Land use / land cover change research at Charles University in Prague

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LUCC change detection in Czechia as a matter of different:

- data sources
- scales
- time periods
- methods

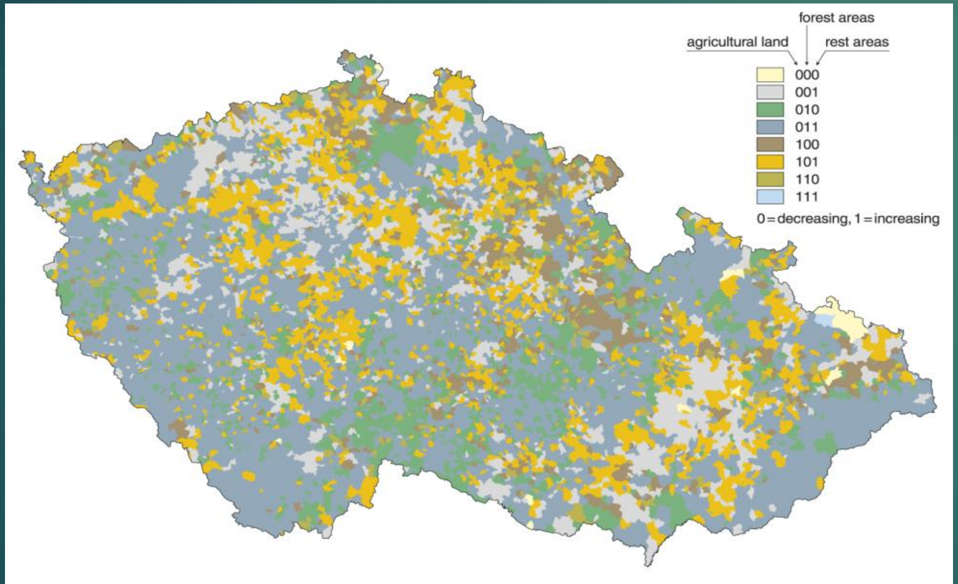
1) LULC change detection based on cadastral records

- Team of professor Ivan Bičík
- Cadastral records for – land use for data 1845, 1869, 1948, 1990, 2000 and 2010 (time comparable units – level of cadastral units)
- Socio-economic DF – location in central Europe – crossroad of European history (socialization, collectivisation, displacement of Germans from border regions, „courtain iron“ instalation, after 1989 return of private property, market economy, restitutions)… laboratory for studying LULC
- Unique dataset for the whole country territory
- Stable cadastre maps (1811 - patent of Frantz I – Austria-Hungarian Monarchy) – arround 1845 – source of detail information about landscape – change detection inside the cadastres

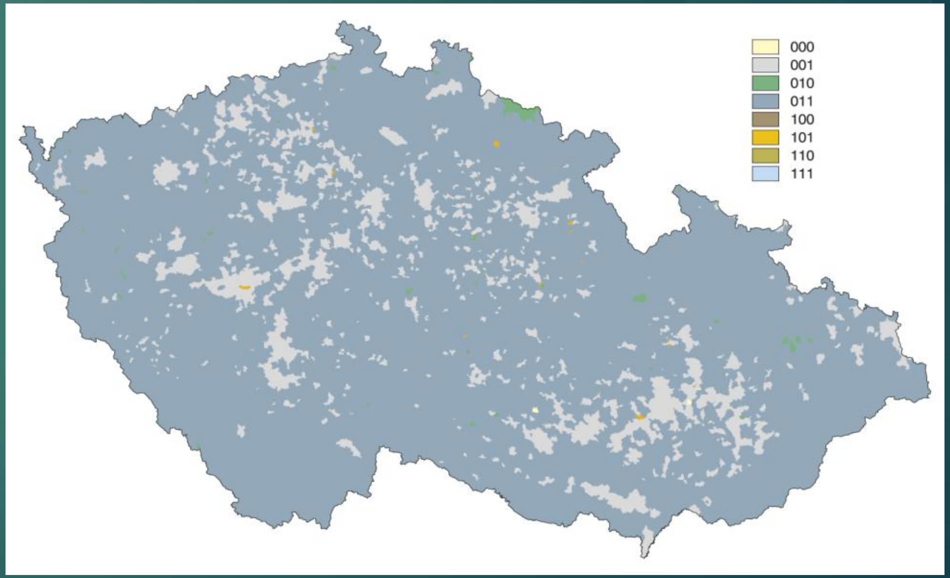
Typology of land use changes in Czechia

The difference in development during the communist period (1948–1990: unification) and the previous period is obvious

