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Assessment of forest decline and forest regeneration process from combined space/airborne data

Global Change Research Centre

Academy of Sciences of the Czech Republic

Brno, Czech Republic

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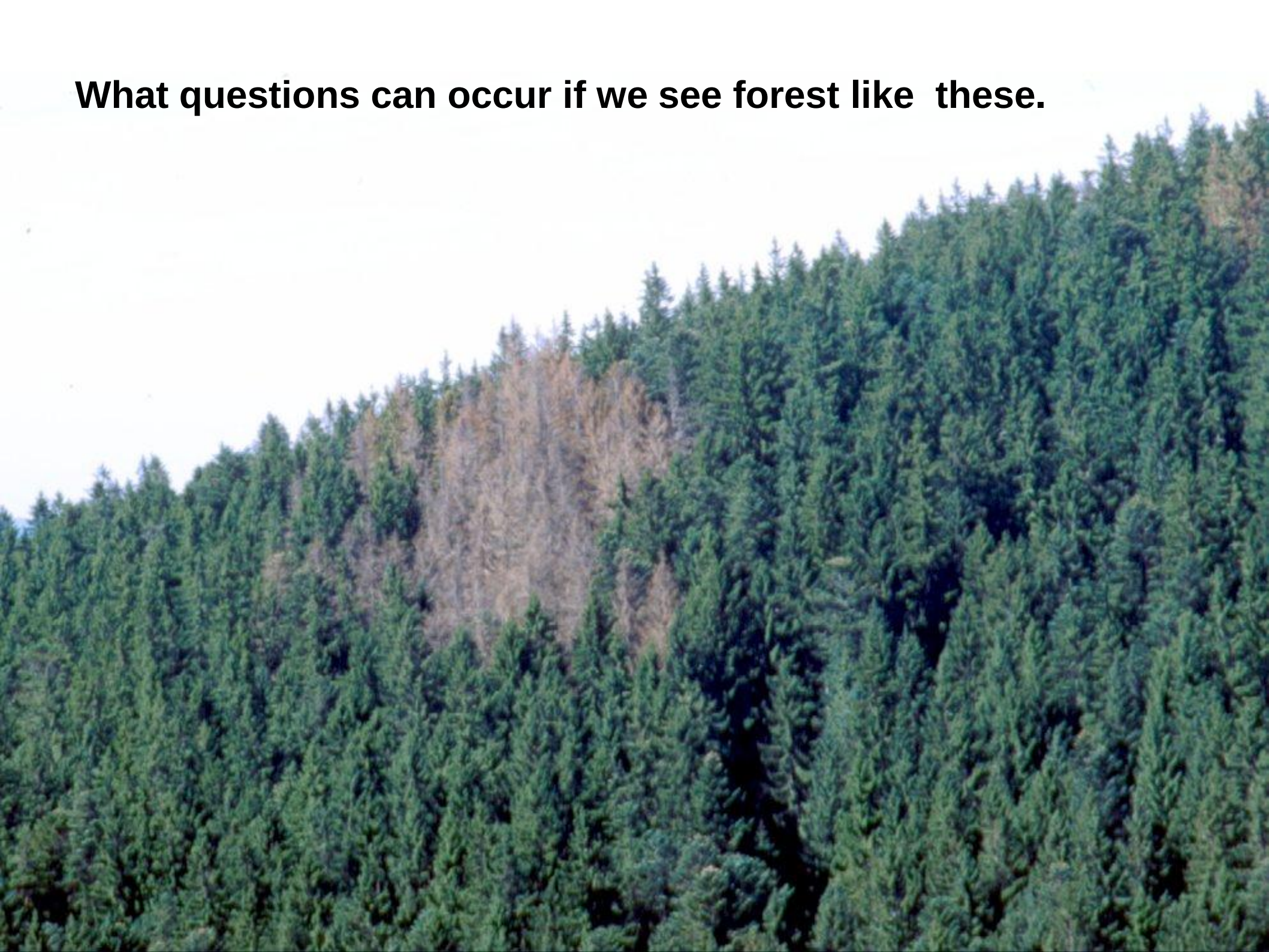
Siri Jodha Khalsa, Michal Heřman, Jan Hanuš

What questions can occur if we see forest like these.

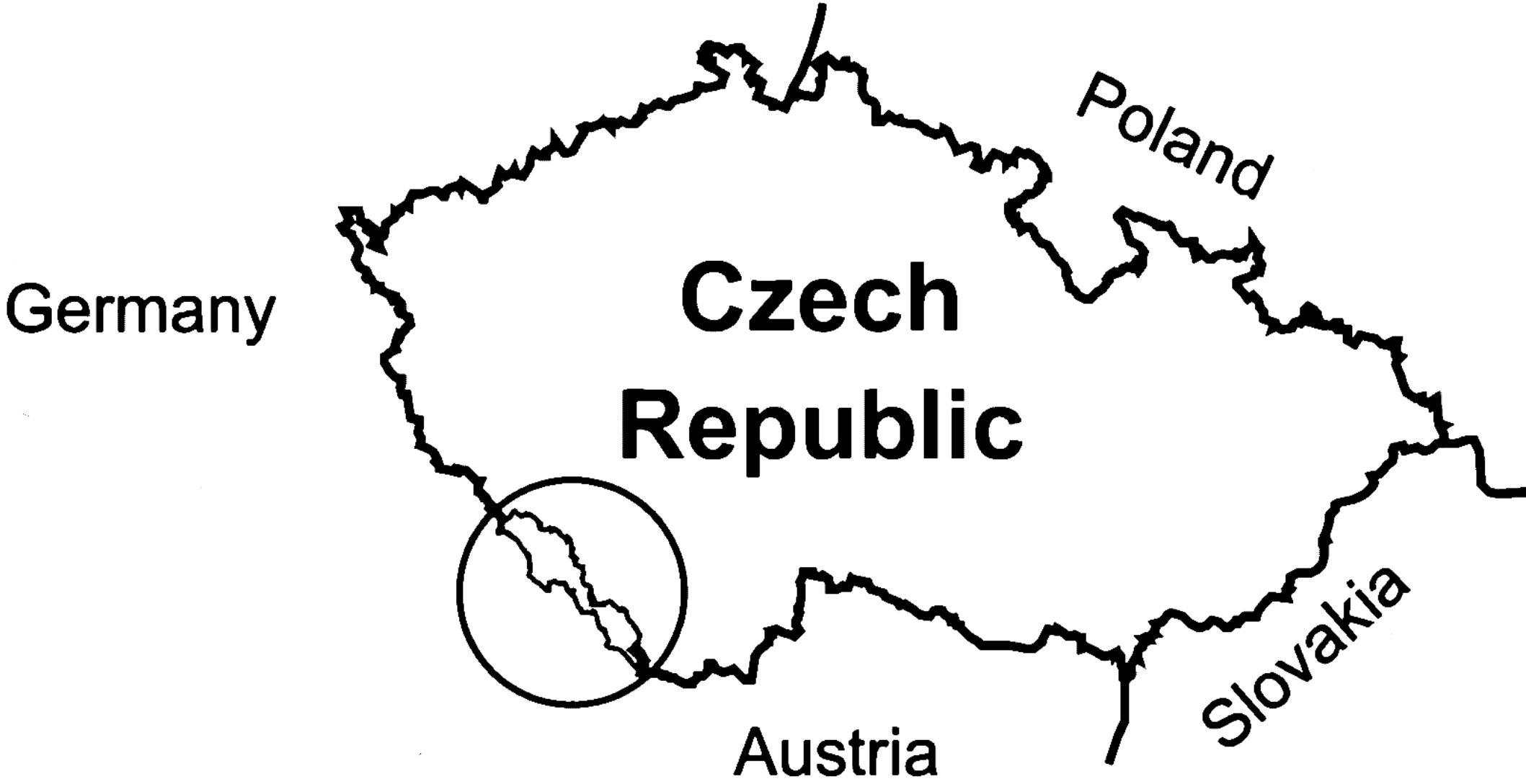


What happened there?


What is the trajectory of the development?


Will be a „regular“ forest there again?

Are there similar stand conditions for the regeneration?


Poland
Germany
Czech
Republic
Slovakia
Austria

Focus of the study

When the forest decline started, its spatial extent in time.

What vegetation cover is now there?

How much time each part had already for the recovery?

What is a role of different stand conditions in regeneration?

What can be a role of forest management? – Is there a difference in regeneration process between areas with and without forestry intervention?

