Committee on the Peaceful Uses of Outer Space
Forty-ninth session, Vienna, 7 – 16 June 2006

Symposium

„SPACE AND FORESTS”

Applications of RS data in forestry

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Introduction

- RS applications in forestry
  - When did the forestry RS applications begin?
    - As the first satellite images acquired, foresters tried to use these new data to solve many tasks regarding forests:
      - Forest mapping (wooded area)
      - Disease detection (fire, storm disease)
      - Forest area monitoring
      - Forest management data (timber species composition, structure, age, stocking, diameter, height, quality, health, crown cover, canopy closure, biomass, leaf area index, mean annual increment)

Introduction

- RS applications in forestry
  - Which types of satellite data can be used to fulfil the above mentioned tasks?
    - The low resolution data (e.g. NOAA AVHRR) are suitable for mapping or change detecting forests in very large areas,
    - The medium resolution data (e.g. Landsat, SPOT, IRS) are suitable for more detailed mapping of forest areas,
    - With VHR data (IKONOS, QuickBird) we can make maps for forest managements with very detailed parameters.

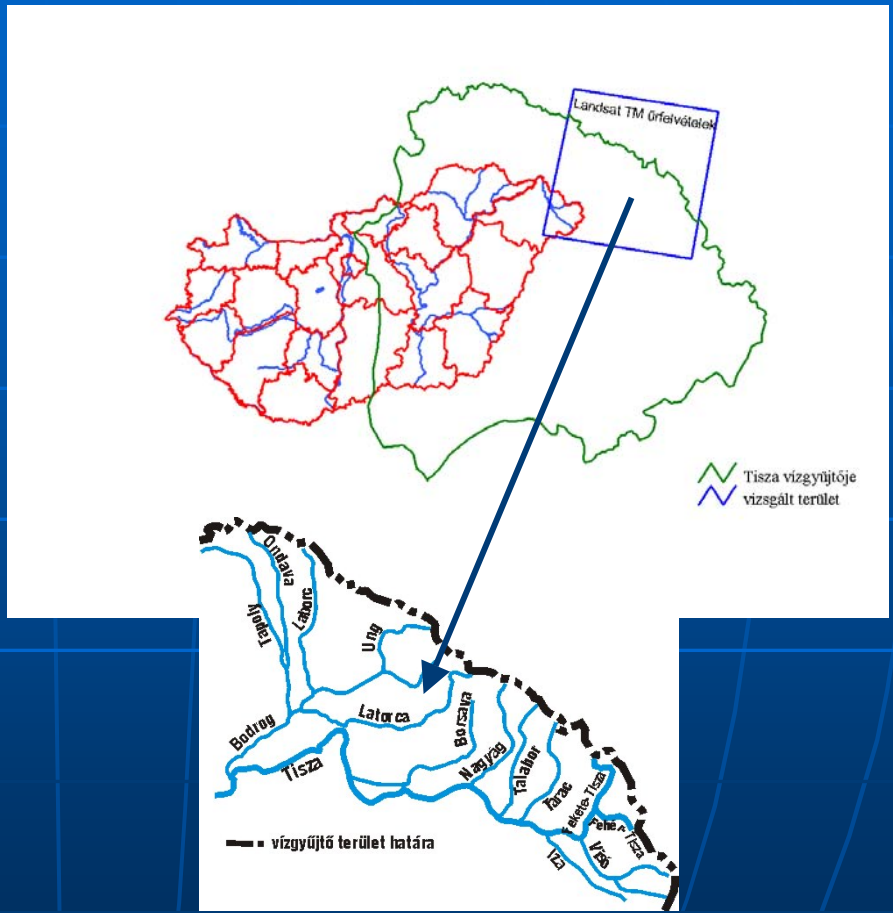
Case studies

- Changes in forest coverage for the area most likely affecting the Tisza river floods by using medium resolution satellite imagery (e.g. Landsat TM and ETM+) and for the whole catchment area using small resolution satellite imagery (e.g. NOAA AVHRR).

- Application of VHR RS data (IKONOS) for mapping of forest management needs.

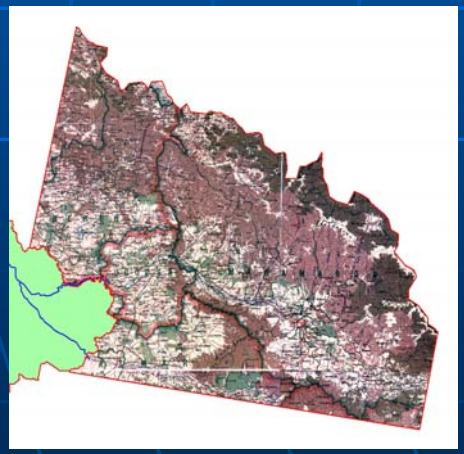
Area of investigation

- Forest changing of Carpathian basin by using of NOAA AVHRR data (1x1 km/pixel)
- Forest changing of the upper Tisza region and its tributary streams area by using Landsat TM data (30x30 m/pixel)

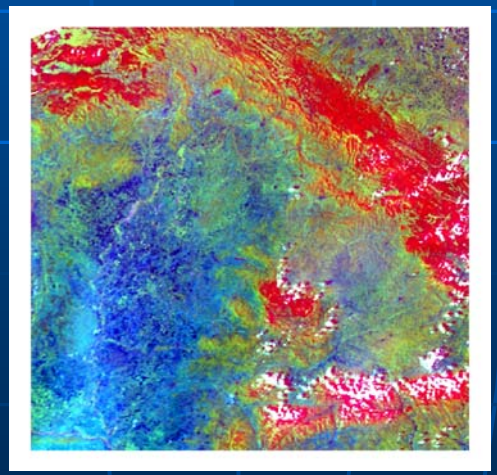


Data sources

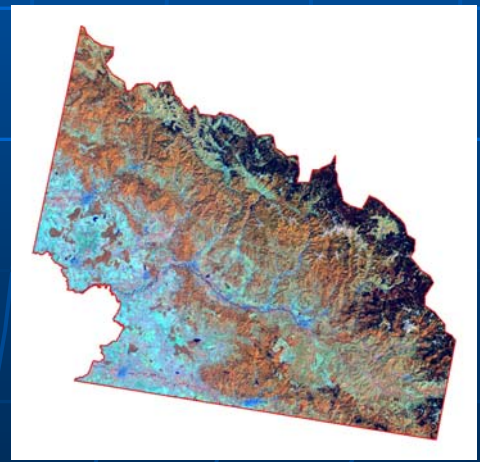
- The “Topographic Map of Forests in Hungary” scale 1:360 000 (Bedő’s map) issued in 1896
- NOAA AVHRR scenes (21 July 1995 and 21 August 2000)
- Landsat TM and ETM+ scenes (25 September 1992 and 22 August 2000)