1845–1948



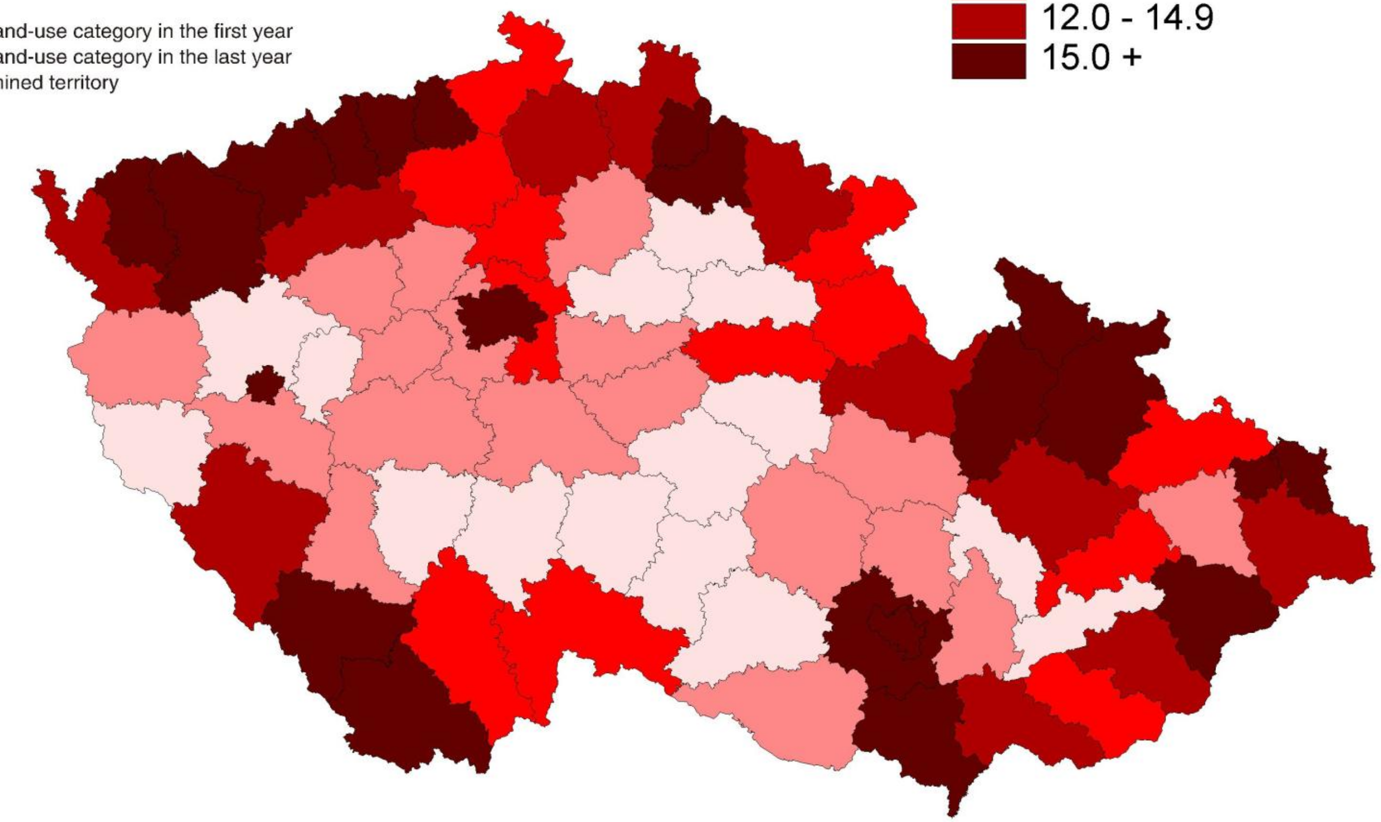
1948–1990



Index of change 1948 - 1990 in Czechia

$$IC = \frac{\sum_{i=1}^{n} \left| A_{1i} - A_{2i} \right|}{2 \times E} \times 100$$

A_{1i} – the areal extent of i th land-use category in the first year
A_{2i} – the areal extent of i th land-use category in the last year
E – total areal extent of examined territory

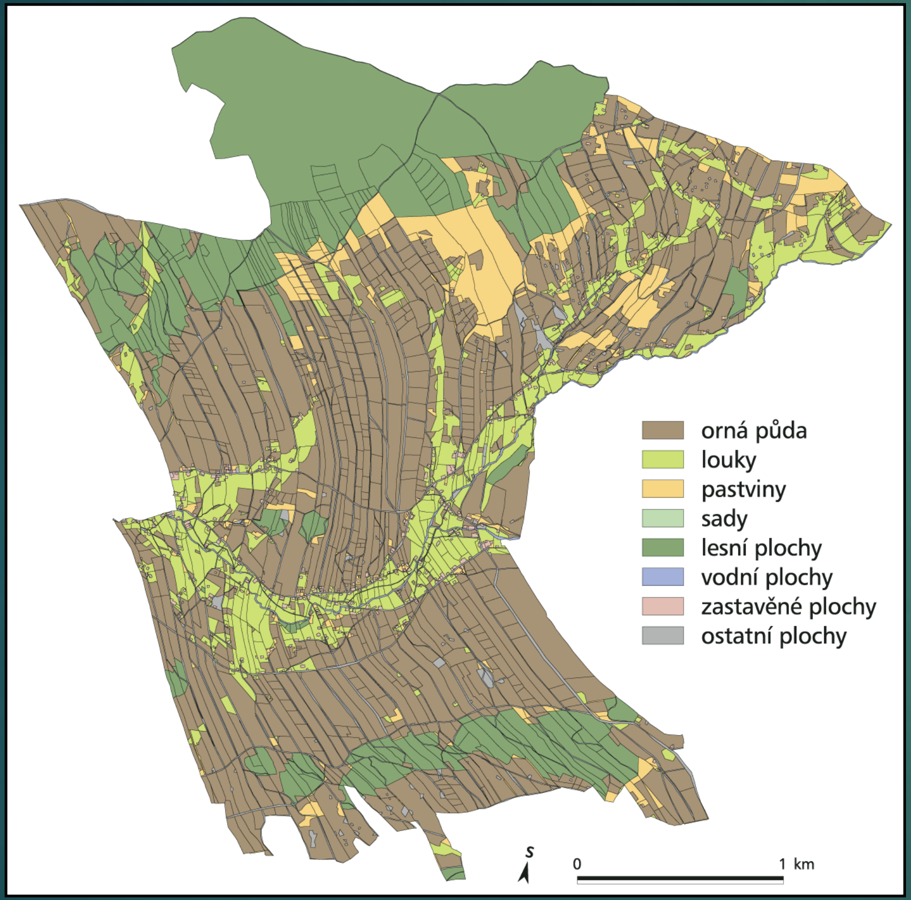


Legend

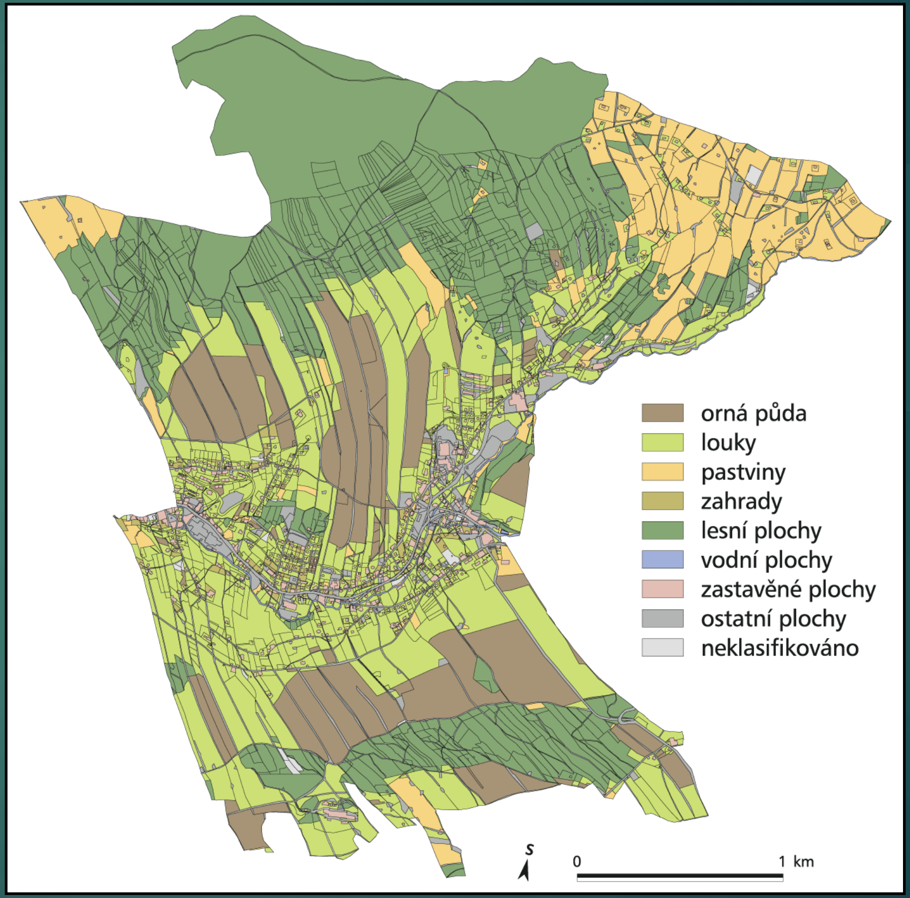
- 6.0 - 7.9
- 8.0 - 9.9
- 10.0 - 11.9
- 12.0 - 14.9
- 15.0 +

