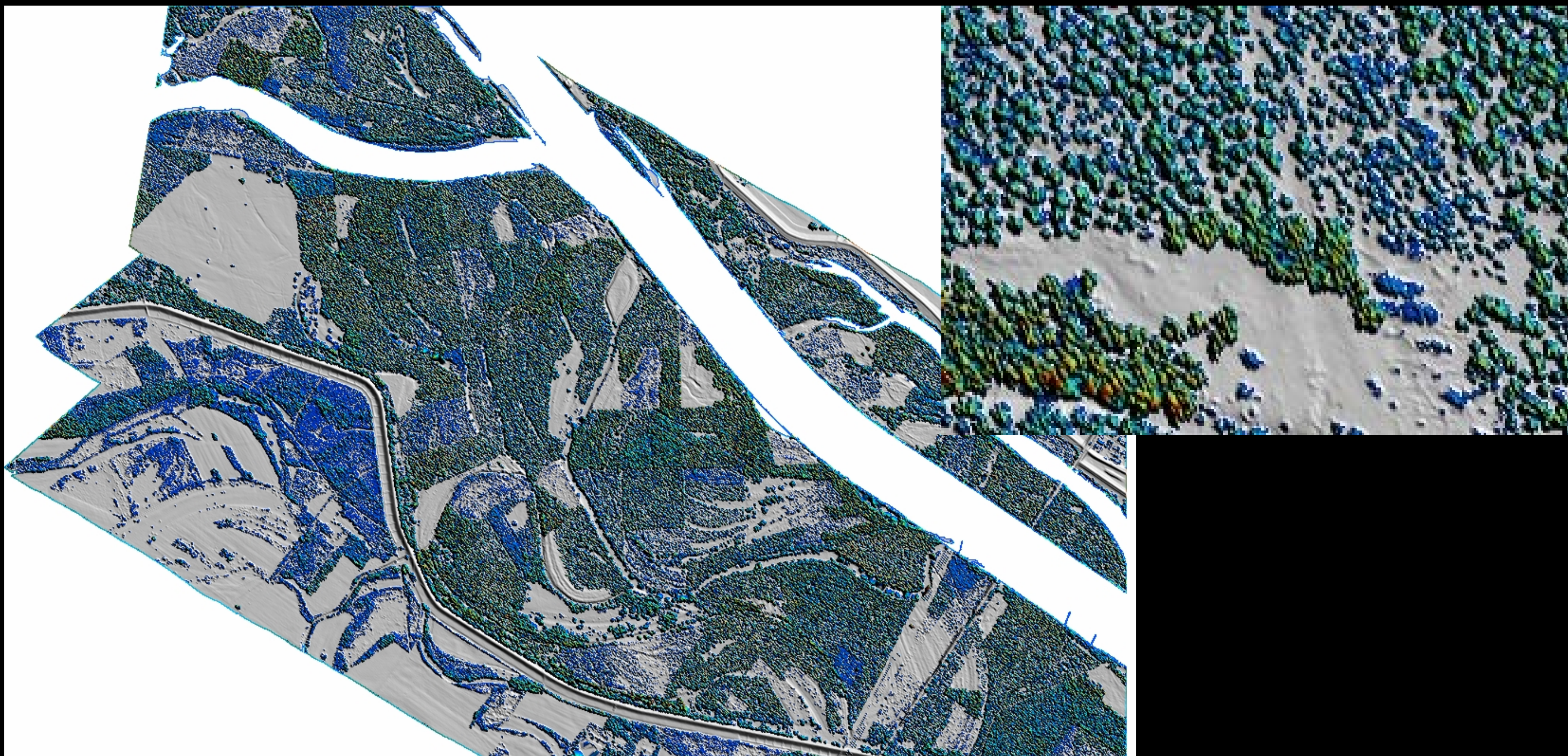


nDSM = DSM-DTM

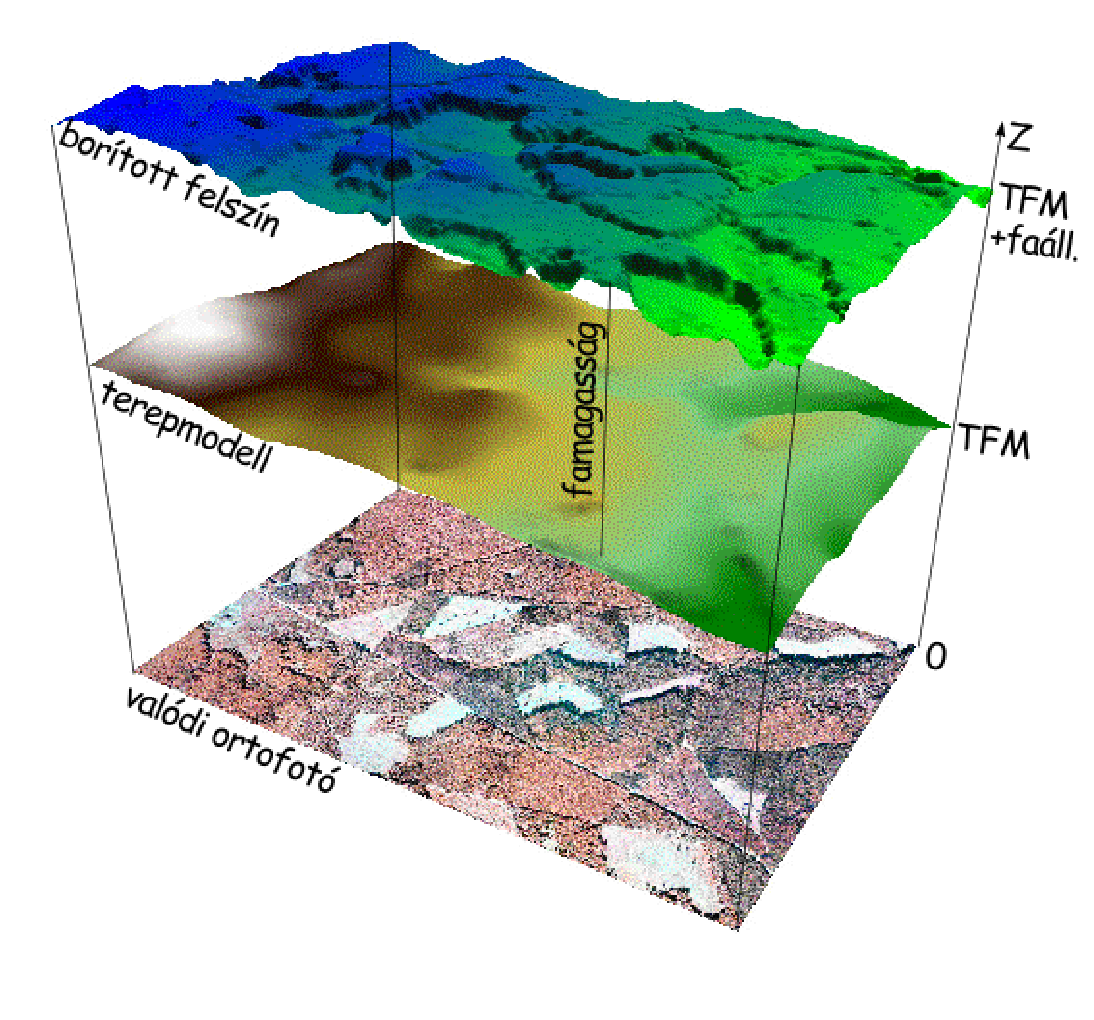
Digital Terrain Model (DTM)