Bedő’s Map



Copyright: NOAA (2000)



Copyright: ESA (2000)

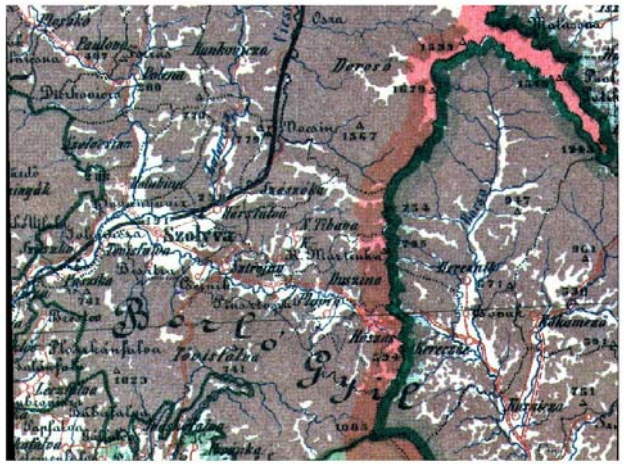
Data processing

- Geometric correction of all data bases
- Thematic interpretation (content extraction)
  - Automatic image processing
    - Nonsupervised interpretation (clustering)
    - Supervised interpretation (classification)

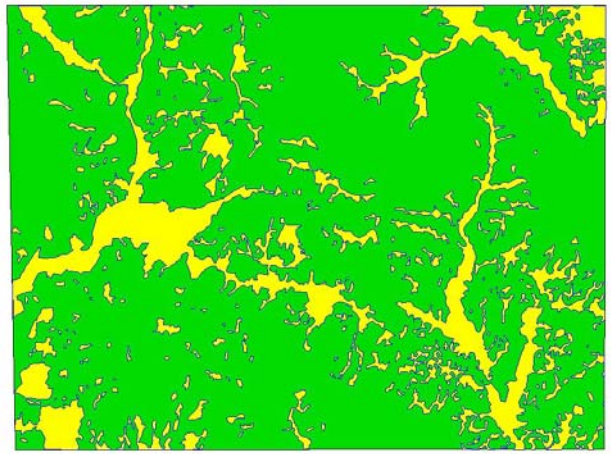
Results

Thematic content extraction

- Unsupervised classification (clustering)
- Supervised classification



Original map segment
(Bedő's map)

