Landscape transformation in Czechia over the last 30 years:

Diversity of changes on two spatial levels

Lucie Kupková, Zdeněk Boudný

Charles University Prague, Faculty of Science,

Department of Applied Geoinformatics and Cartography

Faculty of Science
Charles University

Goals

- Over the last 30 years, Czechia has experienced significant landscape transformations following the fall of communism in 1989 – the political and societal changes influenced the land use / land cover significantly

- The goals:
  - To map and analyze these **landscape transformations**
  - Focusing particularly on the **diversity of changes during the transformation period**
  - Detailed changes of habitats: **invasions**

  ……**in contrast to the socialist era**, characterized by uniform changes like widespread conversion of agricultural land for construction, industrialization, and large-scale farming on extensive arable land blocks

Data and methods

- Two spatial levels – cadastral (parcels detail / habitat level) and country level (cadaster = black box)
- 1990 - 2000
- Legend

1. built-up areas (BuA)
2. arable land (AL)
3. permanent grasslands (pastures and meadows) PG
4. permanent cultures (orchards, gardens, vineyards and hop gardens) PC
5. forest areas (FA)
6. water areas (WA)
7. other areas (roads, dump sites etc.) OA

- Cadastral level (parcels) – orthophotos – vectorization, spatial overlay

Country level – database LUCC Czechia (cadaster = black box)

Coefficient of Anthropogenic influence

(1)

$$CAI = \frac{AL + BuA + OA}{PG + FA + WA}$$

The coefficient ranges from 0 to infinity, with values closer to 0 indicating lower human (anthropogenic) pressure on the landscape. The CAI map presented within the final map sheet illustrates the difference in CAI values between 1990 and 2020, thereby presenting the increase (positive values) or decrease (negative values) in anthropogenic pressure across individual stable territorial units.

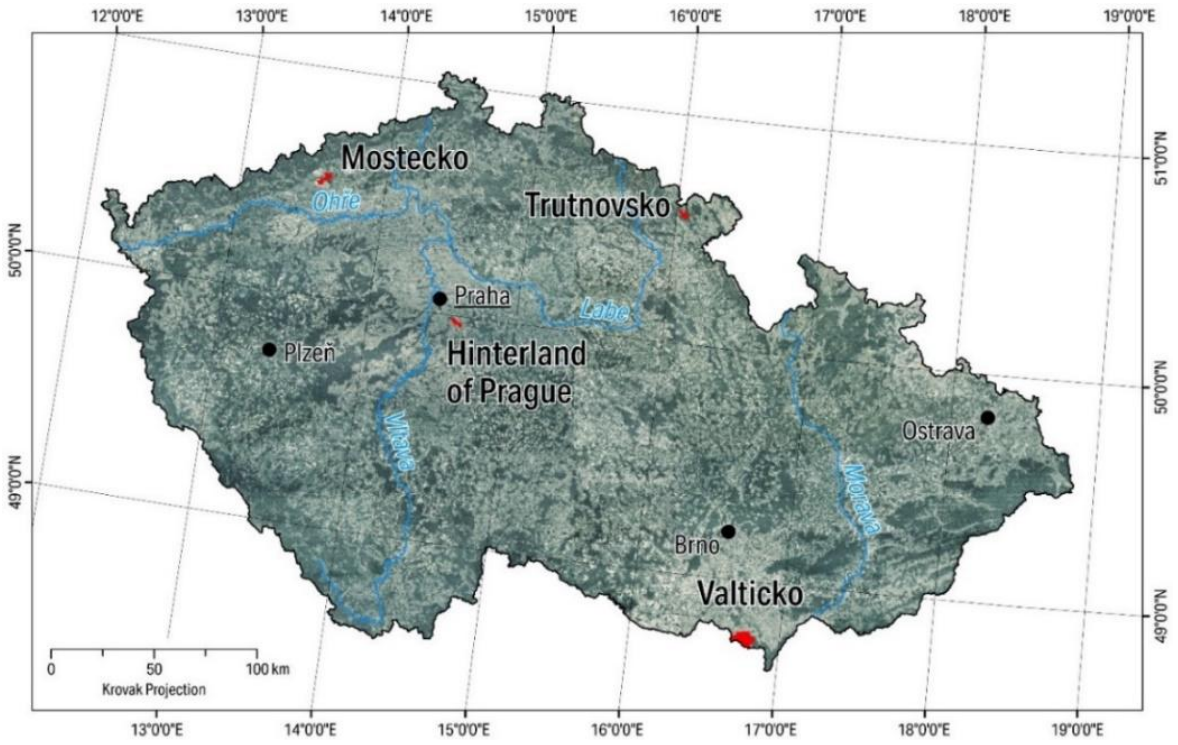
Index of change

(2)

$$IC = \frac{\frac{Ac_{2020}}{TA_{2020}}}{\frac{Ac_{1990}}{TA_{1990}}}$$

where A_{c2020} is area of the category in 2020, TA_{2020} total area of STU in 2020, A_{c1990} is area of the category in 1990, TA_{1990} total area of STU in 1990. The Index of Change (IC), evaluates the overall intensity of change in % for a specific land use/land cover category in the given period (Bičík et al. 2015). Negative values indicate a decrease in a given category, while positive values indicate an increase.

Cadastral level - areas of interest



		Hinterland of the Prague	Mostecko	Valticko	Trutnovsko
The analysed cadastral units		Dobřejovice, Modletice u Dobřejovic, Jažlovice	Holešice, Třebušice, Souš	Valtice, Úvaly u Valtic, Hlohovec	Radvanice v Čechách, Slavětín
Area (km²)		10.4	17.7	56.8	10.5
Population	**1991**	901	383	4901	1027
	2021	2000	540	4889	967
Altitude (m above sea level)		315-424	172-304	165-299	489-723
Average temperature in °C		8-9	7-8	8-9	4-6
Average precipitation in mm		500-550	400-500	450-550	600-700
Predominant soil type		Brown earth, chernozem	chernozem	chernozem	Cambisol

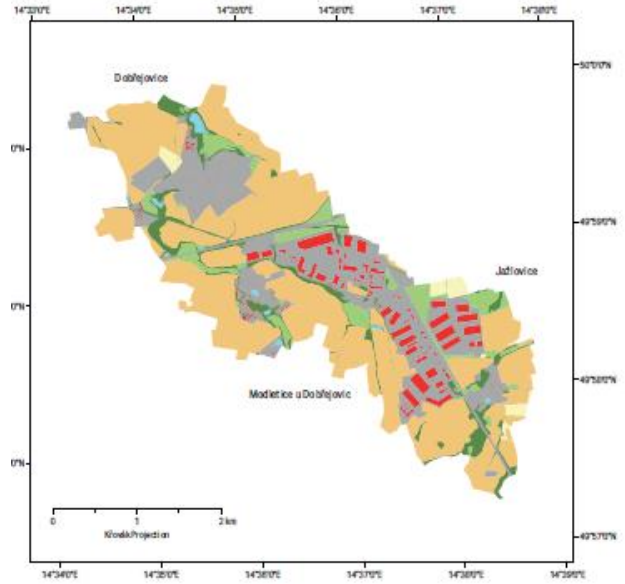
Hinterland of Pague – suburban area
Mostecko – mining area (coal mines and reclamations)
Valticko – rural-touristic area (vineyards, UNESCO site)
Trutnovsko – peripheral agricultural area