Normalised Digital Surface Model (nDSM) and its detail



Normalised Digital Surface Model, Canopy Height Model (nDSM – CHM)



$$nDSM = DSM - DTM$$

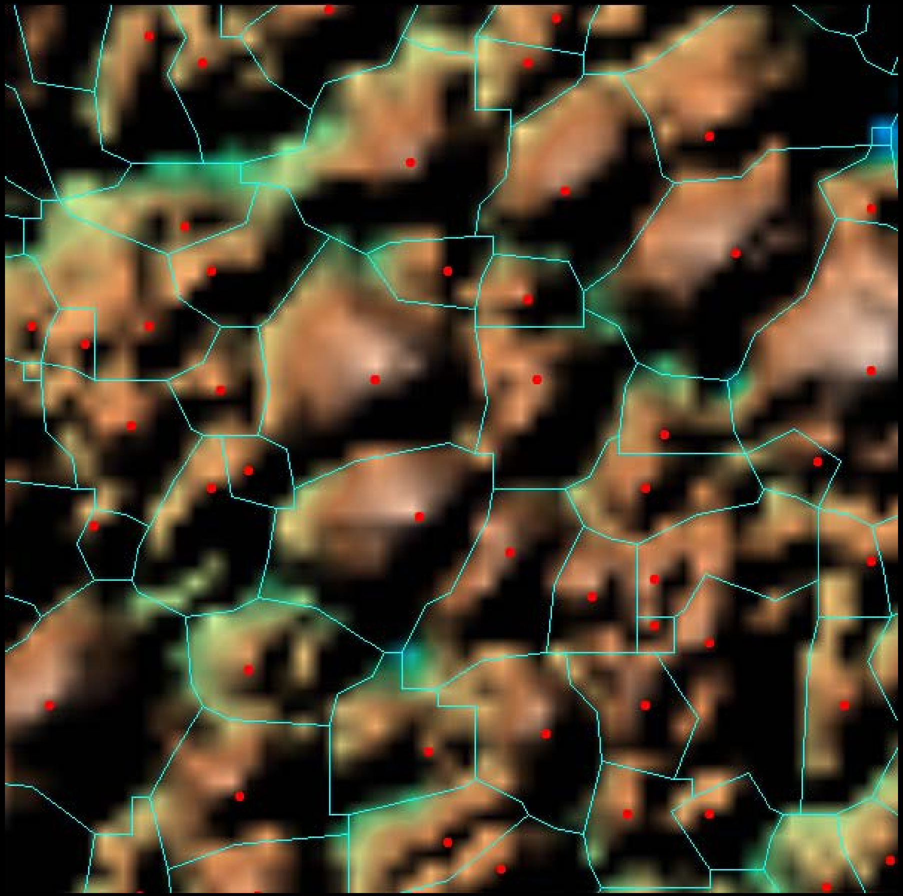
$$V = F_c \cdot G_c \cdot H$$

where:
V: Volume of the stand (m^3)
F_c: form number for crown projection area
G_c: Sum of crown projection area (m^2)
H: average stand height (m)

Segmentation of the crowns

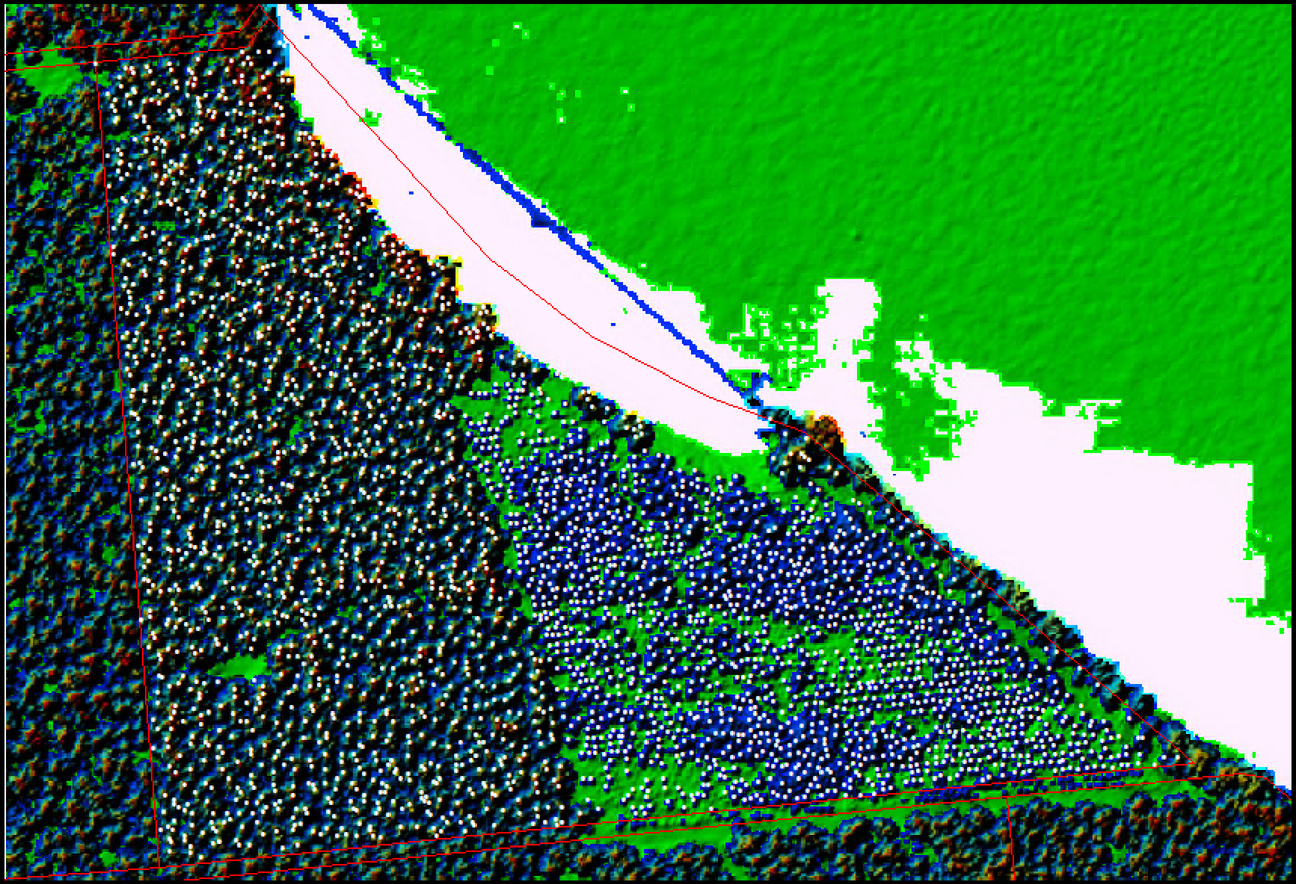
- Inverse watershed modelling
  - Jenson and Domingue 1988
  - Gougeon 1995
  - Hyyppä, Inkinen 1999