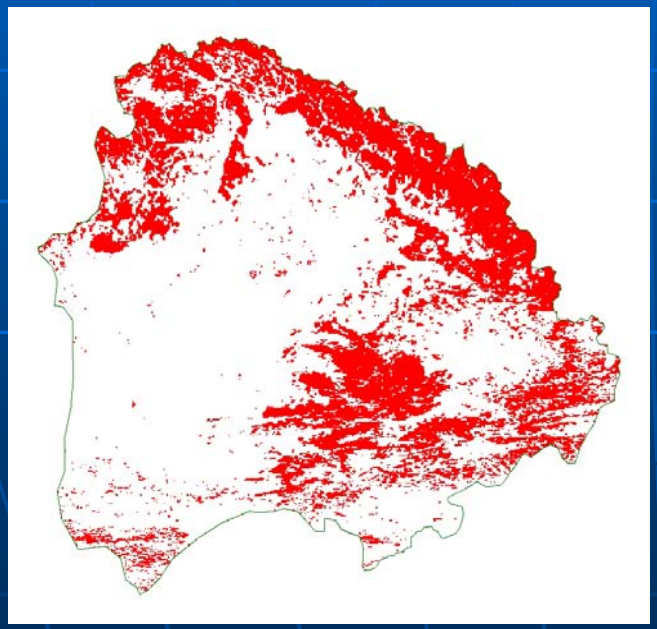


Classification by
pixels

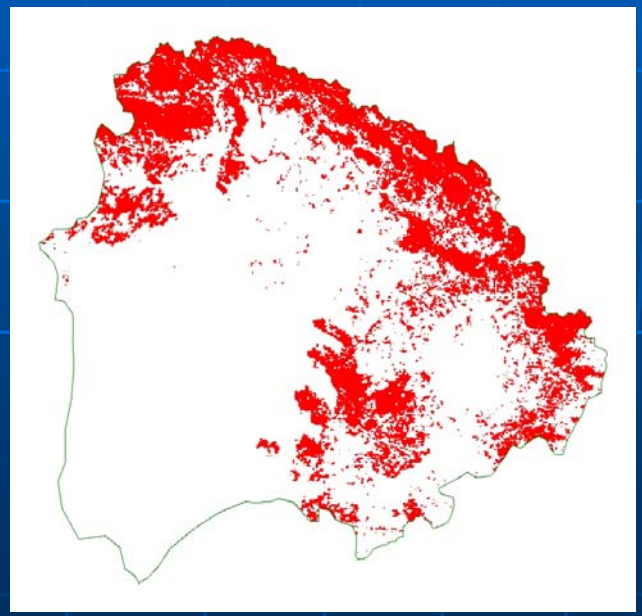
Results

Thematic content extraction

- Unsupervised classification (clustering)
- Supervised classification



NOAA AVHRR, 21 July 1995

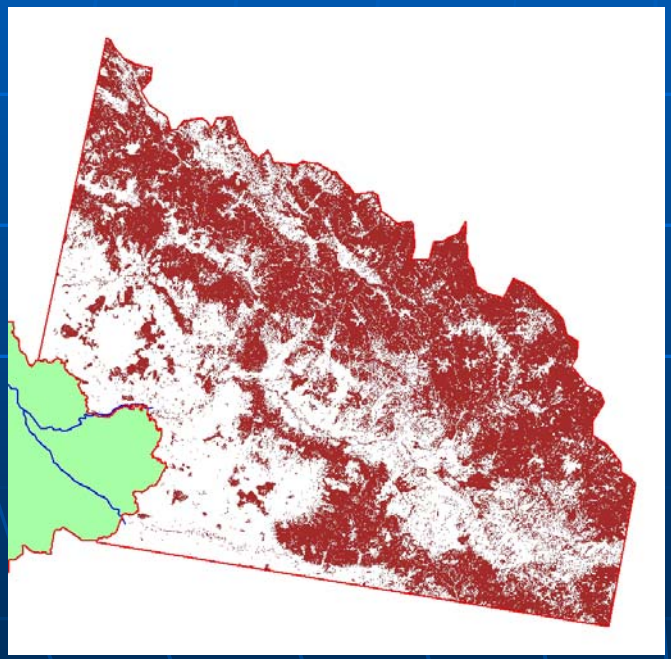


NOAA AVHRR, 21 August 2000

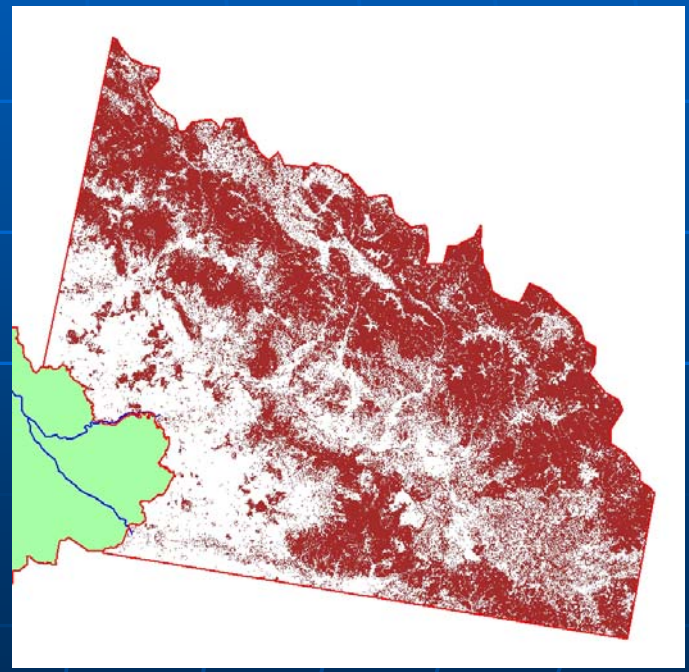
Results

Thematic content extraction

- Unsupervised classification (clustering)
- Supervised classification



Landsat TM, 25 September 1992



Landsat ETM+, 22 August 2000

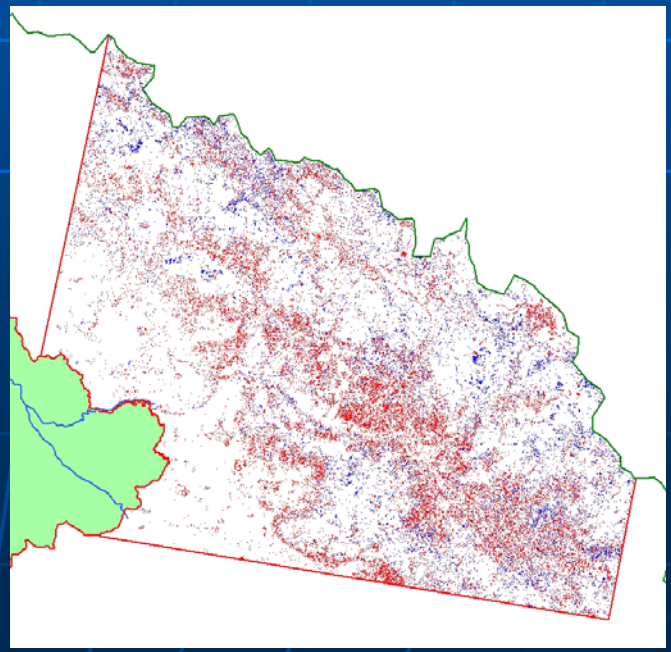
Results
Change detection

Year of investigation	1896	1992	2000
Area of forests (km^2)	13 693	9 773	8 937
Change (%)	- 28,1	- 7,5	

Change between 1992-2000:

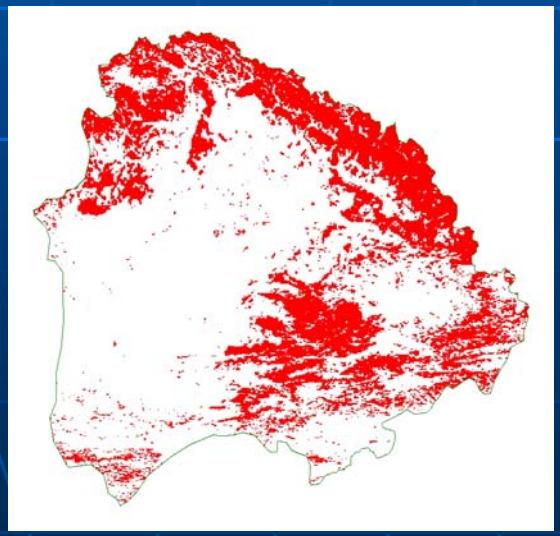
Red = cutting

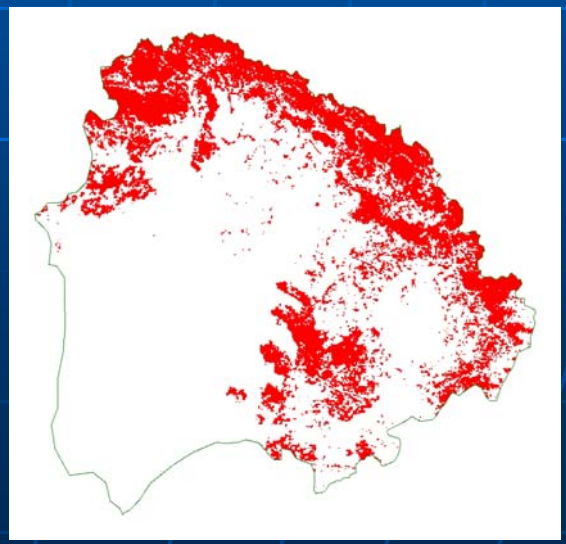
Blue = replantation



Results
Change detection

Year of investigation	1995	2000
Area of forests (km^2)	46 572	39 181
Change (%)	- 16	