Approach

To get **standardized assessment** of the whole area - data obtained by the same method for the whole region

1. Detail **field measurements** about few sites – geobotanists (subjective method)
2. **Space/airborne** data about the territory
    - Time series of satellite data
    - Scarce, purpose-oriented aerial photos/data
    - Newly acquired airborne multi/hyperspectral data and LiDAR

Four categories of analyses have been carried out:

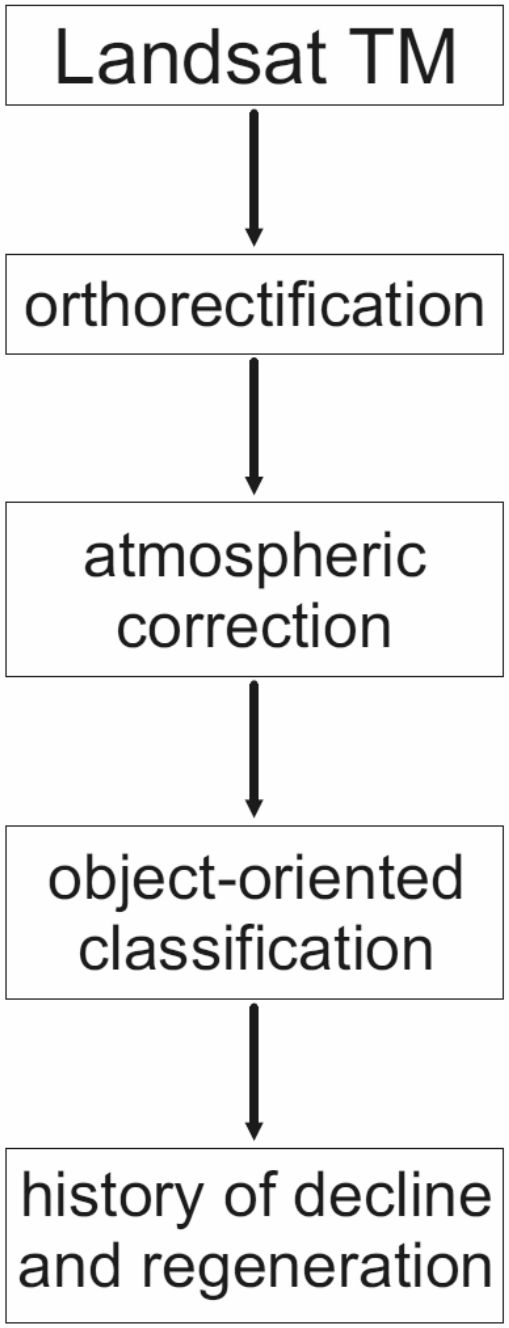
1. **Image segmentation** of satellite Landsat TM time series data
2. **Image segmentation** of hyperspectral and LiDAR data
3. **GIS analysis** of orographical parameters - elevation, slope, topographic wetness index (TWI), solar radiation (SR), time span of regeneration
4. **Statistical analysis**: General regression model

Dependent variables: 1/projected tree area

2/number of trees in 30 m pixels

Explanation variables: elevation, slope, TWI, SR, type of forest intervention, regeneration time

Retrospective analysis of forest decline/regeneration



Landsat 5 TM
11 scenes between 1987 – 2011,
scene 192/26, 30×30 m pixel size,
6 spectral bands

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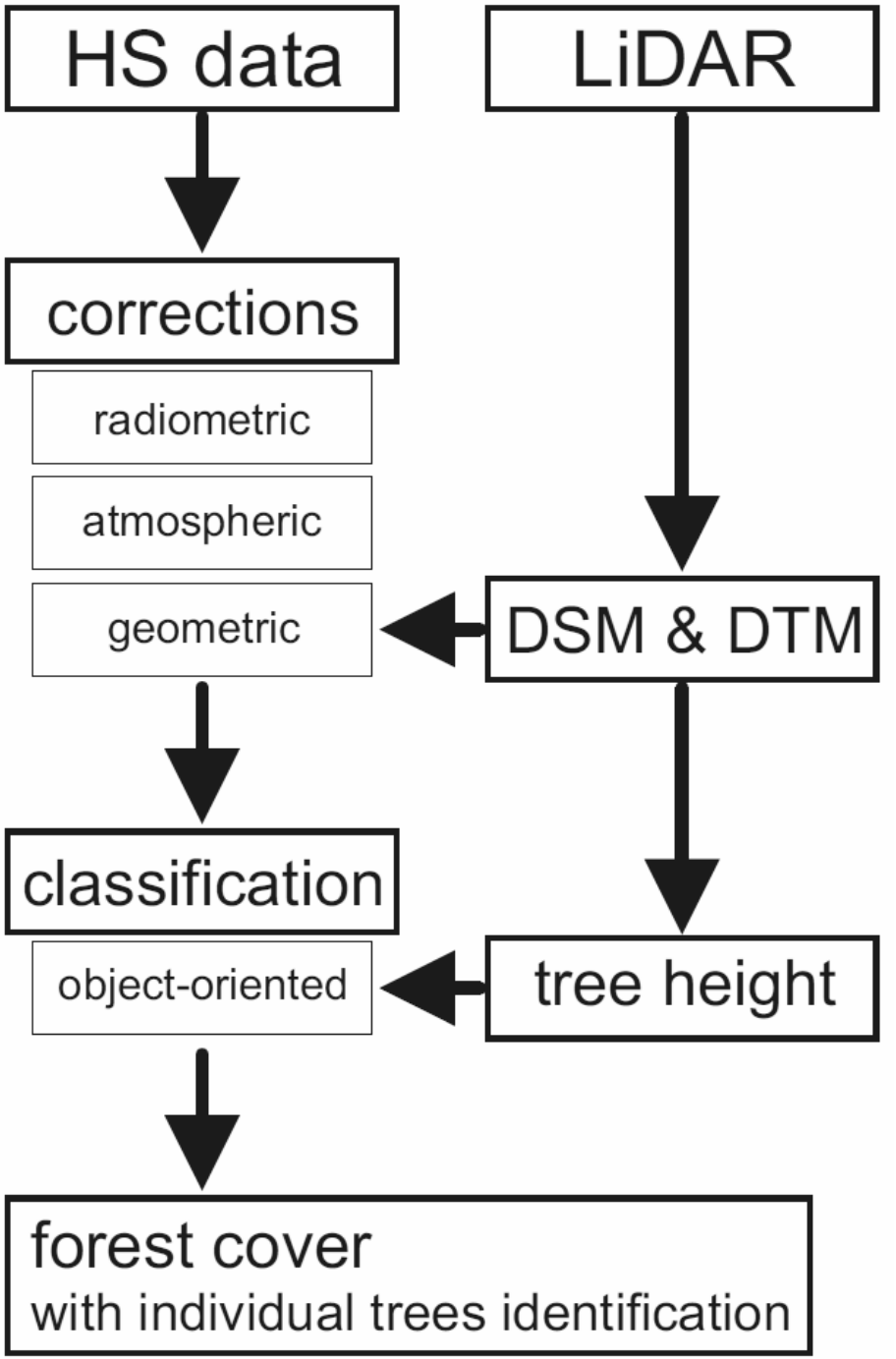
What vegetation cover is now there?



Hyperspectral data
AISA Eagle, August 2009
spatial resolution 0.4 m, spectral resolution 10 nm and spectral range 400-1000 nm

LiDAR data
TopEye Mk II 1064 nm,
October 2010
cloud density 1 point / m2

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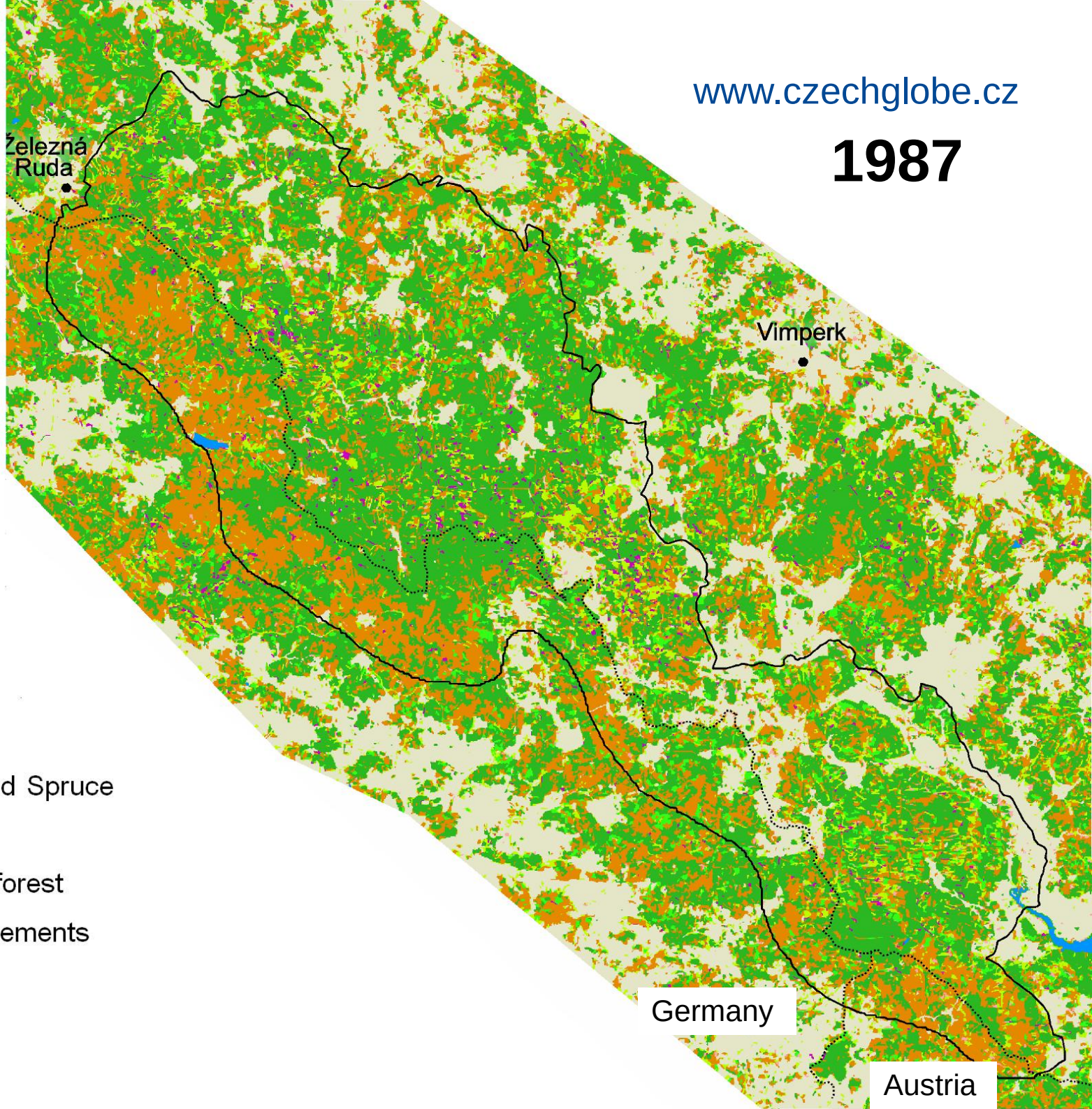
1987