- Sinkpoints -> tip
- Watershed -> crown

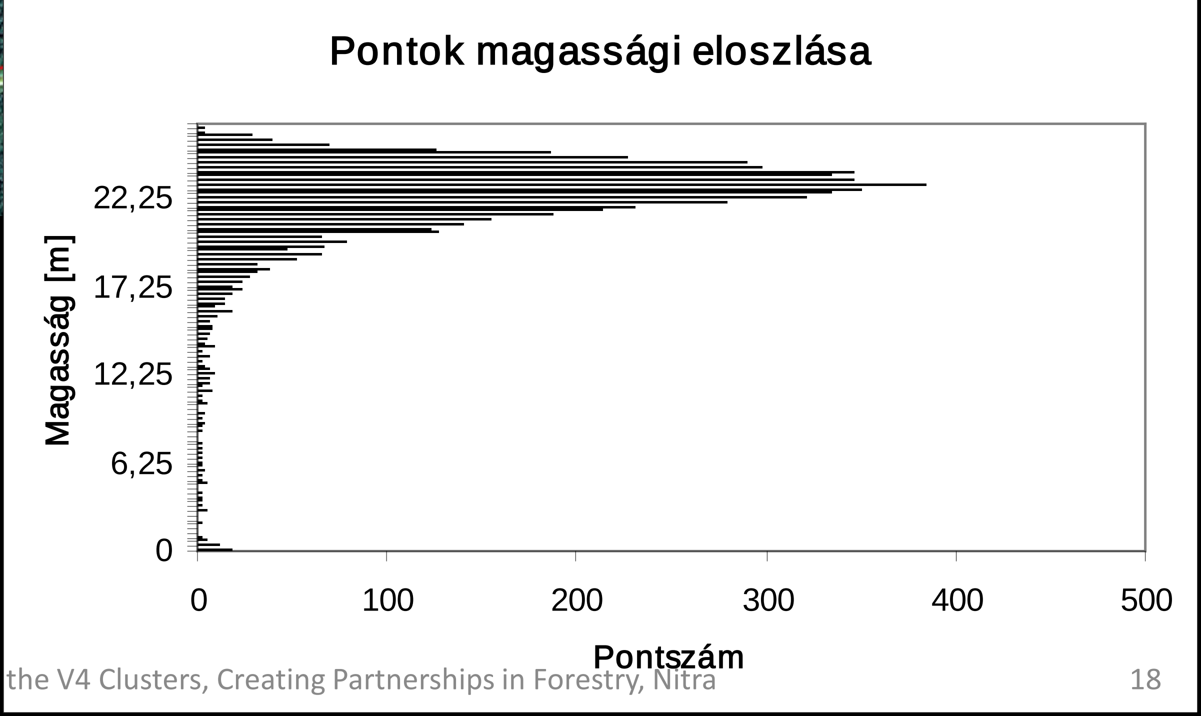


Results
Number of trees

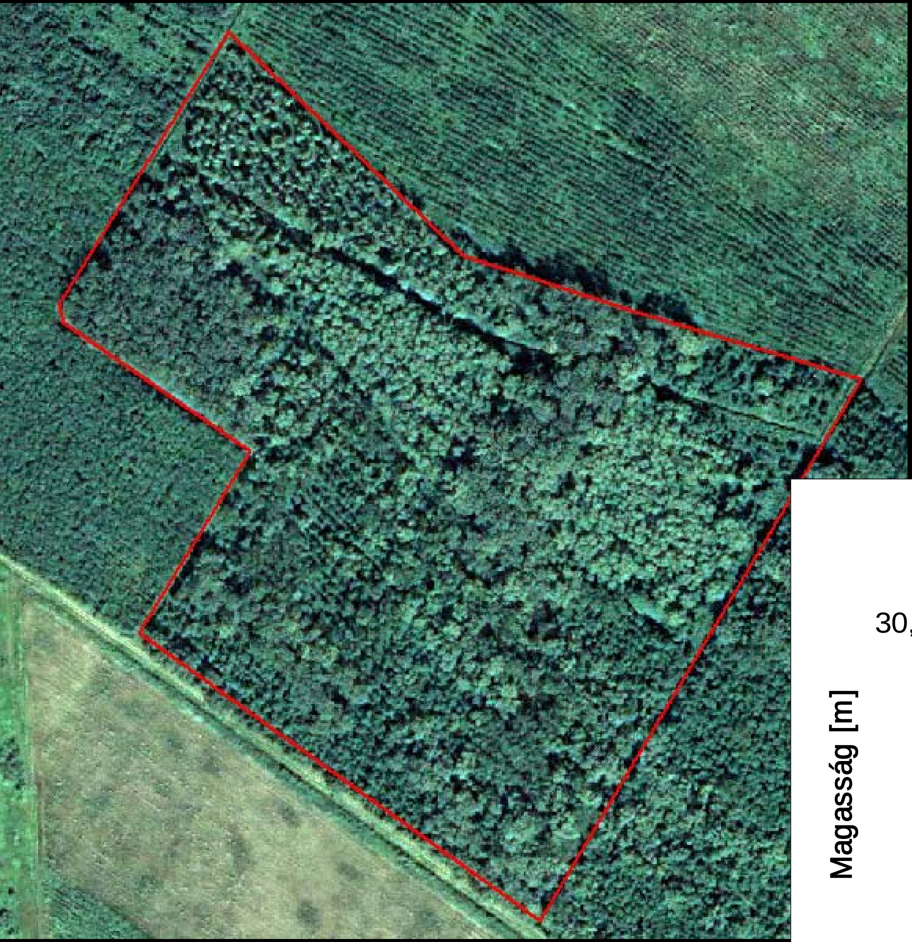
- Old stand:
  - 383 (227)
- Reforestation:
  - 582 (100)

