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Land Use/Cover Changes in Selected Regions in the World

Volume XIV

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of Culture of the Czech Republic for the support of applied research and experimental
development of national and cultural identity for the years 2016 to 2022 (“NAKI II”).

CONTENTS

PREFACE

Dear readers,

we present here Volume XIV of the Atlas Land Use/Cover Changes in Selected Regions in the World – IGU-LUCC Research Reports (Atlas LUCC for short) prepared by the International Geographical Union – Commission on Land Use and Land Cover Change. This time, the atlas is largely devoted to the outputs of the project G18P02OVV008 "Heritage of Extinct Landscapes: Identification, Reconstruction and Presentation" within the Ministry of Culture of the Czech Republic Program for the Support of Applied Research and Experimental Development of National and Cultural Identity for 2016–2022 ("NAKI II"). The project deals with the issue of the heritage of extinct landscapes in Czechia and the issue of land use and land cover is one of its main topics. For more information about the project, see Chapter 1. There is also one contribution from colleagues from Russia and one contribution from colleagues from Slovakia.

The requirement to publish further volumes of LUCC atlases was made at the conference of IGU Commission on Land Use/Cover Change held in September 2019 in Koper, Slovenia.

At the conference in Koper, the participants interested in the work of the LUCC Commission met and discussed further activities of the Commission and the election of a new commission chairman for the years 2020–2024. The current commission chairman Matej Gabrovec can no longer lead the Commission after 2020, as he has been a member for 12 years. Present member of the Commission nominated Monica Dumitrascu, a researcher and director of the Institute of Geography of the Romanian Academy of Sciences. The nominees unanimously approved the nomination and the current commission chairman will inform the IGU executive for the International Geographic Congress in Istanbul about this nomination. The attendees further recommended that the work of this Commission should continue in the next years as it represents a major focus of geographic research for complex understanding to the nature-societal interactions on various geographical levels (e.g. local, regional, global). In the opinion of those present, this is not only about basic research, but also about understanding the long-term trends of landscape development and change.

The attendees of the conference in Koper recommended preparation of further Volumes of the Atlas LUCC, as it represents an important documentation of the research activities of the collaborators involved in the work of the Commission. During the discussion, it was recommended to reduce the number of hard copies of the Atlas LUCC and to support the publication of a digital version on the commission website (now: http://lucc.zrc-sazu.si/). On this website you can find all information about the Commission. If you are interested in working on IGU-LUCC activities, contact any member of the current Steering Committee. You can also submit contributions for publication in further Volumes of the Atlas LUCC, which is prepared alternately by Yukio Himiyama in Japan (Hokkaido University of Education Hokumoncho, Asahikawa; himiyama.yukio@a.hokkyodai.ac.jp) or Lucie Kupková in Czechia (Charles University, Prague; lucie.kupkova@natur.cuni.cz).

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I

Disappeared Landscapes of Czechia

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CHAPTER 1

Disappeared Landscapes of Czechia: Introduction and Evaluation Methods

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1. Introduction

This Atlas of Land Use/Cover Changes in Selected Regions in the World represents the results of the NAKI II project entitled "Dědictví zaniklých krajin: identifikace, rekonstrukce a zpřístupnění" (Heritage of Extinct Landscapes: Identification, Reconstruction and Presentation).

The aim of the project is to identify, document, reconstruct the heritage of the lands that have disappeared during the dynamic changes of society in Czechia since the end of the 18th century – in particular:

1) to identify, document, and reconstruct cultural heritage and values of different types of landscapes by using both historical sources and modern technologies;
2) to present, on the example of extinct landscapes, the diversity of cultural landscape heritage and to contribute to creating conditions for its systematic conservation, presentation and use by professionals, relevant institutions, for example in the area of landscape protection or regional development, as well as by public.

We would like to present the legacy of the disappeared Czech cultural landscape also to the international group of experts. That is the reason why this atlas, which is distributed in printed and digital versions to a wide range of people interested in the topic of land use/cover and its changes, has been elaborated.

The results of an analysis of eight transformed/extinct landscapes (model areas) in various parts of Czechia are presented in this atlas. Landscape changes are analysed and evaluated in the so-called "core area of interest", where the biggest change occurred (mostly 2 or 3 cadastral areas), and in the so-called "wider area of interest", which includes municipalities within 8 km of the core area. The distribution of core areas within Czechia is shown at the Figure 1. All areas were examined by using the same methods. Therefore, we will introduce the methods of processing individual outputs in the beginning of this Chapter.

2. Methods of Map Outputs Creating

Each Chapter contains 13 map outputs. Emphasis is placed on outputs that show changes in land use (Figures 3 and 6–9), but also outputs characterizing the so-called landscape memory (Figures 10–13) are included. The following paragraphs list the methods used to create these map outputs. The structure and order of the methods described here correspond to the ordering of the outputs/results in Chapters 2–9 (results for certain area of interest). Each Chapter is introduced by two maps showing both the above-mentioned core area of interest (Figure 1) and the wider area of interest (Figure 2).

2.1 Landscape and Land Use/Cover Changes

The section Landscape and Land Use/Cover Changes includes four sets of results, in the case of two areas of interest (Krkonoše and Boletice) there are five sets of results. These are (1) comparative maps of land use at the time of the Stable Cadastre and at present, (2) landscape models, (3) comparative photographs, (4) cartograms characterizing land use changes between year 1845 and 2010. For the Boletice and the Krkonoše Mountains areas also 3D photorealistic models of extinct buildings/village are included (5). Sections 2.1.1–2.1.5 show the data processing methods for these four result sets.

2.1.1 Land Use at the Time of the Stable Cadastre and the Present

The evaluation of land use changes occurring in the areas of interest from the middle of the 19th century (mapping of the Stable Cadastre) to the present is based on the set of two maps (Figure 3 in all Chapters).

For the first time horizon colour raster copies of the so-called imperial mandatory prints of the Stable Cadastre maps were used. These are maps from the years 1826–1843. In contrast to the so-called original maps of the Stable Cadastre, these maps capture the original situation of the landscape without additional drawing of later changes (see http://geoportal.cuzk.cz). Raster data was georeferenced, and vector map was created in ArcView.

Cadastral maps from the Register of Territorial Identification of Addresses and Real Estates ("Registr územní identifikace, adres a nemovitostí"; RÚIAN) were used as a basis for creating the map of the current situation of the landscape (see https://www.cuzk.cz/ruian/). Because these maps contained a large number of errors in the categories of land use, the data were corrected by using the current orthophoto from the State Administration of Land Surveying and Cadastre ("Český úřad zeměměřický a katastrální"; ČÚZK). The orthophoto was connected to ArcGIS via WMS (Web Map Service) server. A simplified legend was used for map outputs and evaluation of changes (the current cadastre records only basic categories of land use). Changes are evaluated numerically in tables and their spatial distribution is evident from the comparison of maps for both time horizons.

The map legend includes the categories of arable land, permanent grassland (sum of grassland categories), permanent crops (gardens and orchards), forest areas, water areas, built-up areas and remaining areas. In some cases, the abandoned land category is also included for the current horizon. This is a

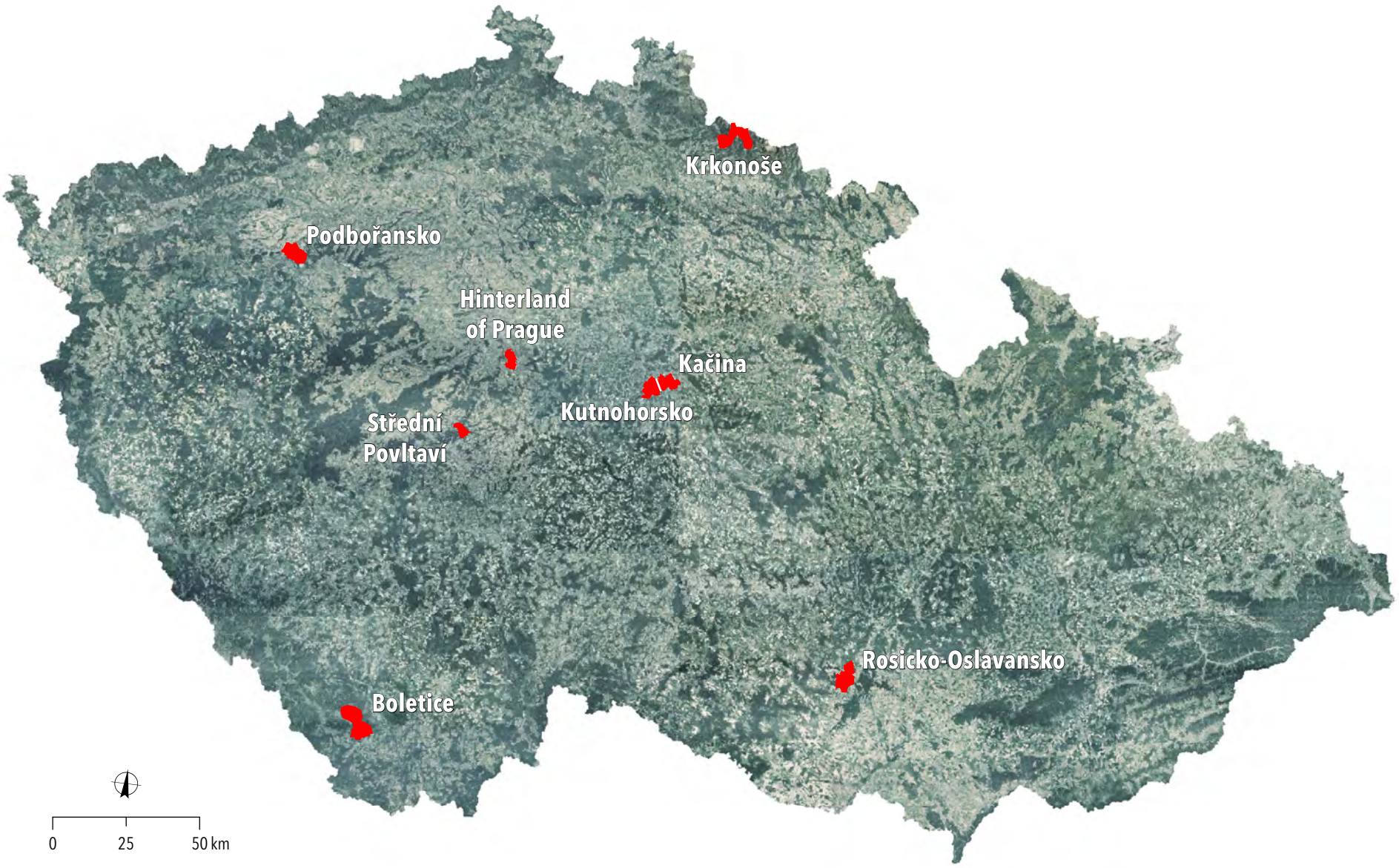

Fig. 1 – The core areas of interest within Czechia.

land that has not been farmed in recent years/decades and it is affected by a spontaneous succession.

2.1.2 Landscape Models

The aim of the landscape model-making is to present/illustrate and assess the state of the landscape of core area, or certain detail of the area, in several time horizons using archival and contemporary aerial photographs (Figure 4 in all Chapters; in Chapters "Boletice" and "Krkonoše" Figure 14 too).

The images were placed in the S-JTSK coordinate system using the intersection (collinearity equations) and control points, whose coordinates were subtracted from the current orthophoto and elevation model available from the web mapping service of the State Administration of Land Surveying and Cadastre (ČÚZK). The ZABAGED elevation contour model was then used for the purpose of depicting the elevation of the area. The procedure for processing individual data bases was as follows:

a) Archival Aerial Photos

Aerial survey images were obtained from the archive of the Military Geographical and Hydrometeorological Office in Dobruška ("Vojenský geografický a hydrometeorologický úřad"; VGHMÚř). Black and white images of 23 cm × 23 cm were scanned at resolution of 15 μm. With the exception of the camera constant shown on the frame of the image, the elements of internal orientation (i.e. the position of the main frame point and the lens distortion) were unknown and were neglected for further processing. Due to the interpretative purpose of the use, the resulting geometric distortions were acceptable. At least 4 points identifiable in both the archival photo and the current orthophoto were found in each image to obtain the elements of external orientation. Using the collinearity equations, the coordinates of the projection centre and the inclination of the photos were calculated. The images were further orthorectified above the ZABAGED elevation contour model. This model was subsequently used for 3D landscape visualization from 1990. For processing was used software PCI Geomatica, ArcMap and ArcScene.

b) Orthophotos from the 1950s

The orthophoto from the 1950s was provided by the Czech Environmental Information Agency ("Česká informační agentura životního prostředí"; Cenia). This orthophoto was projected on ZABAGED elevation contour model for 3D visualization. ArcMap and ArcScene software were used for processing.

c) Contemporary Orthophoto

The current orthophoto available via the ČÚZK web mapping service is displayed above the ZABAGED elevation contour model. ESRI software was used for processing.

2.1.3 Comparative Photographs

Old photographs were collected from archives or private collectors and places in landscape, locations from where these photos were taken were identified in the field. From these places the actual pictures were taken. The current photos show the state of landscape at the present, and also illustrate the change that took place in the given place (Figure 5 in all Chapters).

2.1.4 Cartograms Presenting Changes in Land Use

The aim of this analysis is to document long-term changes in the area of selected land use/ cover categories within the wider area of interest. A database of the Land Use Land Cover Czechia

Database (LUCC Czechia Database, https://www.lucccz.cz) was prepared at the Faculty of Science, Charles University. This database, which is based on cadastral data for the years 1845, 1948, 1990, 2000, and 2010. The database collects data on land use at the level of the Stable Territorial Units (STUs). STUs are units at the level of cadastre or units merged from several cadastres (merged in the way that its area does not change by more than 2% during the whole monitored period). Areas of arable land, permanent grassland, permanent crops, forest areas, water areas, built-up areas and other areas are recorded for each STU and for every year. The methodology for creating and analysing of the database is described in detail in Bičík et al. (2015). Changes in arable land, permanent grassland and forest areas as a percentage for individual reporting periods are shown in Figures 6–8.

The Index of Change (IC) was calculated in the database from the area values of each category. This aggregate index indicates the intensity of land use changes over a certain period of time in the area of interest (STU in our case). The IC does not, however, assess the "quality" (structure) of such changes:

$$IC_{A-B} = 100 \cdot \frac{\sum_{i=1}^{n} |P_{iB} - P_{iA}|}{2}$$

where IC_{A-B} – index of change between year A and year B; n – the number of land use categories; P_{iA} – the proportion of relevant land use category at the beginning of the examined period; P_{iB} – the proportion of relevant land use category in the end of examined period.

The higher value of the Index of Change means more intensive land use change in the area. This index ranges from 0 to 100 and – put in a simple way – indicates the proportion of area where any land use change occurred, based on the comparison of beginning and end of the evaluated period. Changes that may have occurred during the examined period are not reflected (Bičík et al. 2015).

2.1.5 3D Photorealistic Models

Detailed 3D photorealistic models (Figure 14 in the Chapters "Boletice" and "Krkonoše") were produced to document and "revive" disappeared places in the landscape. For their production historical photographs and postcards were used, historical orthophotos, the elevation contour model ZABAGED, overview maps of the Czech Republic for ZABAGED (Geoportal ČÚZK 2018) and original maps of the Stable Cadastre of Bohemia in a scale of 1:2,880 (1824–1843).

For the processing of the 3D model, it was first necessary to define the topographic base of the area for model-making. This was done on the basis of data obtained from the State Map (1st edition). The map is available in a scale of 1:5,000 (published in 1954). The building ground plans were created on the basis of historical photographs and postcards taken from different perspectives. Model-making of particular textures, windows, entrances and other details was done on the basis of historical graphic models. It was difficult to determine the dimensions for which there were no data. The dimensions were estimated, for example, by the height of the door. Placing the 3D model in the landscape was made by using the height model ZABAGED.

SketchUp, V-Ray for SketchUp, ArcMap, Zoner Photo Studio, Sweet Home 3D, 3dsMax, Blender, and Lumion were used for model-making.

2.2 Regional and Local Symbols

Local symbols, often also symbols of a larger region, are often depicted on municipality emblems. Each emblem represents the municipality, but it is also its "chronicle". Using various graphic elements, the emblems tell of the past, monuments, traditions or legends, as well as of the economic and cultural activities of former inhabitants of municipality, or also of the present or/and past (extinct) landscape. If the municipality emblem is processed according to heraldic principles and if its iconography does not distort or shift reality, it is a valuable source of local or/and regional historical-geographical information. The aim of this analysis is to find references to the landscape and its changes within the symbols used in the emblems of municipalities in the area of interest (Figures 10 and 11 in all Chapters).

For the analysis of the form and content of the municipality emblem, content analysis has been chosen as an analytical method (Krippendorff 2004; Rose 2007). Content analysis was originally introduced in many fields for text analysis (linguistics, sociology, anthropology, political science, etc.). However, its principals can be used very well also in the analysis of visual materials (Rose 2007). The emblems of all municipalities in the area of interest (as of 1 October 2018) are shown in the map. But not all of the municipalities have an emblem. Cities and towns traditionally have their emblem (given the historical right of cities and towns to "own" an emblem). Other municipalities could not start to "create" its emblems until 1990 (Šifta 2016). It is not the duty of municipalities to have a municipality emblem. Thus, the areas of municipalities that do not have the emblem remain empty in the maps.

The first step of the content analysis is to select the type of materials examined, followed by its collection. On the example of the content analysis of municipality emblems in Czechia, the source of data is the Registr komunálních symbolů (Register of Municipal Symbols; https://rekos.psp.cz). In the second step, the set of emblems is subjected to analysis ("reading", deciphering its content) with the result of identifying certain symbols pictured in the emblem (it can contain, and usually contains, more symbols) and interpret their meaning. In the third step, the set of identified symbols is then divided into predetermined categories. Only those emblems, that contain the references to the history of the landscape and reflect its changes, are included in the analysis. These symbols are divided into following landscape-related categories: agriculture, water course/body, location of the municipality (e.g. symbol of the location of the settlement on a hill, in a valley, etc.), landscape/natural element (presence of rock formation, memorial tree, etc.), forest (occurrence of forest in the surrounding of the settlement), economic tradition, and other symbols. The "other" category includes all other types of symbols depicted in the municipality emblems (historical, church, cultural, administrative). In the next step, the results are quantified (using simple descriptive statistics, the frequencies of symbol use are analysed and the differences between categories are compared). The portion of the types of symbols in the emblems of municipalities in the area of interest is shown in the form of a thematic map with charts (diagrams). Subsequently, spatial patterns in the use of the same or similar symbols in the emblems of municipalities in the area of interest are identified. Symbols used in more places (in more emblems) thus often reflect the history, development and changes of the landscape in the wider area.

2.3 Heritage Sites

Cultural monuments comprise a complex of heritage, representing values and meanings related to the past which should be protected and preserved for future generations. Preservation of monuments focuses on the research of monuments, their

identification, protection, documentation or administration (Harvey 2001; Smith 2006). Internationally, UNESCO is dedicated to the protection of monuments, in Czechia, the National Heritage Institute (*Národní památkový ústav, NPÚ*) is a professional organization of the state monument care established by the Ministry of Culture of the Czech Republic (*Ministerstvo kultury ČR*). The aim is to get acquainted with the monuments and monument areas which are related to the monitored landscape transformation in the core (or in some cases in the wider area of interest), and which are registered in the National Heritage Monument Catalogue (*Památkový katalog NPÚ*).