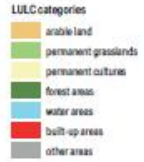
Hinterland of Prague

LULC category	Share of category in % 1994	Share of category in % 2020	Change 1994 – 2020		
			PP	ha	%
built-up areas	1.22	7.46	6.24	64.72	512.50
other areas	12.27	27.32	15.05	156.06	122.61
water areas	0.56	0.62	0.06	0.59	10.11
forest areas	6.81	8.31	1.50	15.56	22.03
arable land	74.99	48.68	-26.31	-272.93	-35.09
permanent grasslands	2.83	6.03	3.20	33.16	113.00
permanent cultures	1.32	1.59	0.27	2.81	20.47

Note: PP – percentage points

LULC CATEGORIES IN 2020

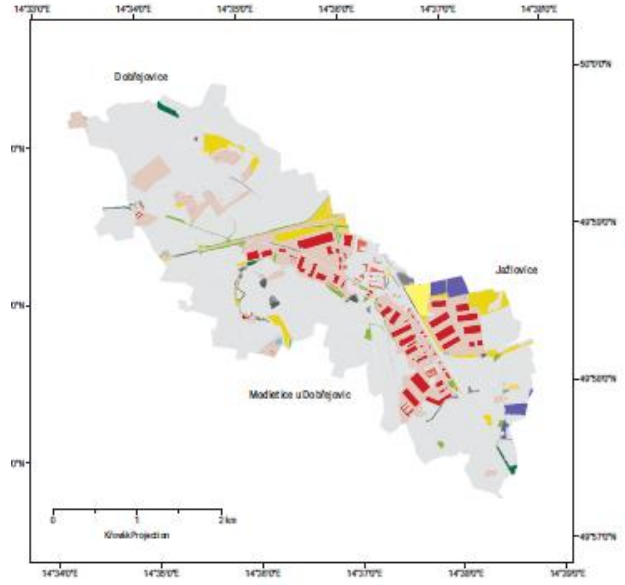




2001

2020

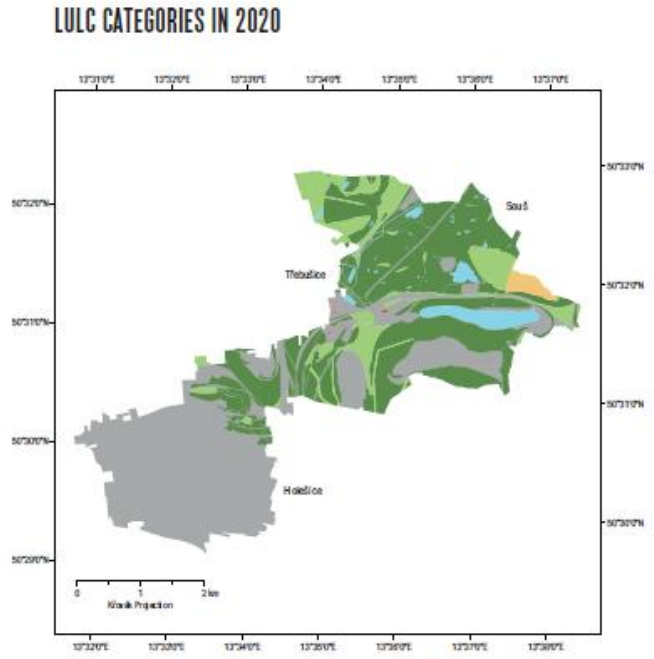
CHANGES OF LULC BETWEEN 1994–2020

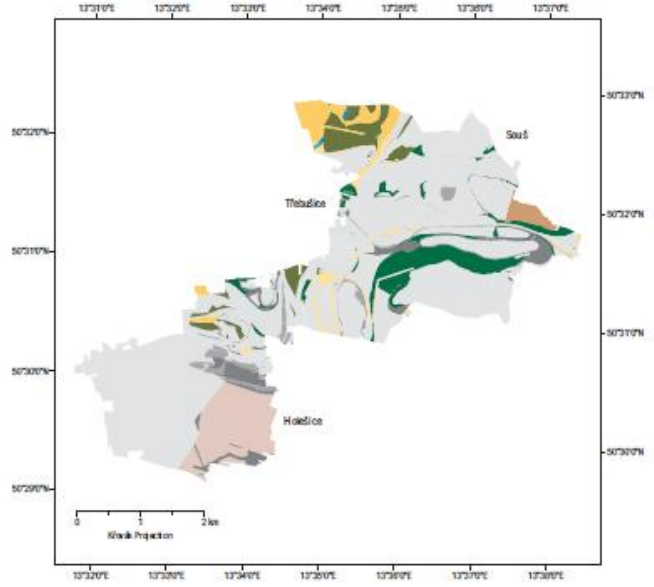


Mining area Mostecko

LULC category	Share of category in % 1992	Share of category in % 2020	Change 1992 – 2020		
			PP	ha	%
built-up areas	0.50	0.31	-0.19	-3.22	-37.28
other areas	41.15	47.37	6.22	107.72	15.16
water areas	3.76	3.79	0.03	0.51	0.79
forest areas	30.20	37.61	7.41	128.26	24.60
arable land	7.59	1.12	-6.48	-111.81	-85.30
permanent grasslands	16.79	9.79	-7.00	-120.75	-41.64
permanent cultures	0.00	0.00	0.00	0.00	0.00