- Spruce 30+
- Spruce 15+
- Clearcut
- Dead and highly damaged Spruce
- Scattered spruce 5+
- Broadleaved and mixed forest
- Agriculture land and settlements
- Open water bodies
- Clouds and shadows
- National borderline

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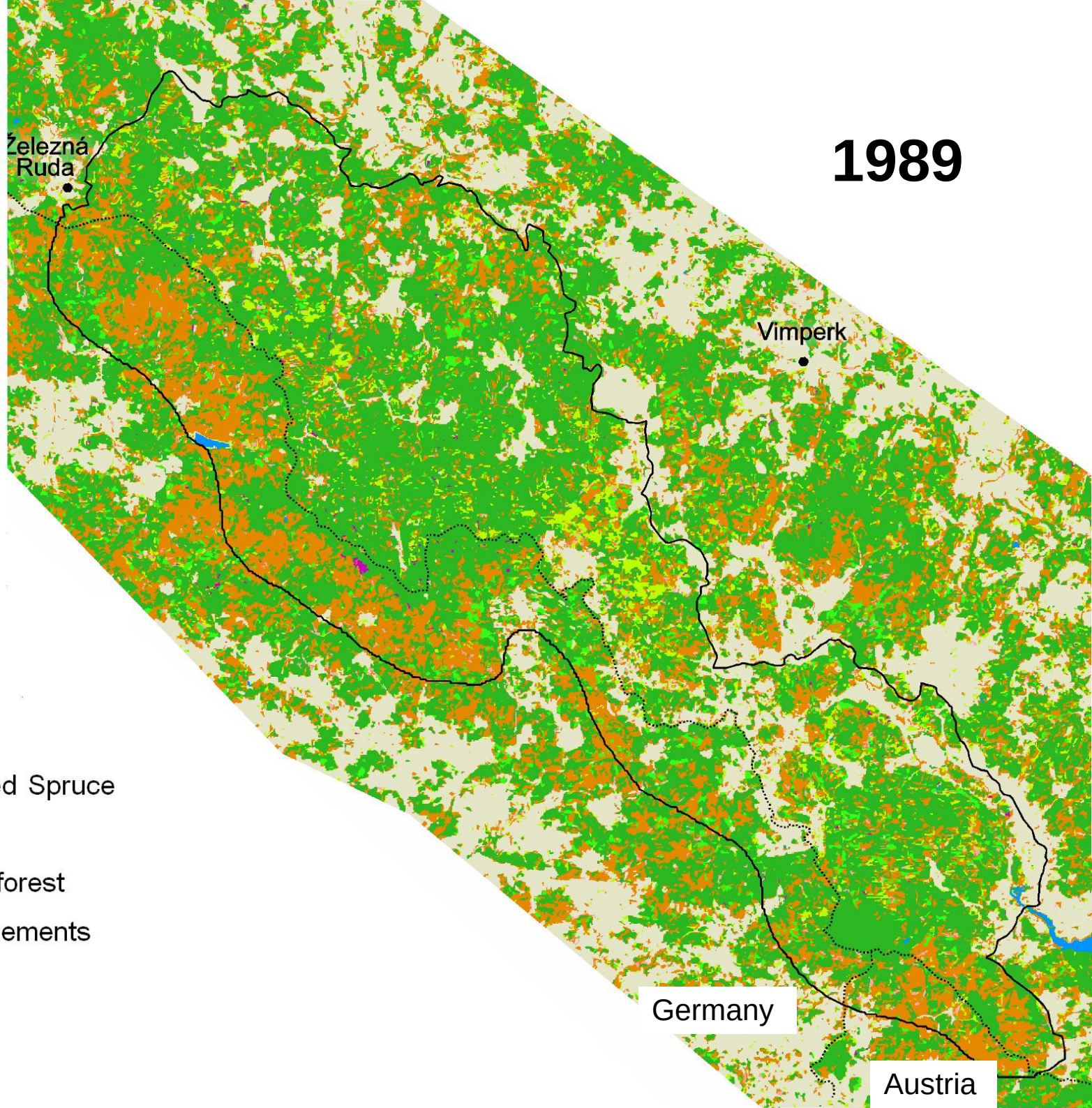
1989



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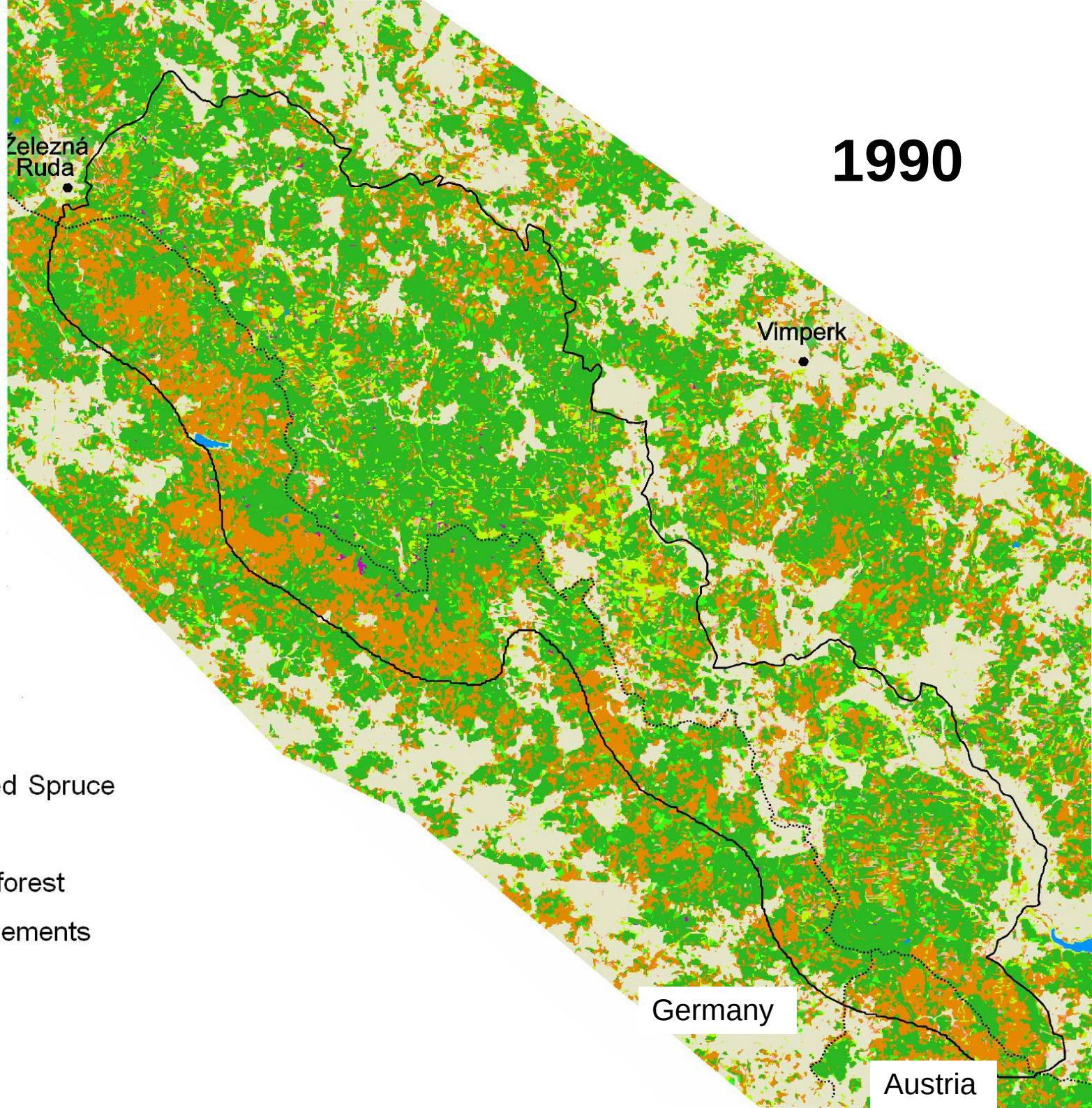
1990