The list of cultural monuments was created on the basis of a detailed research of the resources of the National Heritage Institute. This institution creates and manages above-mentioned National Heritage Monument Catalogue (www.pamatkovykatalog.cz). The catalogue contains basic descriptive information about monuments, including photographs and references to the location of monuments in the cadastral map.

The Ministry of Culture of the Czech Republic declares as cultural monuments under the Act of the Czech National Council on the Care of Monuments no. 20/1987 Coll. (*Zákon České národní rady o památkové péči č. 20/1987 Sb.*) immovable or movable property (or a set thereof), which is a significant proof of the historical development, way of life of the society from the oldest times to the present. Also, the creative abilities and the work of man from various fields of human activity are defined as cultural monuments, because of its historical, artistic, scientific and technical values. Monuments can also have a direct relationship to significant personalities or historical events.

For the purposes of the analysis of the area of interest, only those monuments that are directly related to the characterized landscape changes, i.e. refer to the specific historical development of society or values and remind meanings connected to a specific human activity in the landscape, were purposefully selected from the National Heritage Monument Catalogue. In the catalogue, each monument is introduced in text and its "description of the monument value" is described. The monuments shown on the map (Figure 12 in all Chapters) are selected based on the data contained in this description.

The selection of monuments was performed mainly for the purpose of the best representation of the character of the examined landscape, because the National Heritage Monument Catalogue contains a large number of records that represent different historical periods or heritage values. In some core areas, however, monuments documenting the monitored landscape change did not occur, and therefore the search was extended to all cadastral areas in the area of interest (thus to the wider area of interest).

Features registered for each monument:

- catalogue number,
- name of the monument,
- cadastral area in which the monument is located,
- category of monument (small object, object, compound, area),
- date of obtaining the status of monument and monument protection,
- date of loss of the monument protection,
- type of monument protection (cultural monument, national cultural monument, heritage),
- annotation (brief description),
- location (GPS coordinates),
- data source.

2.4 Places and Institutions of Memory

Memory institutions preserve and transmit the information about the past and the changes of landscape in the area. Memory institutions are primarily museums or independent exhibitions, and also archives and collections that contain and manage related archival documents (Matero 2008). The aim of the analysis (using examples of museum expositions) is to create a basic overview and typology of memory institutions that are located in the wider area of interest or those institutions in whose exposures are related to the examined area of interest (Figure 13 in all Chapters).

The list of memory institutions was created mainly on the basis of research of electronic information sources. For this reason, it cannot be considered absolutely complete (there are many private collections, which are not represented on the Internet), but can be sufficiently valid with respect to the project objectives.

In the first step, a database of local exhibitions was created based on information about Czech museums provided by the *Asociace muzeí a galerií České republiky* (Czech Association of Museums and Galleries). The obtained data were further supplemented with information available from popularizing web projects the *Do muzea* ("To Museum") and the Muzeum.cz. In the second phase the expositions were searched according to the main localities in the areas of interest, i.e. larger cities with more than a thousand inhabitants. The resulting database contains detailed information about individual memory institutions (address, GPS coordinates, link to the institution's website).

The memory institutions (museums and individual expositions) were then analysed with regard to the focus of the expositions and collections. The expositions are divided according to:

a) their relation to the transformation of the landscape in the area of interest (expressed in the map by the inclination of the map sign):
- exhibitions which are directly related to the area of interest and present the past and changes of the local landscape in the area of interest;
- exhibitions which indirectly, respectively only partially, present the past and changes of the landscape in the area of interest (e.g. city museums, or those exhibitions which do not present a specific transformation of the landscape).

b) scale (expressed in the map by size of the map sign) on those representing:
- institutions of local importance;
- institutions of regional importance.

In the last step, the collections and exhibitions are described in terms of its content and focus. Colour of map signs symbolizes a maximum of three of the most typical themes of the exhibitions.

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References and Data Sources

BIČÍK, I., KUPKOVÁ, L., JELEČEK, L., KABRDA, J., ŠTYCH, P., JANOUŠEK, Z., WINKLEROVÁ, J. (2015): Land Use Changes in the Czech Republic 1845–2010: Socio-economic Driving Forces. Springer.

HARVEY, D.C. (2001): Heritage Pasts and Heritage Presents: Temporality, Meaning and the Scope of Heritage Studies. International Journal of Heritage Studies, 7, 4, 319–338.

KRIPPENDORF, K. (2004): Content Analysis: An Introduction to Its Methodology. Sage, Thousand Oaks.

MATERO, F.G. (2008): Heritage, Conservation, and Archaeology: An Introduction. Heritage, Conservation, and Archeology. Archeological Institute of America. https://www.archaeological.org/pdfs/Matero.pdf (1. 12. 2019).

ROSE, G. (2007): Visual Methodologies. An Introduction to the Interpretation of Visual Materials. Sage, Thousand Oaks.

SMITH, L. (2006): The Uses of Heritage. Routledge, London, New York.

ŠIFTA, M. (2016): Graphic Symbols and Local Identity: The Case of Use and Perception of Municipal Emblems in the Liberec Region (Czechia). Geografisk Tidsskrift-Danish Journal of Geography, 116, 2, 147–158.

Archive Maps of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK), Central Archive of Surveying and Cadastre. https://archivnimapy.cuzk.cz/uazk/pohledy/archiv.html (1. 10. 2019).

Czech Association of Museums and Galleries (Asociace muzeí a galerií České republiky). https://www.cz-museums.cz/web/amg/titulni (1. 10. 2019).

Do muzea. https://www.do-muzea.cz (1. 10. 2019).

Geoportal of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřičský a katastrální – ČÚZK). https://geoportal.cuzk.cz/ (1. 10. 2019).

Land Use Land Cover Czechia Database. https://www.lucccz.cz/databaze (1. 10. 2019).

Museum.cz. https://www.museum.cz (1. 10. 2019).

National Heritage Monument Catalogue, The National Heritage Institute (Národní památkový ústav – NPÚ). https://pamatkovykatalog.cz (1. 10. 2019).

Register of communal symbols (Registr komunálních symbolů), Chamber of Deputies of the Czech Republic. https://rekos.psp.cz (1. 10. 2019).

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CHAPTER 2

Boletice: How Rural Landscape in the Borderland was changed into Military Training Area

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1. Introduction

The Military Training Area (MTA) Boletice was established in 1947 as a successor of the Military Training Camp Boletice. The area, covering almost 220 square kilometres in the Šumava (Bohemian Forest) and foothills in the district of Český Krumlov, was handed over to the army in 1950 and was intended to serve the needs of state defence. The area is very sparsely populated with the density of just 1.2 inhabitants per sq. km. Before World War II, ethnic Czechs had accounted for only 1% of the population and most of them were displaced after the German seizure of border areas in 1938. After World War II, in 1945, Czech Germans were expelled. However, that was not all, the incoming post-1945 population was again sent away after the military training area had been established. Nowadays, the area is managed by the state-owned company Military Forests and Estates of the Czech Republic, division Horní Planá.

Historically, forests and mountain farming dominated the landscape. This has changed abruptly since the establishment of MTA. After that, the landscape served the needs of ground forces who practiced shooting, military tactics, vehicle movements, etc. Treeless areas are typical for the whole area. These areas are in the process of secondary succession following the military activities that included mechanical disturbance of vegetation and soils. Thus, a relatively varied mosaic of places ranging from wetland habitats, wet thistle meadows and mesophilic habitats to forest steppe xerothermic habitats came to existence on training grounds and shooting ranges. High environmental values of area of the MTA Boletice have led to the proclamation of a rather extensive the Special Area of Conservation Boletice and the Special Protection Area Boletice. Both are part of the NATURA 2000 network, which includes protected areas of European importance.

For the purposes of this project, the so-called core area has been delimited and most analyses are carried out in this core area (Figure 1). It includes the municipal areas of Jablonec and Polná (both not far from Český Krumlov). The wider area of interest (see Section Introduction for more details) is shown in Figure 2.

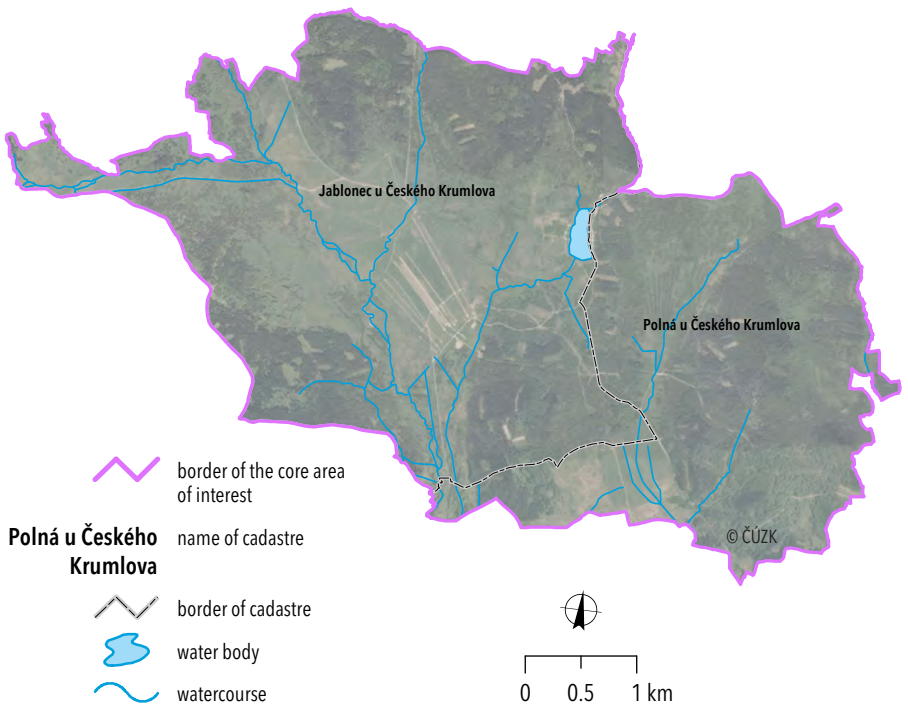


Fig. 1 – The core area of interest. Map basis: Data50; Orthophoto © The State Administration of Land Surveying and Cadastre, 2019.

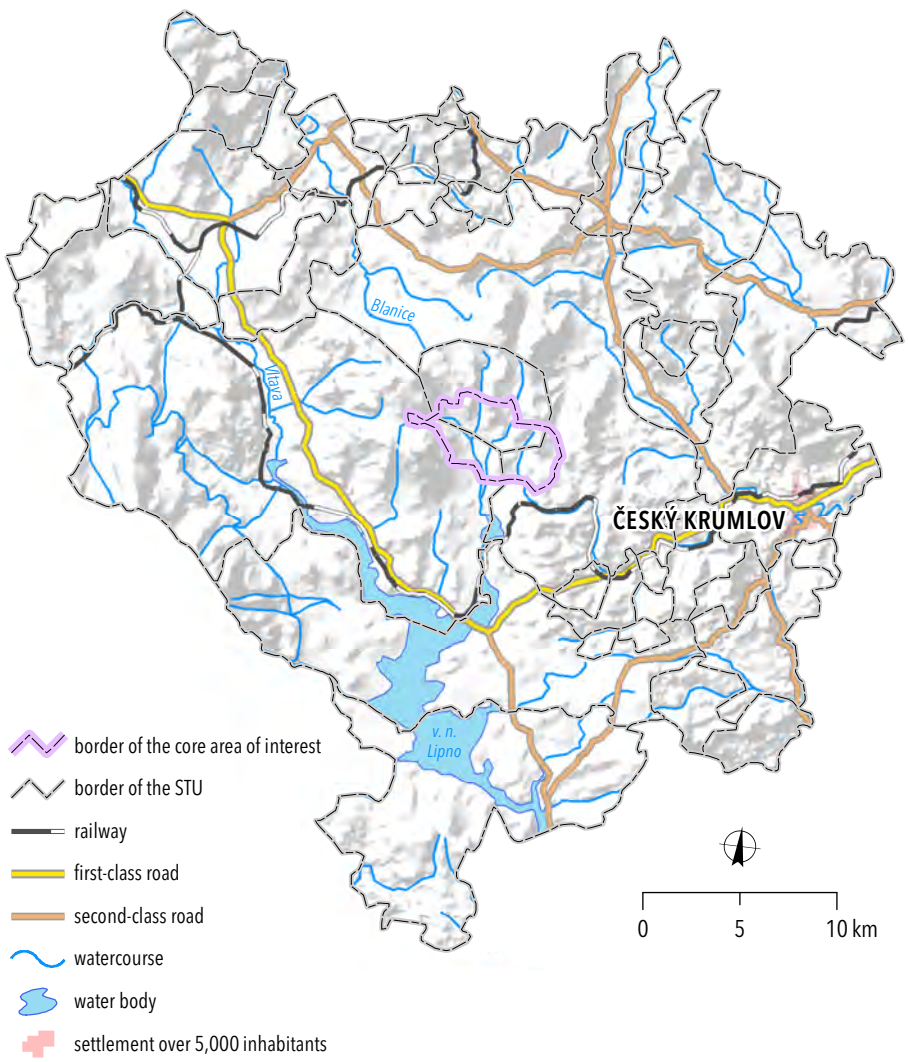
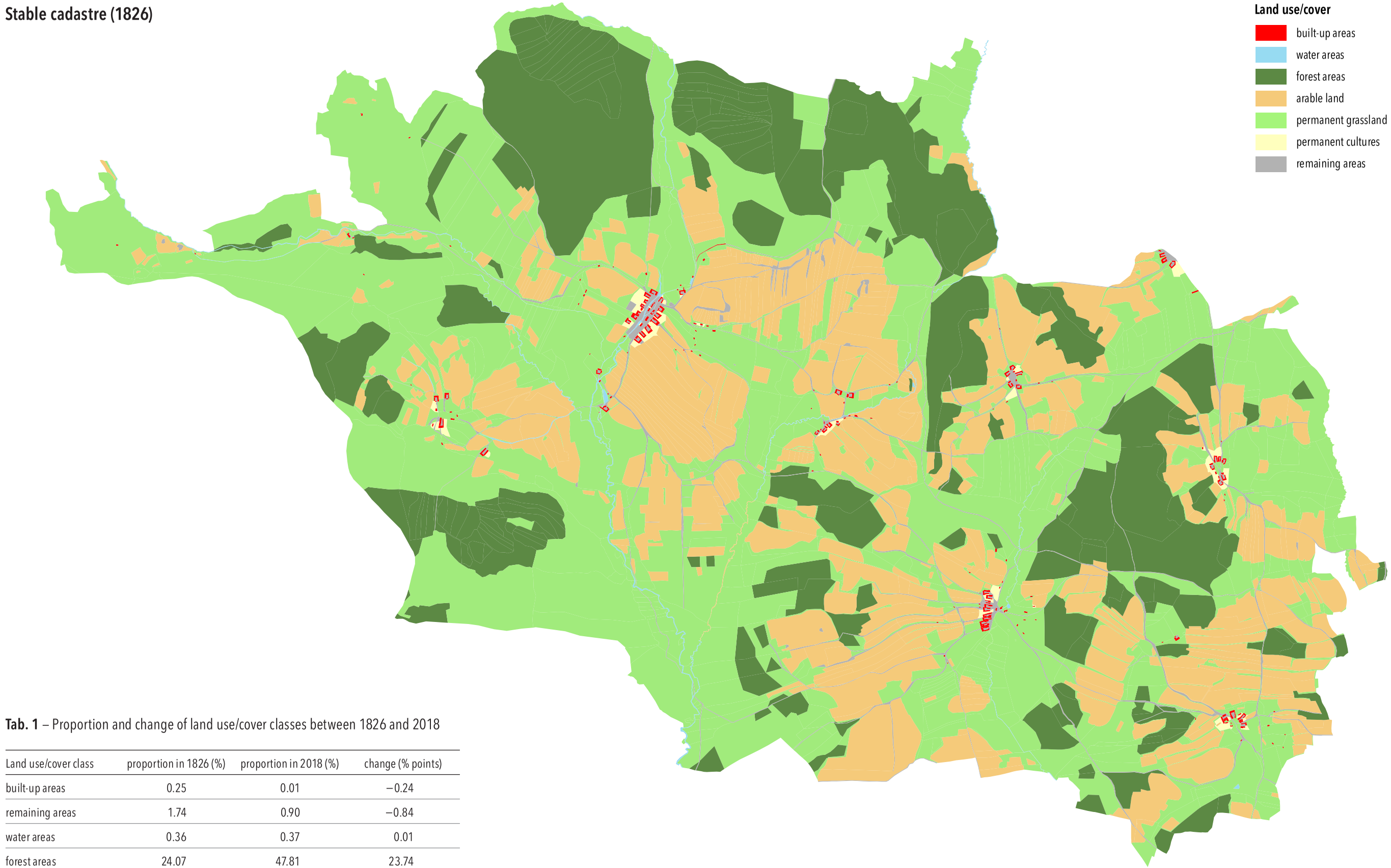


Fig. 2 – The wider area of interest.
Map basis: Data50.