Note: PP – percentage points

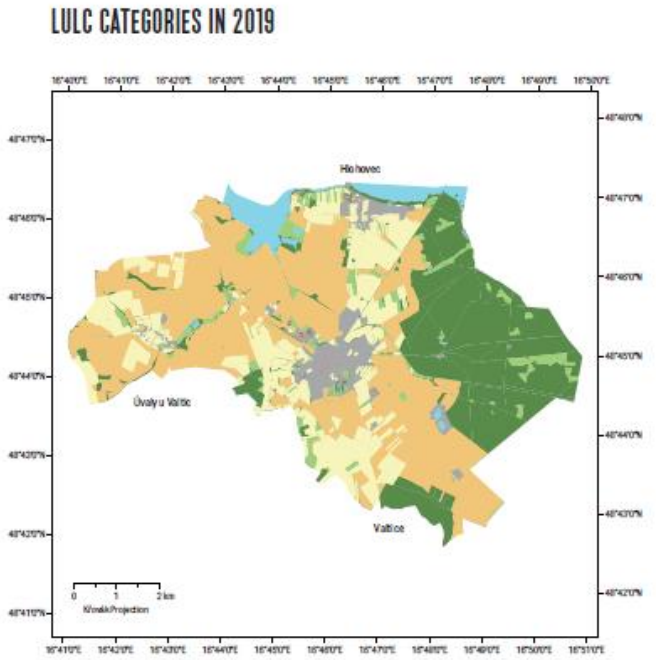


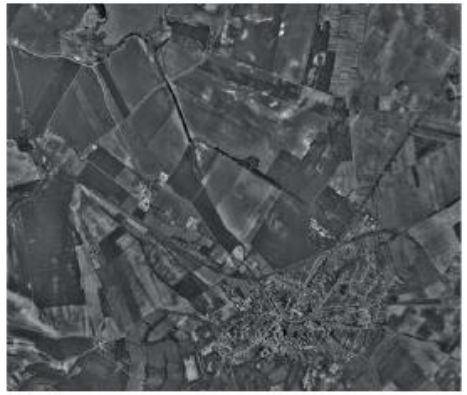


Rural-touristic area Valticko

LULC category	Share of category in % 1990	Share of category in % 2019	Change 1990 – 2019		
			PP	ha	%
built-up areas	0.77	1.00	0.23	13,03	29,93
other areas	5.46	6.76	1.30	73,79	23,78
water areas	3.89	4.17	0.28	15,84	7,16
forest areas	27.43	28.42	0.99	56,23	3,61
arable land	45.83	39.06	-6.77	-384,64	-14,77
permanent grasslands	4.00	4.36	0.36	20,32	8,93
permanent cultures	12.61	16.23	3.62	205,43	28,67

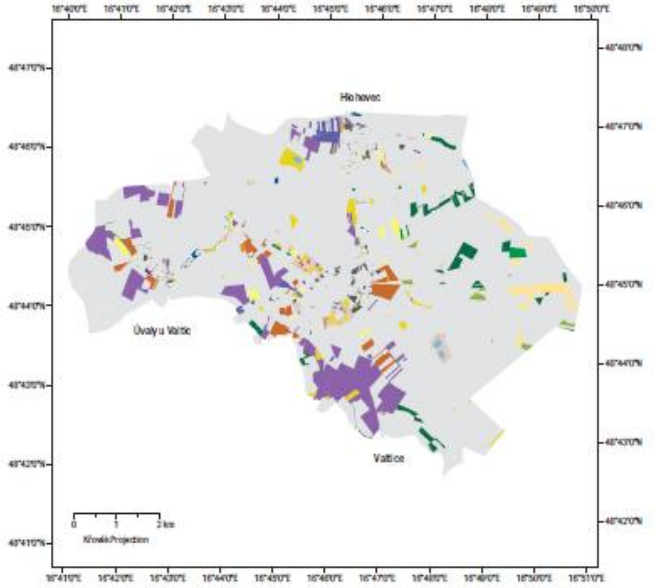
Source for the year 1990: Rašín, 2010; Note: PP – percentage points