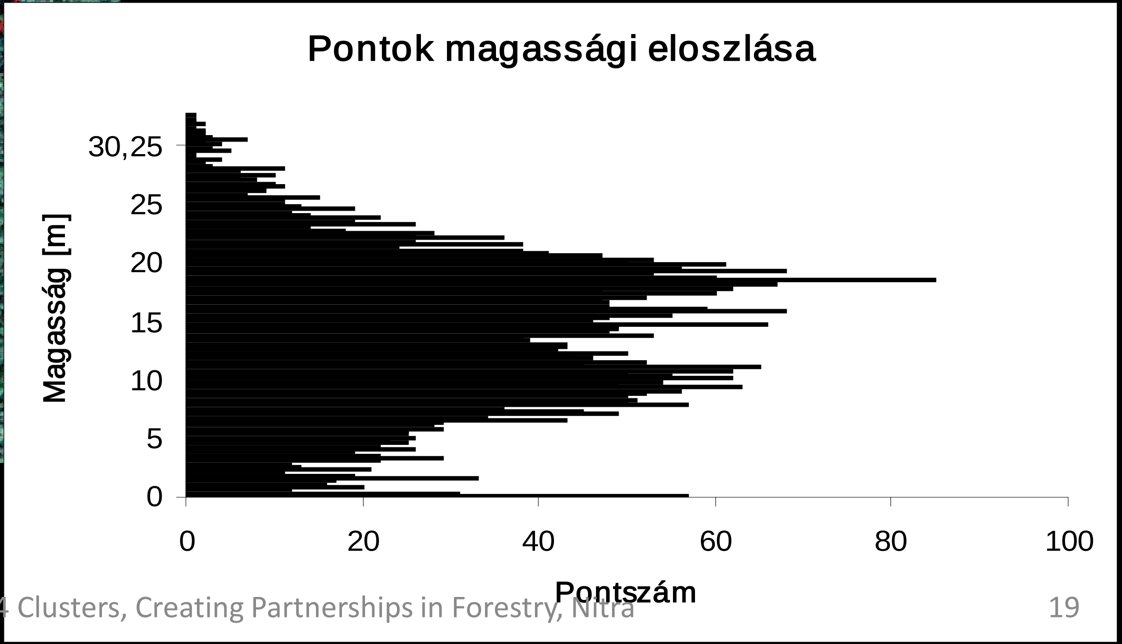


Vertical distribution of the points



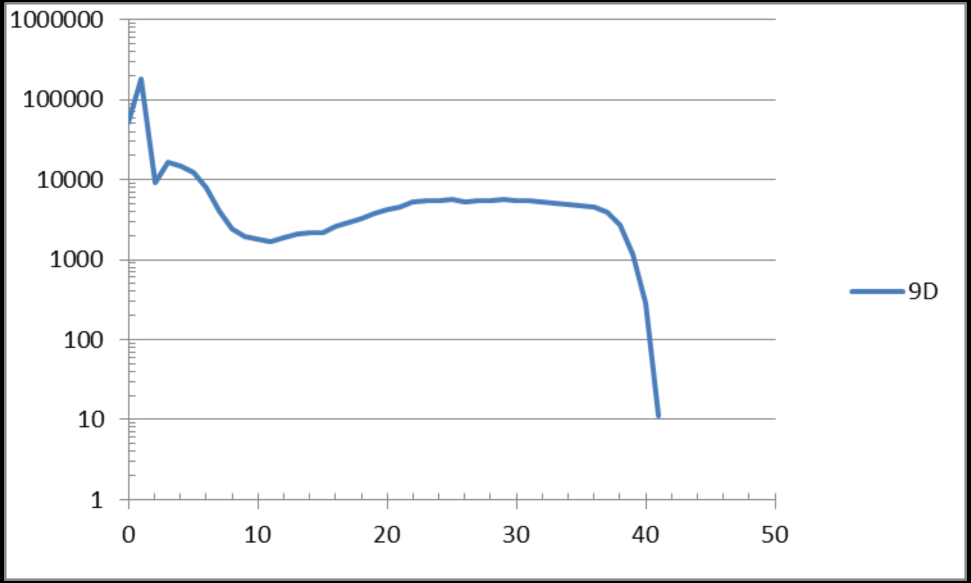
Vertical distribution of the points



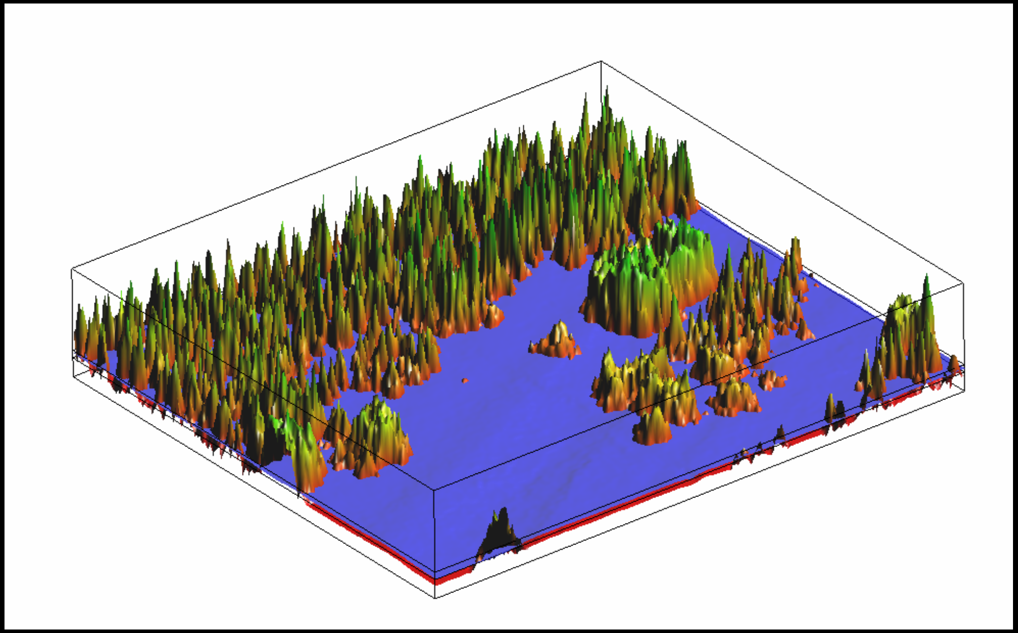


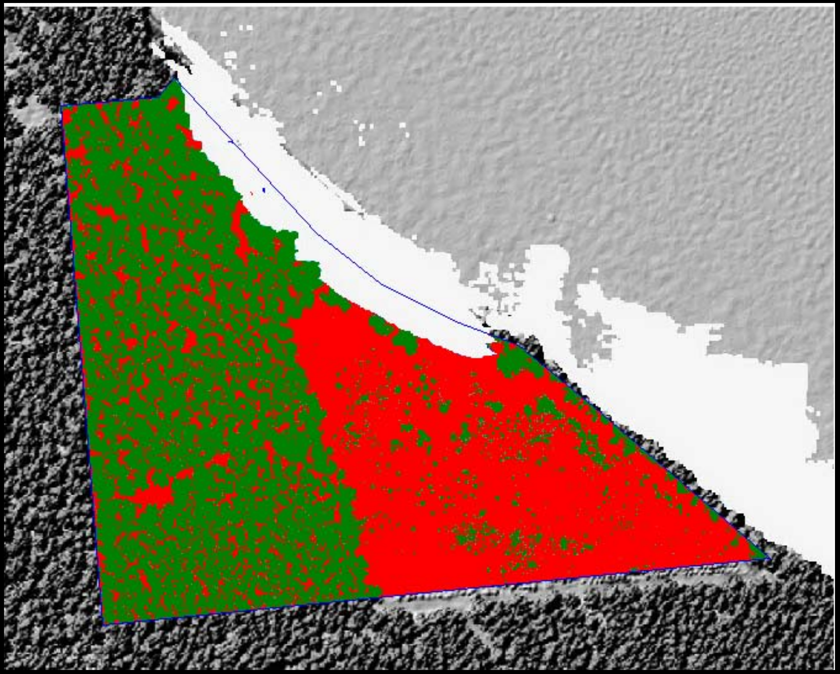
Results
Forest stand height

- Distribution of the relative heights of the points
- 90% perc:
  - 29.25 m (39 m/34 m)
- Delineation of sub-stands