2. Area of Interest: Main Features

The area of former rural landscape in the MTA Boletice is located in the Bohemian Forest (Šumava) and its foothills in southern part of Bohemia. The geological bedrock consists mainly of metamorphic crystalline rocks of the Moldanubian Zone (orthogneiss, migmatite, and granulite). Quaternary sedimentary layer is rather thin (slopes dominate); in the floodplains



Tab. 1 – Proportion and change of land use/cover classes between 1826 and 2018

Land use/cover class	proportion in 1826 (%)	proportion in 2018 (%)	change (% points)
built-up areas	0.25	0.01	−0.24
remaining areas	1.74	0.90	−0.84
water areas	0.36	0.37	0.01
forest areas	24.07	47.81	23.74
arable land	25.86	0.00	−25.86
permanent grassland	47.41	50.92	3.51
permanent cultures	0.31	0.00	−0.31

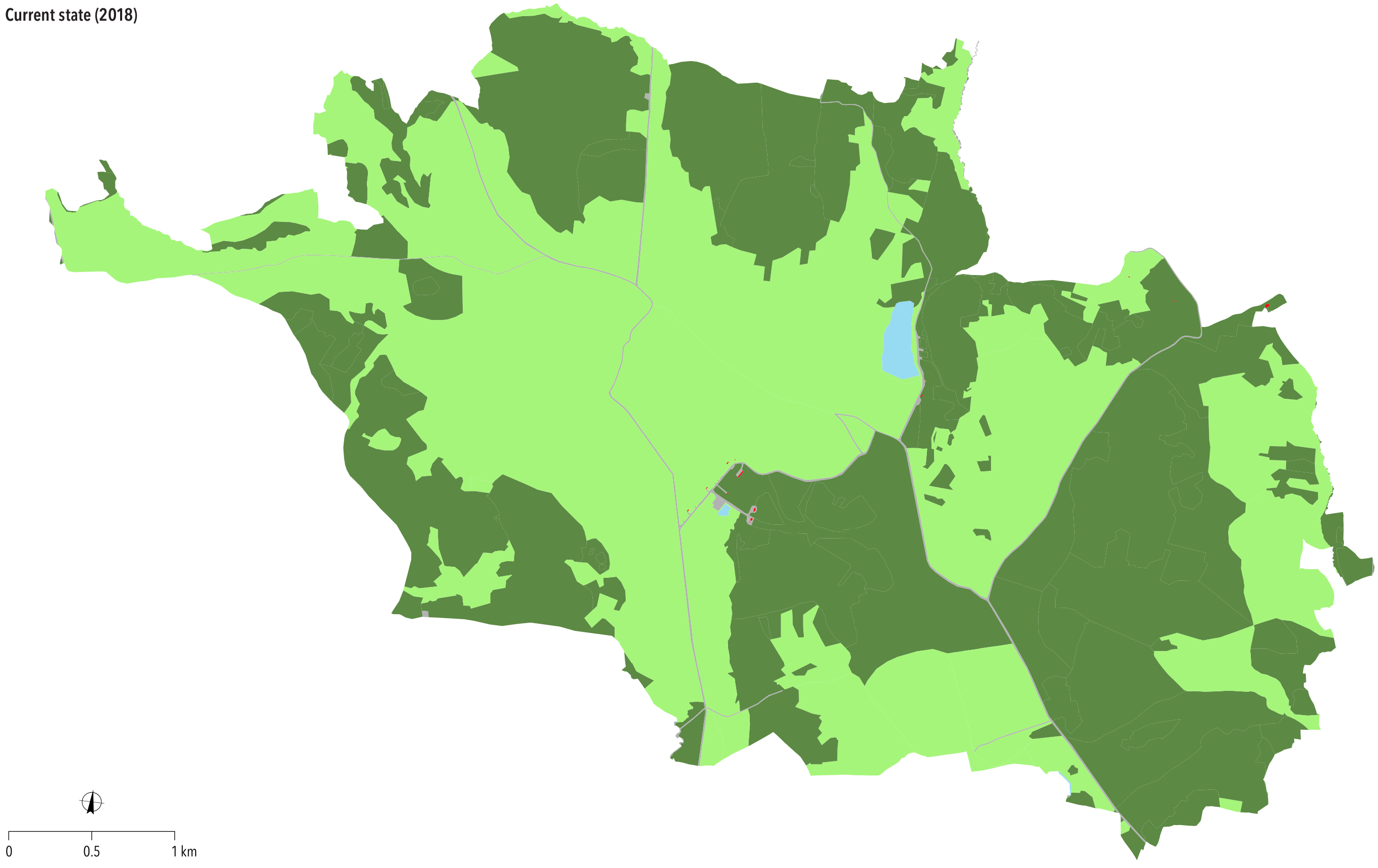


Fig. 3 – Land use/cover in cadastres Jablonec u Českého Krumlova and Polná u Českého Krumlova in 1826 and 2018.
Map basis: The State Administration of Land Surveying and Cadastre.

there are fluvial sediments. Peat bogs are common. The largest and most valuable one, called Mrtvý luh (Dead Bog), is located in the Vltava River valley above the the Lipno Dam in the south periphery of the wider area of interest.

The higher areas in the northwest, the Želnavská hornatina (Želnava Highlands), are quite rugged and typologically correspond to gently sloping mountains with an altitudinal difference between 300–450 metres. In most parts of the area, including the core area, the landscape resembles highlands with an altitudinal difference of 150–300 m. In the centre part of the area, there is rather flat relief of the Olšinská kotlina (Olšina Basin). In general, gentle slopes and wide valleys with minor watercourses dominate the landscape. The higher grounds of the Želnavská hornatina (Želnava Highlands) are an exception – this is an elevated fold-and-break massif flanked by steep slopes, with numerous rock outcrops and traces of periglacial activity. Local granites are much weathered and partly washed away creating rock formations, debris, and block fields.

Altitudes within the area of interest range from 500 m a.s.l. (near Lhenice and Křemže in the east, outside the area of MTA) to over 1,200 m a.s.l. in the highest parts of the Želnavská hornatina (Želnava Highlands). However, much of the wider area of interest Boletice, including the core area, is located between 700 and 1,000 m a.s.l.

The MTA Boletice has a rather cold climate, with an average annual temperatures ranging between 3 and 5 °C. The average precipitation is 700–1,000 millimetres per year. Only the lowest sections, towards Lhenice and Český Krumlov, have a slightly warmer climate, with higher average temperatures and lower precipitation (about 600–700 millimetres per year). Temperature decreases with increasing altitude, while the amount of precipitation decreases significantly towards north. Winters tend to be quite long, with snow on the ground for 90–120 days in year. The weather in summer is usually unstable and often wet.

From the phytogeographical perspective, most of the area of interest lies within the limits of the Czech Mesophyticum. The northwestern part, the Želnavská hornatina (Želnava Highlands), belongs to the Czech Oreophyticum. The potential vegetation cover in most parts of the area is formed by beech forests or acidophilic beech forests, in higher altitudes there are mixed spruce and beech forests. Waterlogged peat spruce, alders, and pines would grow on wetlands.

At the present time, the landscape is dominated by spruce forests. Treeless areas were in the past used for farming, nowadays these are mostly covered by grassland. In large sections of MTA, spruce forests alternate with secondary grassland. The Lipno Dam, the largest artificial water body of in Czechia covering ca. 48 sq. km, is located in the south part of the area of interest (outside MTA). The Olšina Pond (138 ha) is situated within the limits of MTA at an altitude of 731 m a.s.l. and ranks among the highest situated ponds in Czechia.

The western half of the MTA Boletice is part of the Šumava Protected Landscape Area. A number of small-scale protected areas (nature reserves and natural monuments) have also been declared in the area – mainly protect wetlands and peat bogs (Bobovec, Olšina, Mrtvý luh, and more).

If the military function of the area of interest will be still dominate in the future, preservation of this specific landscape, which has evolved over the past 70 years, is likely. However, due to the strong pressure of some lobby groups is possible, that local unique landscape will undergo fundamental changes. Either the Šumava NP and PLA can extend its ecological and protection functions into naturally valuable parts of the area, or parts of the area will be used for the recreational functions (residential function/building construction, traffic infrastructure construction, ski slopes construction and maintenance, maintenance of cross-country trails, etc.).

The Boletice area of interest is located in close proximity to the Austrian state border which classifies it as a highly peripheral area. It has only poor connections (roads and railways) with principal regions of Czechia. Population has been decreasing since the beginning of the 20th century and after World War II. The army takeover after World War II brought in a special military administration – in that time, however, the area was already largely depopulated.

Due to the mountainous character and military use of the area of interest, the official agricultural land price remains very low, well below the national average. It reflects the fact that subsistence farming and forestry – main economic activities in the past – are limited now and under current conditions cannot be profitable.

3. Results

3.1 Landscape and Land Use/Cover Changes

Figure 3 and Table 1 show how the landscape looked like in the 1st half of the 19th century (1825) and compare it with the present situation (2018).

The Boletice area of interest is a special area thanks to its specific military use. Farming activities were significantly reduced, arable land was transformed into permanent grassland or afforested (forest cover increased significantly, by almost 24%). Permanent grassland currently cover half of the area and forests account for almost the other half. Built-up areas decreased significantly as the local population had been displaced. Villages previously existing in the area disappeared and the remaining houses serve military purposes. The original mix of farming landscape and forests does not exist anymore. Nowadays, there are large contiguous tracts of forest and arable land practically disappeared after having been overgrown by grassland.

The above-described landscape/land use/cover changes are illustrated in detail by 3D landscape models (Figure 4), which show the gradual forest expansion north of Polná. It is evident that built-up areas, visible at several places in the 1947 model, practically disappeared (except for military buildings). Arable land is gone, too. On the contrary, there has been a massive increase of permanent grassland and forests. Also interesting is the network of newly built roads used by the military as well as new lakes.

The abandoned village of Jablonec, now part of the MTA Boletice, is shown in 3D photorealistic model. Jablonec, situated approximately 8 km from Horní Planá, had been populated mostly by ethnic Germans until World War II. After the war, however, inhabitants were expelled, and the village became part of the military area. Tank shooting range was set up directly in the village and consequently the remaining buildings, including the church, were razed to the ground. The village comes to life again in the 3D model – on the project website (www.zaniklekrajiny.cz) the model is shown using video presentation (www.zaniklekrajiny.cz/atlas/index.php/boletice-video).

Figures 6–9 show wider perspective of land use/cover changes in STUs and describe changes over the time by comparing years 1845, 1896, 1948, 1990, and 2010. In 1845 about one third of the area was covered by permanent grassland which indicates the importance of animal husbandry, while crop farming was relatively modest.

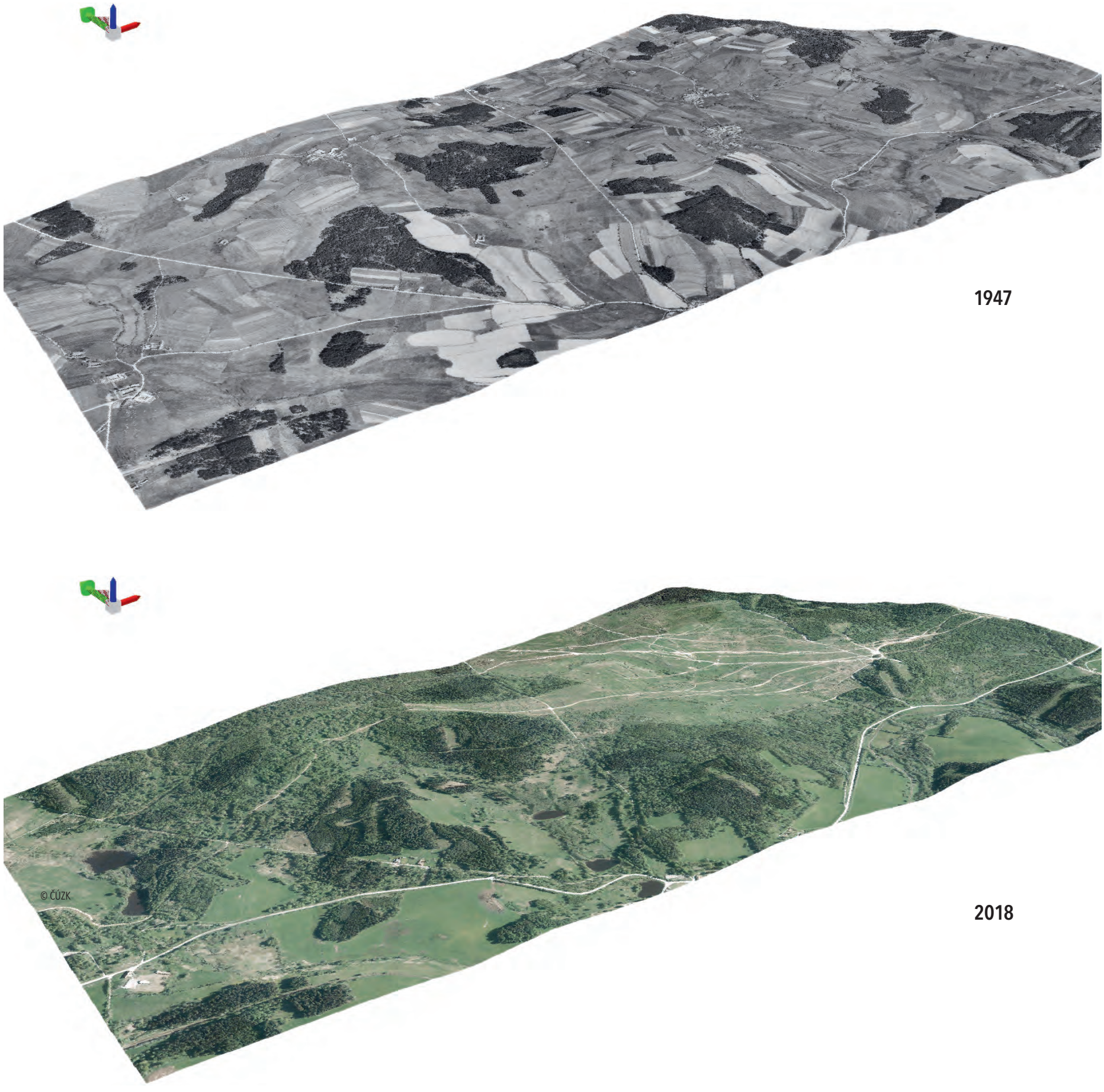


Fig. 4 – Models of landscape – Boletice in 1947 and 2018. Source: Aerial photos © Military Geographical and Hydrometeorological Office in Dobruška, Ministry of Defence, 2018; Orthophoto © The State Administration of Land Surveying and Cadastre, 2018.

Fig. 5 – The view of Jablonec (Ogfolderhaid) in the Boletice Military Training Area. Source: Archive of the NAKI project no. DG18P02OVV008. Photo (2018): Miroslav Čábelka.

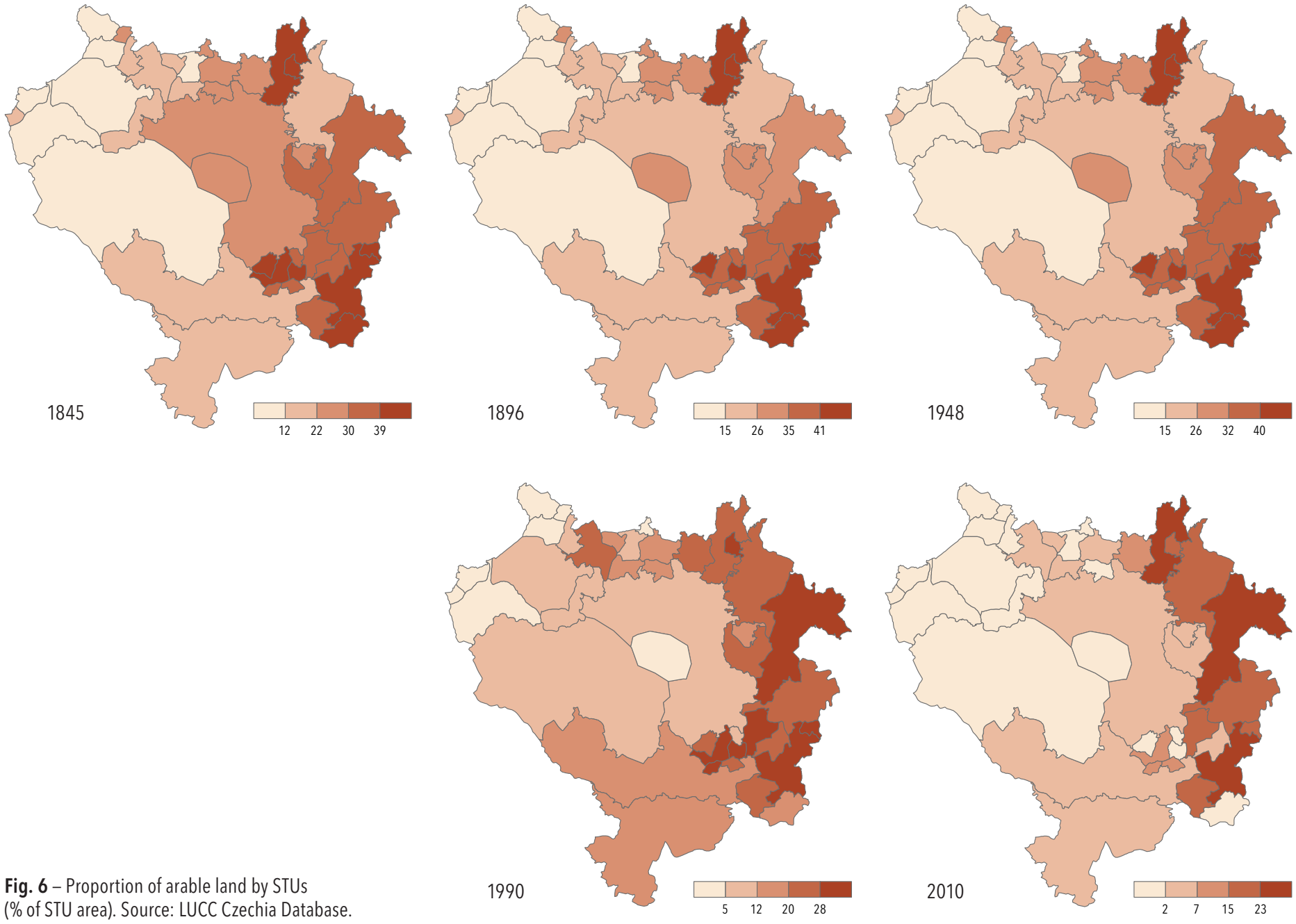


Fig. 6 – Proportion of arable land by STUs (% of STU area). Source: LUCC Czechia Database.

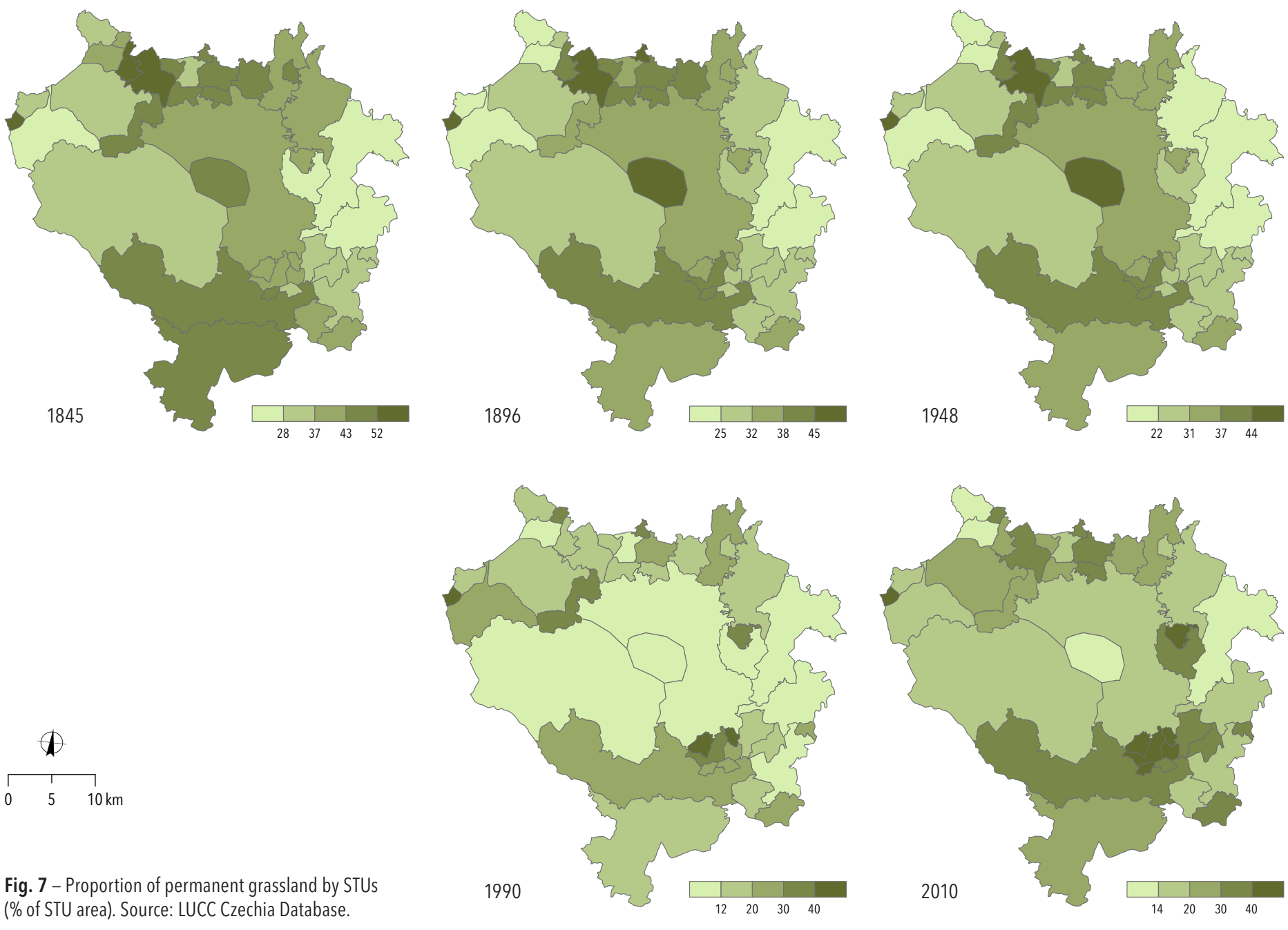


Fig. 7 – Proportion of permanent grassland by STUs (% of STU area). Source: LUCC Czechia Database.