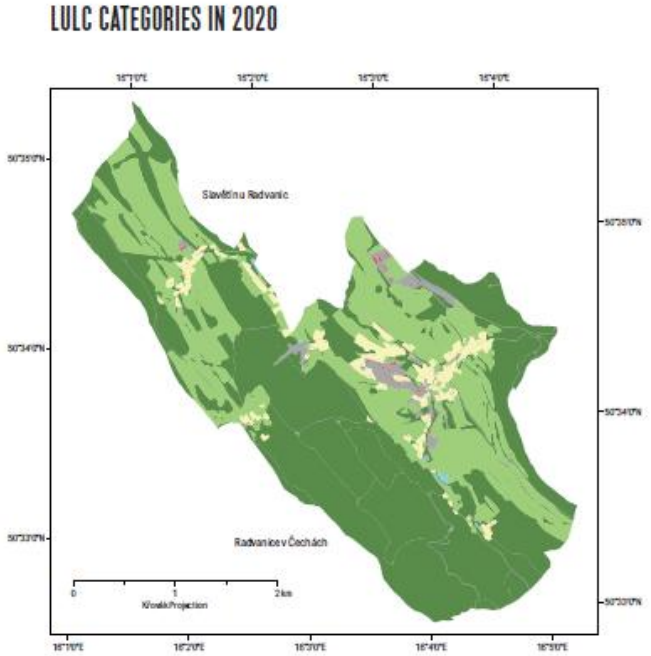
2000

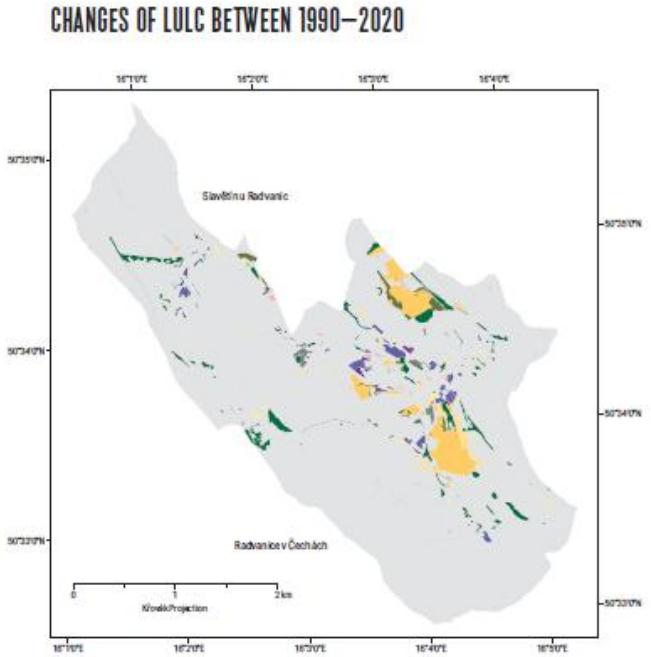
2020



Peripheral area Trutnovsko

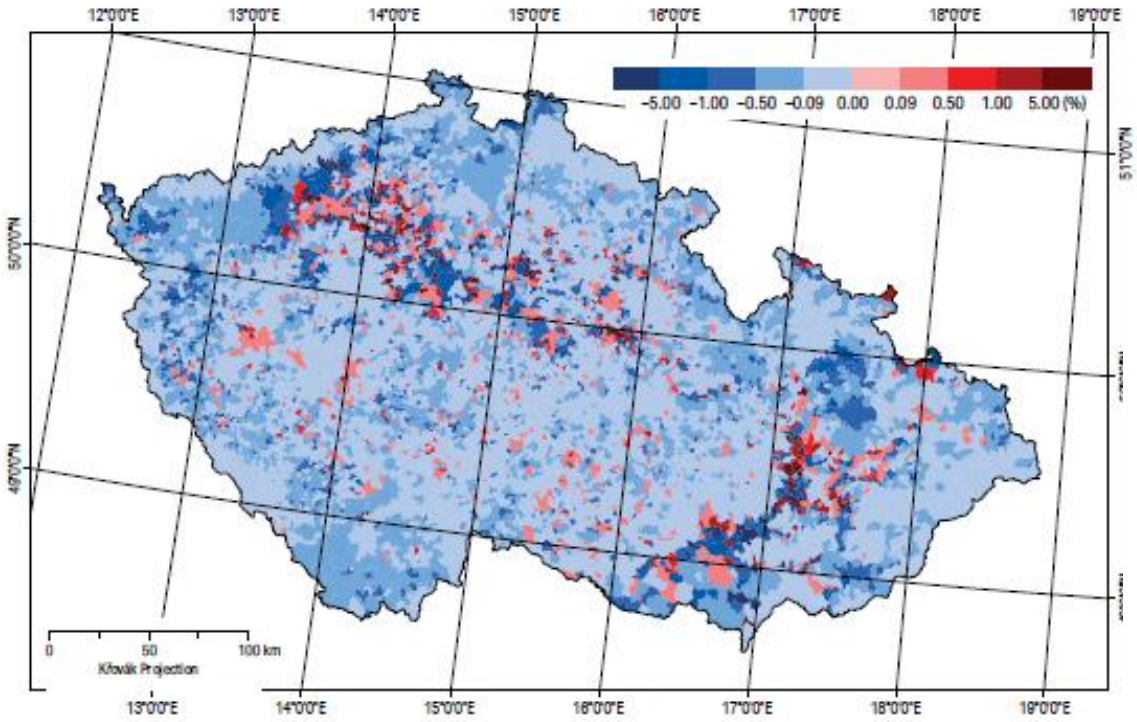
change 1989-2020	share 1989	share 2019	change 1990 – 2019 (in percentage points)	ha	%
built-up areas	0.80	0.70	-0.10	-1.08	-12.79
other areas	7.99	4.71	-3.29	-34.54	-41.14
water areas	0.03	0.12	0.09	0.94	260.56
forest areas	57.36	59.29	1.93	20.26	3.36
arable land	0.00	0.02	0.02	0.18	ND
permanent grasslands	30.99	31.53	0.54	5.63	1.73
permanent cultures	2.82	3.64	0.82	8.61	29.05