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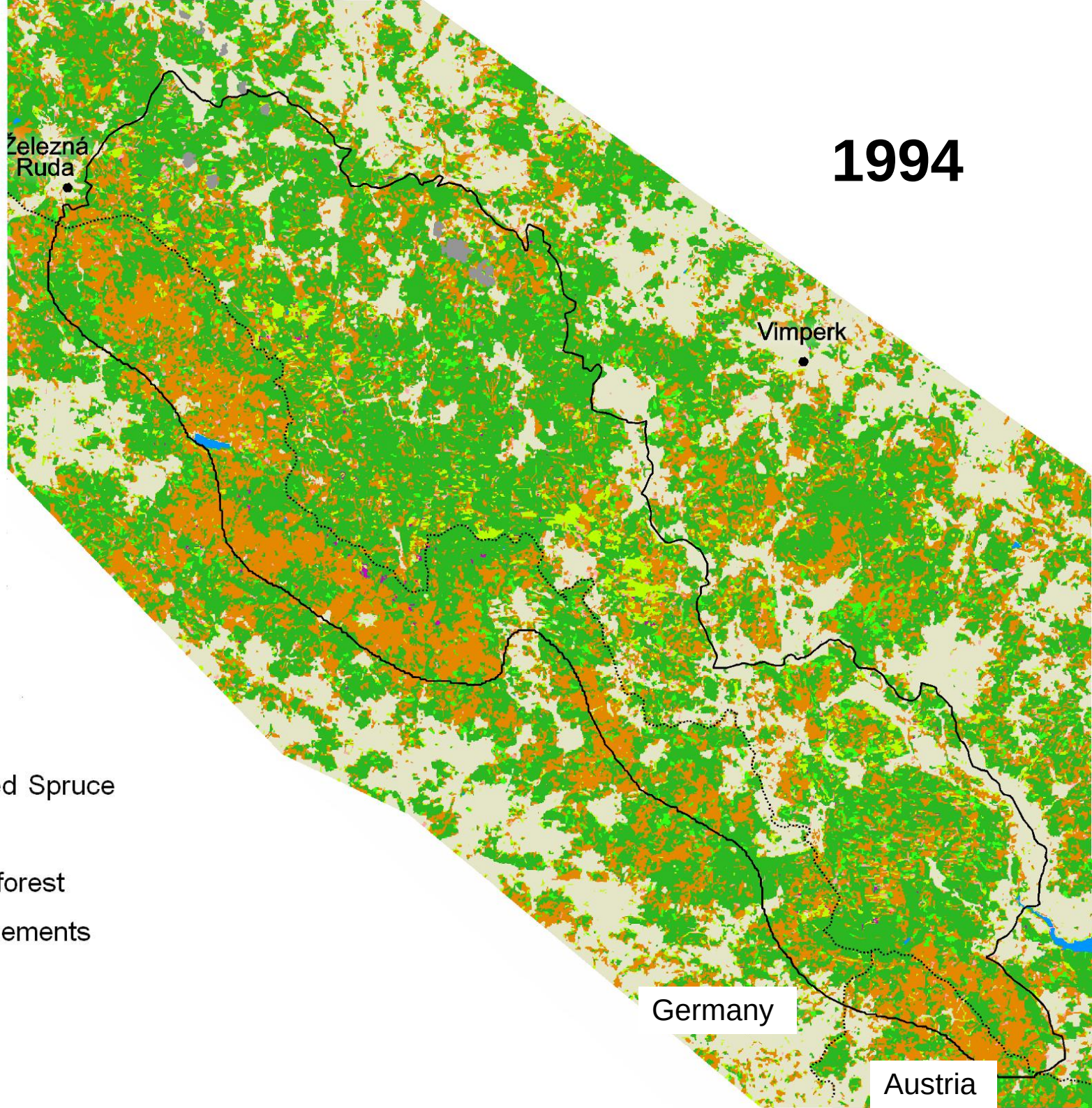
1994



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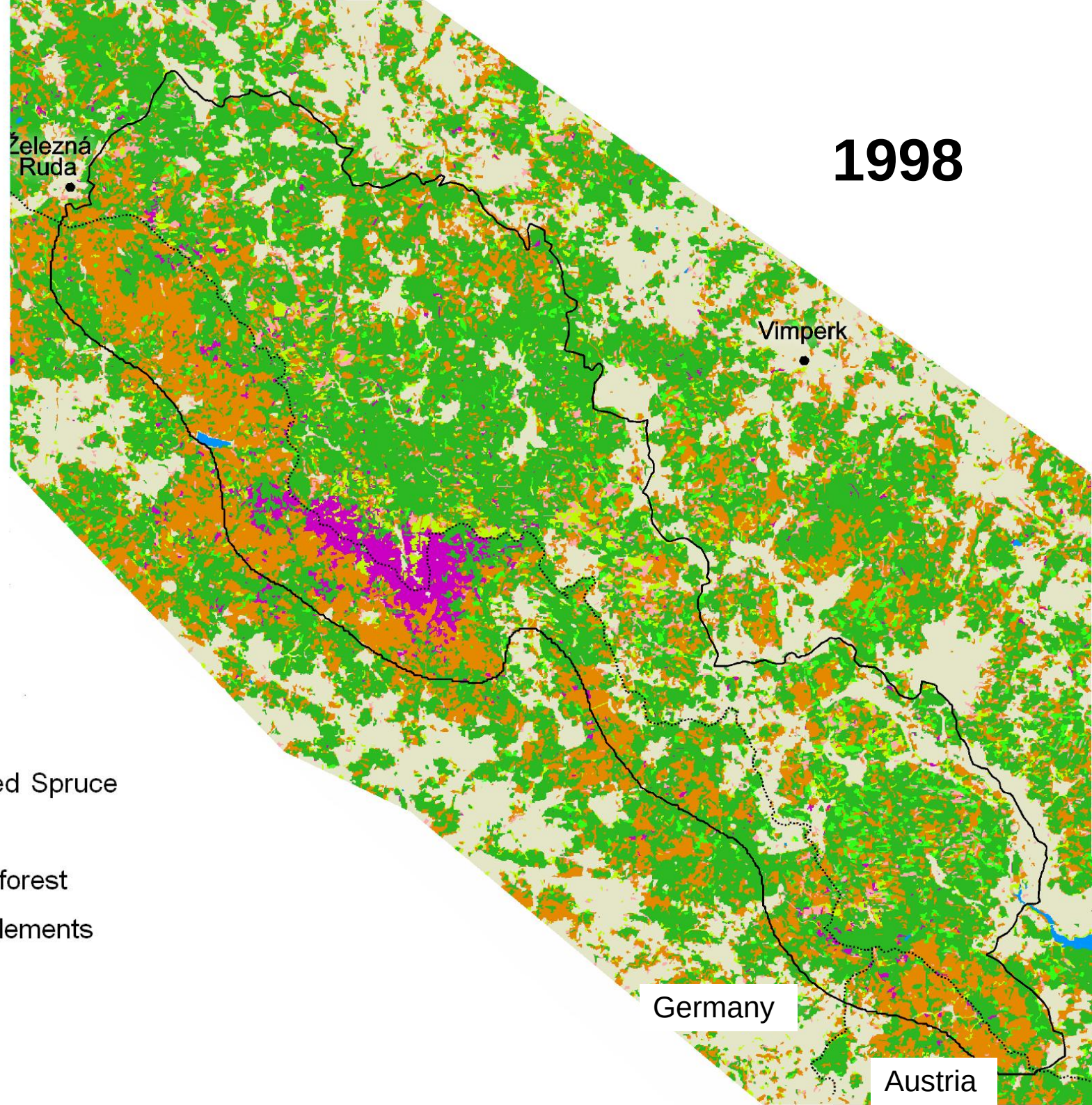
1998



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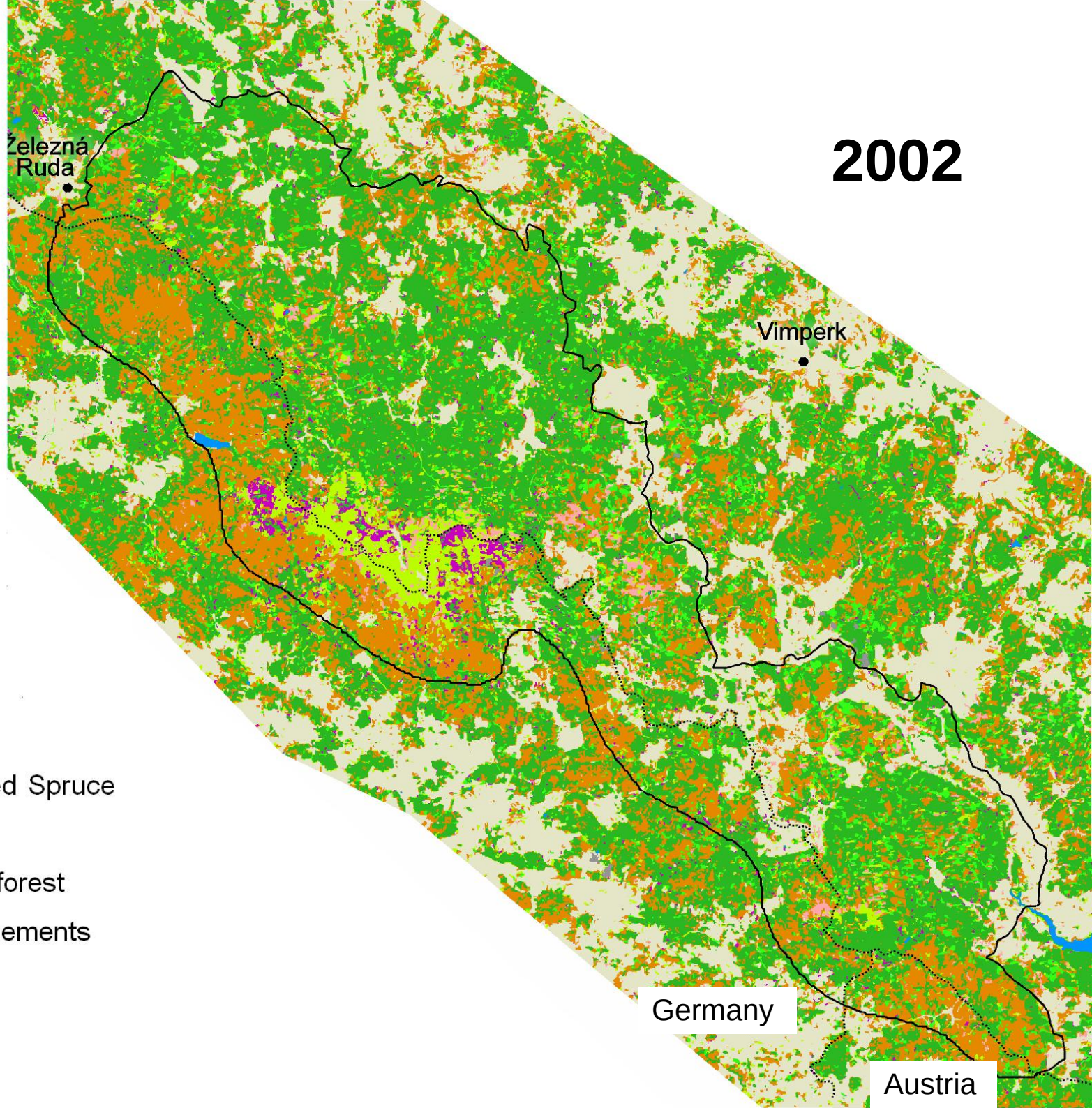
2002