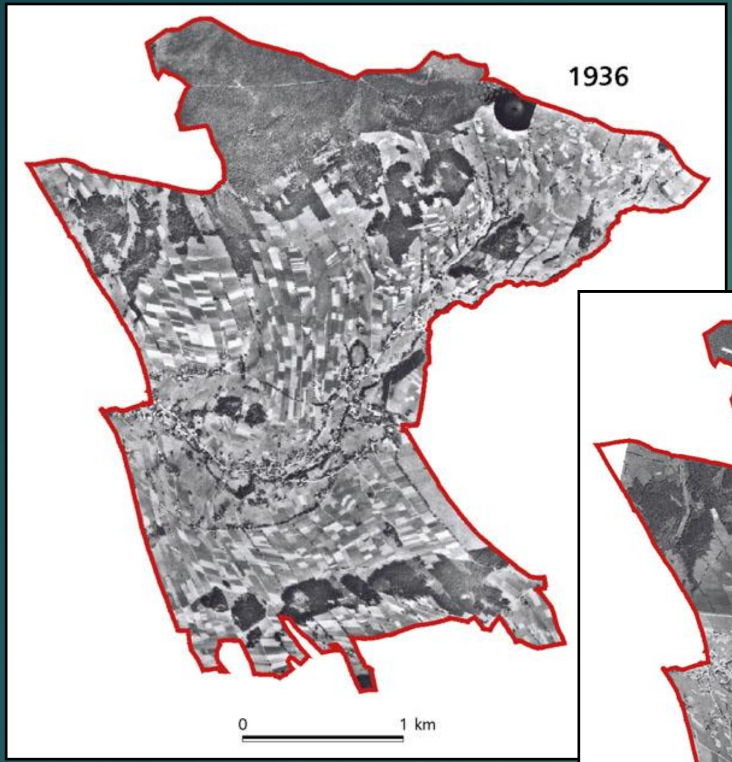
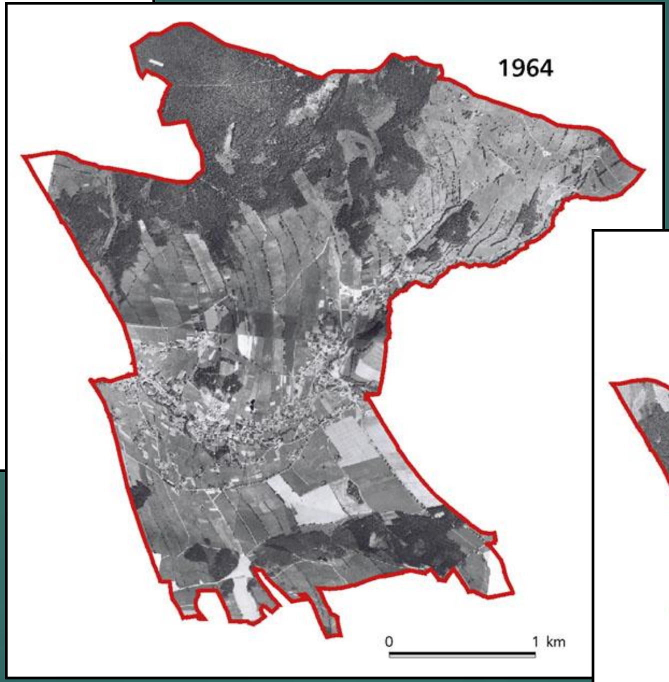
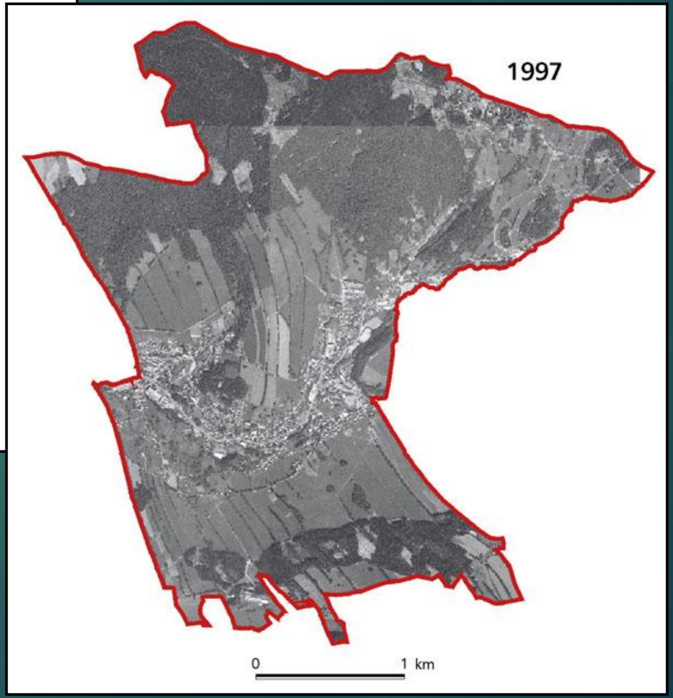
Processed in GIS Laboratory Faculty of Science Charles University Prague

1842


orná půda
louky
pastviny
sady
lesní plochy
vodní plochy
zastavěné plochy
ostatní plochy
S
0
1 km