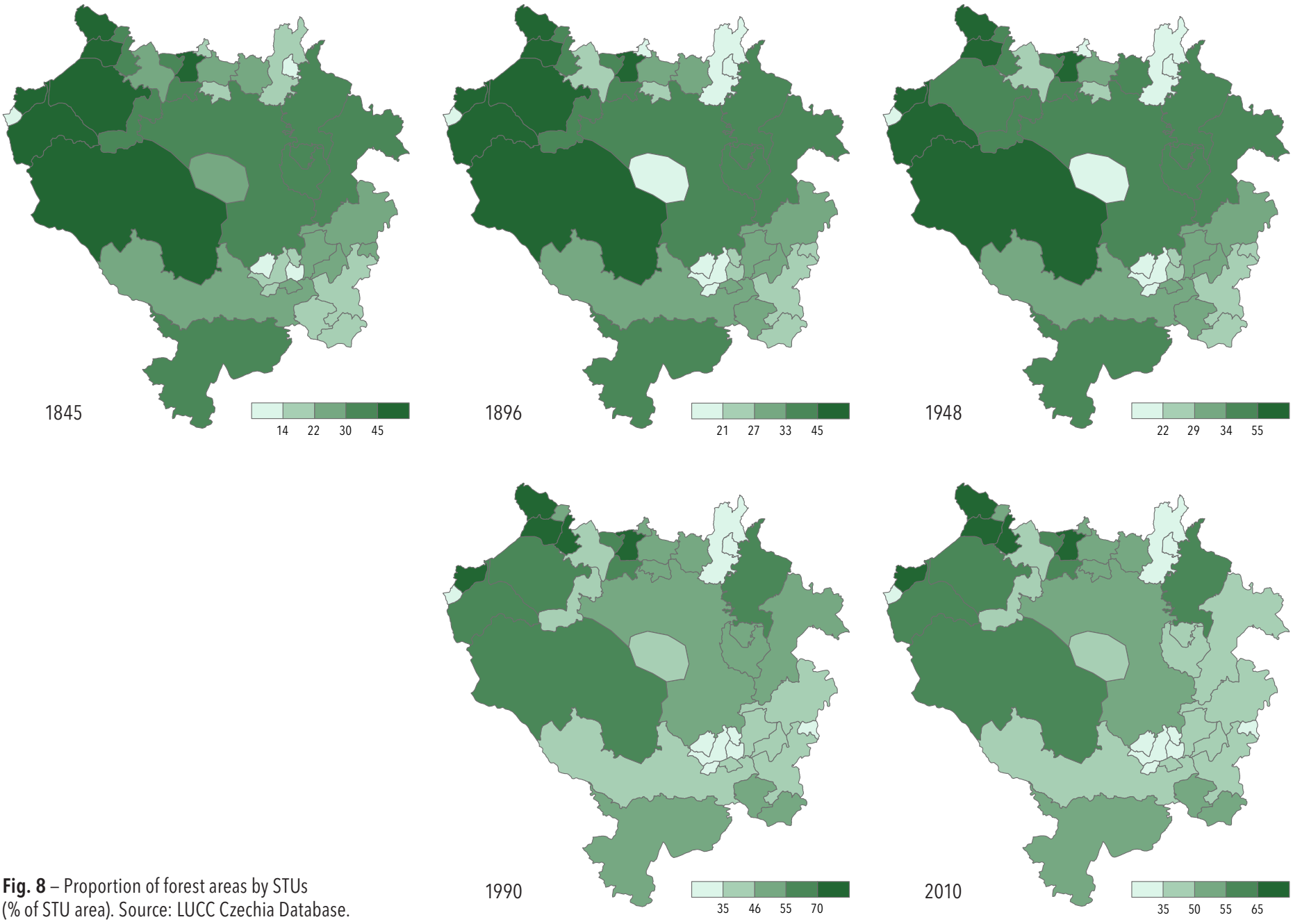


Fig. 8 – Proportion of forest areas by STUs (% of STU area). Source: LUCC Czechia Database.

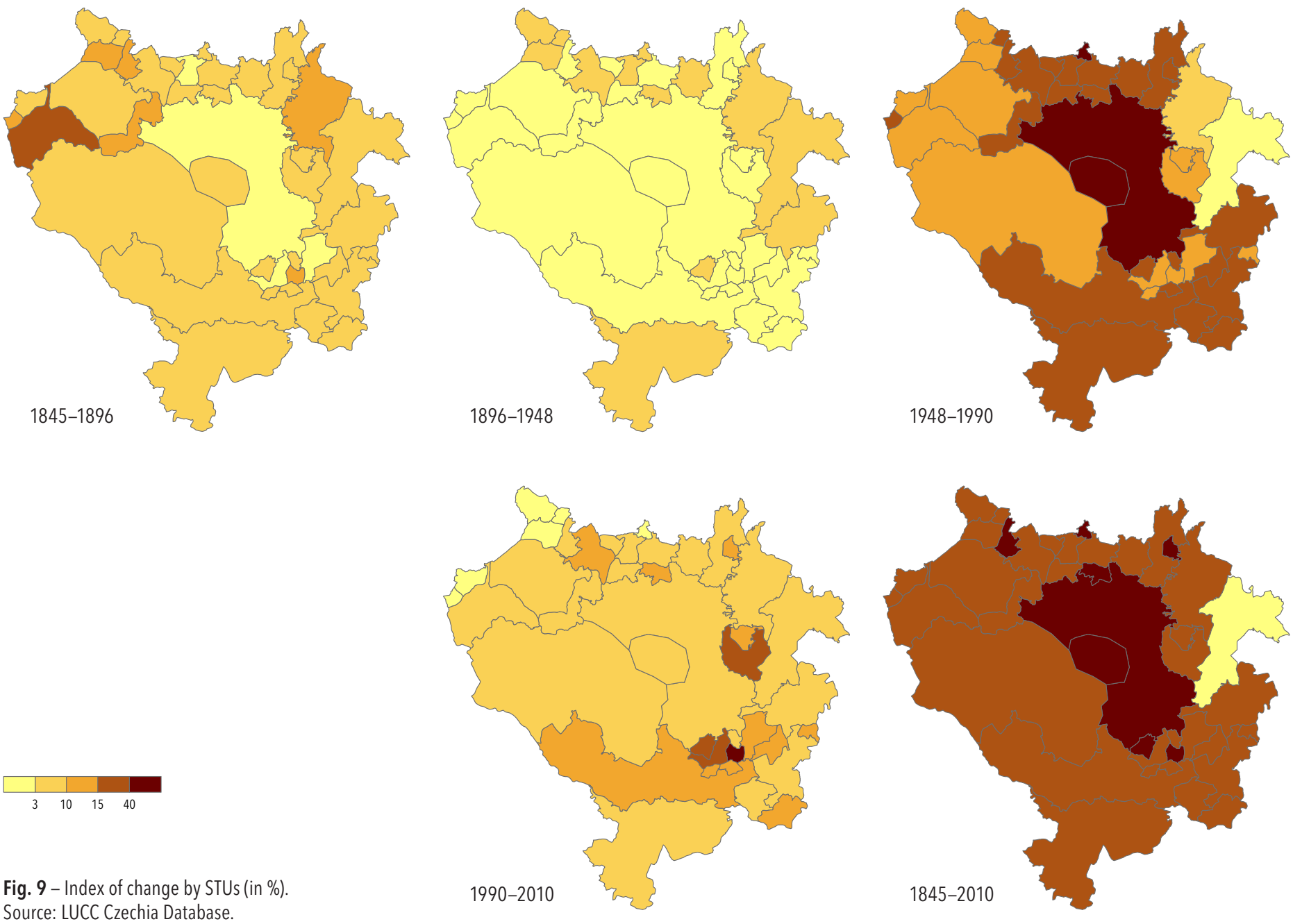


Fig. 9 – Index of change by STUs (in %). Source: LUCC Czechia Database.

Fig. 10 – Municipality emblems.
Source: Register of municipal symbols, Chamber of Deputies of the Czech Republic (https://rekos.psp.cz; as of 1 October, 2018).

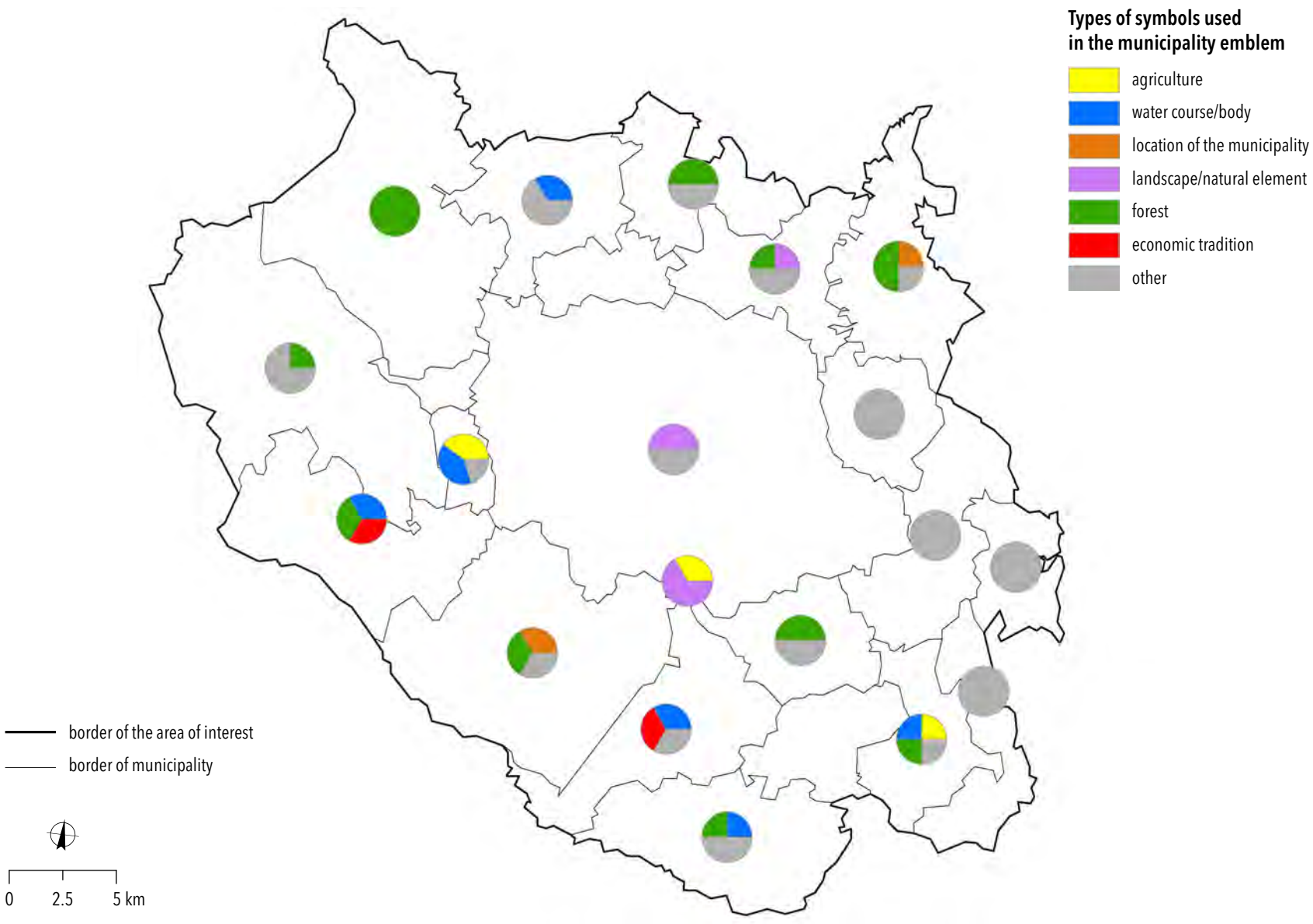


Fig. 11 – Types of symbols used in the municipality emblems.
Data source: Contant analysis of the municipality emblems (as of 1 October, 2018).

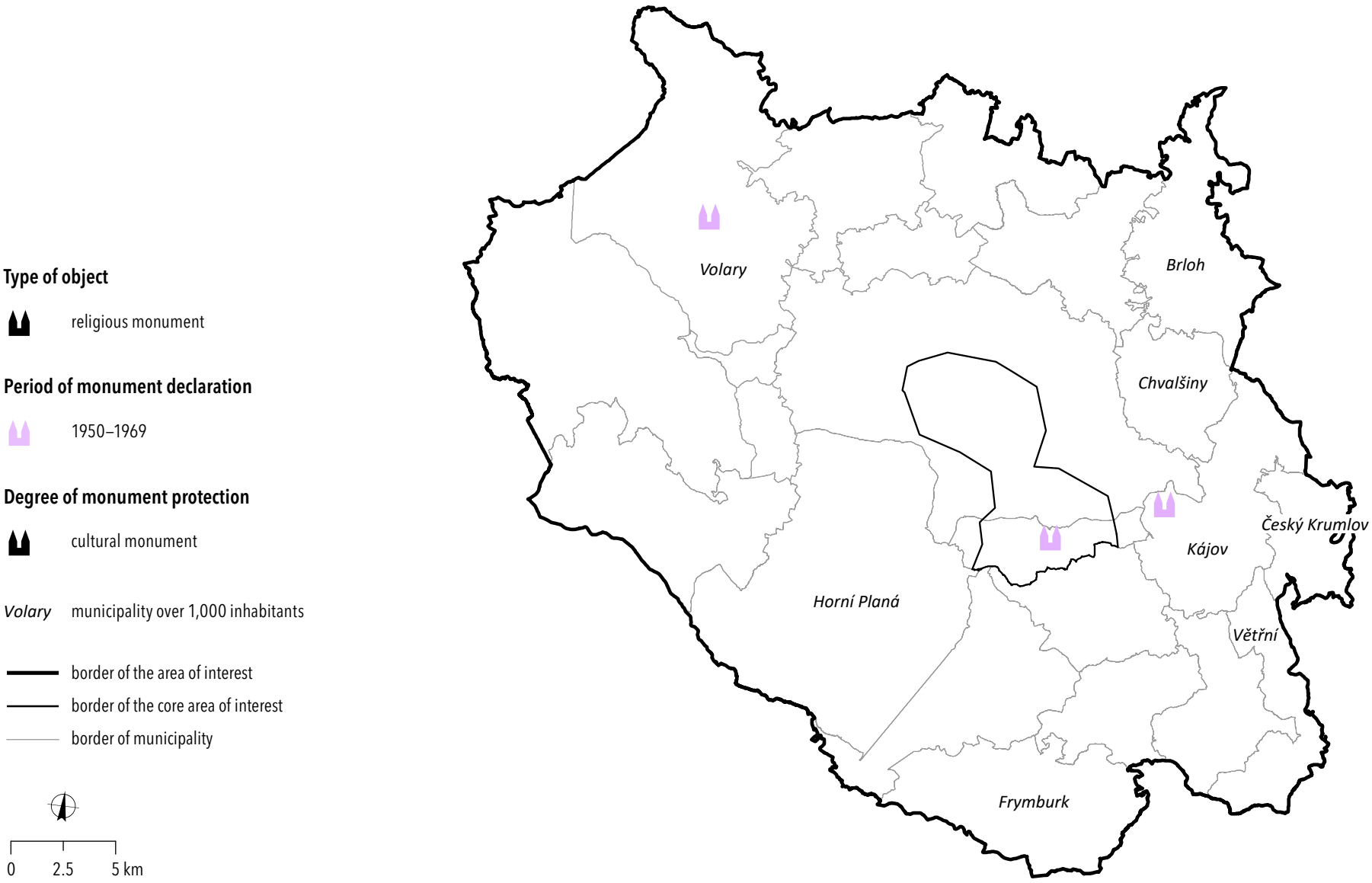


Fig. 12 – Cultural monuments and heritage areas.
Data source: National Heritage Monument Catalogue, National Heritage Institute (https://pamatkovykatalog.cz; as of 1 October, 2018).