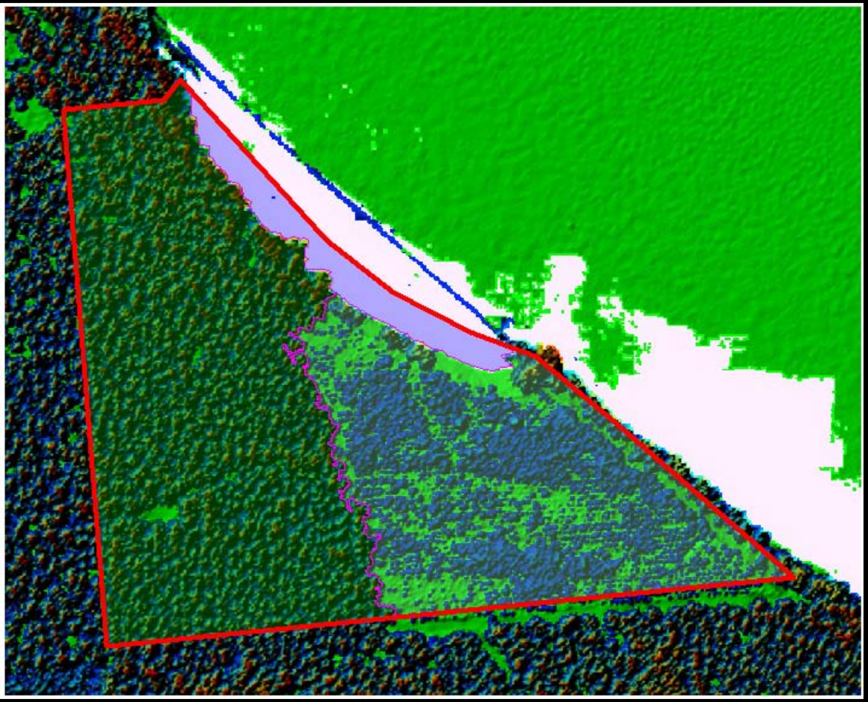
Results
Crown-closure



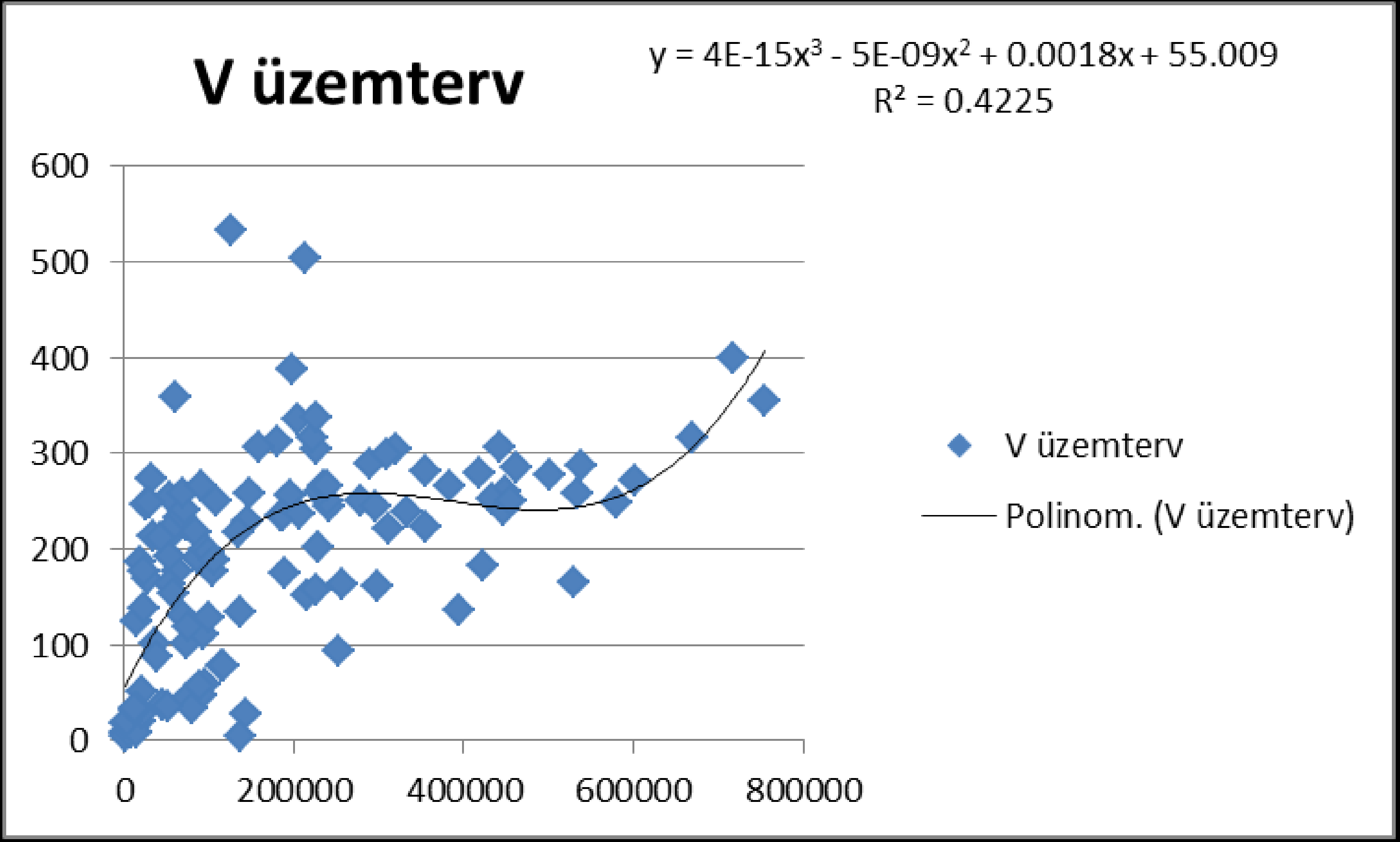


Results
Delineation of sub-stands