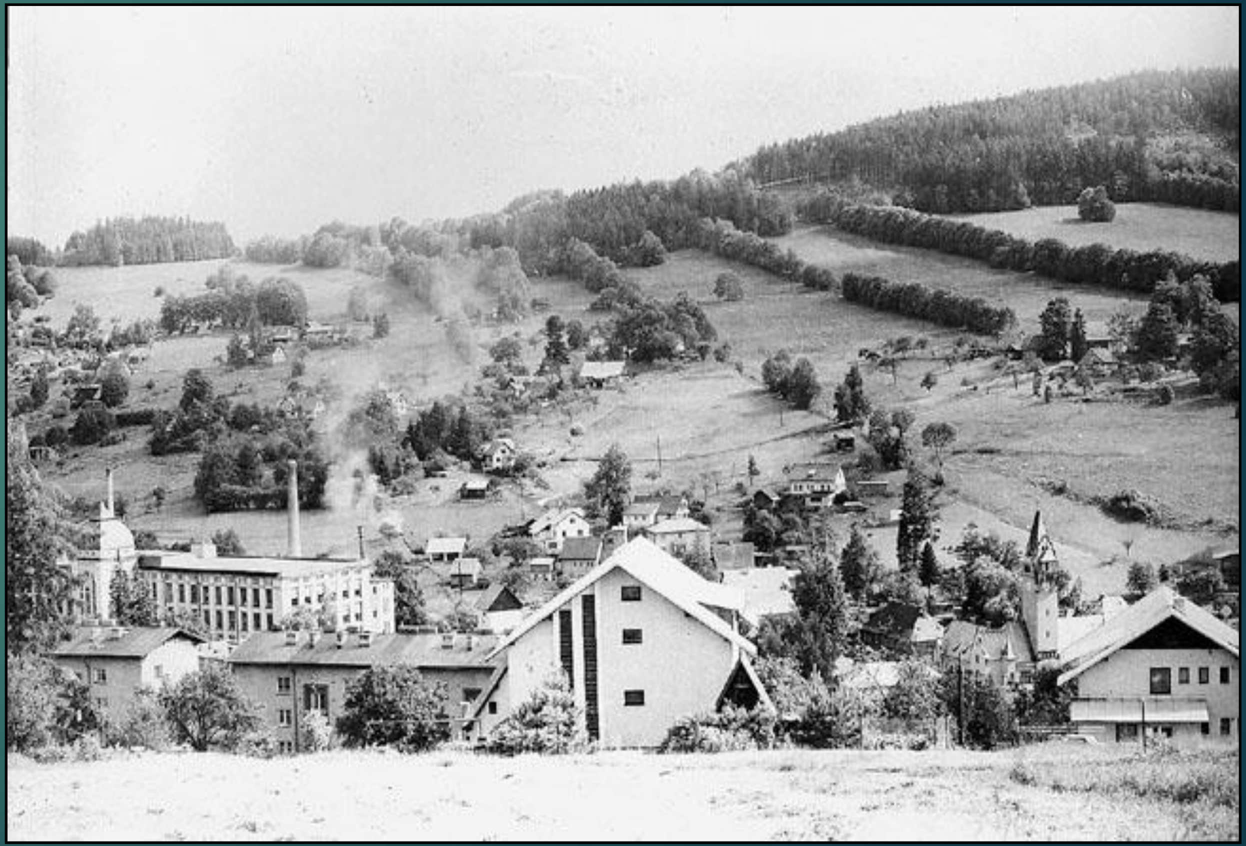
1995


orná půda
louky
pastviny
zahrady
lesní plochy
vodní plochy
zastavěné plochy
ostatní plochy
neklasifikováno
S
0
1 km


1936
0
1 km

1964
0
1 km

1997
0
1 km

1935

1993



2) LULC change detection based on CORINE dataset

- Changes along the „Iron Curtain“ 1990 - 2006

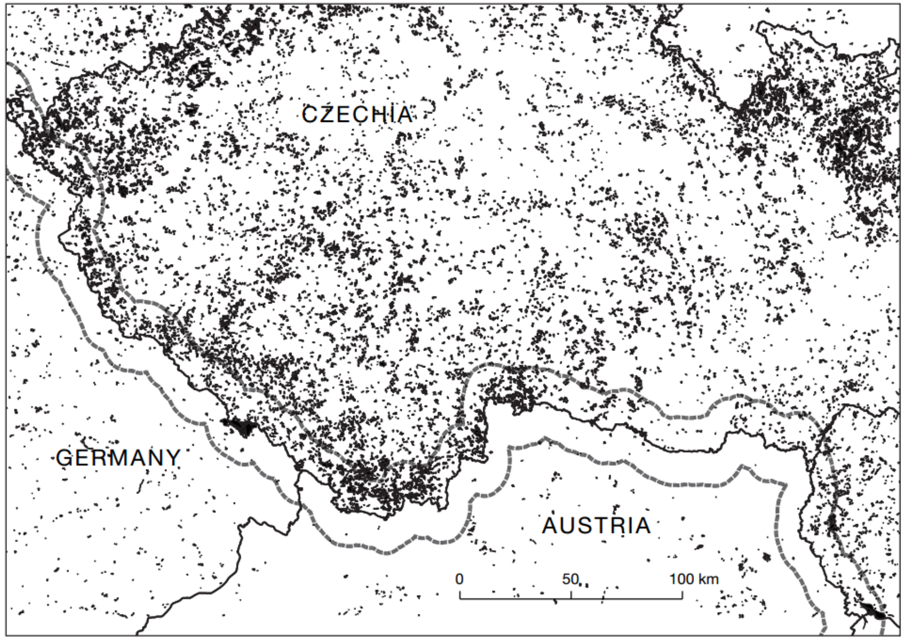
Fig. 1 – Area of interest with the fifteen kilometres wide border zone on the eastern and western sides of the border

Tab. 3 – Index of Change during the Periods 1990–2000 and 2000–2006 for Different Border Sections East and West of the Iron Curtain

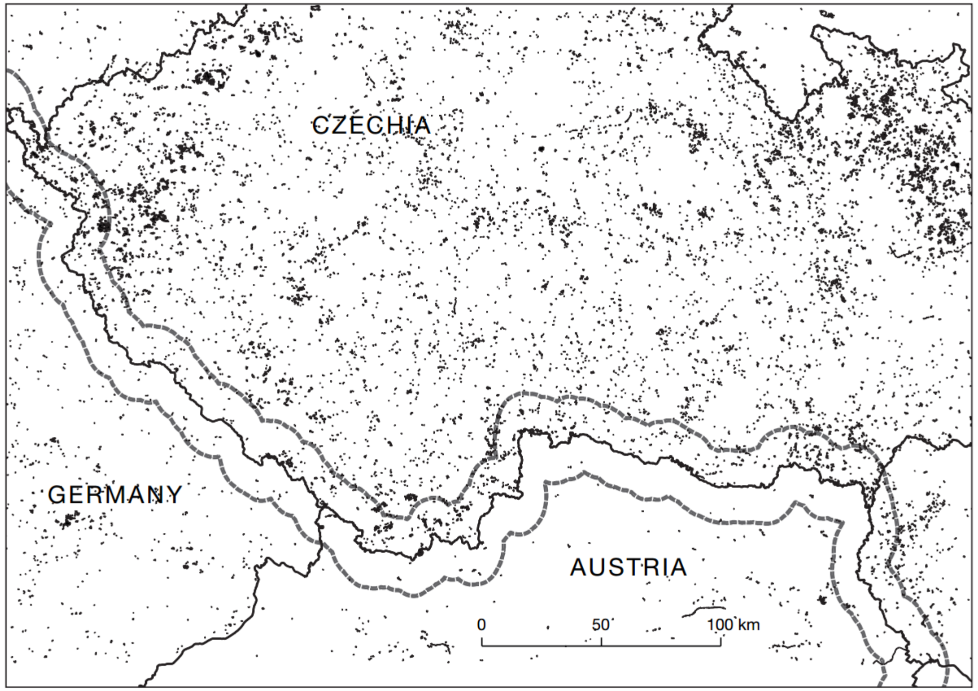
Area	Index of change (%)			
	1990–2000		2000–2006	
Border section	East	West	East	West
Iron curtain	3.96	0.52	0.61	0.16
Czechia – West Germany	8.42	1.43	1.34	0.25
Czechia – Austria	8.19	0.13	1.48	0.13