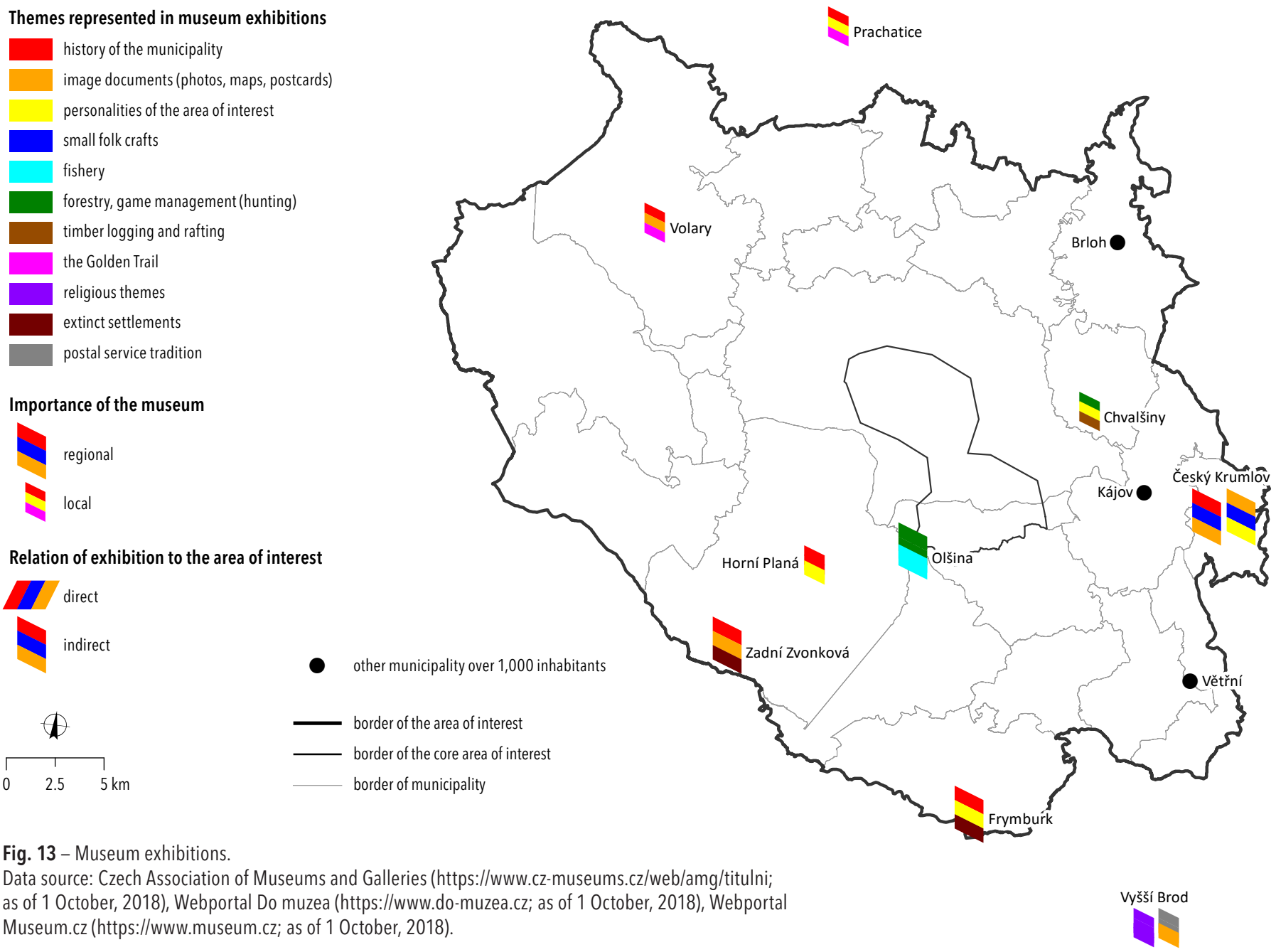


Fig. 13 – Museum exhibitions.
Data source: Czech Association of Museums and Galleries (https://www.cz-museums.cz/web/amg/titulni; as of 1 October, 2018), Webportal Do muzea (https://www.do-muzea.cz; as of 1 October, 2018), Webportal Museum.cz (https://www.museum.cz; as of 1 October, 2018).

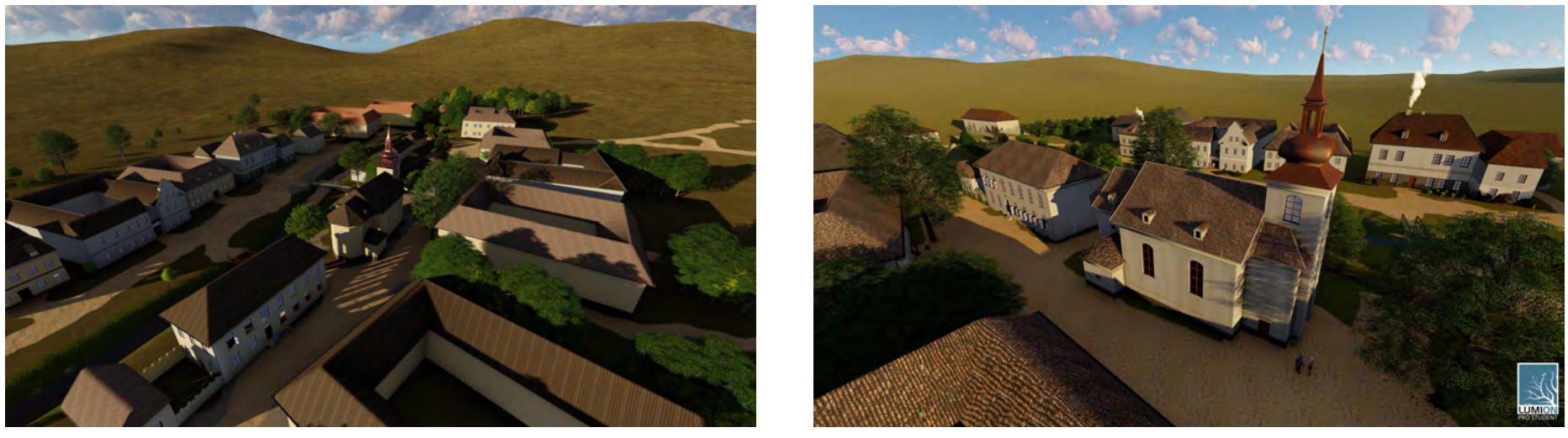


Fig. 14 – 3D photorealistic model – disappeared village Jablonec – based on available photographs from the 1920s and 1930s.

Arable land shrank significantly and nowadays it is mostly found in the eastern part of the area. The conditions for agriculture in general are very unfavourable, so there are cadastres with the price of agricultural land mostly in the value of only CZK 1.5–2.5 per sq. metre. The highest share of arable land in all five monitored time horizons occurred always in the east of the area of interest at lower altitudes. The highest proportion of arable land was reached in the late 19th century, but these areas were very small. In 2010, the share of arable land was two or three times lower than in 1896.

Figure 9 show index of change (in terms of land use/cover changes). The area of interest had the greatest changes in land use between 1948 and 1990, when, in half of the area, the change index was above 10%. During other time periods changes were significantly lower. The total change index between the years 1845–2010 was more than 24% in the whole area of interest, over 42% in the core area. Thanks to the strengthening of the military function of the area, its landscape was fundamentally transformed.

3.2 Landscape Memory

The landscape memory of the area is shown in four maps described in following sections 3.2.1–3.2.3 (for more details about methodology of mapping see Chapter 1 of Atlas).

3.2.1 Places and Institutions of Memory

Eleven institutions of memory are dedicated to presentation and interpretation of various aspects of the area of interest (Figure 13). The most important museum in the area of interest is the Regional Museum in Český Krumlov, which also has a basic exhibition presenting the entire region. One of the branches of this museum, the Museum Fotoatelier Seidel, offers information on the beginnings of photography and on the lives of photography pioneers, all accompanied by fine examples from the Czech-Austrian border. Thus, it contains many pictorial documents related to landscape changes in the area of interest.

There are other interesting museums, namely in Prachatice and Volary, including exhibits presenting the trade routes that once connected Bohemia with the Danube Basin (the network of such ancient routes is generally known as the Golden Route). Other local exhibitions throughout the region provide information on some of the distinctive towns and villages in the Šumava and also show one local rarity – the Schwarzenberg Canal.

3.2.2 Regional and Local Symbols

Symbols that represent regions (and/or localities) are often depicted in municipal emblems (Figures 10 and 11). The area of interest is dotted by mountain villages whose symbols often include attributes of forestry. In the case of Volary, as an example, the emblem shows that Volary had the official right to graze cattle and cut trees. The emblem was granted to the city on 30 April 1871 by the Emperor Franz Joseph I. The emblem of Nová Pec includes a lot of green colour, which represents vast forests in the surroundings. The green section, part of the emblem of Brloh, refers to the position of the village in the centre of forest (the Blanský les). In the case of Černá v Pošumaví, the blue and white crooked beam symbolizes the Lipno Water Reservoir and the confluence of the Vltava and Olšina rivers, the black colour represents a so-called "talking symbol" reminiscent of the Czech and German versions of the name ("černá" means black in Czech, originally Schwarzbach in German). The municipality emblems of Nová Pec, Želnava, and Frymburk also include blue colour referring to watercourses. Agriculture is represented by ear of grain (Bohdalovice, Želnava).

The existence of military training area makes the Boletice model area special. Areas connected with military function are traditionally represented by depiction of a sword, or crossed swords. Polná na Šumavě is a very new municipality because it is located in the area of former (originally larger) the MTA Boletice (the area of MTA was reduced in 2016), thus municipality of Polná could by "renewed" (and it was officially "re-established" in 2016 yet). The symbol of Polná refers both to the military function (sword) and to a typical local flora (Bohemian version of Gentiana). Natural features (yew tree) can be also found in the municipality emblems of Ktiš and Chroboly.

3.2.3 Heritage Sites

The long-term existence of the MTA Boletice is accountable for the fact that there is only a handful of well-preserved cultural monuments in the area of interest (Figure 12). At the present time, the Church of St. Nicholas in Boletice constitutes the most important heritage site. Originally a Romanesque church, situated on elevated ground south of the village, it dates from the 2nd half of the 12th century and it is surrounded by a cemetery. The church forms also an important urban element, visible from the distance. However, its location within the military area caused its gradual deterioration after 1950. After the Velvet Revolution in 1989, the army carried out some repairs of the badly damaged

building (roof and floor were fixed). As of 1 January 2016, the church as well as the village ceased to be part of the military area and became part of Kájov municipality. Reconstruction of the site continues.

The current state of the church reflects the clash of conflicting interests – conservation and military use of the area. Historically, it bears traces from different periods – from the Middle Ages till the Modern Age – and it manifests the Christian faith in a region that was badly affected by population transfers and military activities.

The Church of St. Martin (in Polná na Šumavě) is among the other heritage sites. It also forms an important urban element in a village that was negatively affected by forced depopulation after World War II and by the by the creation of military area. Outside the core territory, near Volary, one can find a war cemetery where Jewish victims of the death march in the end of World War II are buried.

4. Summary

The shift towards a less intensive use of the landscape in the Boletice area of interest is obvious. It results from major transition of the territory – residential function, agricultural activities, and forestry diminished, and military use of the territory became prevalent. Two main driving forces can be identified: (1) unprofitable agricultural use of the landscape due to ongoing modernization and specialization, and (2) special military function of large parts of the area of interest. The Military Training Area Boletice was delimited after the expulsion of Czech Germans from the area after World War II. The area of interest is peripheral, and the military functions of its core make it even more peripheral.

The specificity of the area of interest presents its extraordinarily high scientific value, not only in the context of Czechia, where it is one of the most valuable areas, but also in the context of whole Europe. While most of the area of Czechia has been altered by the collectivization or development of industrial agriculture leading to eutrophication of the landscape, the specific use of the military area allows the preservation of a number of very valuable habitats and related species of plants and animals. We can find, for example, the corncrake, the little ringed owl, the rowan, the three-toed woodpecker, the rare representatives of insects (dusky large blue, scarce large blue) and plants (crocus white). The military technology maintained a mosaic of forest-free enclaves at various stages of forest growth and created a new wilderness at the same time. Unique beech and fir forests have been preserved in the wider background of the area. The area of interest has a relatively high degree of stability. Stable parts represent 51% of the area, i.e. its land cover has not changed compared to the situation recorded on the maps of the Stable Cadastre.

If the military function of the Boletice area will be retained also in the future, it is likely that this special type of landscape, which has developed over the past 70 years, will stay largely unchanged, serving the needs of the military. However, given the strong pressures of certain lobbies, the area may soon undergo major changes. As a well-preserved natural area, it may become part of the adjoining Šumava National Park and Protected Landscape Area. The other scenario would open the area around Boletice for leisure time activities. In connection with the unique natural value of the model area, only soft forms of tourism should by supported in planning of the (land) use of the area in future. Nevertheless, there is a lot of pressure on the area by the entrepreneurs in tourism to acquire this space for the construction of mass tourism facilities. In terms of the quality of the original natural environment, such use of a local unique landscape is extremely inappropriate.

Acknowlegment

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References and Data Sources

BALATKA, B., KALVODA, J. (2006): Geomorfologické členění reliéfu Čech. Kartografie, Praha.

DEMEK, J. (ed.) a kol. (1987): Zeměpisný lexikon ČSR. Hory a nížiny. Academia, Praha.

NEUHÄUSLOVÁ, Z., MORAVEC, J. (eds.) a kol. (1997): Mapa potenciální přirozené vegetace České republiky. Map of potential natural vegetation of the Czech Republic. Kartografie, Praha.

PLÍVA, K., ŽLÁBEK, I. (1986): Přírodní lesní oblasti ČSR. SZN, Praha.

QUITT, E. (2009): Klimatické oblasti. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SEDLÁČEK, J., JANDERKOVÁ, J., ŠEFRNA, L. (2009): Půdní asociace. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SKALICKÝ, V. et al. (2009): Fytogeografické členění. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

Archive Maps of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK), Central Archive of Surveying and Cadastre. https://archivnimapy.cuzk.cz/uazk/pohledy/archiv.html (1. 10. 2019).

Czech Association of Museums and Galleries (Asociace muzeí a galerií České republiky). https://www.cz-museums.cz/web/amg/titulni (1. 10. 2019).

Do muzea. https://www.do-muzea.cz (1. 10. 2019).

eKatalog BPEJ. https://bpej.vumop.cz/ (1. 10. 2019)

Geologická mapa ČR 1 : 50 000. https://mapy.geology.cz/geocr50/ (1. 10. 2019).

Geoportal of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK). https://geoportal.cuzk.cz/ (1. 10. 2019).

Land Use Land Cover Czechia Database. https://www.lucccz.cz/databaze/ (1. 10. 2019).

Museum.cz. https://www.museum.cz/ (1. 10. 2019).

National Heritage Monument Catalogue, The National Heritage Institute (Národní památkový ústav – NPÚ). https://pamatkovykatalog.cz/ (1. 10. 2019).

Portál informačního systému ochrany přírody. http://webgis.nature.cz/mapomat/ (1. 10. 2019).

Půdní mapa ČR 1 : 50 000. https://mapy.geology.cz/pudy/ (1. 10. 2019).

Register of communal symbols (Registr komunálních symbolů), Chamber of Deputies of the Czech Republic. https://rekos.psp.cz (1. 10. 2019).

Ústřední seznam ochrany přírody. http://drusop.nature.cz/ (1. 10. 2019).

CHAPTER 3

Kačina: Traces of Aristocratic-style Man-made Landscape

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1. Introduction

Great examples of aristocratic-style (or feudal) man-made landscapes (landscapes formed by aristocrats on their vast lands at the end of the Early Modern Era and during the Modern Era) can be found in the environs of the Kačina Castle near the town of Kutná Hora. Most of this area now belongs to municipalities of Nové Dvory and Svatý Mikuláš and partly extends beyond the municipal boundaries. Landscaping on the grounds of the Nový Dvůr manor started in the end of the 17th century. Aesthetic aspects have been crucial since the very beginning – an intricate network of paths lined with alleys came to existence as well as different water features and many small-sized buildings. These generous landscape compositions culminated in the construction of the magnificent Kačina Castle built in Empire style in early 19th century. Extensive landscaping in the surroundings of the castle (creation of castle parks and gardens) took place at the same time.

Since the second half of the 19th century, many aspects of this unusual man-made landscape have deteriorated. The crucial changes, however, were to come in the second half of the 20th century when socialist-style collectivization and agricultural intensification took the upper hand. As a result, many centuries old roads vanished, fields were merged into large blocks, and a number of rather huge and ugly "modern" buildings serving the needs of socialist-style agriculture came to existence. Many elements of the aristocratic (feudal) landscape, which had been created in the area mainly before the turn of the 18th and 19th centuries and mainly at the beginning of the 19th century, either completely disappeared or were overshadowed by modern structures. This was also the case of the castle park and adjoining game preserve, which became gradually overgrown. The original landscape composition as such disappeared completely. Thus, the extensive rehabilitation of the Kačina Preserve (carried out between 2011 and 2013) was much needed. It was chiefly intended to recreate the landscape around the castle as it had looked like in early 19th century.

The above-mentioned rehabilitation, however, could not be done in the area beyond castle grounds which is under intensive farming. Due to preserved traces of aristocratic-style man-made

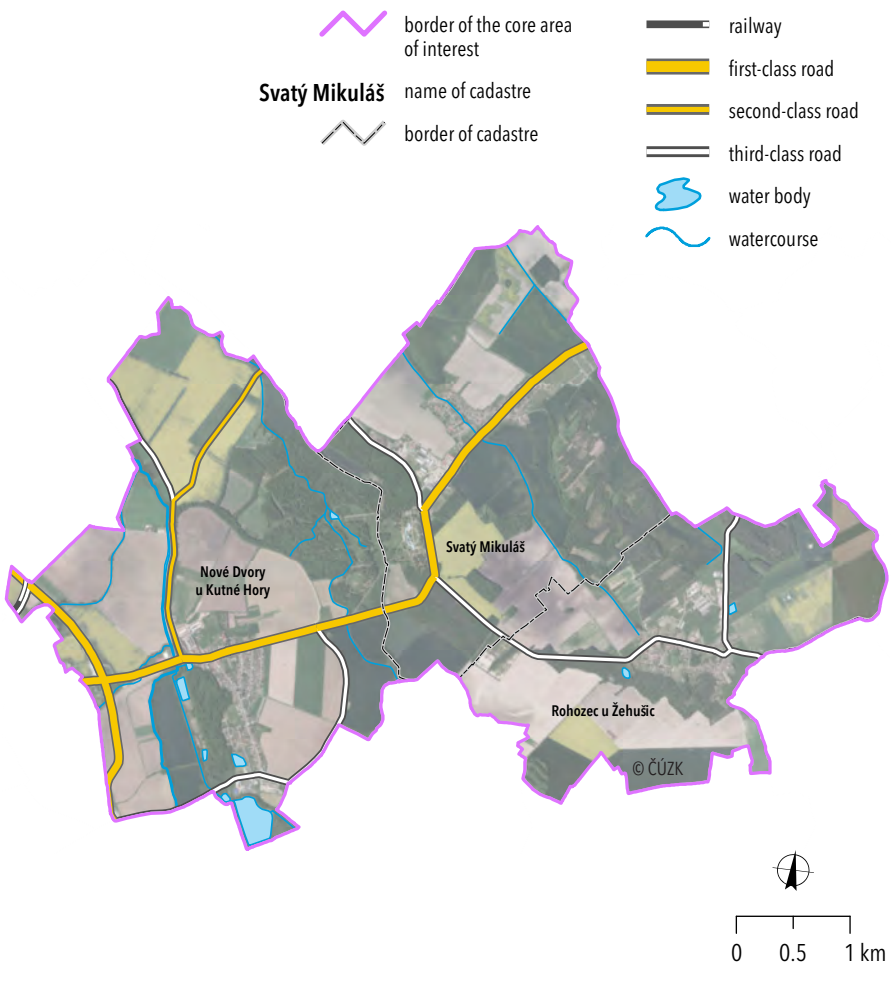


Fig. 1 – The core area of interest. Map basis: Data50;
Orthophoto © The State Administration of Land Surveying and Cadastre, 2019.