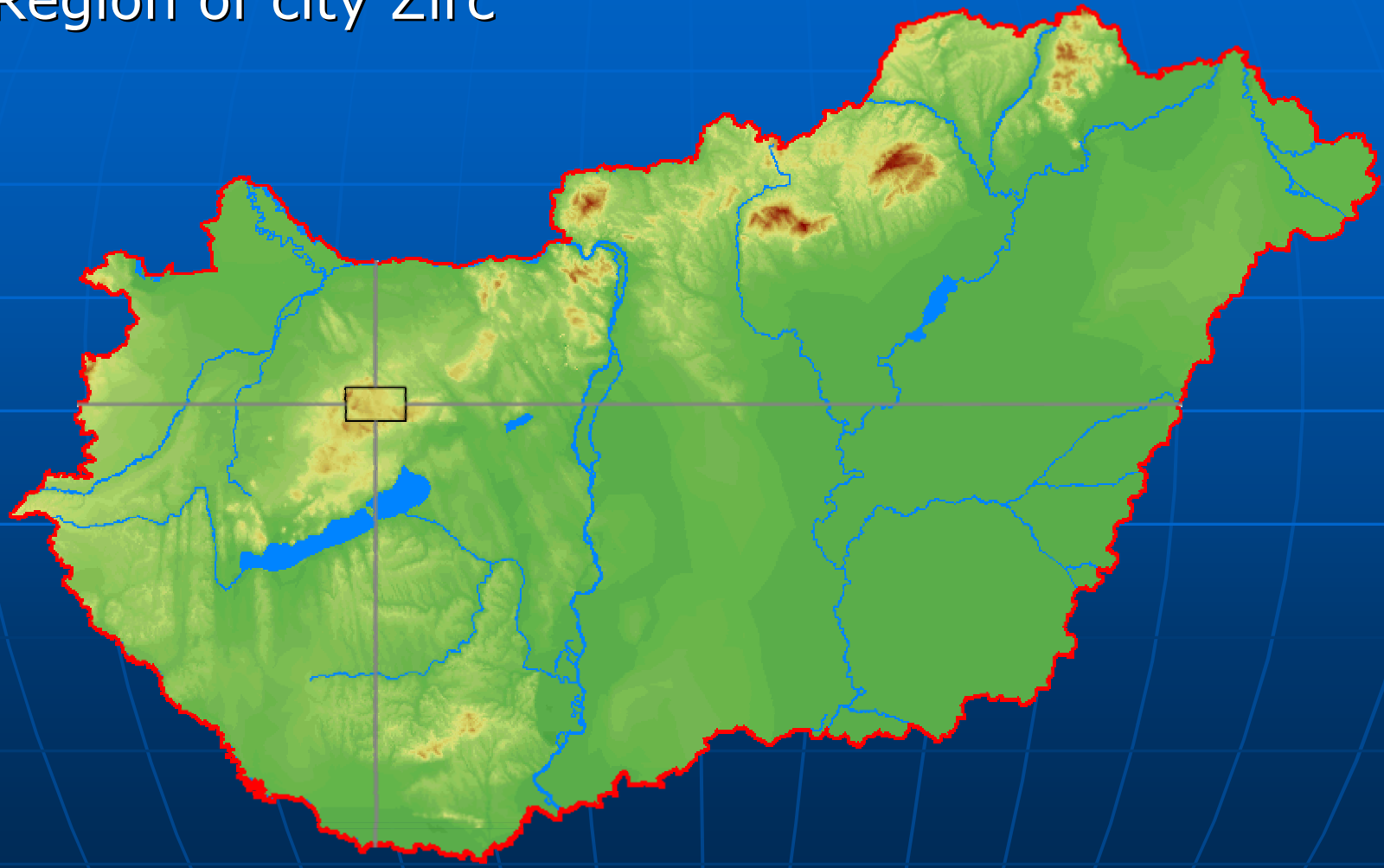


Conclusions

- Decreasing of forest area in the whole Carpathian basin between 1995 and 2000 is 16%, in the upper Tisza region between 1992 and 2000 is 7,5%
- Decreasing of forest area -- especially on the slopes -- may affect to the faster runoff, which can contribute to the heavy floods of Tisza and it's tributaries
- In our project we didn't deal with other very important climatic data (precipitation distribution, temperature, slope angles etc.).
- Deforestation is one of the possible causes only which can affect to the floods of rivers have their rise in the mountains of Carpathian basin