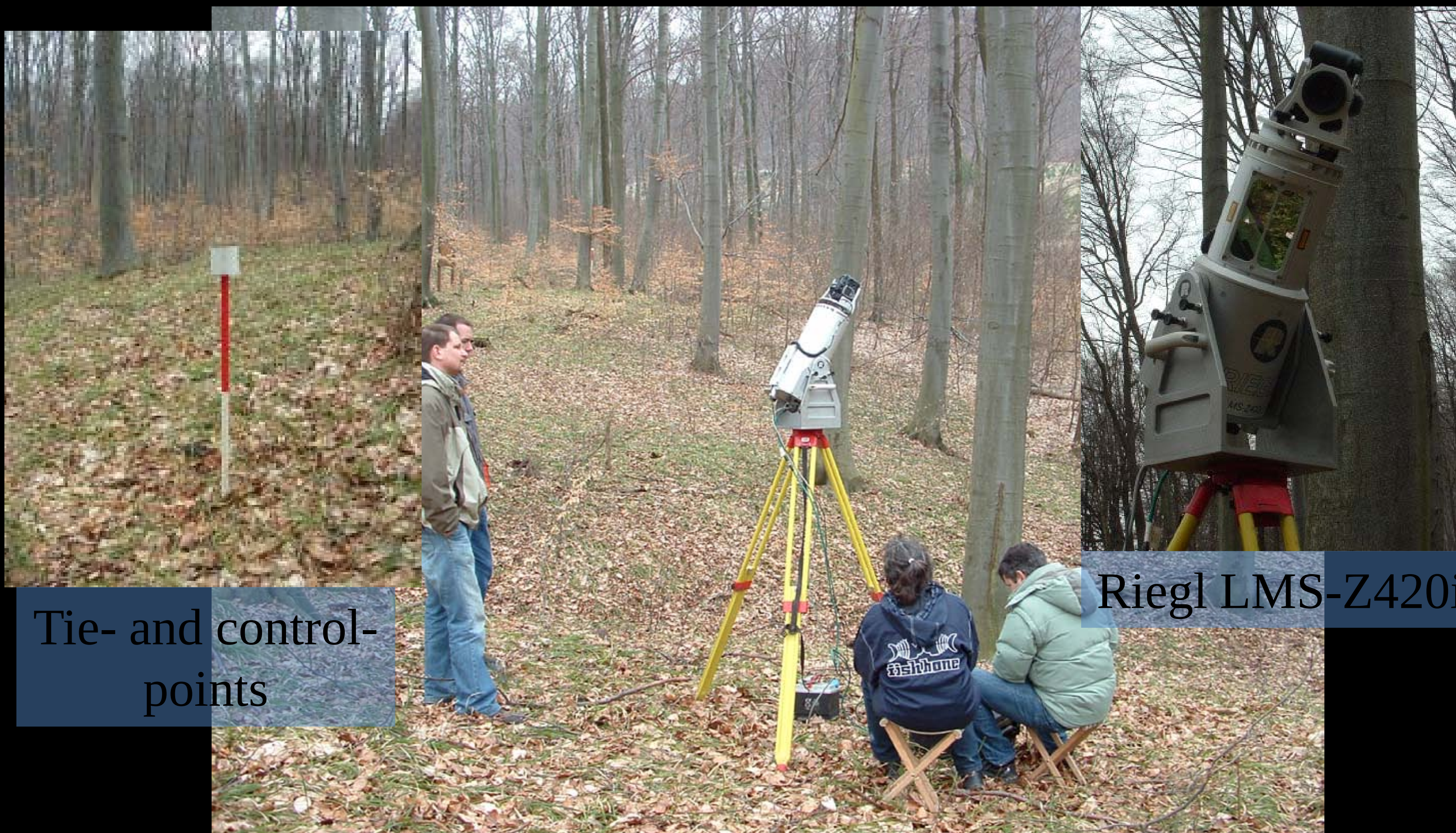
Name	Area (m2)
Old stand	40 709
Reforestation	28 665
Water	4 103
Sum	73 477