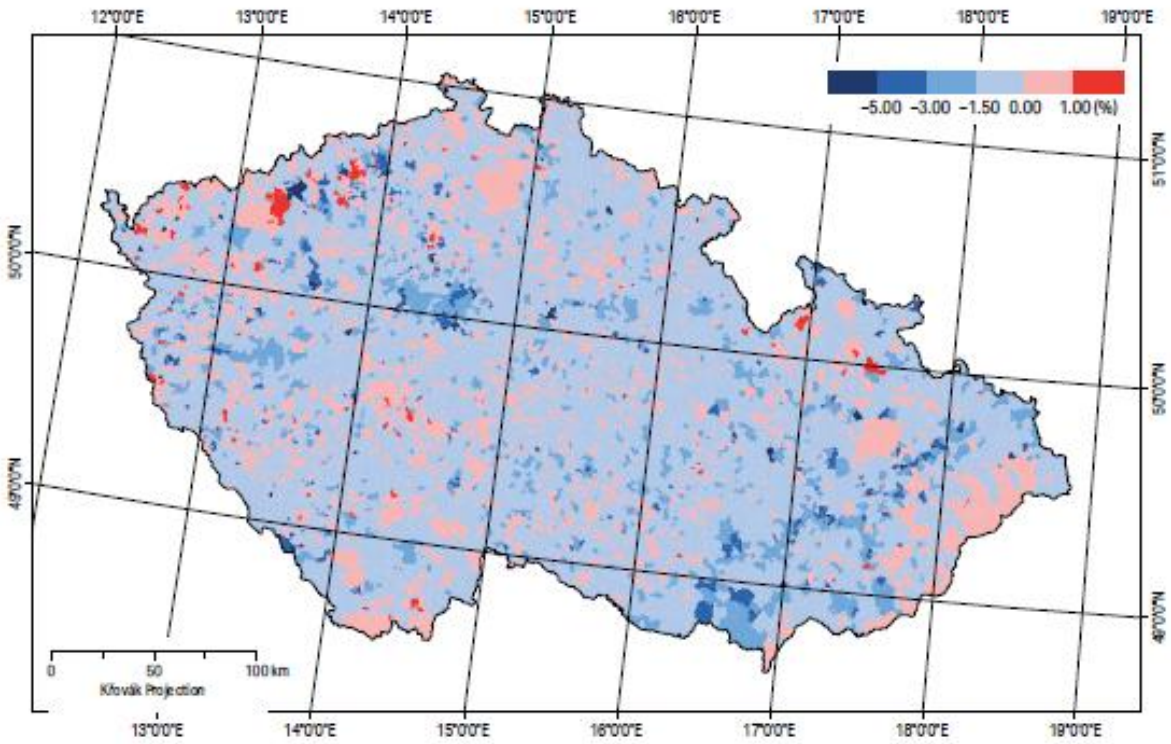


Results country level

Difference of the coefficient of anthropogenic influence between 1990–2020

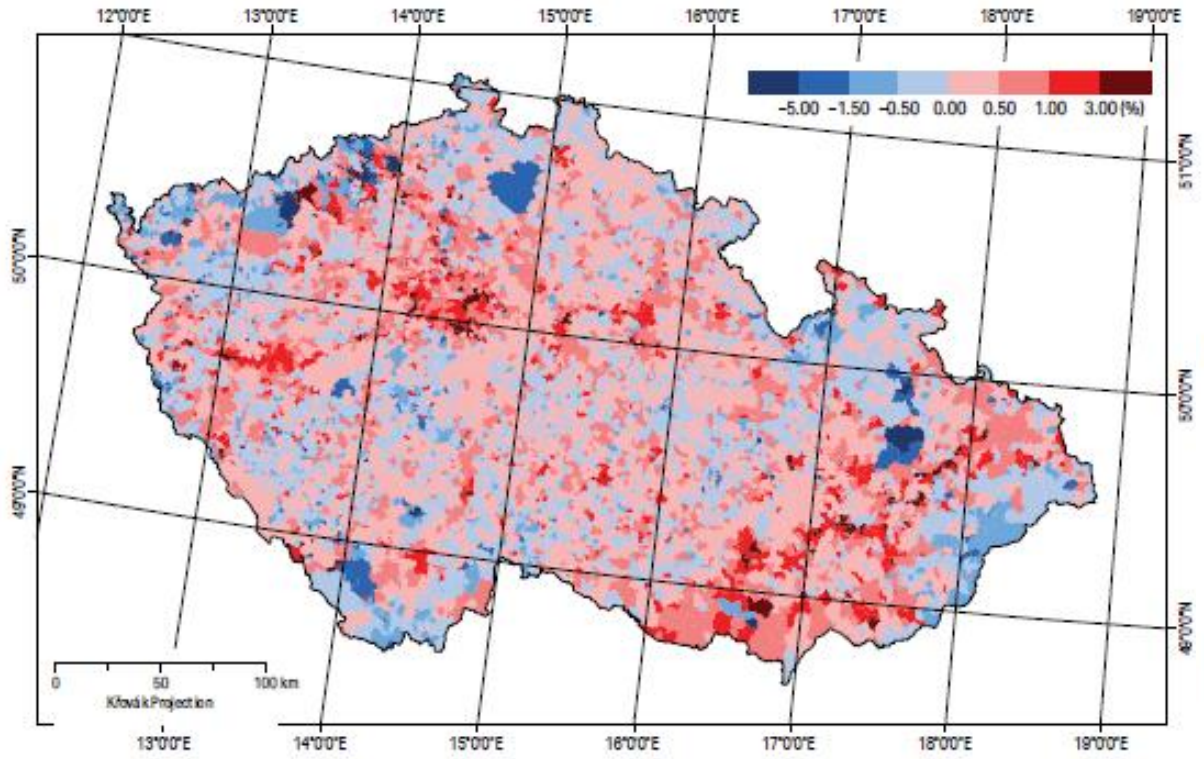


Index of change of agricultural land between 1990–2020

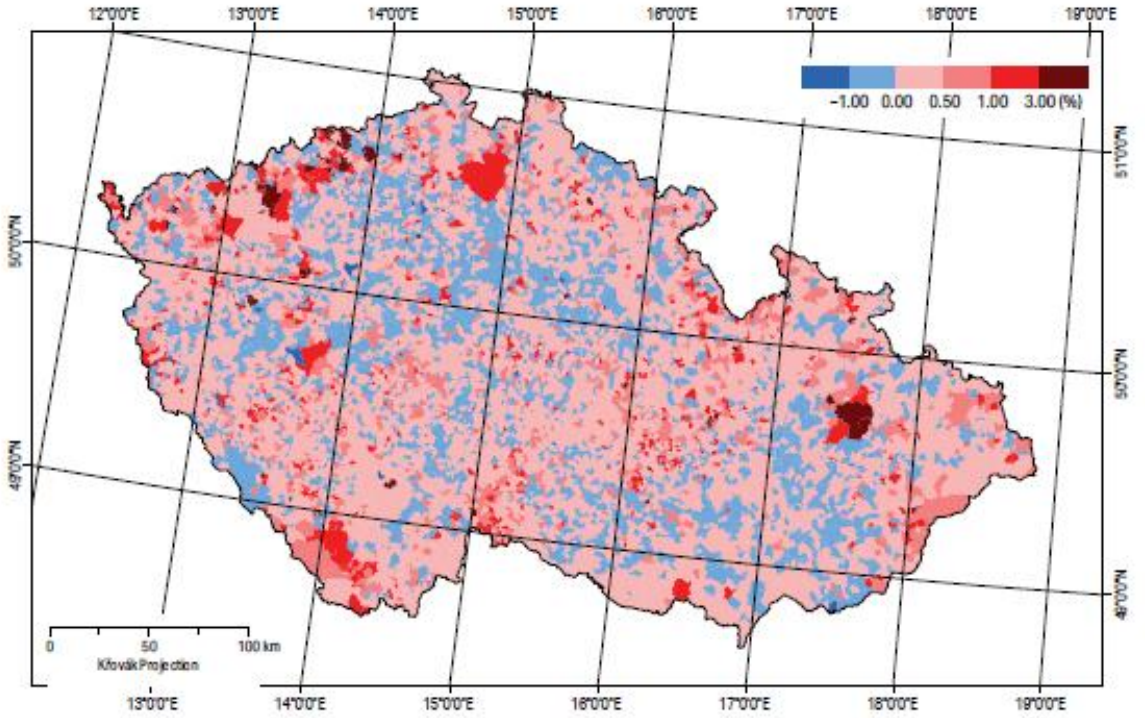


Results country level

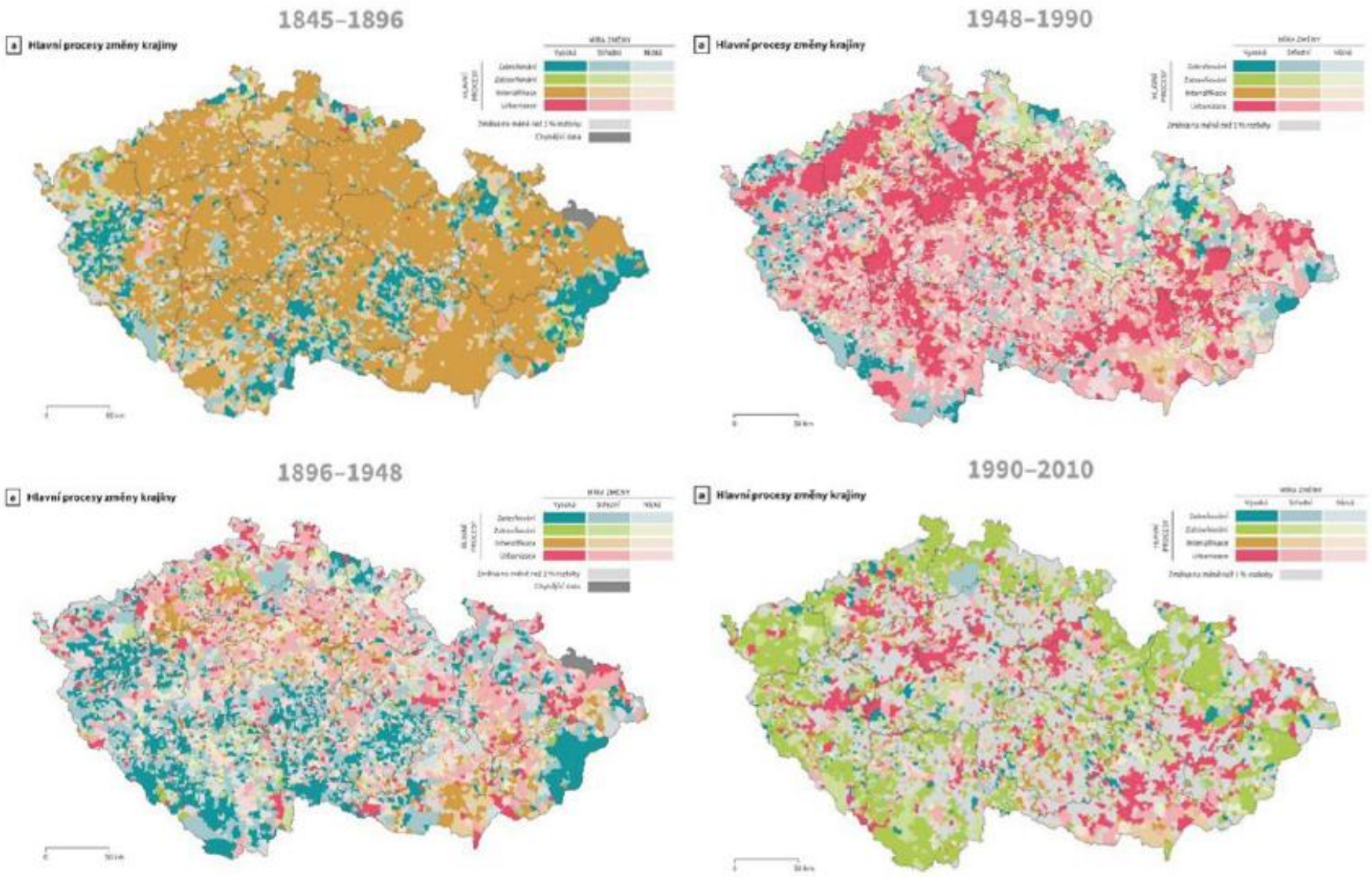
Index of change of built-up and other areas between 1990–2020