Source: based on Corine Land Cover data

1990 - 2000

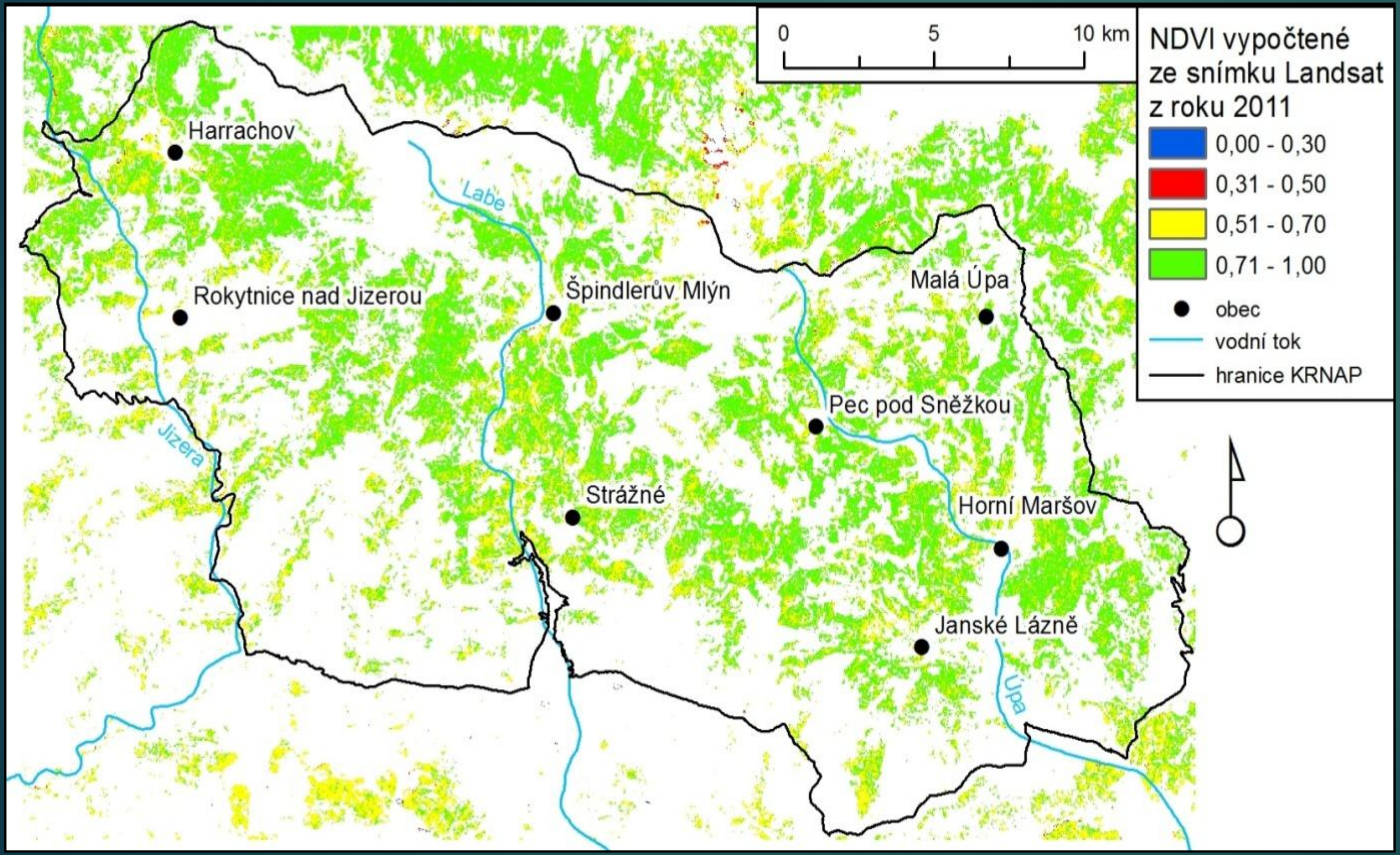


2000 - 2006



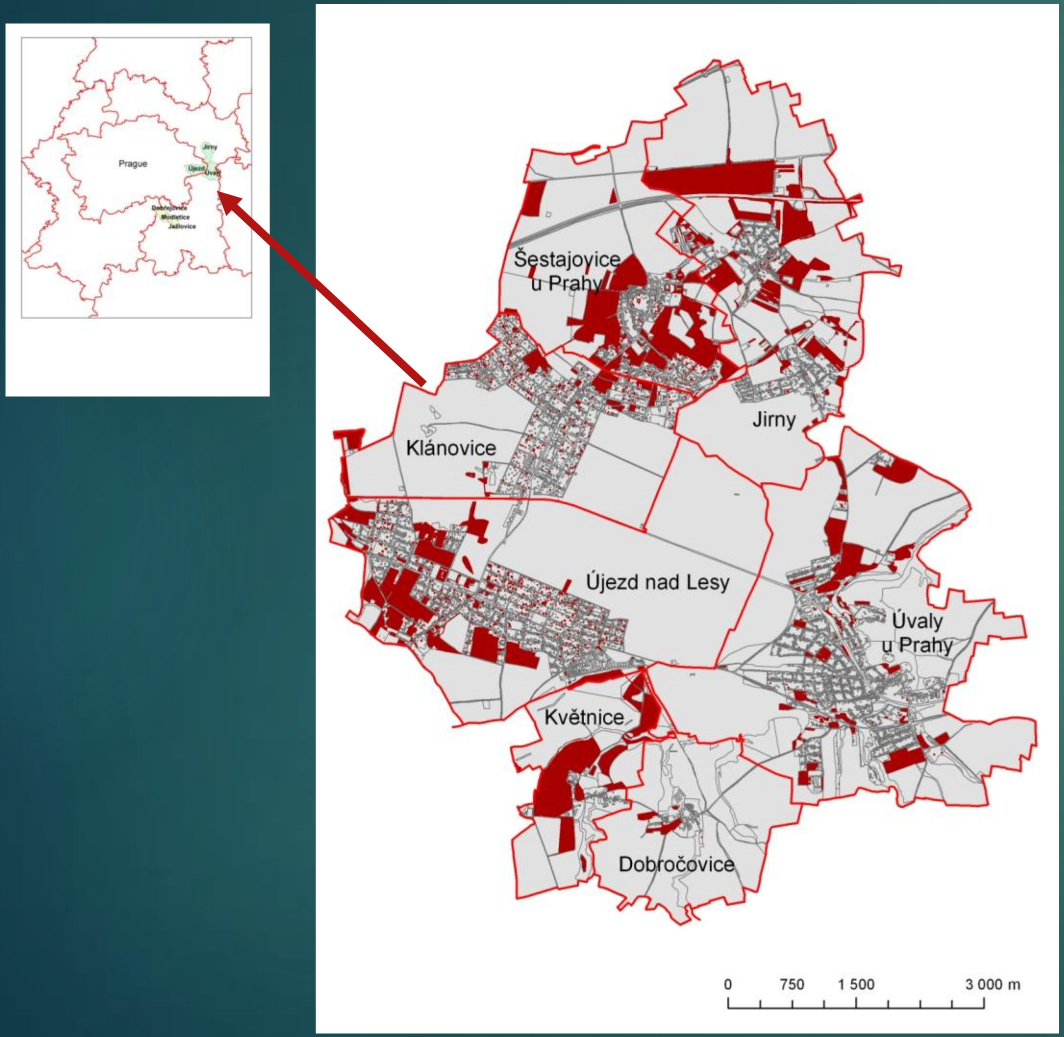
3) HR multispectral data for the LULC change detection Landsat and SPOT series

NDVI change for Norway Spruce stands (the Krkonoše Mts. NP)