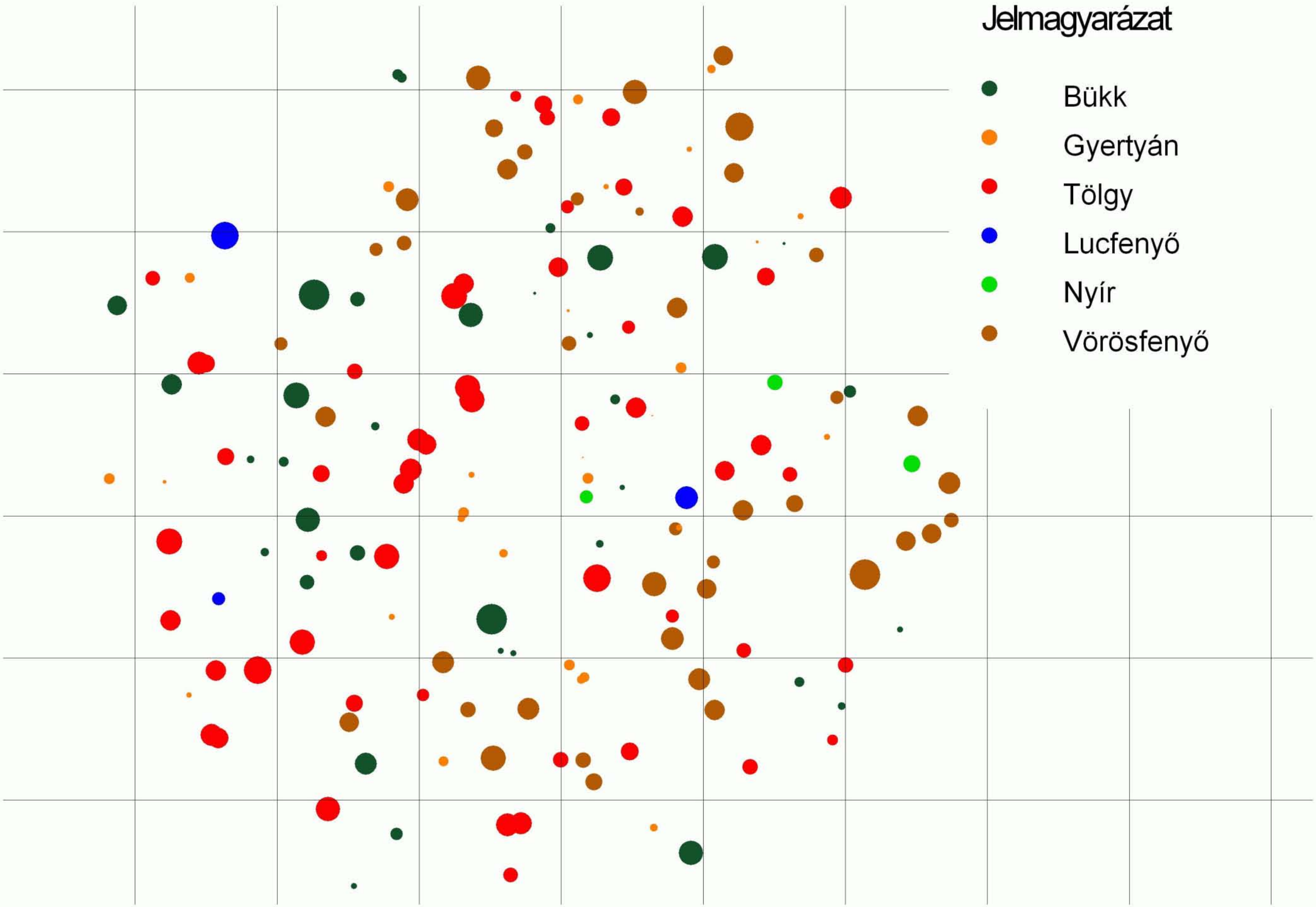
Results
Volume



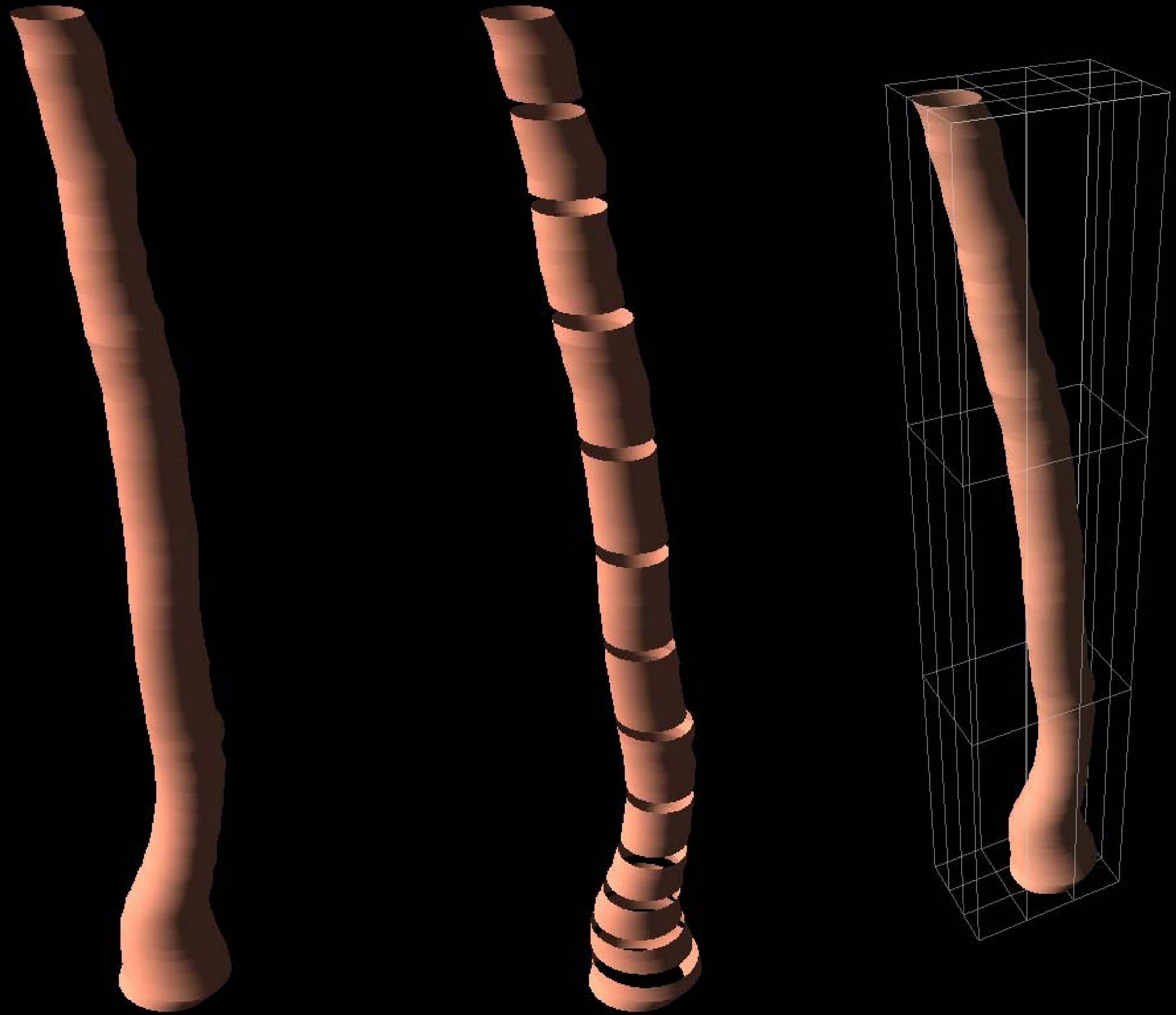
Performing a terrestrial laser scanning (TLS) survey




Z
Y
X



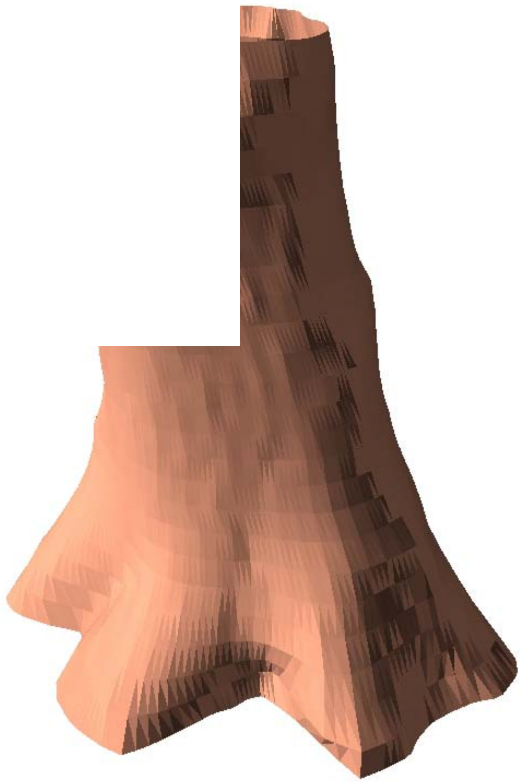
Jelmagyarázat
Bükk
Gyertyán
Tölgy
Lucfenyő
Nyír
Vörösfenyő