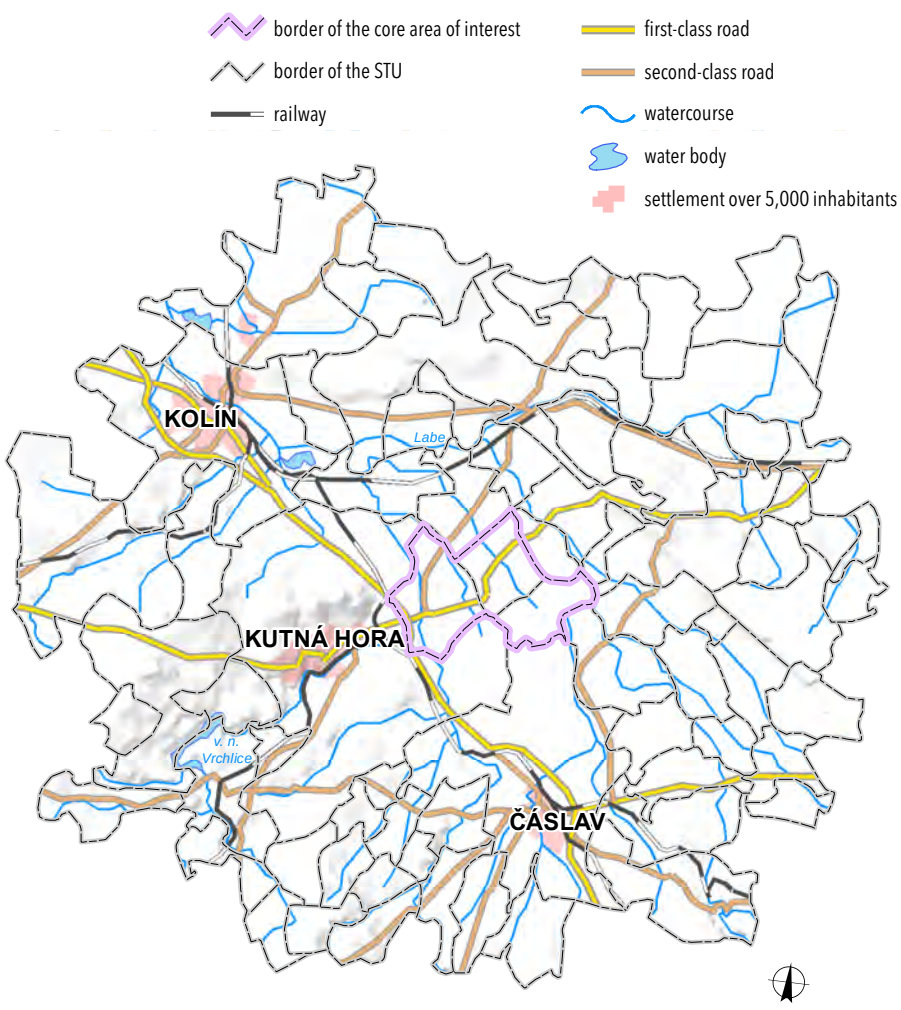
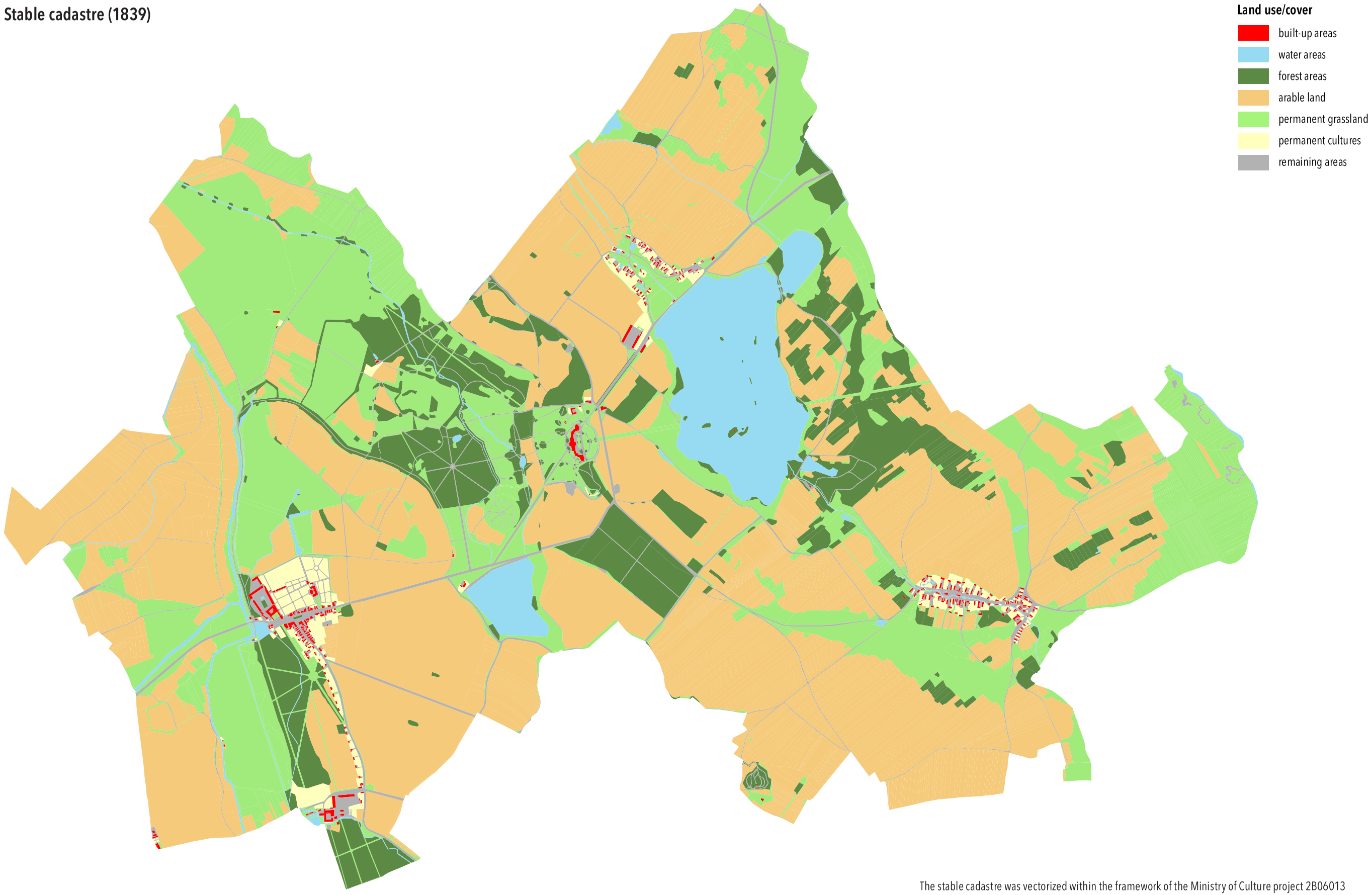
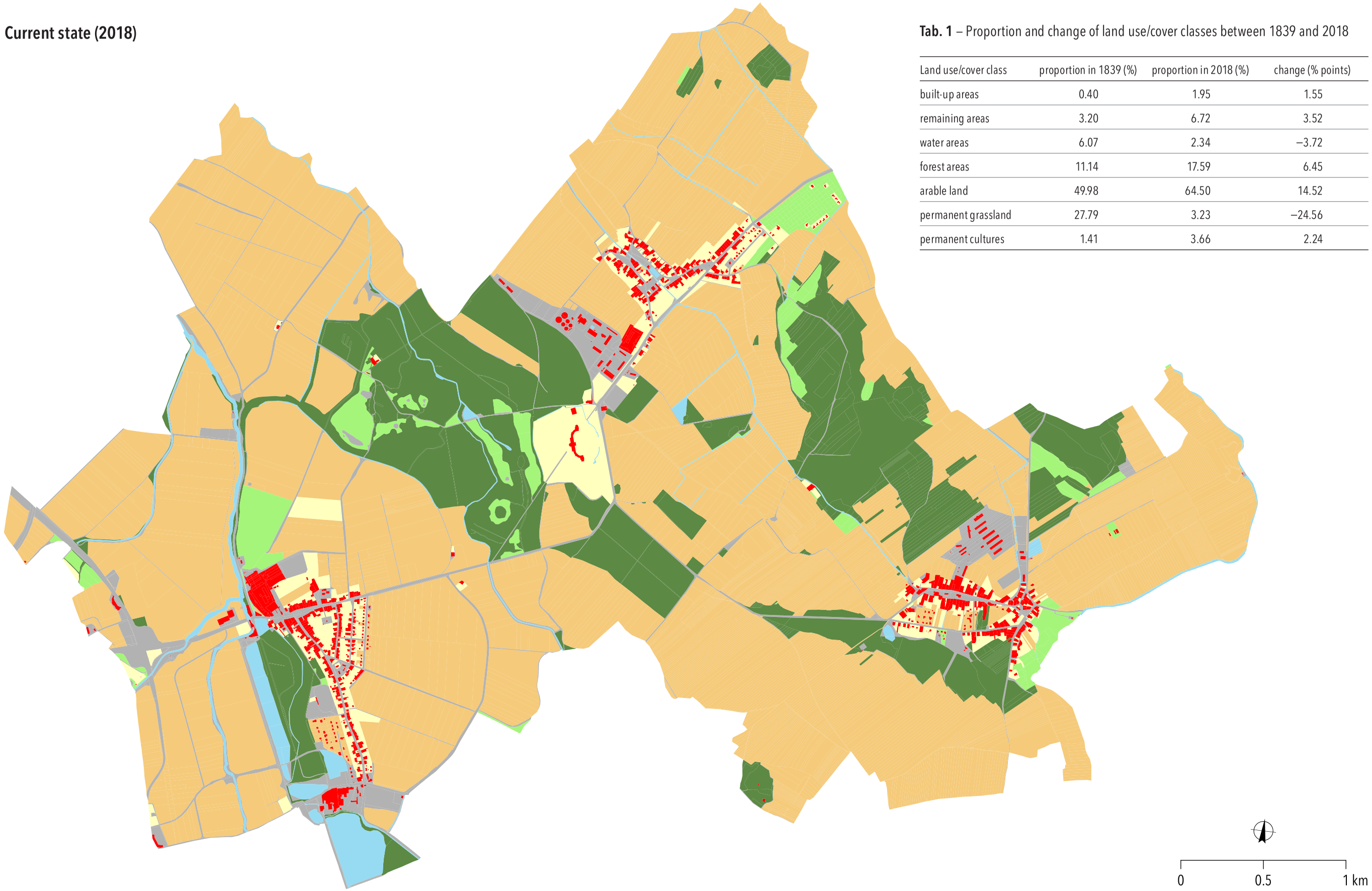


Fig. 2 – The wider area of interest.
Map basis: Data50.

Stable cadastre (1839)



The stable cadastre was vectorized within the framework of the Ministry of Culture project 2B06013 Implementation of measures of the European Landscape Convention in intensively agriculturally utilized areas with traces of historical landscaping – pilot study Nové Dvory – Kačina. The stage, which included vectorization of stable cadastre maps, was solved by Jan Skaloš, Pavel Kukla and Lucie Jakešová.

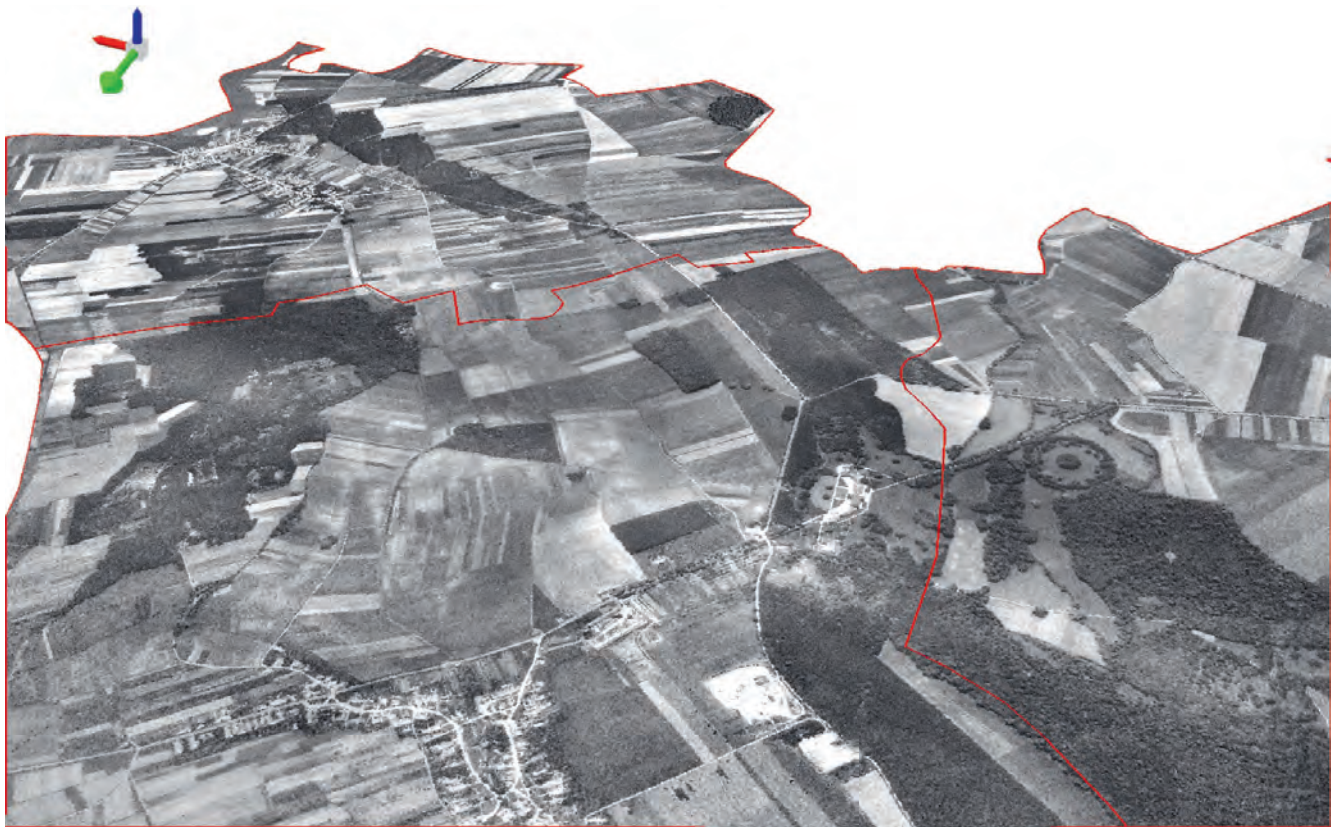


Tab. 1 – Proportion and change of land use/cover classes between 1839 and 2018

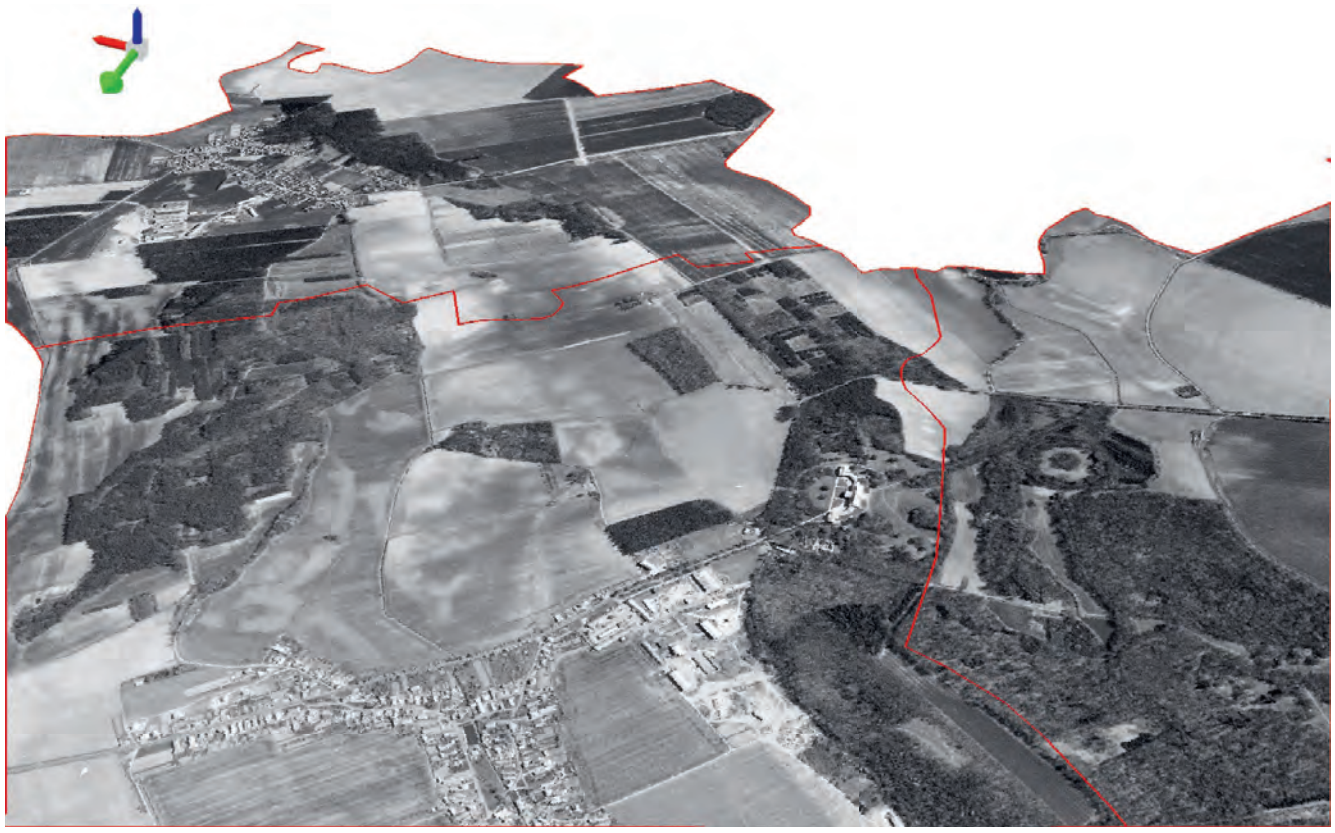
Land use/cover class	proportion in 1839 (%)	proportion in 2018 (%)	change (% points)
built-up areas	0.40	1.95	1.55
remaining areas	3.20	6.72	3.52
water areas	6.07	2.34	−3.72
forest areas	11.14	17.59	6.45
arable land	49.98	64.50	14.52
permanent grassland	27.79	3.23	−24.56
permanent cultures	1.41	3.66	2.24

Fig. 3 – Land use/cover in cadastres Rohozec, Svatý Mikuláš a Nové Dvory in 1839 and 2018.
Map basis: The State Administration of Land Surveying and Cadastre.