Index of change of forest areas between 1990–2020



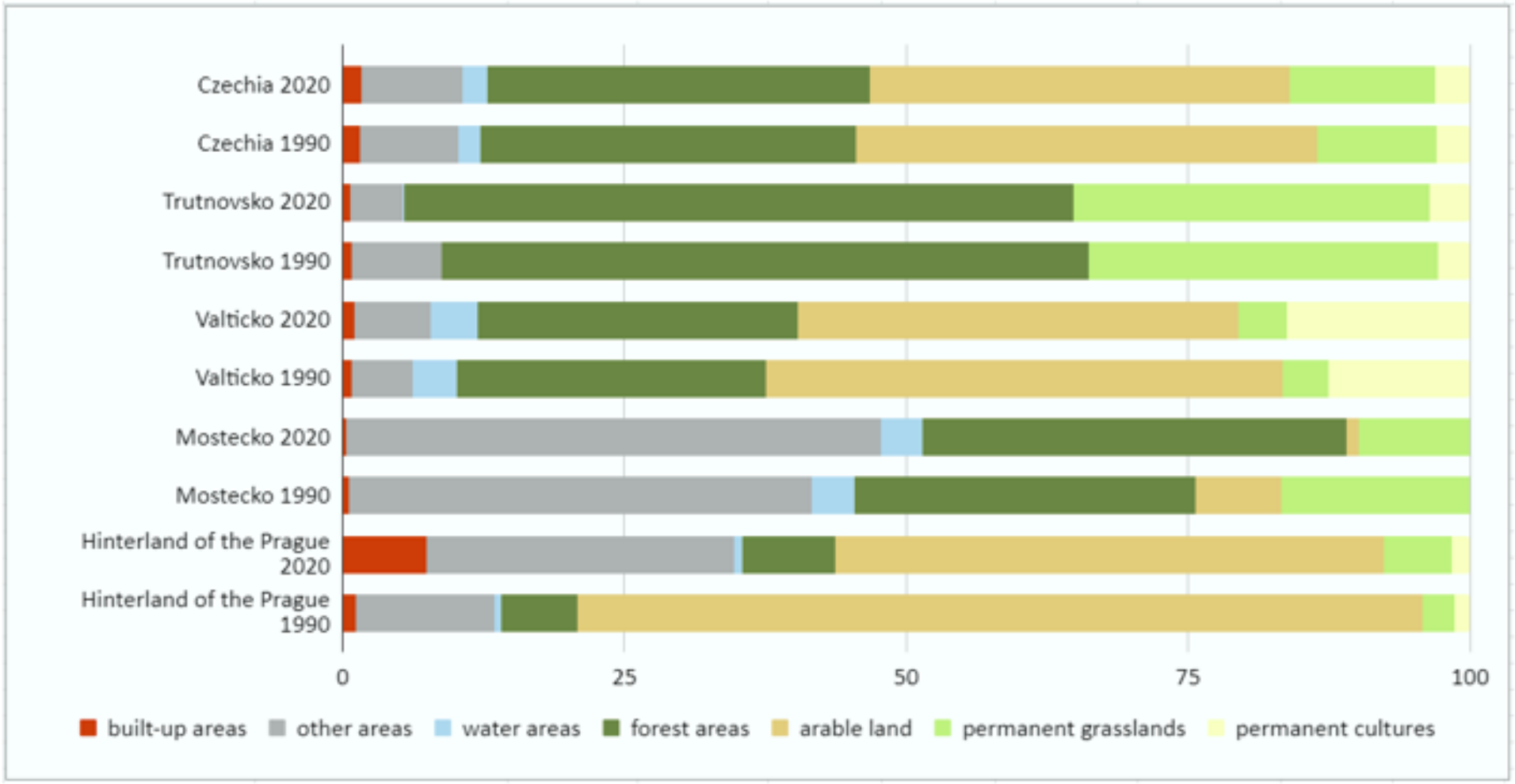
Long term processes of landscape changes



Extent of change

	High	medium	low
Afforestation			
Grassing over			
Intensification			
Urbanization			

Share of LULC categories on total area (in %) in 1990 and 2020 for Czechia and individual areas of interest