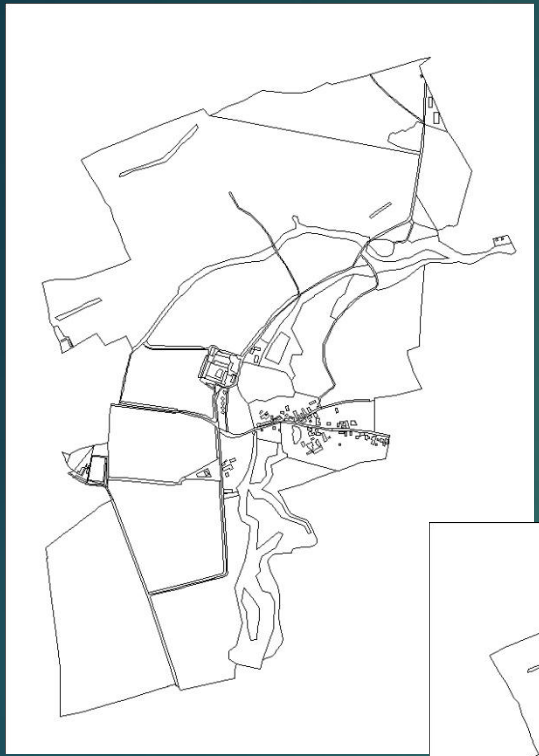
4) VHR data for suburbanization change detection

Results – spatial change 1990 – 2007 in Prague suburban area



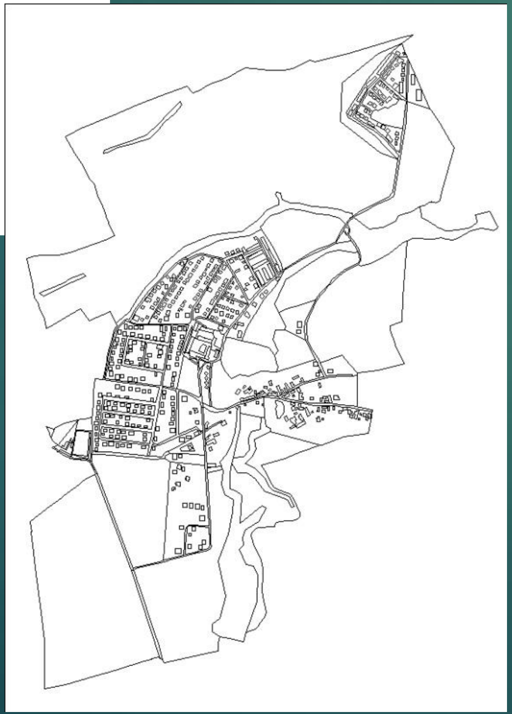
Cadataster	Total area of spatial change (ha)	Share of spatial change on total municipality area (in %)
Dobročovice	4,8	1,33
Jirny	130,1	15,76
Klánovice	30,5	5,19
Květnice	70,2	24,54
Šestajovice	108,7	19,98
Újezd	109,7	10,78
Úvaly	69,1	6,31
Území celkem	**523,1**	**11,1**