1954



1990



2018

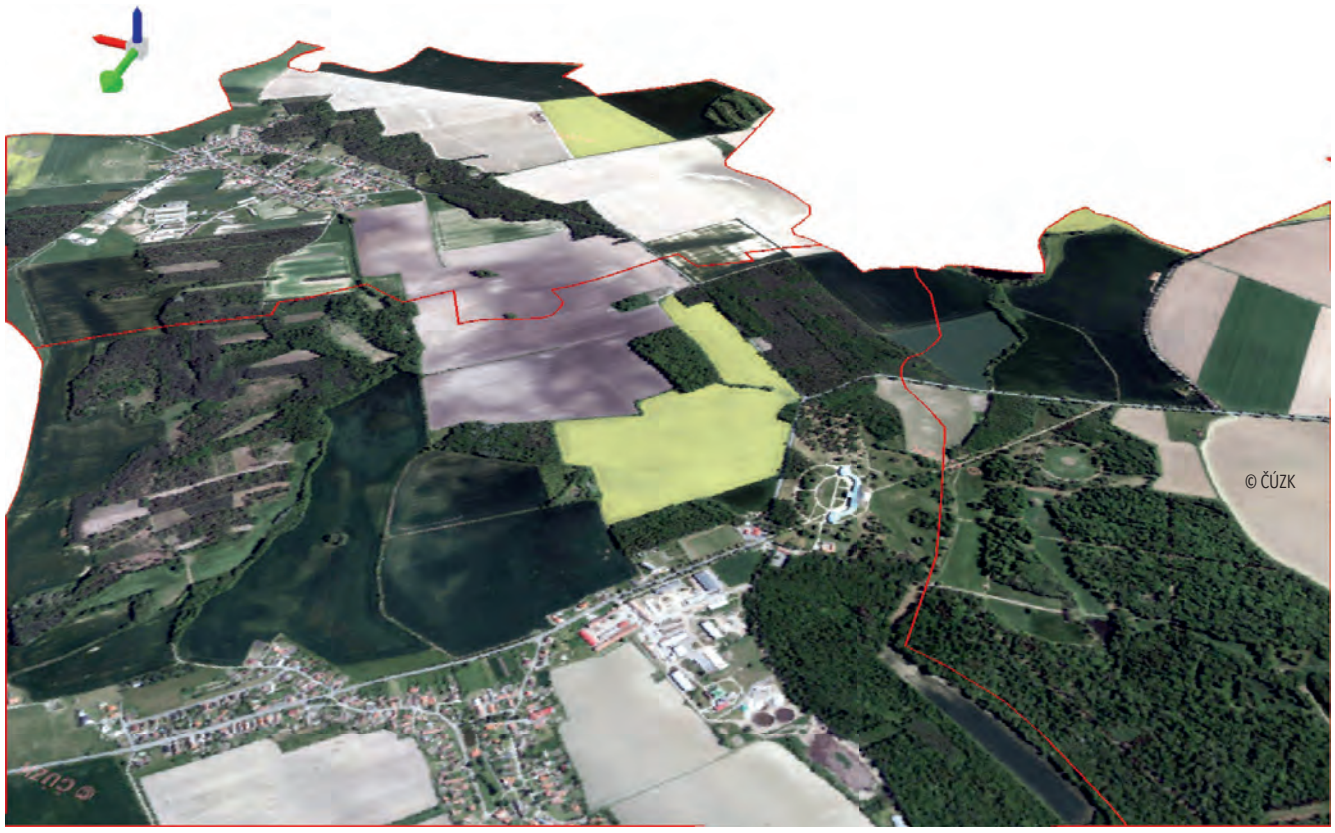


Fig. 4 – Models of landscape – chateau Kačina with surrounding landscape in 1954, 1990 and 2018. Source: Aerial photos © Military Geographical and Hydrometeorological Office in Dobruška, Ministry of Defence, 2018; Orthophoto © The State Administration of Land Surveying and Cadastre, 2018.

Fig. 5 – Kačina chateau. Source: Archive of the NAKI project no. DG18P02OVV008. Photo (2019): Zdeněk Kučera.

landscaping and high aesthetic values, the whole area has been declared a monumental landscape zone. The Kačina Preserve and the castle park were declared a natural monument because of high natural values. It also became part of Natura 2000 network and of gene pool of four species (alder, linden, ash, and oak).

For the purposes of this project, the so-called core area has been delimited and most analyses are carried out in this core area (Figure 1). It includes the municipal areas of Nové Dvory, Svatý Mikuláš, and Rohozec u Žehušic. The wider area of interest (see Chapter 1 of Atlas for more details) is shown in Figure 2.

2. Area of Interest: Main Features

The Kačina model area lies in the geomorphological unit of the Středolabská tabule (Central Elbe Basin), the sub-unit of the Čáslavská kotlina (Čáslav Basin), the district of the Žehušická kotlina (Žehušice Basin). The Čáslav Basin is a neo-tectonic depression at the southern edge of the Bohemian Cretaceous Basin. Distinctive fault slope of the Železné hory (Iron Mountains) marks eastern limit of the Bohemian Cretaceous Basin. In the south and west (already beyond the limits of the area of interest) the transition zone towards the Českomoravská vrchovina (Bohemian-Moravian Highlands) is less obvious. The geological bedrock is formed by the Upper Cretaceous sediments, mainly Turonian marl and sandy marl, with rare occurrence of old crystalline rocks (gneiss, amphibolite) which protrude in the form of monadnocks (Kamajka). There are some traces of surf activity of the Cretaceous sea – Cenomanian conglomerates with numerous fossils (Kamajka, Žehušická skalka [Žehušice Rock]). Young Quaternary sediments are widespread in the area in the form of eolian sand, loess, and floodplain sediments, especially flood loams and gravel sands in the floodplains of the Labe (Elbe) River, Doubrava and Klejnárka rivers. Fluvial sand and gravel were exploited at numerous sand pits. Sand is still being exploited near Žehušice. In the past, small quarries existed in the outcrops of hard crystalline rocks (gneiss, migmatite) on the Kamajka and the Žehušická skalka (Žehušice Rock).

The area represents a typical lowland, with maximum of altitudinal differences up to 30 metres, in many areas only 0–10 metres. Altitudes range between 200 and 239 metres a.s.l. The wide floodplains of the Labe (Elbe), Doubrava, and Klejnárka rivers blend with Pleistocene terraces. In several places, eolian sand is found including low sand dunes up to several meters high. The Kačinský hřbet (Kačina Ridge) consists of sandstones and weathered sands and forms a striking element in the landscape, being 10–20 metres high. Sand was exploited on several places there in the past. The Kačina Ridge stretches from Starý Kolín towards south-east, where it recedes into the plain near Chotusice. It forms a watershed between Klejnárka and Doubrava rivers.

The Kačina area of interest enjoys a relatively warm climate with annual mean temperature around 9 °C and mean annual precipitation 550–600 mm. Winters have been mostly mild and short over the past decades, with sporadic snow cover only. Atmospheric inversions are frequent especially in autumn and winter. Summers tend to be rather long, sunny and often dry.

The area is part of the phytogeographical area of the Czech Thermophyticum, the phytogeographical district of the Střední Polabí (Central Elbe Plain), forest vegetation is mainly oak. The natural potential vegetation in the floodplains mostly consists of alluvial bird cherry-ash woodland, partly in complex with alder carrs. Outside of alluvial floodplains, oak-hornbeam and lime-oak potentially predominate.

The area of interest is situated to the north-east of the town of Kutná Hora. From the natural perspective, it extends along the lower reaches of the Doubrava and Klejnárka rivers, left tributaries of the Labe (Elbe) River. In the past, the Doubrava and Klejnárka rivers had meandered in the plain. Later, mainly in the 16th and 17th centuries, a number of ponds were built. These were supplied with water by several canals, some of which are still visible in the landscape.

The model area is intersected with two major railways (Kolín–Pardubice, and Kolín–Havlíčkův Brod); the highway D5 connecting Prague and Hradec Králové is not far either. Major landscape changes took place in the 17th–19th centuries. In the 1st half of the 19th century, when there was a search for more farming land, many ponds were drained which significantly altered the appearance of the landscape. As a result, residential and agricultural functions became more important and the local agricultural production increased.

To sum up, two human-induced fundamental changes of the landscape can be identified in the past. First, the Kačina Castle with the surrounding park had come to existence; and a number of ponds had been built. Second, most of these ponds were drained for economic reasons in the 1st half of the 19th century. Nowadays, the heart of the area is formed by a beautiful park – English garden (founded in late 18th century). At the present time, the castle hosts the exhibition of the Czech Countryside Museum (the branch of the National Museum of Agriculture). This rather unusual place for that kind of an exhibition reflects

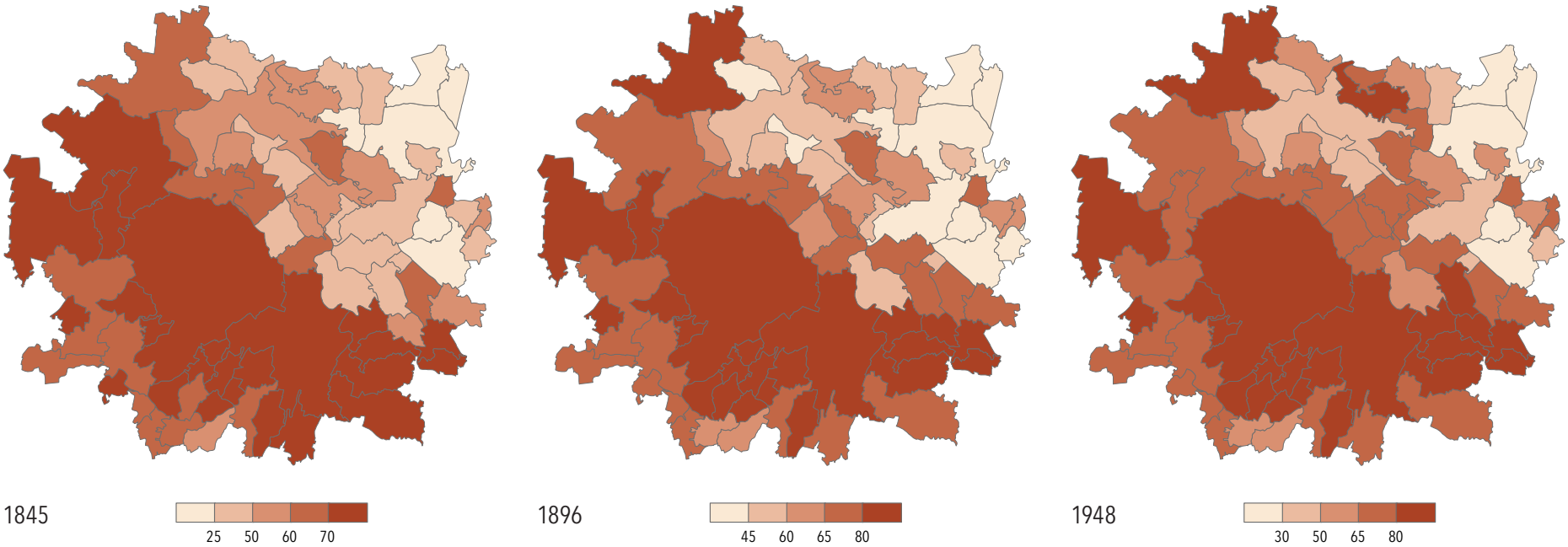


Fig. 6 – Proportion of arable land by STUs (% of STU area). Source: LUCC Czechia Database.

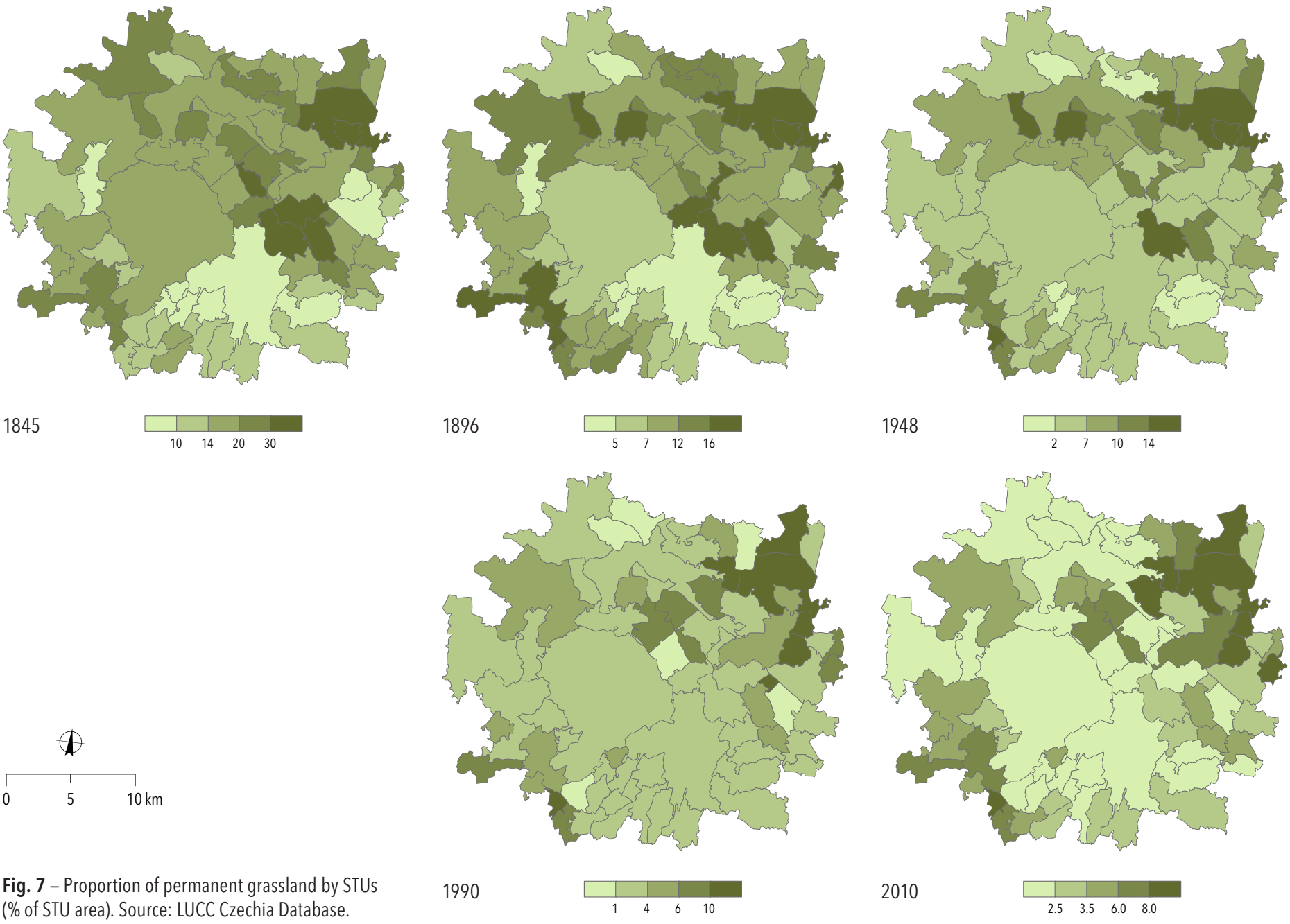


Fig. 7 – Proportion of permanent grassland by STUs (% of STU area). Source: LUCC Czechia Database.

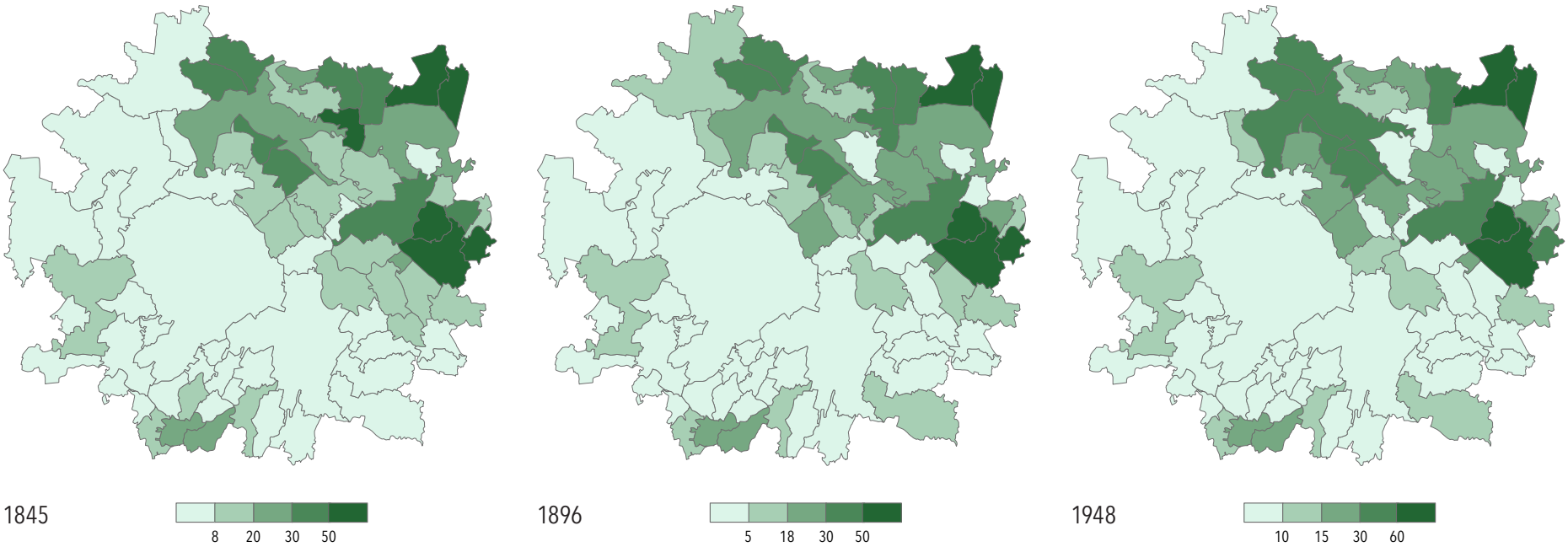


Fig. 8 – Proportion of forest areas by STUs (% of STU area). Source: LUCC Czechia Database.

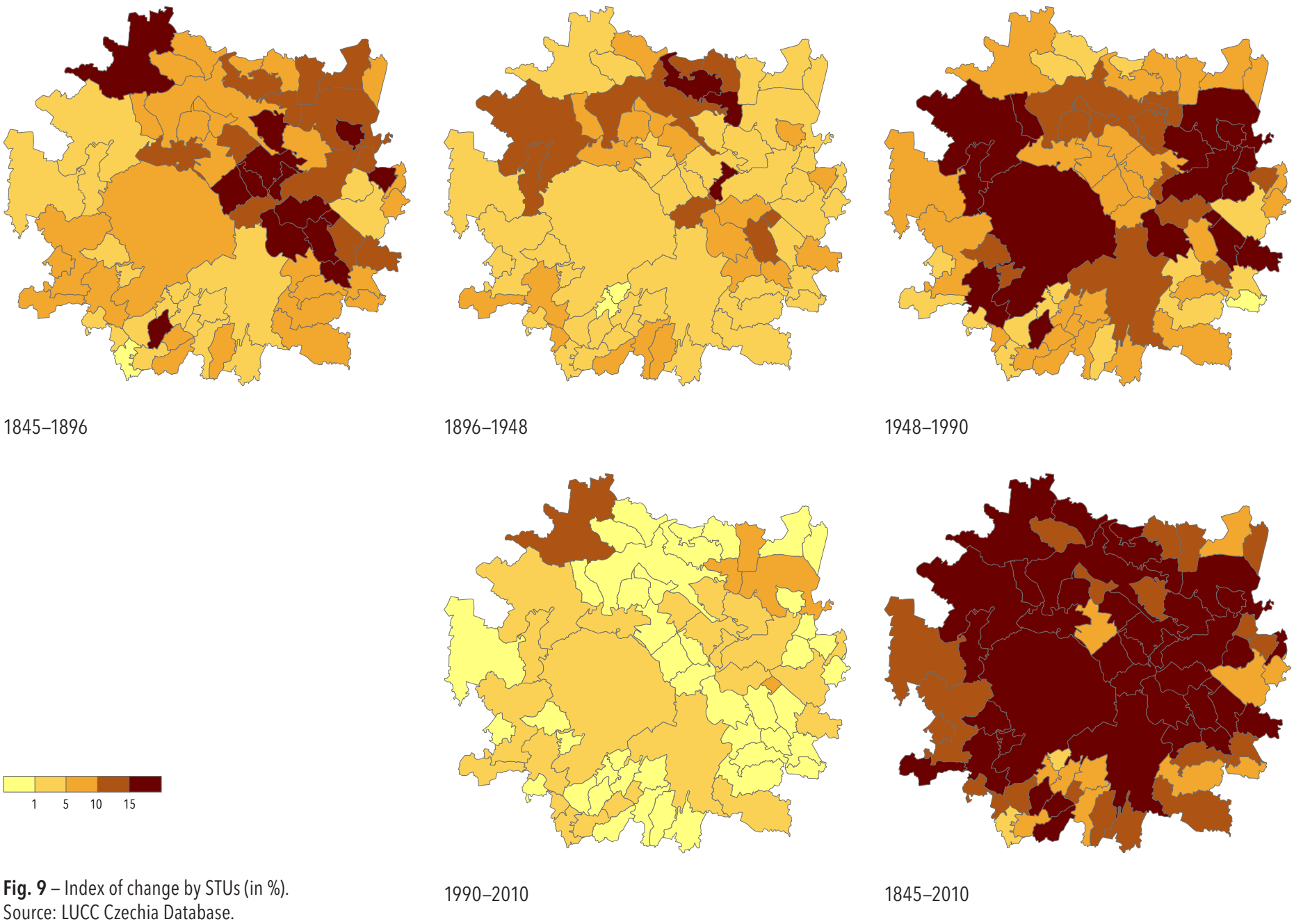


Fig. 9 – Index of change by STUs (in %). Source: LUCC Czechia Database.