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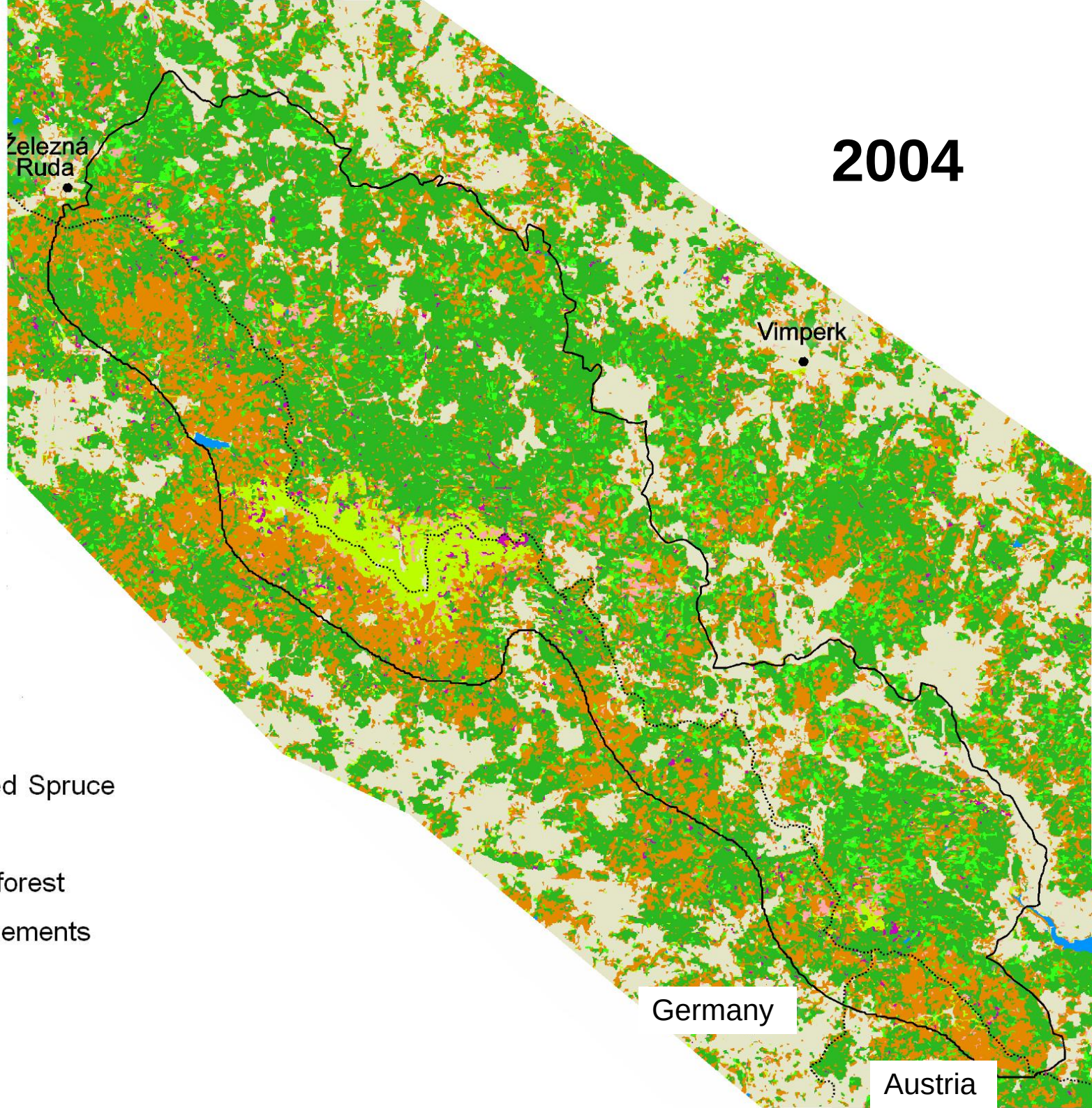
2004



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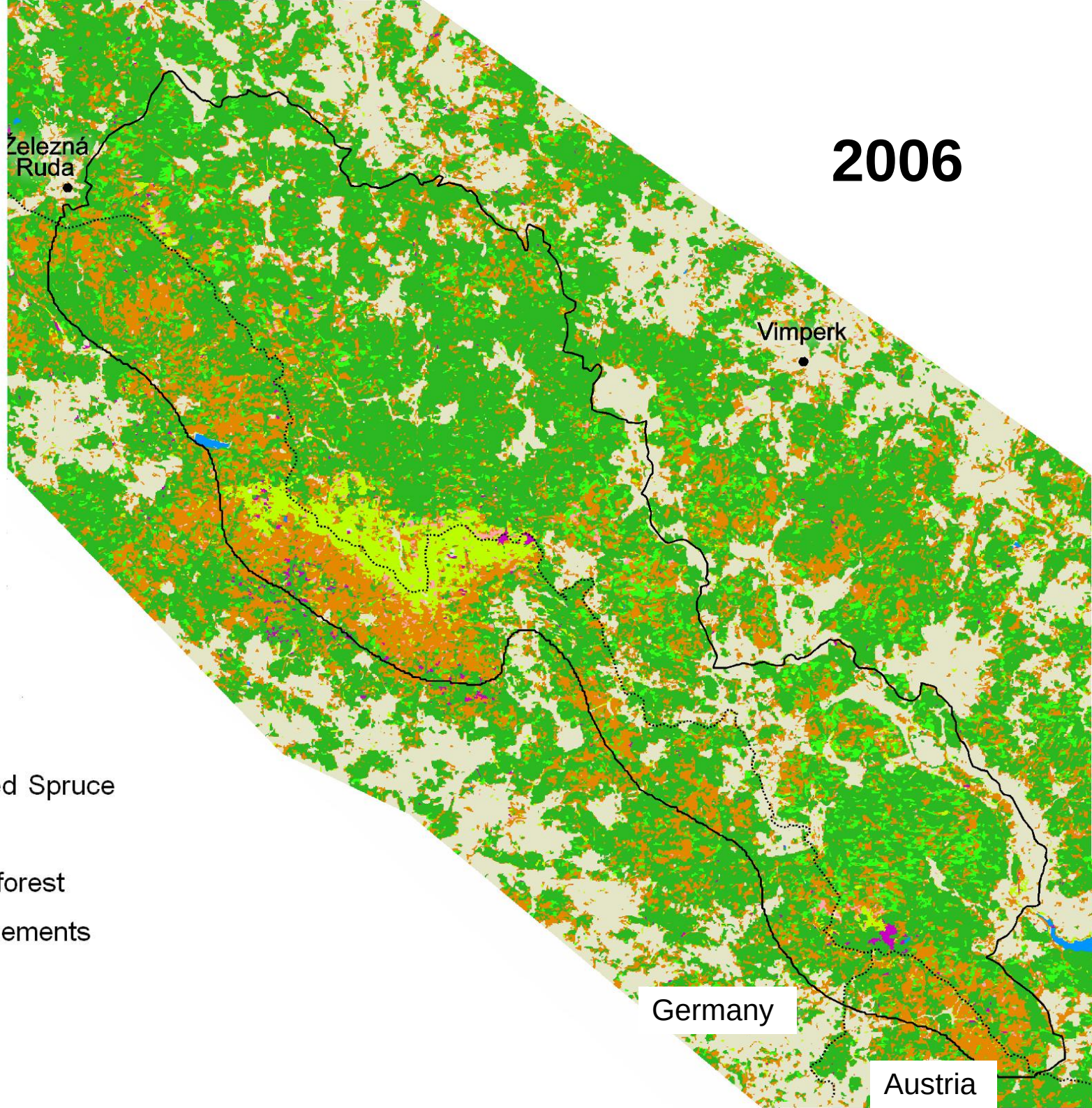
2006



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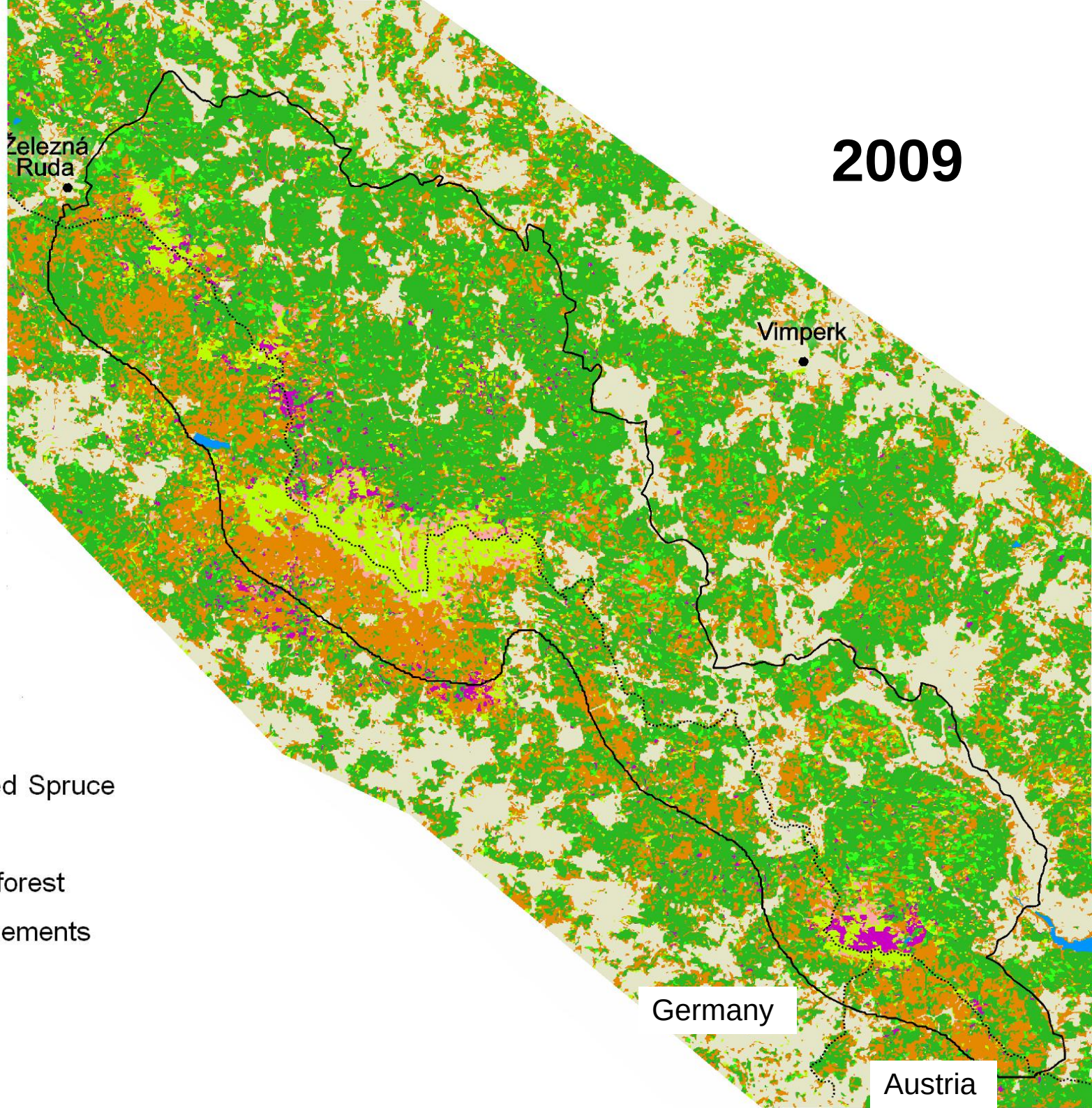
2009