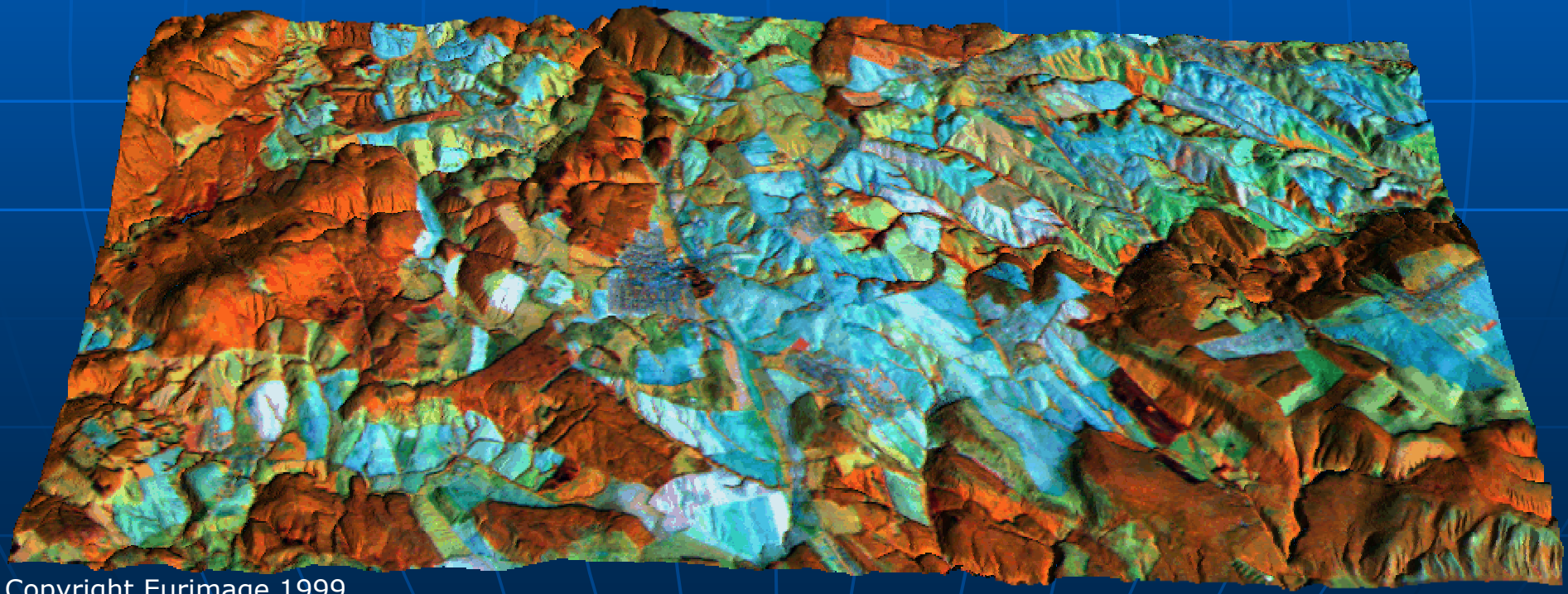
Area of investigation

- Region of city Zirc



Area of investigation

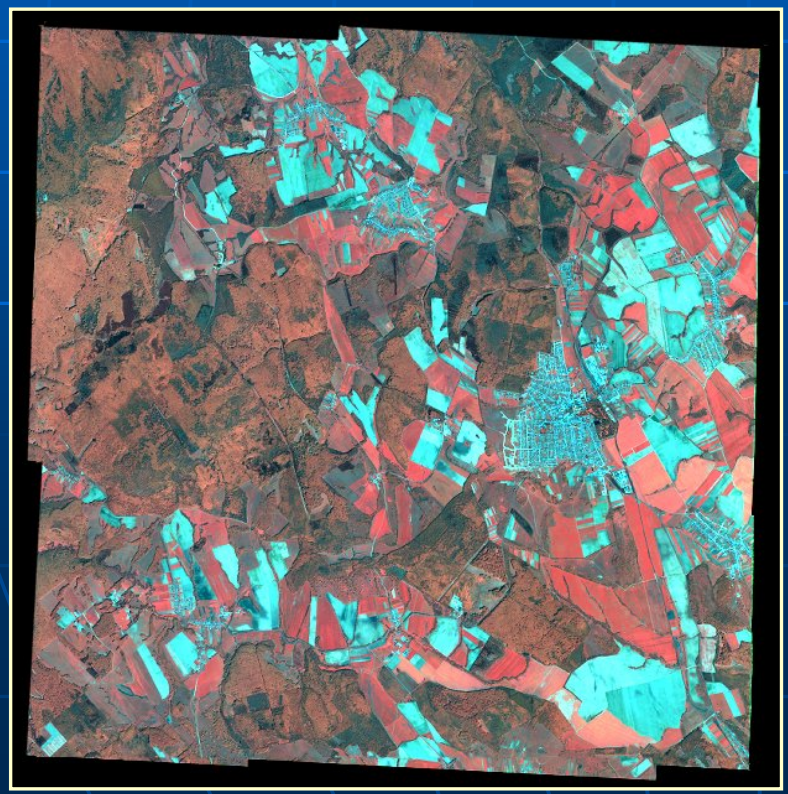
- 40% forest covering
- This area can be characterized by 500 m differences in heights, significant relief
- Suitable test area in many respects (from point of view of geometric correction and forest data attributes)

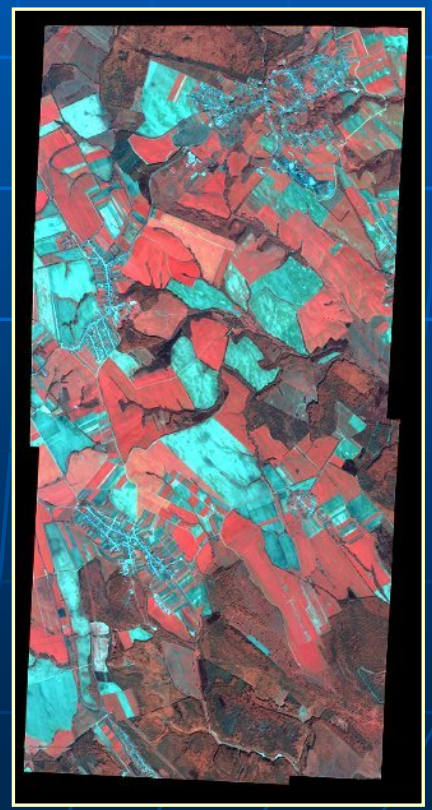


DEM & Landsat 5 TM (4,5,3 RGB)

Data sources
IKONOS scenes

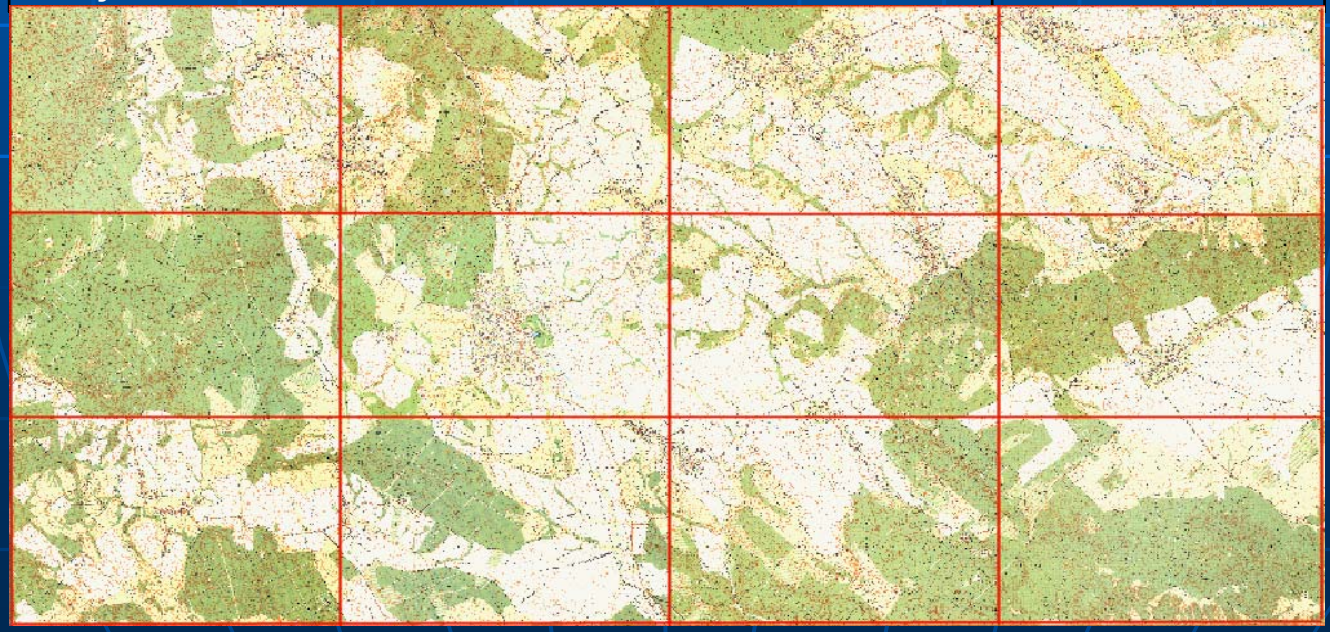
- Two IKONOS scenes
  - Carterra Geo 1m (Pan-sharpened): 4-m multispectral
  - Acquisition time: 2 May 2001