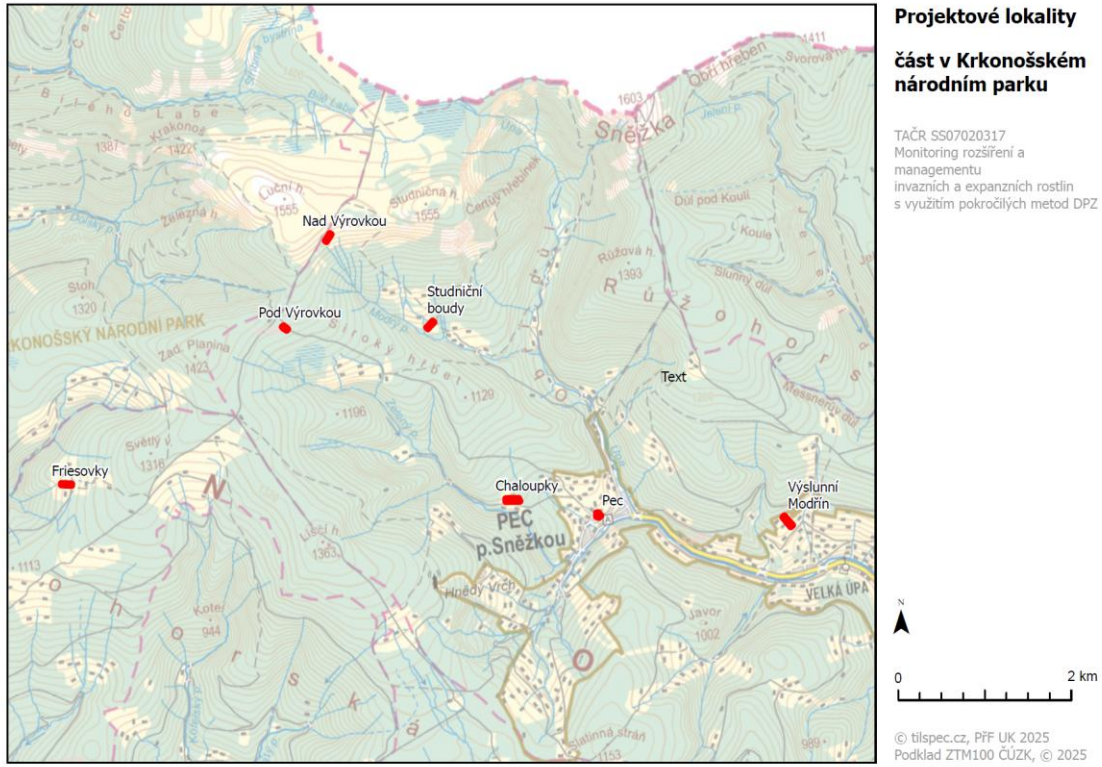


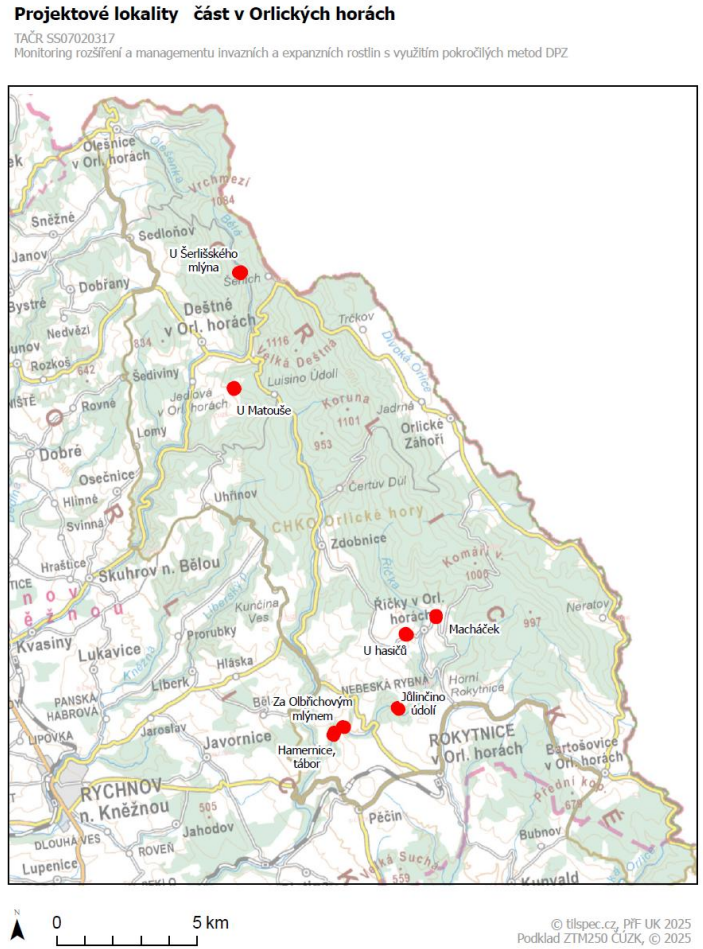
Processes of landscape change on habitat level – invasions

Objectives

- The objective is to develop an automated technology for monitoring the spread of selected invasive/expansive plant species and the efficacy of different management strategies in difficult-to-access mountainous areas using airborne technology.
- Field survey: multispectral UAV data with very high spatial resolution (Dron DJI Mavic 3 Multispectral) and botanical reference data (GPS mapping, relevés on permanent plots)
- Comparison between detection under ideal (mostly flowering period) and limiting conditions (e.g. sprouting of leaves, species mixture, steep slope, shading, mowing and grazing)
- Controlling the efficiency of different managements (grazing, mowing, chemical treatment, mulching, weeding)
- Verification of modern advanced technologies (UAV, remote sensing, satellite imagery), advanced statistical analysis and automated image processing techniques (machine learning, object classification)
- Our results will provide the user with an effective tool for the early detection and monitoring of risky species, and thus reduce the eradication costs.

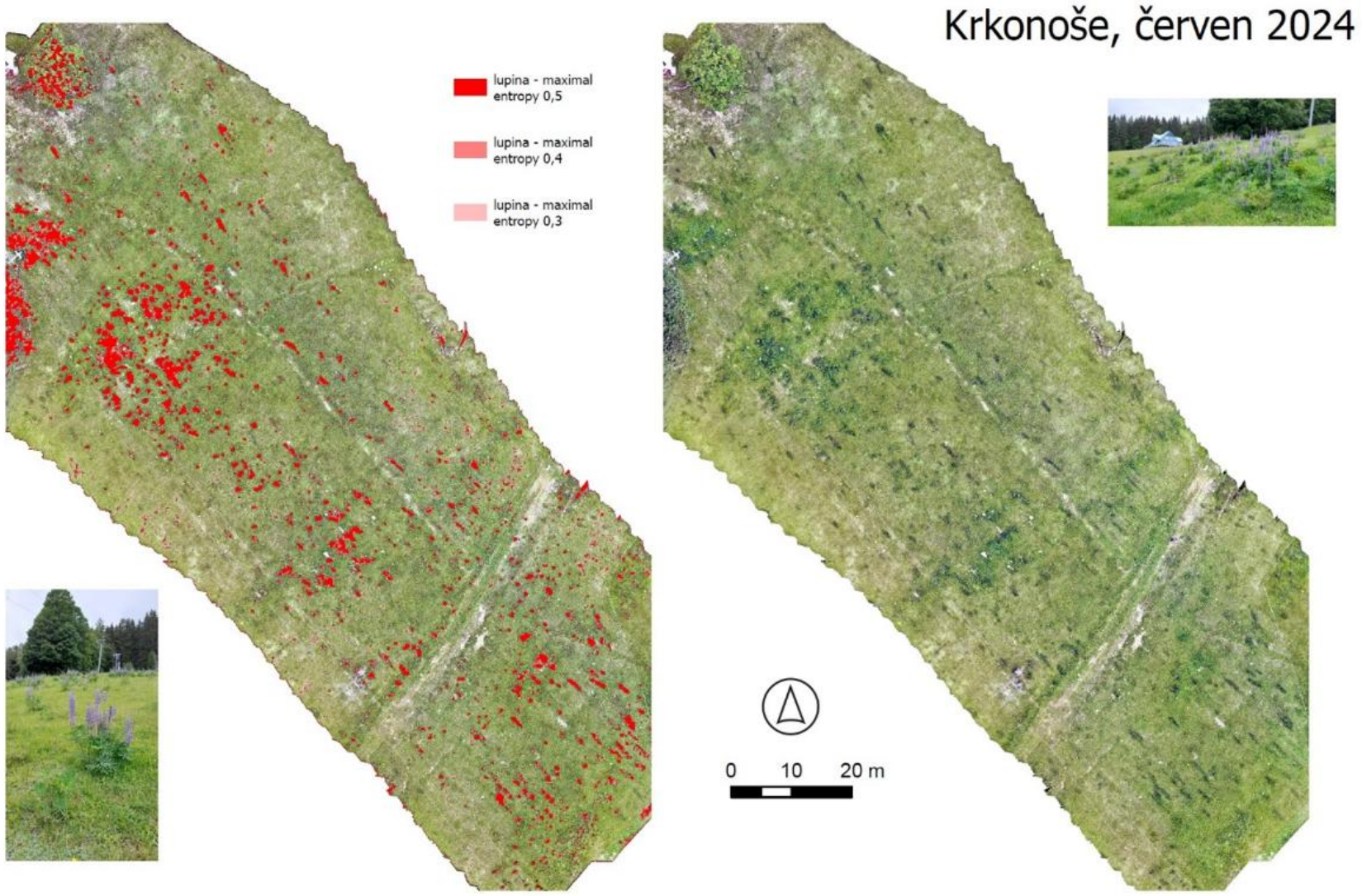
- Study areas – Krkonoše Mts. and Orlické hory Mts.