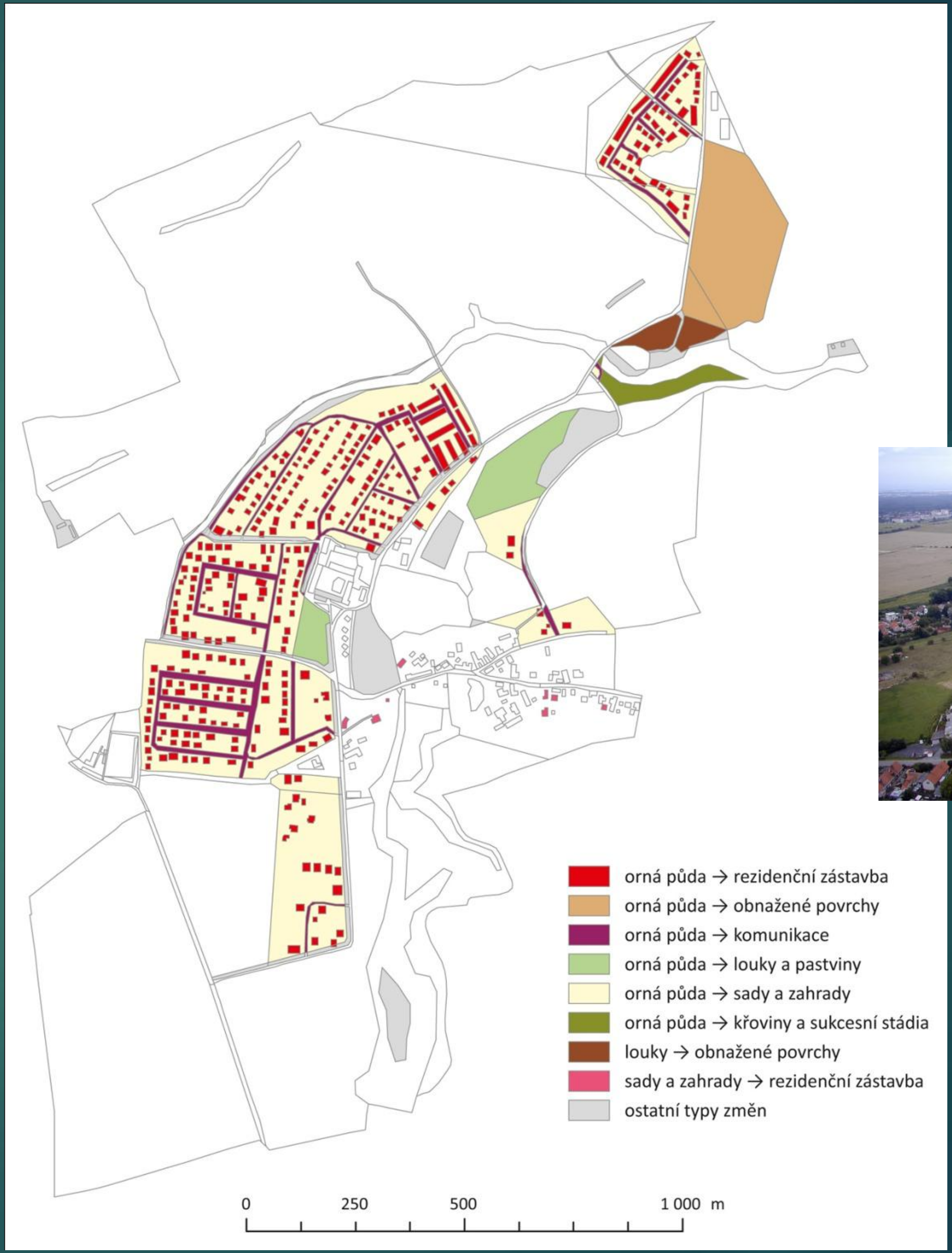
Results Květnice municipality



1990

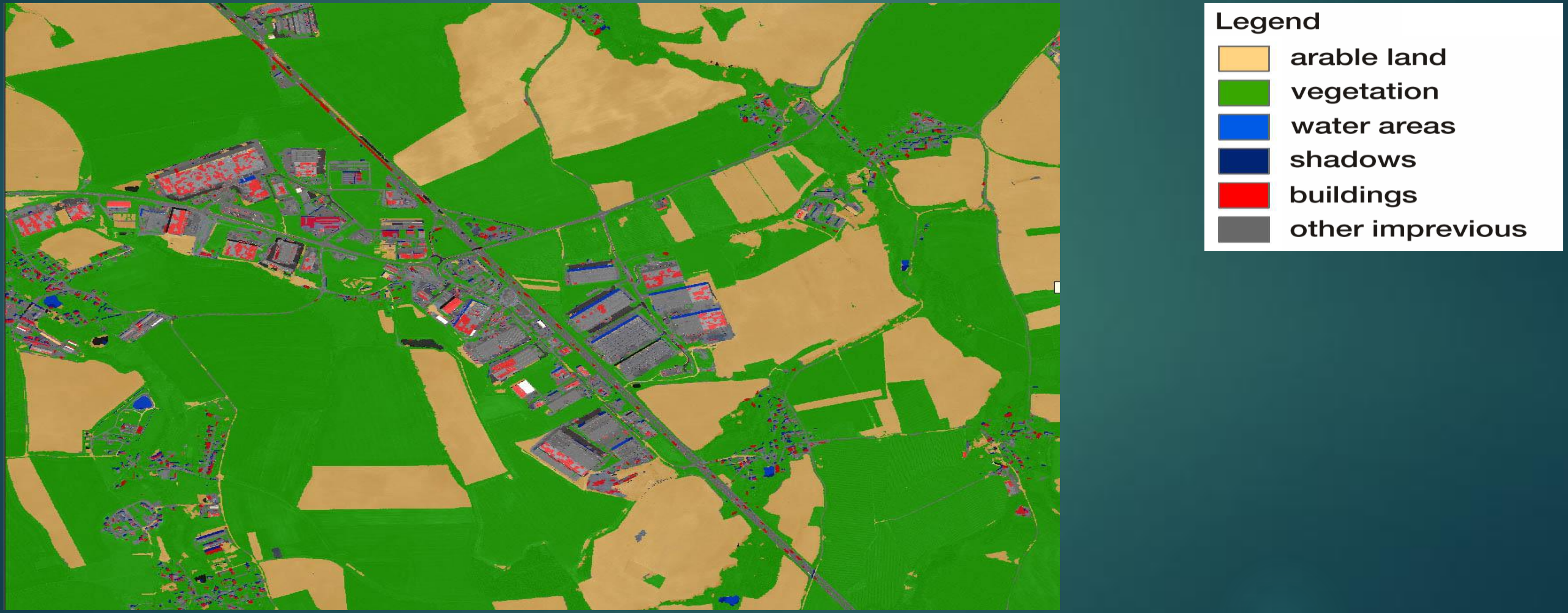
2007





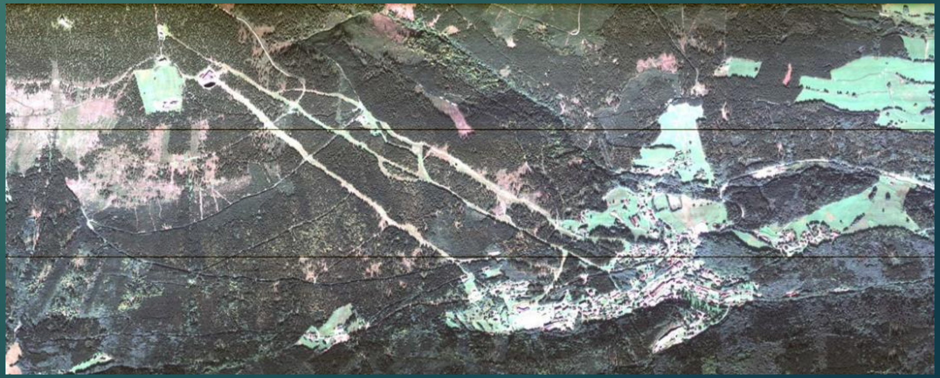
OBIA – buildings extraction - Modletice Municipality

Optical and airborne laser scanning data



5) Hyperspectral data for vegetation change detection

- Project HyMountEcos (Hyperspectral remote sensing for Mountain Ecosystems)
- Together with Warsaw University (doc. Bogdan Zagajewski and his team)
- APEX data (Airborne Prism Experiment)
- operated by VITO Belgium



Mapping of meadow vegetation types in the Krkonoše NP

- The Krkonoše Mountains National Park is situated in the highest mountains in the Czech Republic on the Czech-Polish border.
- Traditionally managed meadows are one of the most valuable ecosystems in the Giant Mountains.
- Regular management is essential for the meadows sustainability and high species diversity.
- Management monitoring requires reliable and repeatable mapping of various types of meadow vegetation.
- Visual mapping and management monitoring certain disadvantages
  - devaluated by a subjective error
  - very time consuming.
- Remote sensing methods can help to map objectively and repeatable the vegetation and to control monitoring practice without such a time demand.
- However classification of meadow vegetation is very complicated because of high spectral and often also structural similarity of individual meadow vegetation types.

Goal

- The goal of this study was to classify meadow vegetation types of meadow enclave Lahrovy boudy using remote sensing data sources with different spectral and spatial resolution.
- We aimed to evaluate and compare classification accuracy of different data sources using Support Vector Machine classification algorithm.

Area of interest – Lahrovy boudy enclave

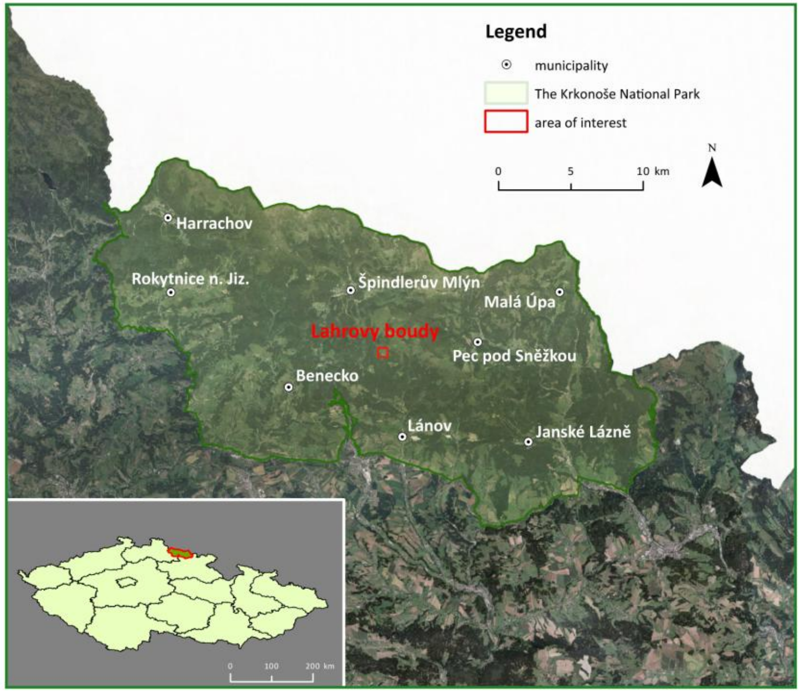


Fig. 1 — Study area

- Area is about 40 ha
- Typical management practices – grazing and cutting are practiced here.
- Various meadow vegetation types are present
- Among valuable plant species we can find for example endemic species *Campanula bohemica.*
- The enclave is a refuge for endangered bird species *Crex crex* that occurs only in several localities in the Krkonoše Mts.
- The real danger for the species diversity and stability of the enclave is an expansion of *Rumex alpinus* (category degraded meadows in our legend) which is invading the meadow zone due to long term fertilization with nitrogen compounds as a result of waste water penetration from above located mountain buildings.