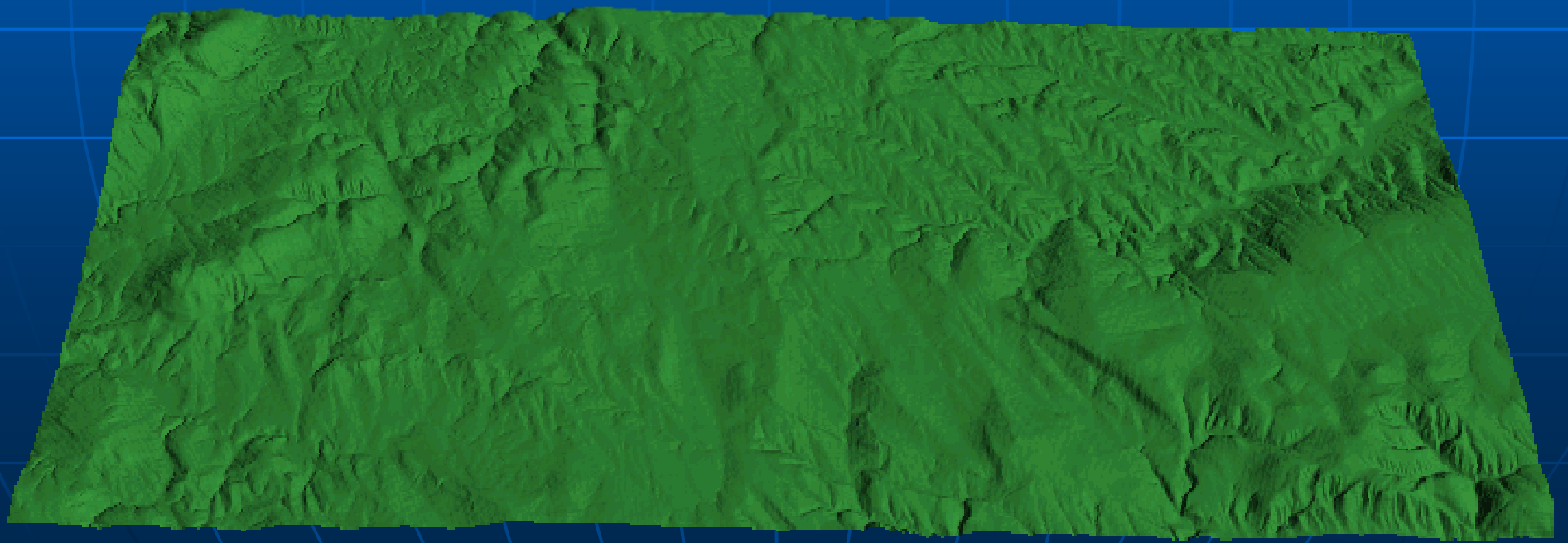
Data sources
Topographic maps

Scale	1 : 10 000
Number of sheets	12
Accuracy (horizontal)	3 m
Contour interval	2.5 m
Accuracy of contour lines (vertical)	0.7 – 0.8 m
Projection	EOV



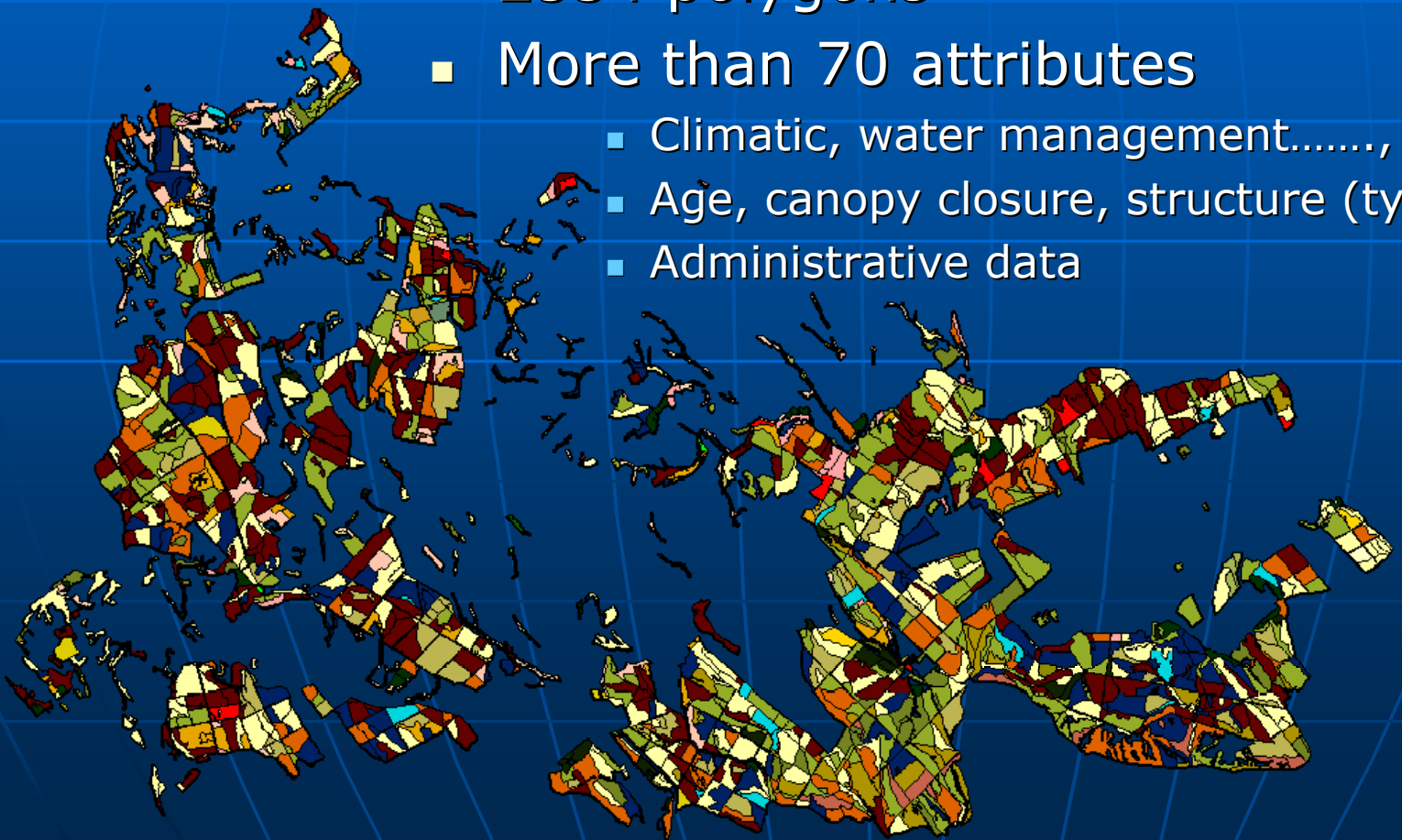
Data sources
Digital Elevation Model (DEM)

- DEM was extracted from contour lines of the topographic maps scale 1:10 000
- „Linear Rubber Sheeting” interpretation
- Pixel size: 2.5 m