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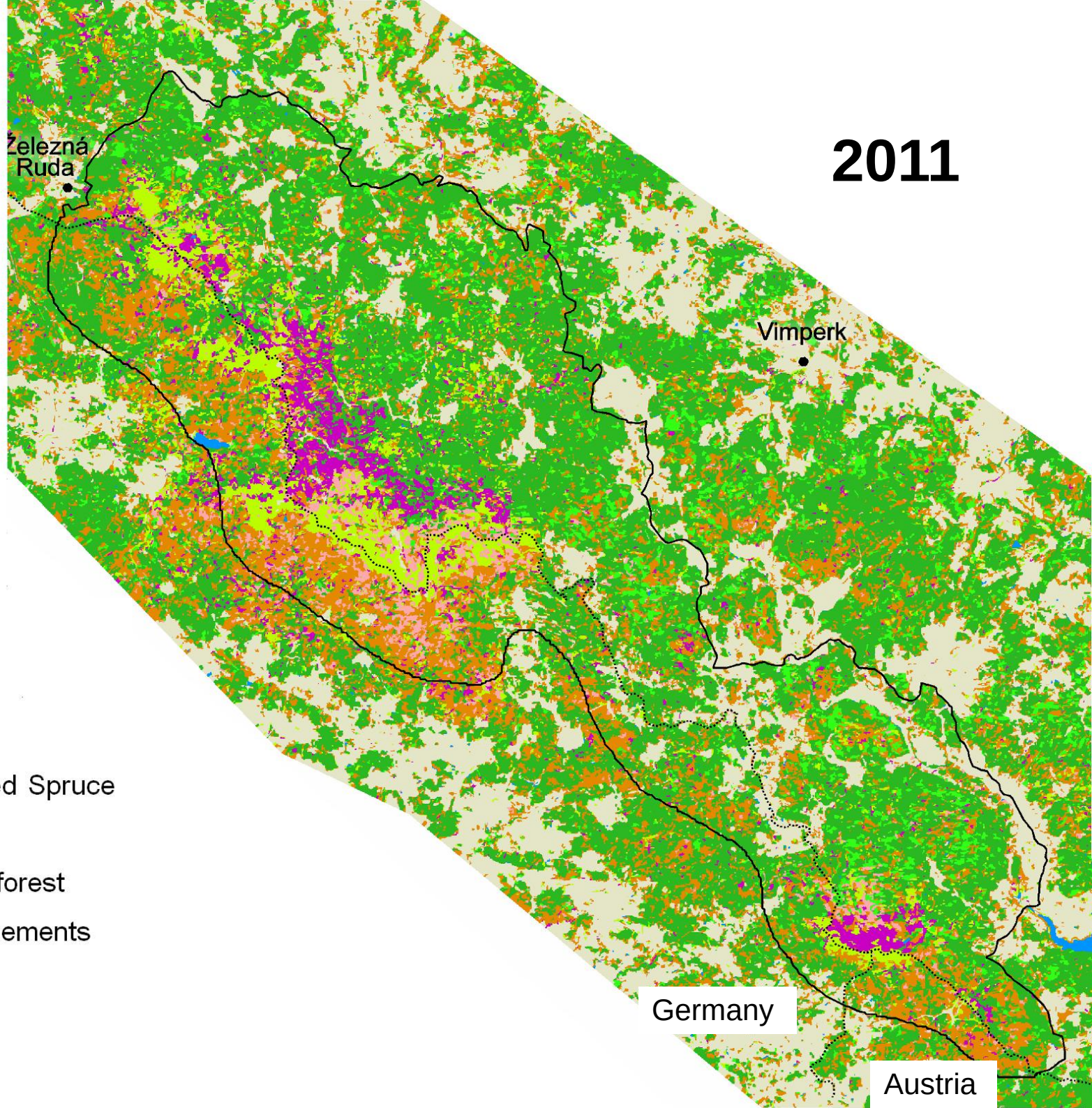
2011



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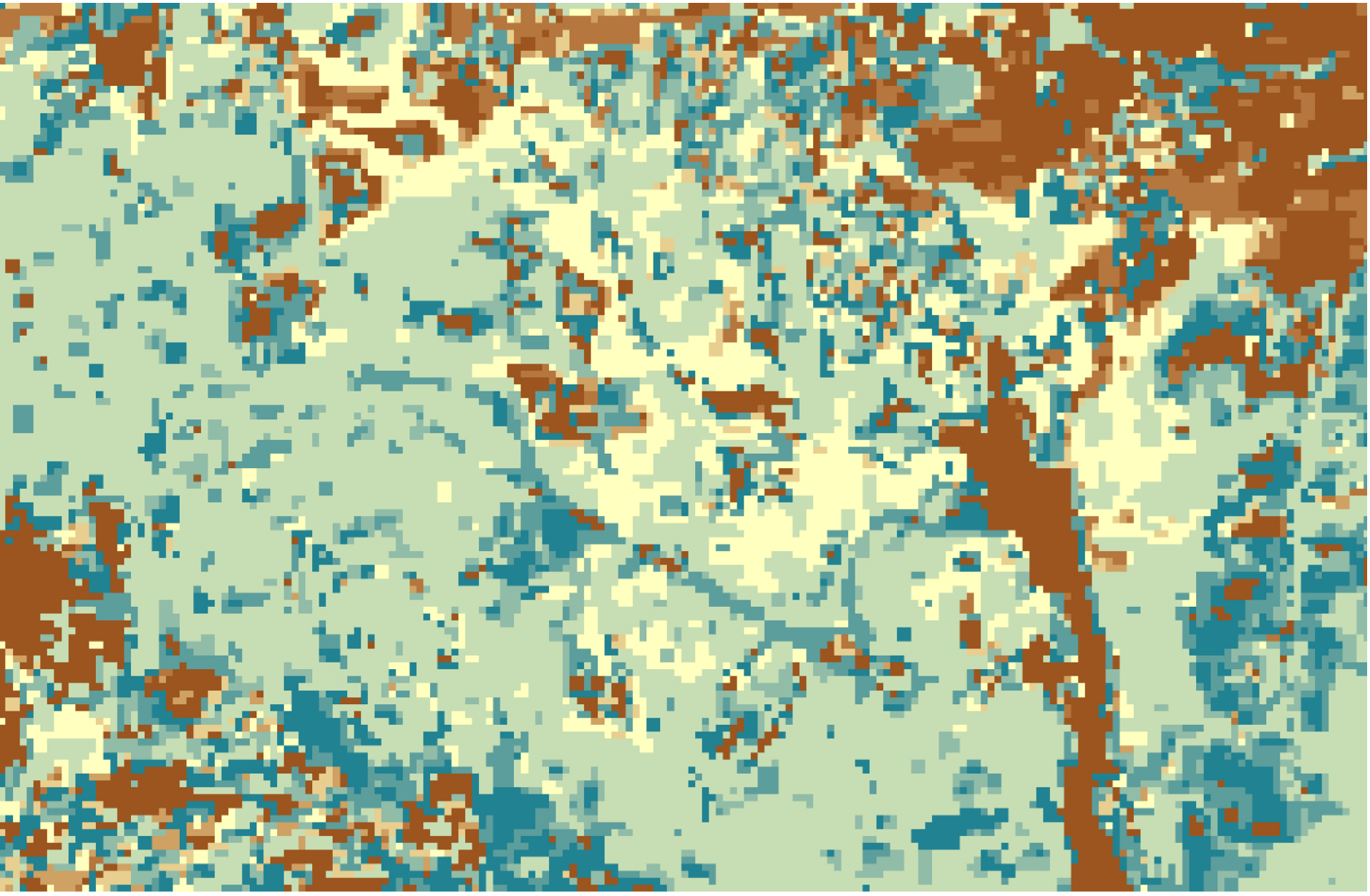
Spatial distribution and time of decline/regeneration