Data sources

Data type	sensor	Spectral resolution	Spatial resolution	Date of acquisition
Hyperspectral aerial data	APEX	288 bands	2.4 m	September 2012
Multispectral satellite data	WorldView-2	8 multispectral bands + Panchromatic band	2 m	September 2011
Ortophoto	Digital camera VEXCEL UltraCamX	RGB + IR	0.12 m	August 2013

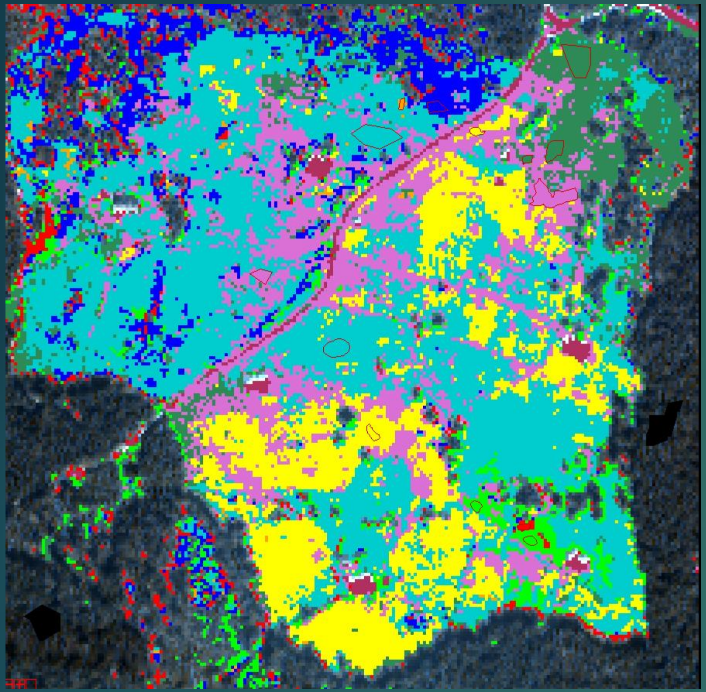
Data sources

APEX

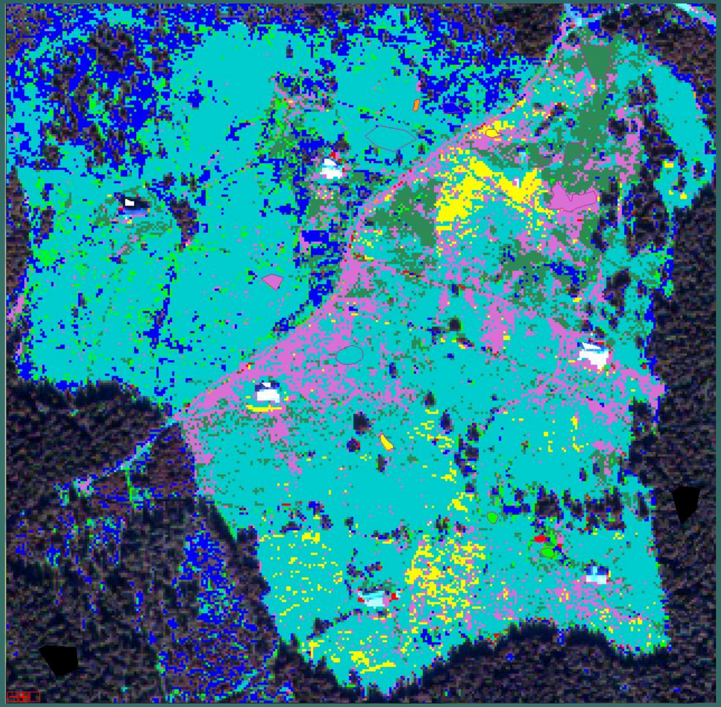
WorldView2

Ortophoto

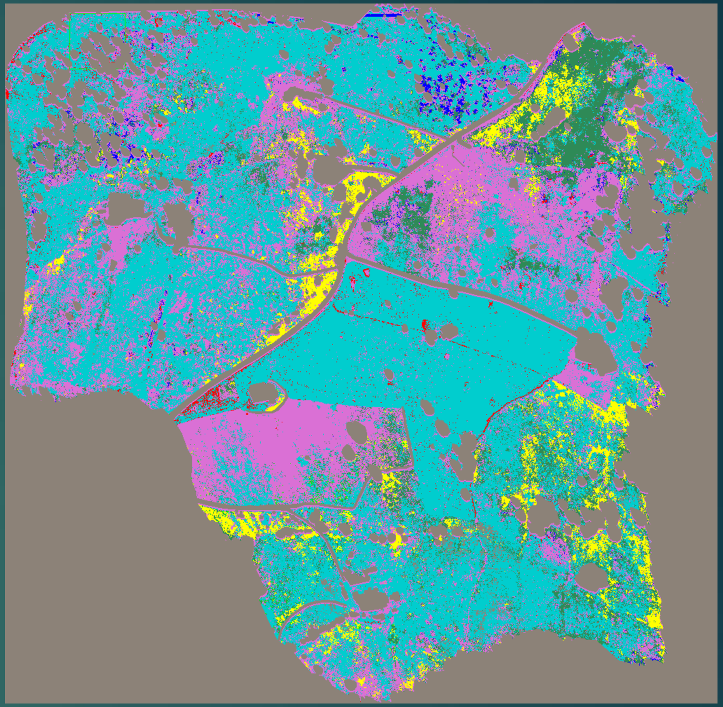
Classification Results



APEX



WorldView2



Ortophoto

- Degraded meadows
- Meadows with dominant *Nardus stricta*
- Oligotrophic meadows
- Mesophilic meadows
- Pastures
- Meadows degraded by monocotyledons
- Meadows with dominant *Vaccinium sp.*
- Waterlogged meadows
- Buildings and roads
- Buildings
- Other

Classification Accuracy Assesement

Data source	Overall Classification Accuracy (%)	Kappa Coefficient	The best classification results of categories		The worst classification results of categories	
			Prod. Acc.	User Acc.	Prod. Acc.	User Acc.
APEX	78.8	0.74	– Degraded – Pastures	– Mesophilic – Dominant *Vaccinium sp.*	– *Nardus stricta*	– *Nardus stricta*
WorldView-2	69.3	0.60	– Degraded	– Dominant *Vaccinium sp.*	– *Nardus stricta* – Mesophilic – Pastures – Oligotrophic	– *Nardus stricta* – Mesophilic – Pastures – Oligotrophic
Ortophoto	51.8	0.38	– Pastures	– Mesophilic	– Degraded by monocotyledons	– Degraded by monocotyledons

Conclusions

- Hyperspectral data provided significantly better classification results than other data types
- High spectral resolution can improve significantly the classification accuracy
- Spatial resolution is not so significant for the classification result (APEX has the lowest spatial accuracy)
- Very important output of our study is the good classification result of Degraded meadows.
- Rumex alpinus that represents the most serious threat for the mountain meadow diversity and stability has significant share in the species composition of this category.
- Using even just multispectral data (WorldView-2) this category and its expansion can be monitored and effective methods of meadows management to prevent this category expansion can be applied.
- For future research also other classification methods (for example Artificial Neural Networks) can be used.
- Also the classification legend can be further improved to meet better “the view of botanist” in combination with “the view of remote sensing sensors”.

Thank you for your attention!

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