Data sources
Forestry database

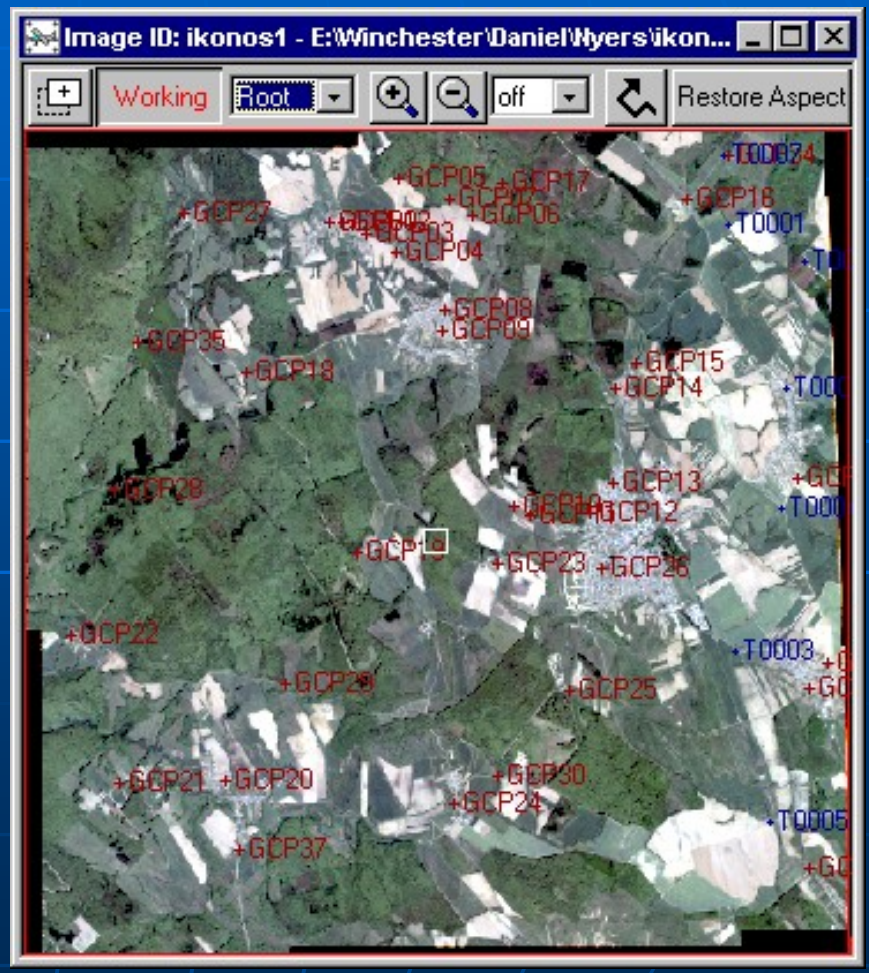
- Database of National Forestry Service
- 2534 polygons
- More than 70 attributes
  - Climatic, water management……,
  - Age, canopy closure, structure (type of trees)…
  - Administrative data



Data processing

- Geometric correction of IKONOS satellite images
- Thematic interpretation (content extraction)
  - In situ data collection (GPS localization)
  - Visual interpretation
  - Automatic image processing
    - Nonsupervised interpretation (clustering)
    - Supervised interpretation (classification)
    - Vegetation indices (NDVI)

Data processing
Geometric correction



The geometric correction was made by using of ground control points (GCP).

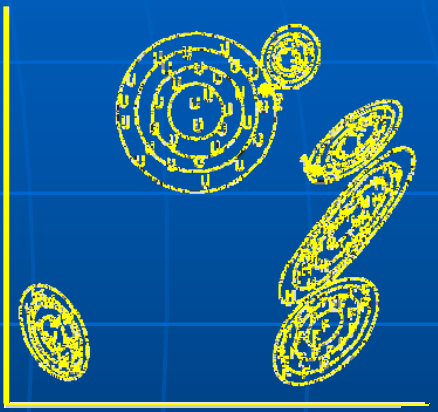
Applied cartographic transformation: Hungarian Unified Map Projection

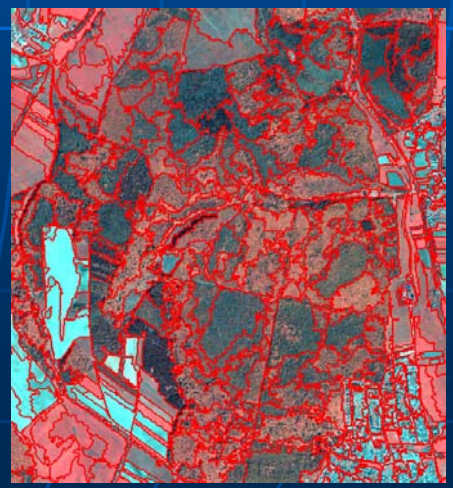
Data processing
Thematic data extraction

- Visual interpretation
  - IKONOS data have good geometric resolution (1 m) and good spectral resolution (4 spectral bands)
  - Comparing with false color aerial photography, the interpretation can be made easily.

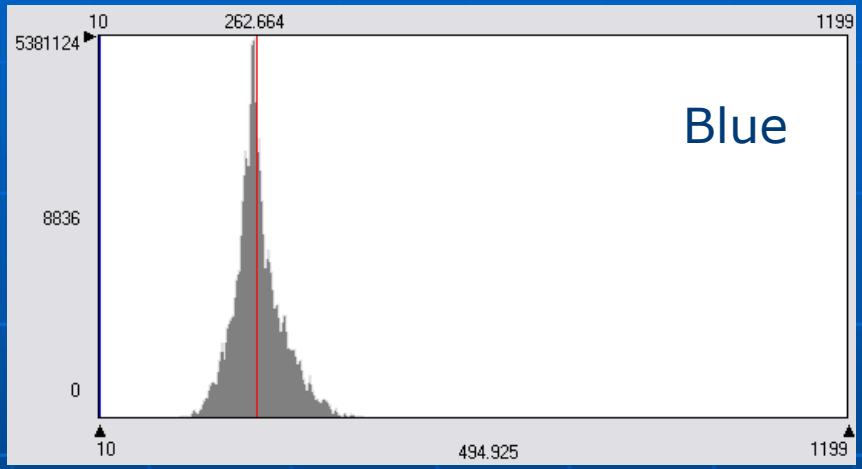
Data processing
Thematic content extraction

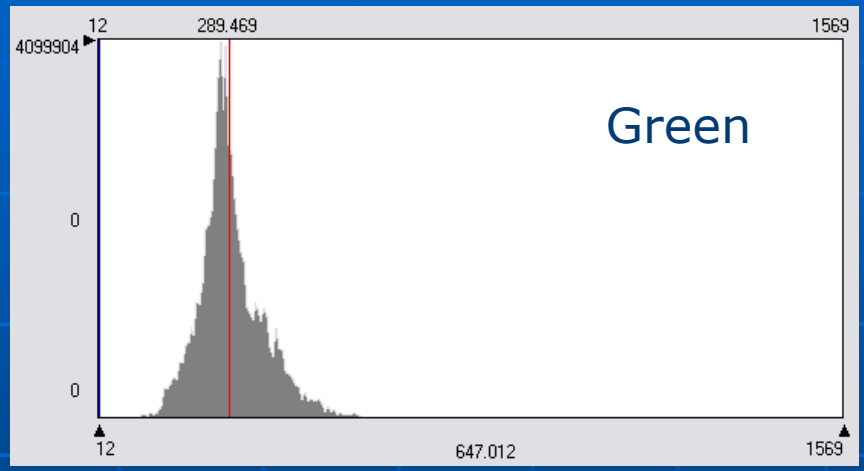
- Classification for identification of tree species:
  - Nonsupervised interpretation
    - Isodata clustering
      - 20 classes, 10 iterations
  - Supervised classification
    - Method: Maximum Likelihood
  - Image segmentation
    - Image object level generating
    - classification