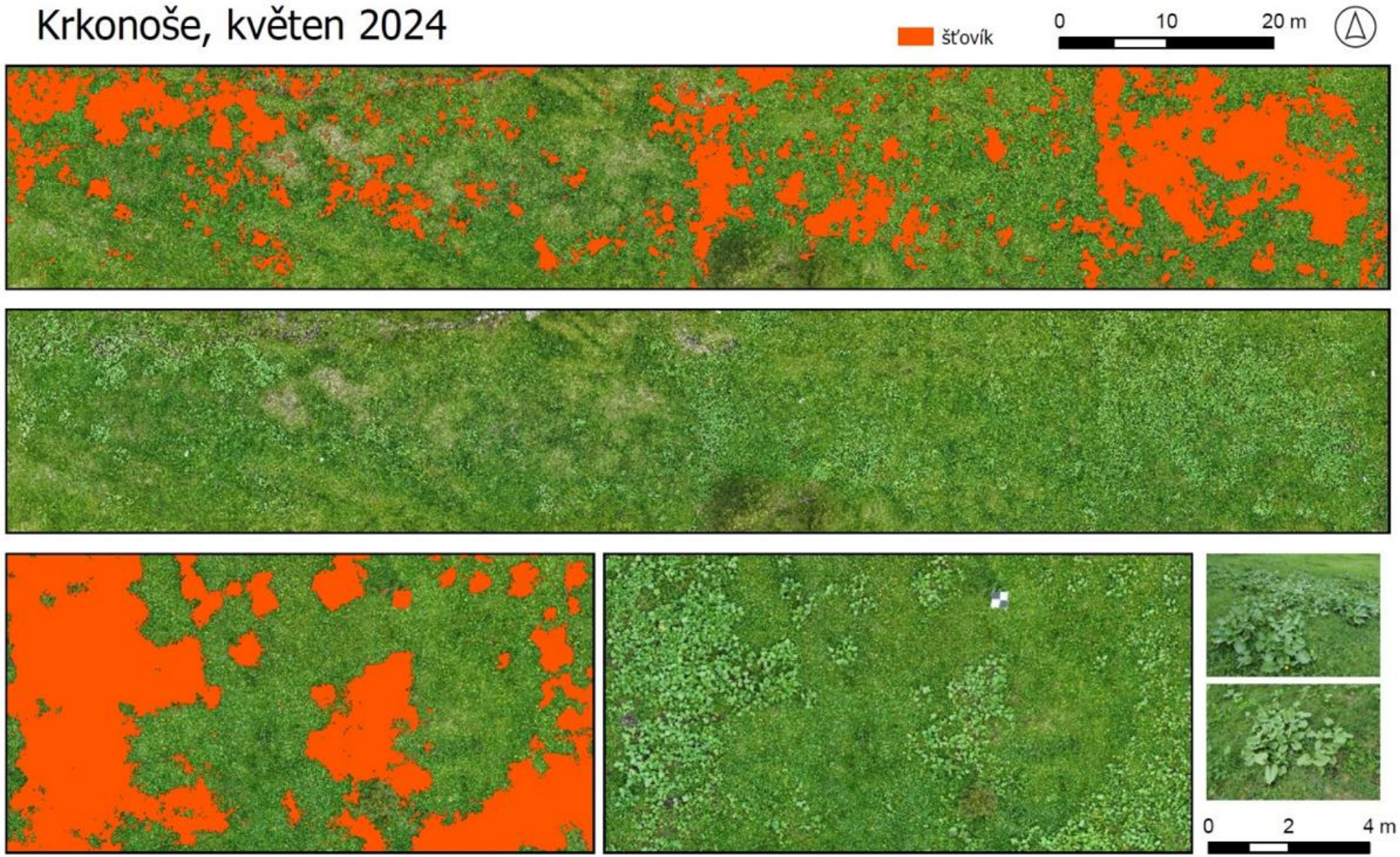


Invasive / expansive species of interest

Preliminary results – *Lupinus polyphyllus*

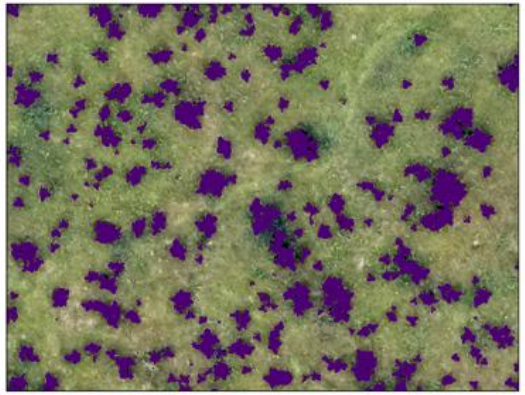


Preliminary results – *Rumex alpinus*



Preliminary results – *Veratrum album*

Orlické hory, červen 2024



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Conclusions

In contrast to the socialist era, the post-communist transformation period reveals a **much greater variety of changes**

Landscape protection - reclamation in former extensive mining areas, conservation of valuable naural sites including monitoring of invasions

Land use extensification - afforestation and grassing over, more sustainable agricultural practices

However, arable land continues to face significant threats from intensive urbanization and **sub/urbanization**, as well as **abandonment and ruderalization** in some areas over the last three decades include a reduction in arable land, a rise in built-up and other areas, an increase in grasslands, and afforestation

- Additionally, this period gave rise to the areas of **"new wilderness„ (abandoned land)**, where reduced human intervention has led to natural succession and reforestation and **expansion of invasions**

- Process of **landscape polarization**, characterized by divergent trends such as afforestation, grassing over, land abandonment on one hand, and land-use intensification on the other

- Driven by socio-economic factors including urbanization, rural depopulation, and changes in agricultural practices, leading to **significant disparities between densely populated urban centres and marginalized rural areas** and contributing to the **substantial decrease in arable land**

- **Addressing these challenges will be crucial for sustainable land-use planning, management and nature protection at both local and national levels in the future**

Thank you for your attention!

lucie.kupkova@natur.cuni.cz

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