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Hyperspectral data

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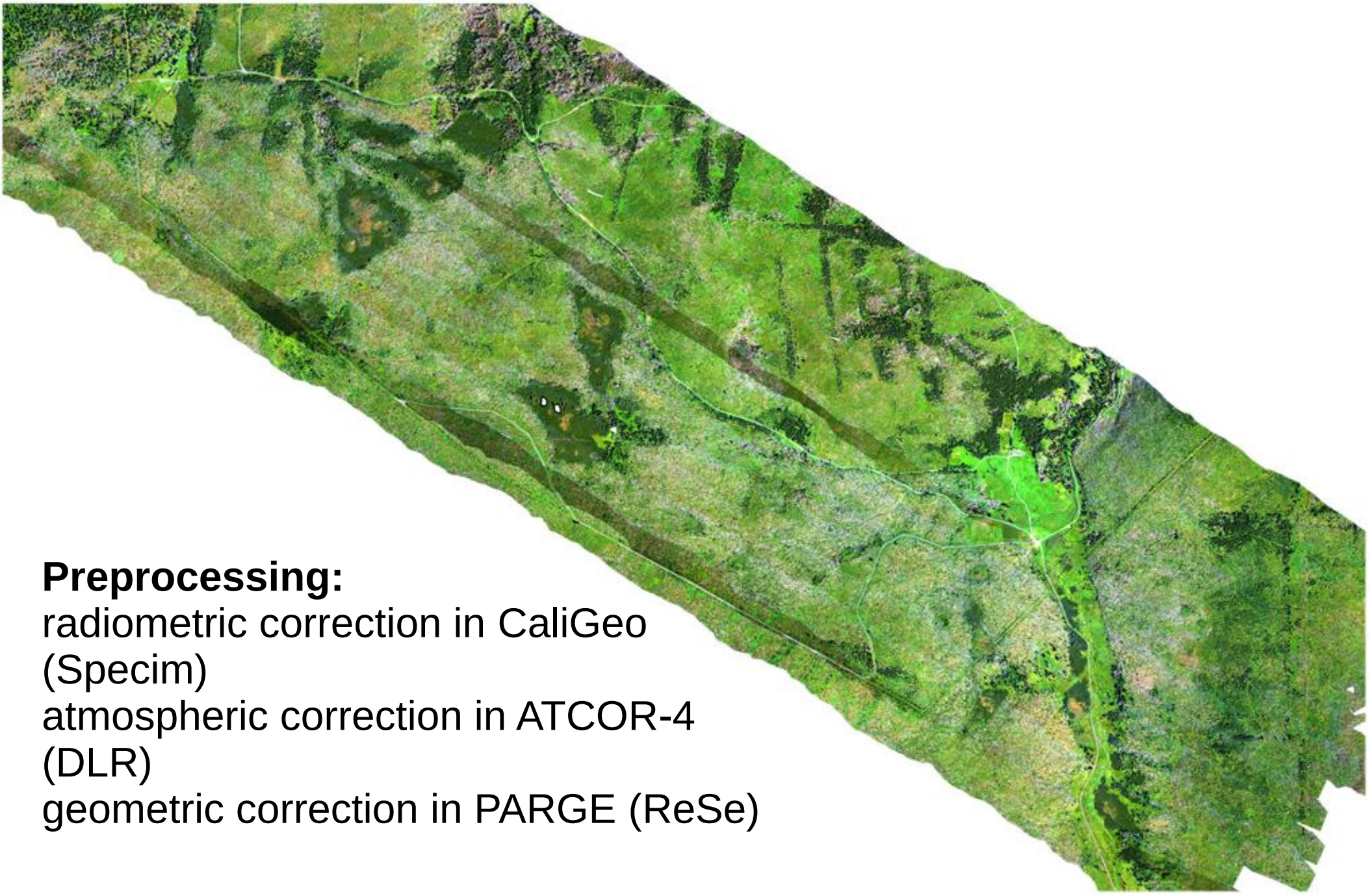
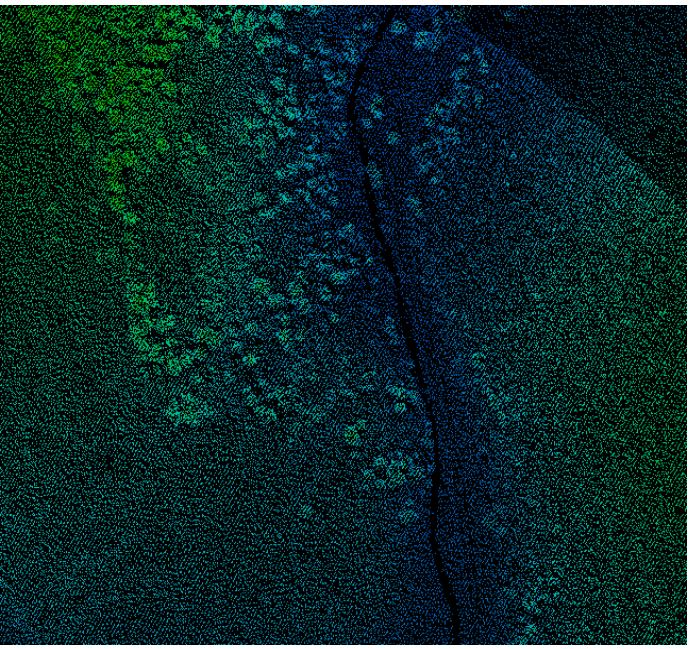
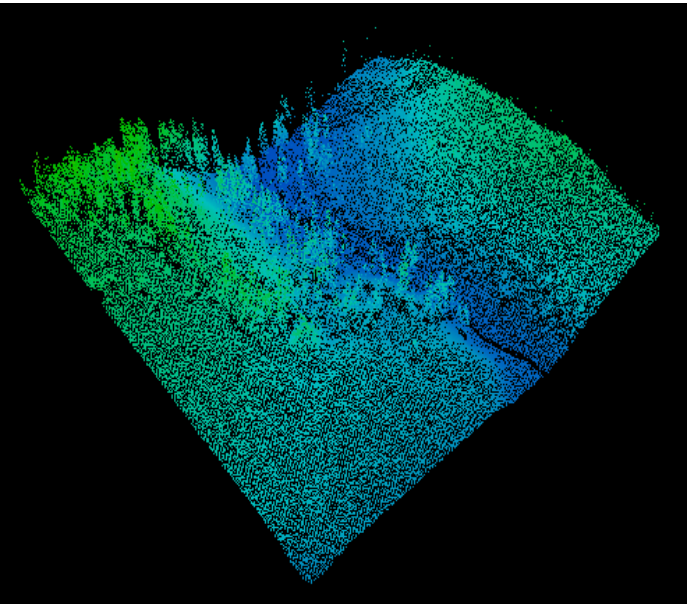


Preprocessing:
radiometric correction in CaliGeo (Specim)
atmospheric correction in ATCOR-4 (DLR)
geometric correction in PARGE (ReSe)

LiDAR input

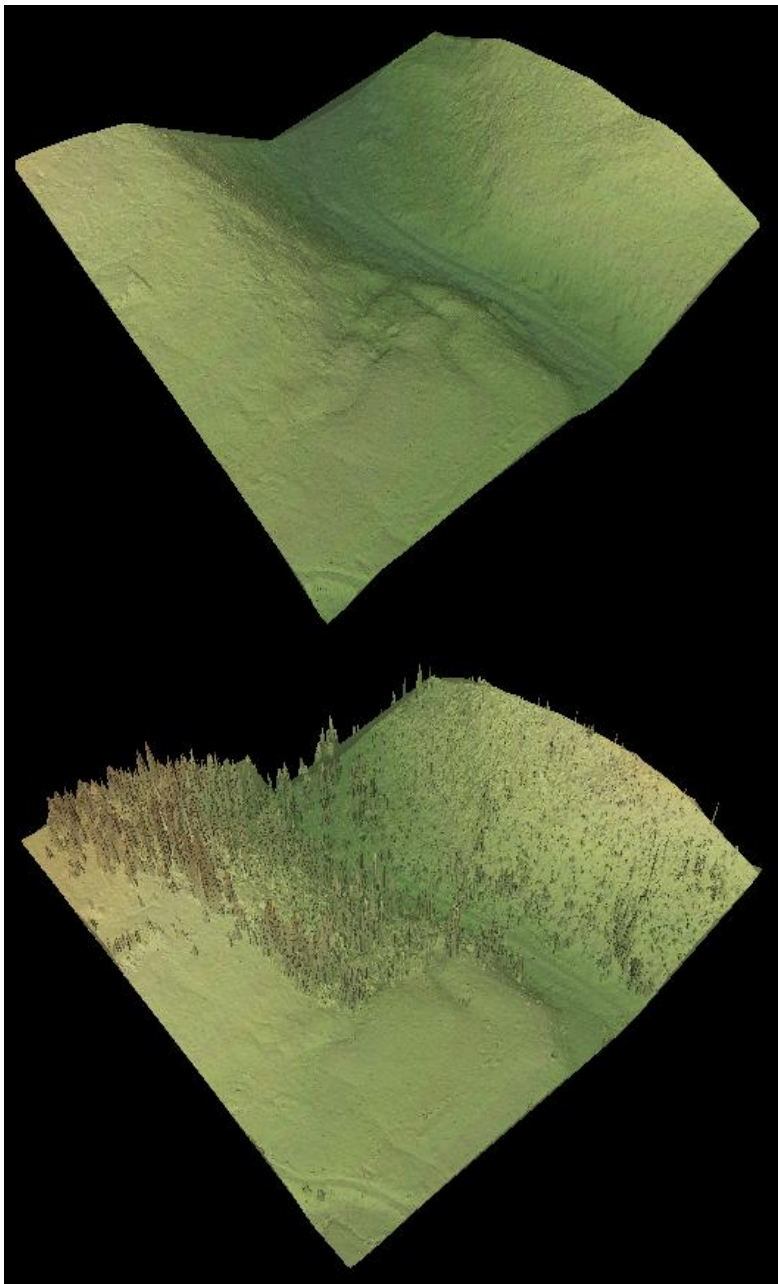




Processing:
splitting into two groups: surface points and terrain points

interpolation of digital terrain model (DTM) and digital surface model (DSM)

calculation of a map of pixel height by subtraction of DTM from DSM



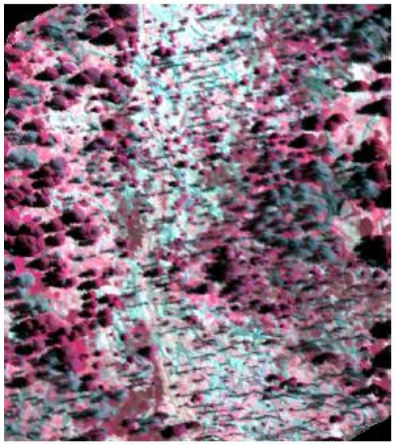
Object oriented classification

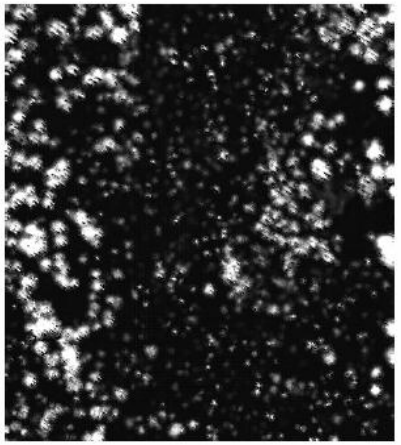
spectral information - from HS data (PCA transformation)