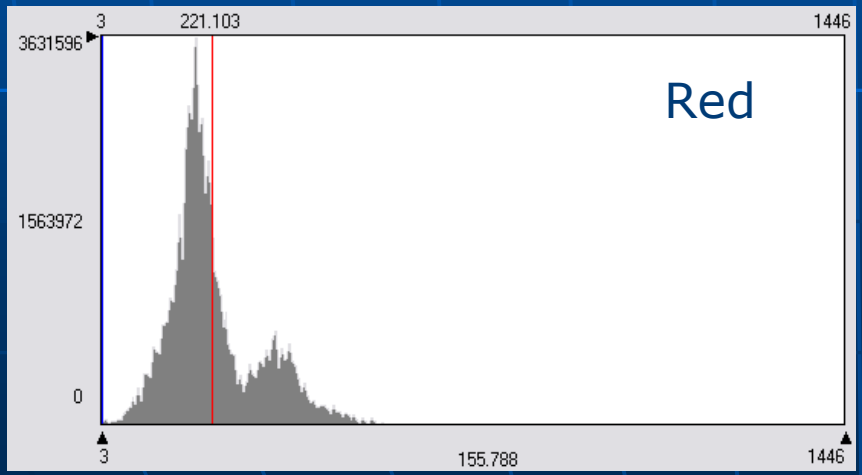


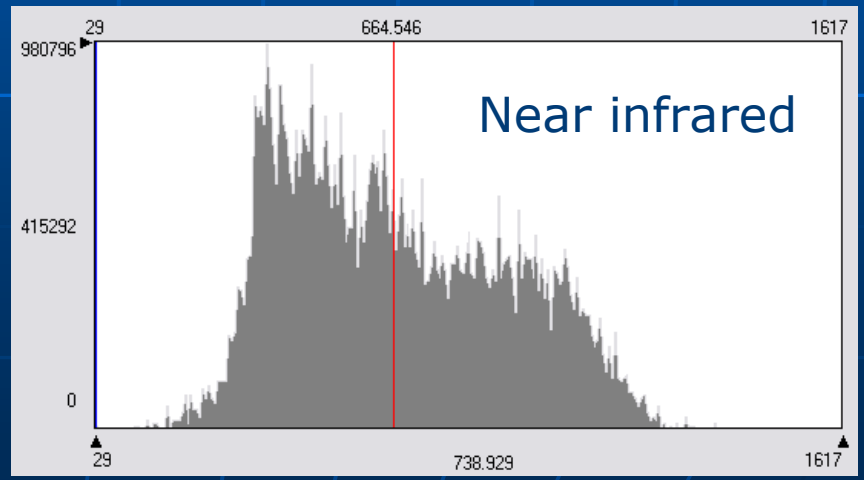


Data processing
Radiometric analysis









Results

Thematic content extraction

- Supervised classification
  - 31..58% of pixels classified as right without texture
  - 45..65% of pixels classified as right with texture
  - 73..95% of pixels classified as right on the segmented image

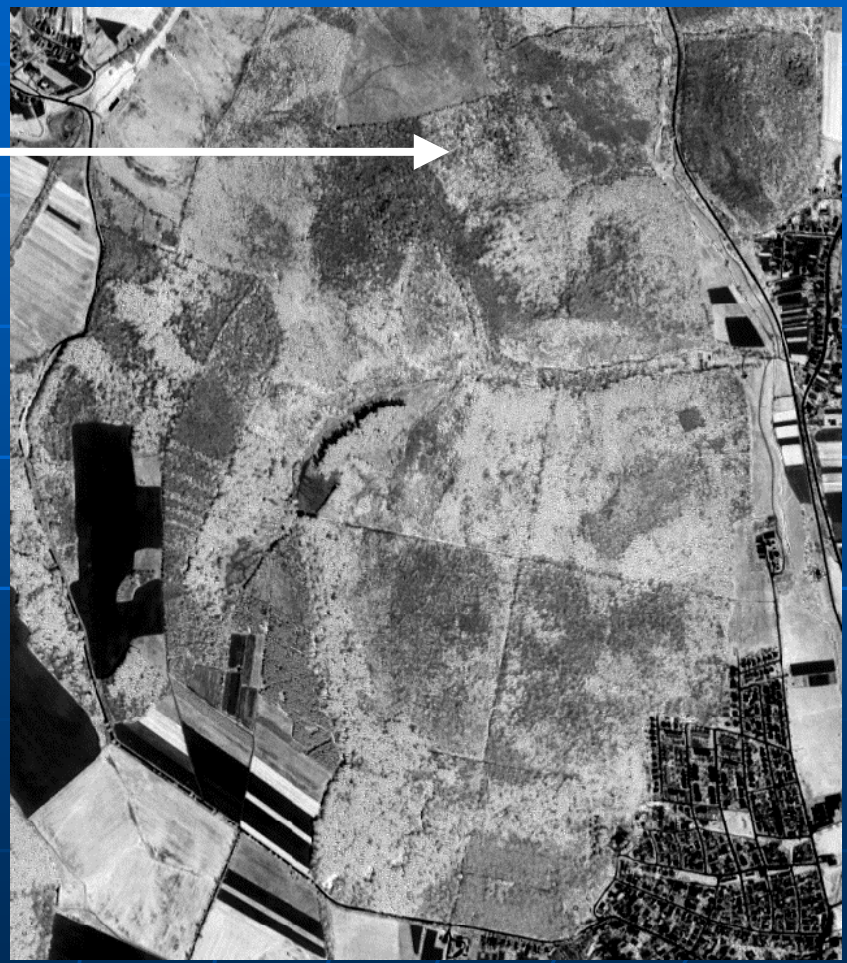
Original image

Classification by pixels

Segmentation & classification

Results
Vegetation indices

- NDVI:
  (IR-R)/(IR+R)



Segmented image

Conclusions

- Large scale forest mapping can be fulfilled by using VHR satellite data
- Joint use of visual interpretation, segmentation method and classification allow identification of several tree species
- The age and the canopy closure can not be estimated by visual interpretation method
- The vegetation indexes don’t show close correlation with any forest attribute
- Better results can be achieved by using satellite data with similar quality and several seasonal acquisition time

Thank you for your attention!