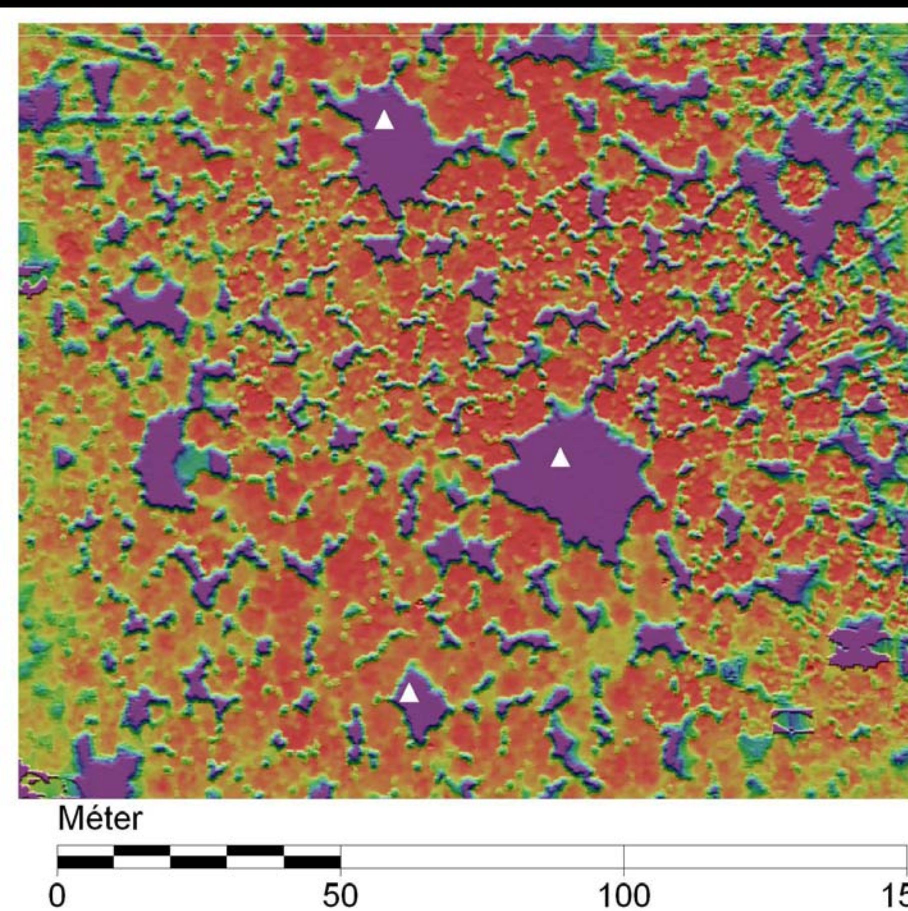
Modelling single trees
Volume of single trees

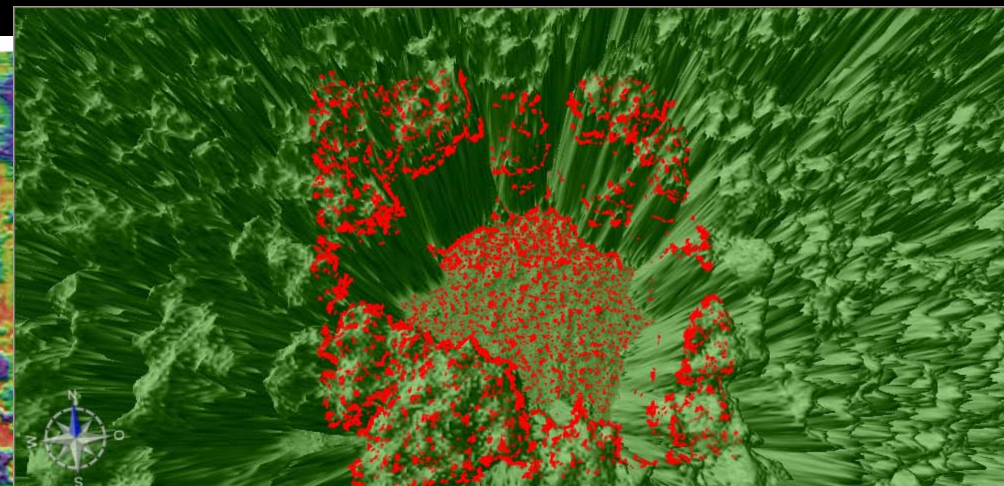
$$v = f \cdot g \cdot h$$

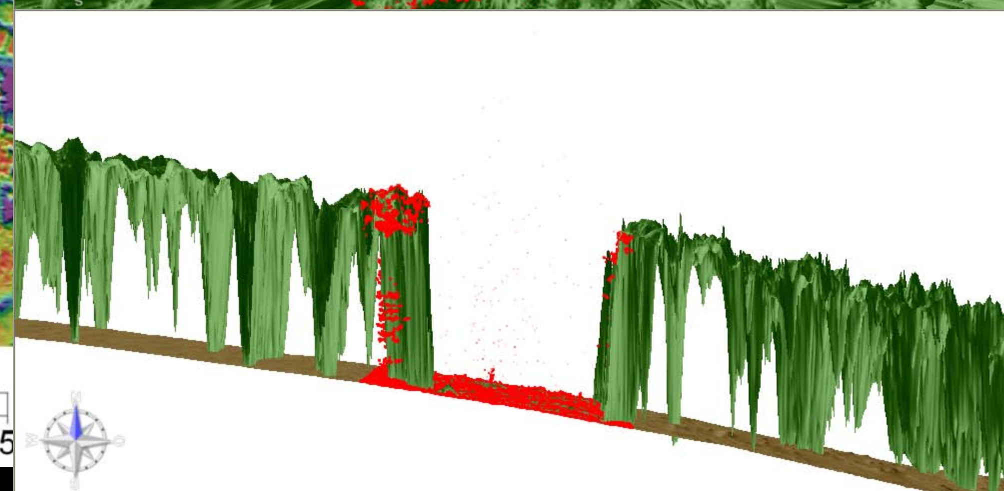
v (0.1-10m) = 1.59926 m3
v (cylinder 1.3) = 1.71462 m3
f1.3 = 0.9327



Digital Surface Model (DSM)







Ideas for cooperation

- Improved inventory information on the forests
- Monitoring
- Modelling
  - Forests
  - Water / Flood
  - Forest – water interactions

- Danube strategy
- Ecology of riparian forests, green and blue infrastructure (GMES)

Forest modelling

Classic clear-cut management

- Single tree
  - Height
  - Volume
- Forest stand
  - Height
  - volume

Continuous forest cover

- Forest stand dynamic
  - Gaps
- Ecological needs
- Answers for changing sources (climate change)

Acknowledgements:

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