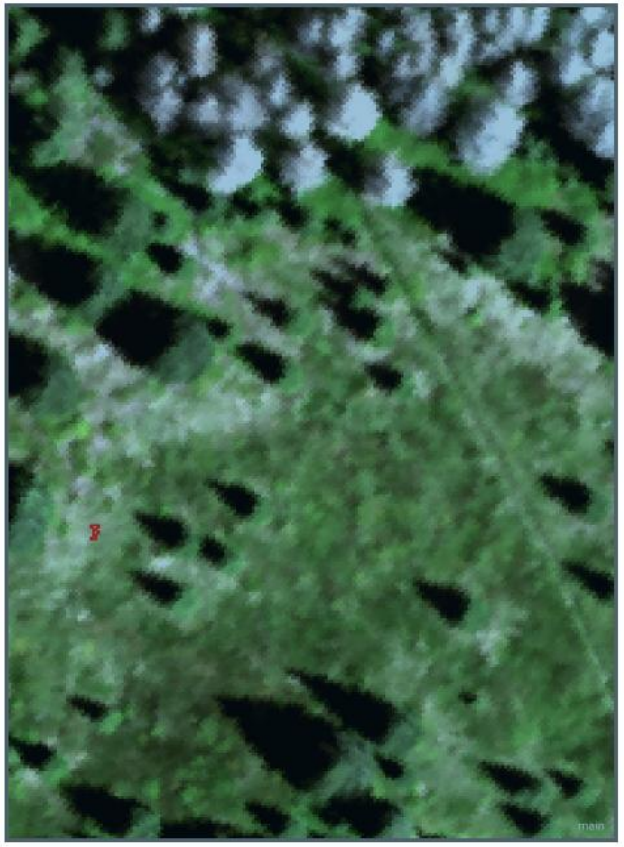
structural information - tree height derived from LiDAR data

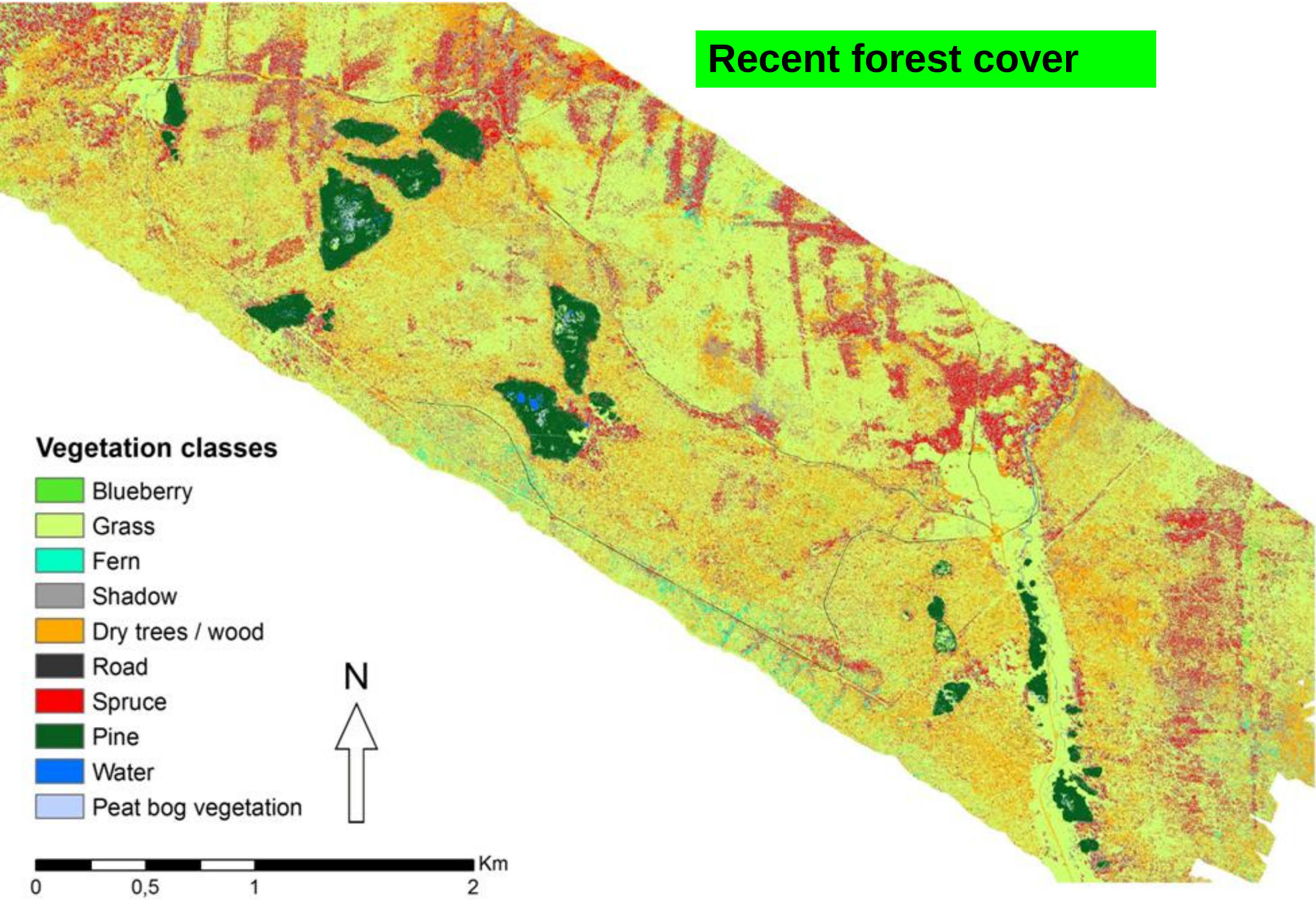
Results of object-oriented classification

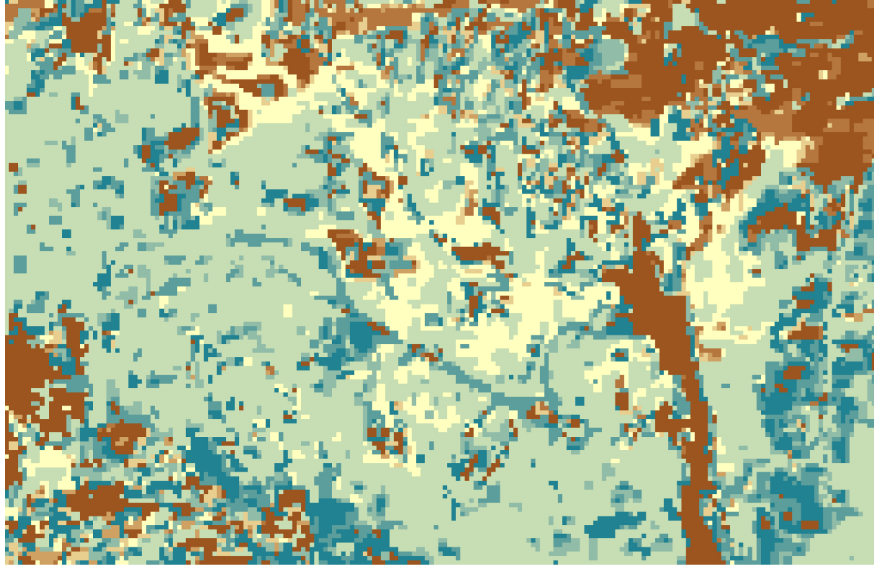
Classification inputs:
hyperspectral data and map of tree heights

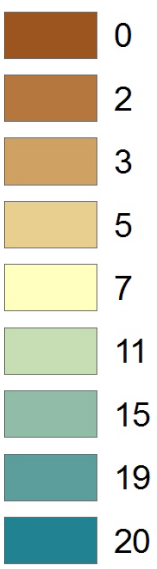







Recent forest cover
Vegetation classes
Blueberry
Grass
Fern
Shadow
Dry trees / wood
Road
Spruce
Pine
Water
Peat bog vegetation
N
0
0,5
1
2
Km





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Spatial distribution and time of decline/regeneration

GIS analysis

SOLAR IRRADIATION

TOPOGRAPHIC WETNESS INDEX

SLOPE

DTM

MAP OF FORESTRY INTERVENTION

Results

Difference ($p<0,001$) in the **projected tree area** between unmanaged plots (low cover), afforested plots after the dead trees logging (medium) and reforested plots without the dead trees logging (highest)

Projected tree area is positively correlated with **time of regeneration process, global radiation, TWI** and negatively correlated with **elevation**

The number of trees (per pixel) under **different management** follows similar difference as that of the tree area

The number of trees in a pixel is **positively related with time of regeneration process, global radiation** and negatively correlated with **elevation**

Thank you for your attention.