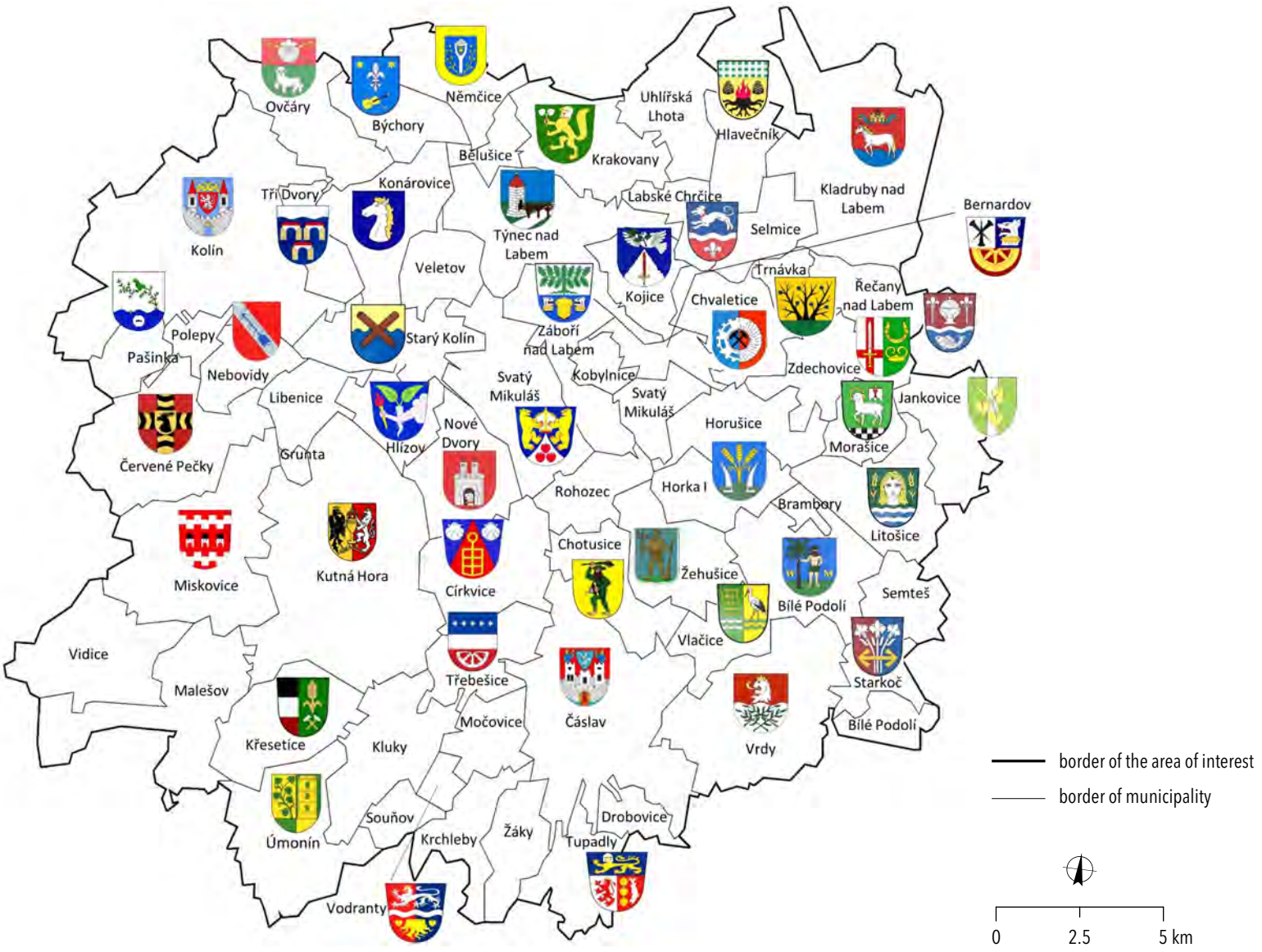


Fig. 10 – Municipality emblems.
Source: Register of municipal symbols, Chamber of Deputies of the Czech Republic (https://rekos.psp.cz; as of 1 October, 2018).

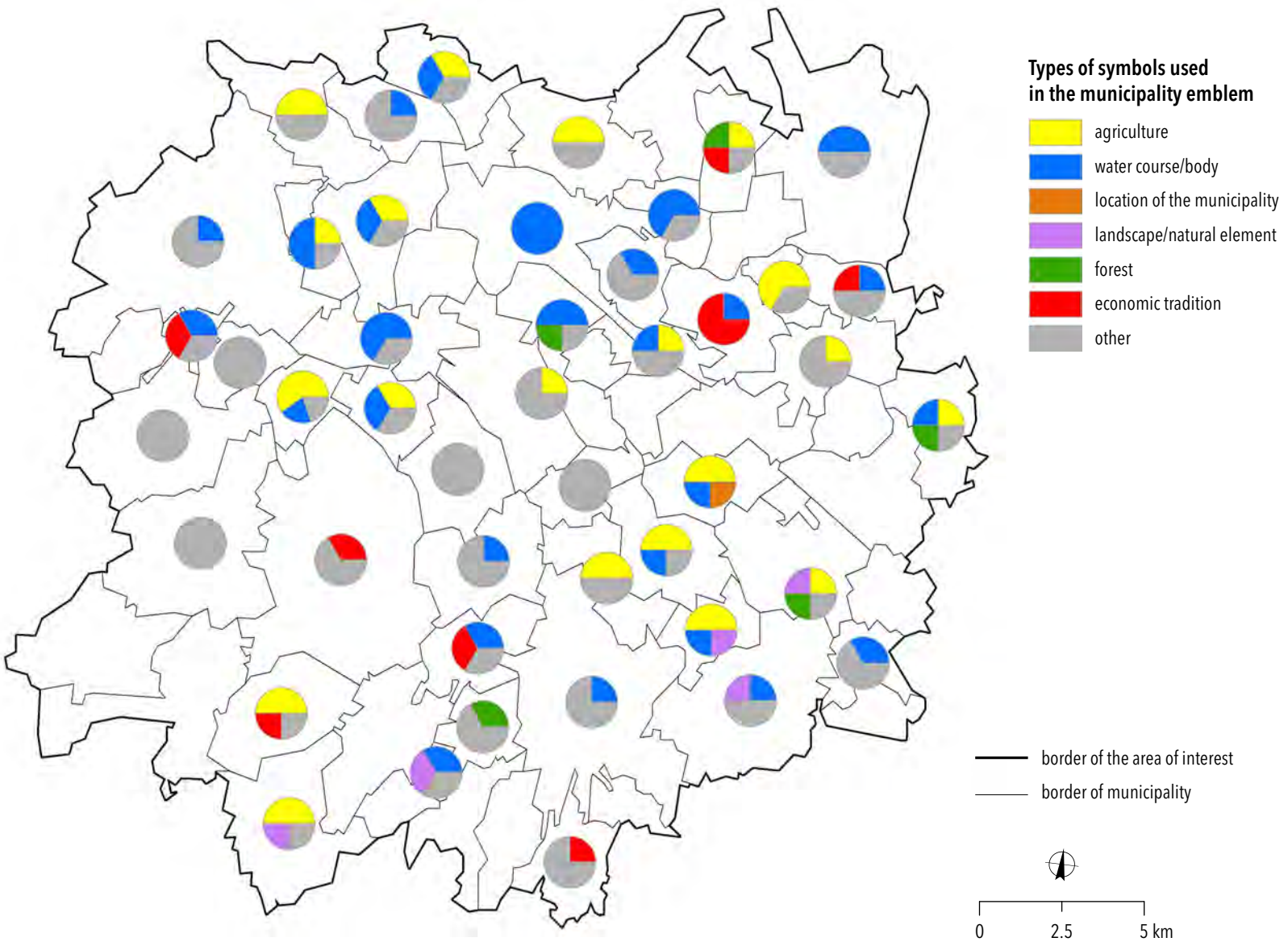


Fig. 11 – Types of symbols used in the municipality emblems.
Data source: Contant analysis of the municipality emblems (as of 1 October, 2018).

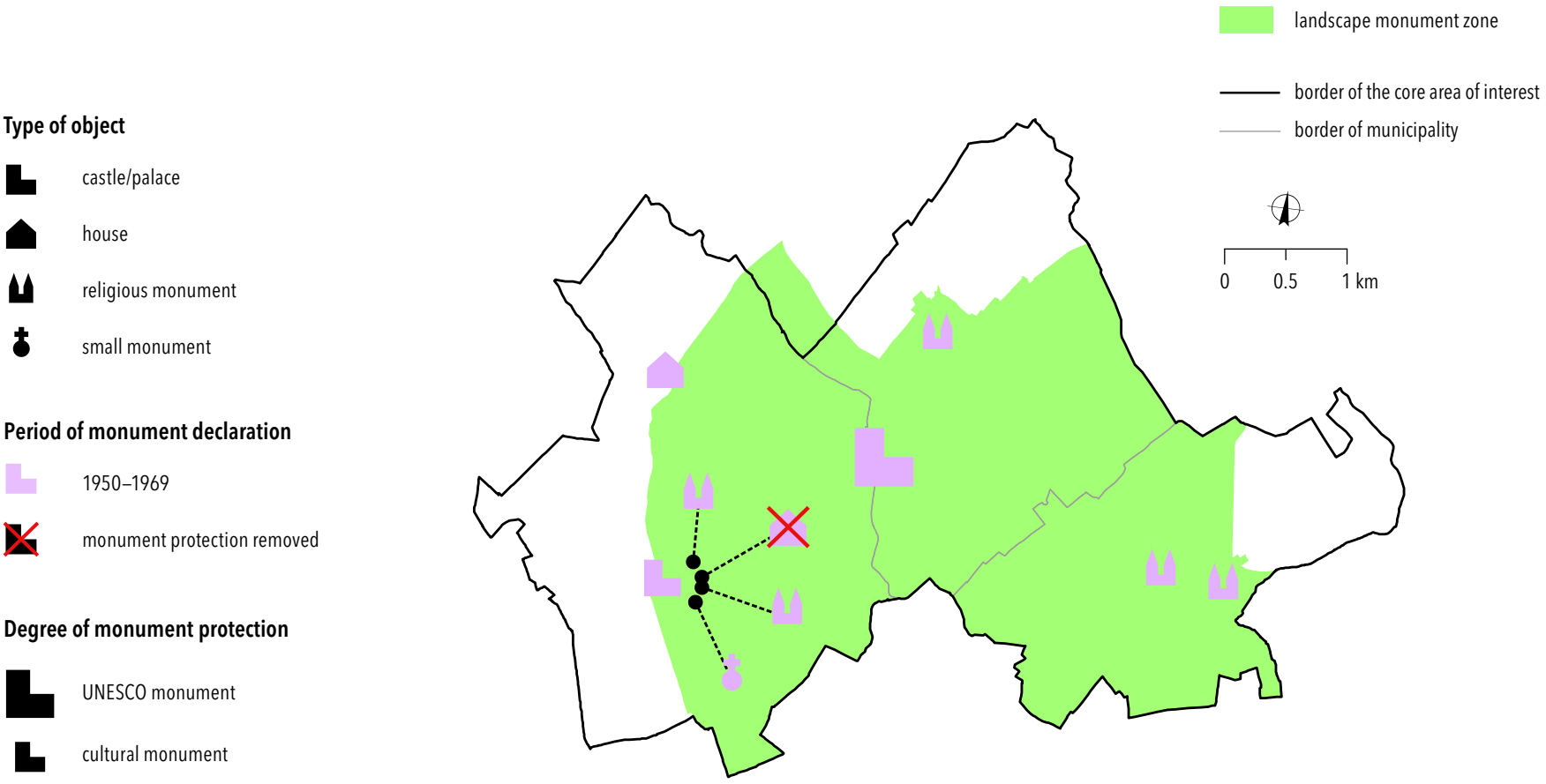


Fig. 12 – Cultural monuments and heritage areas.
Data source: National Heritage Monument Catalogue, National Heritage Institute (https://pamatkovykatalog.cz; as of 1 October, 2018).

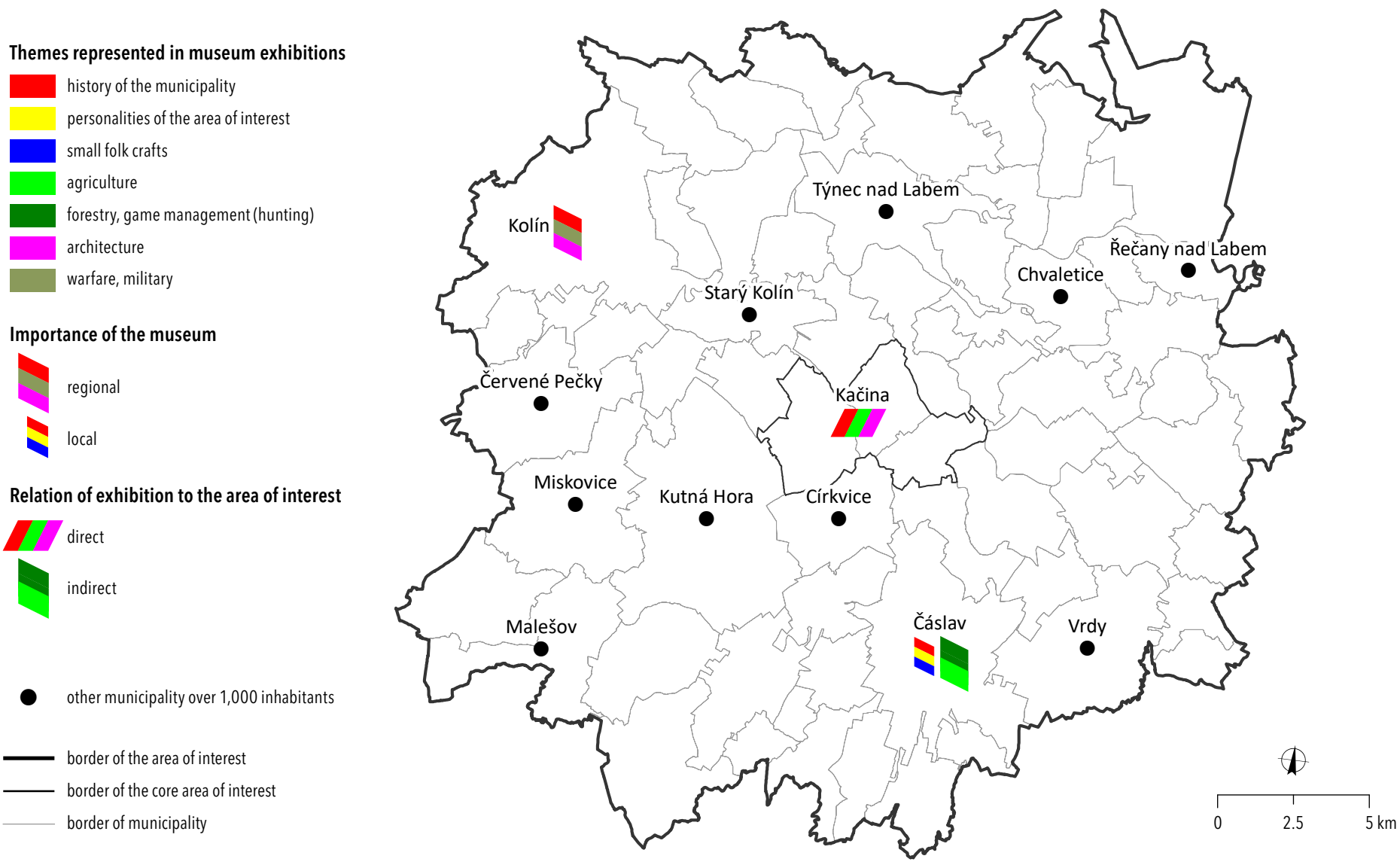


Fig. 13 – Museum exhibitions.
Data source: Czech Association of Museums and Galleries (https://www.cz-museums.cz/web/amg/titulni; as of 1 October, 2018), Webportal Do muzea (https://www.do-muzea.cz; as of 1 October, 2018), Webportal Museum.cz (https://www.museum.cz; as of 1 October, 2018).

the fact that the surrounding area has always been intensively farmed. Nowadays, agricultural function of the area of interest is complemented by the residential one. The castle as well as the English garden are open to the public and attracts visitors – thus, the area also has some recreation function.

Population number of the area has been declining over the past 140 years. Population had reached its peak around 1880. Until 1930 the decline was modest, probably influenced by the high production capacity of soils and the management of family farms. However, in the second half of the 20th century (in the socialist era) the number of inhabitants decreased significantly. The reasons included the intensification and mechanization of agriculture, a change in the administrative system, and the departure of people to work in the secondary sector (in factories in nearby towns). At the present time, the local population is only about 40% compared to late 19th century when the traditional rural society was at its heyday.

The Kačina model area has quite fertile soils. The official price of agricultural land varies between 8 and 10 CZK per square metre in the most fertile belt stretching from south-east to north-west (this part covers about one half of the area of interest). In the north-east, the land costs 4–6 CZK per sq. m, in the south less than 5 CZK per sq. m. (The average price on the national level is less than 4 CZK per sq. m.) The higher-than-average land prices in the area of interest reflect the fact that the area has rather good conditions for agriculture (both crop farming and animal husbandry). This also corresponds to the proportion of arable land on the total area, which has always been high (in average arable land covers more than 60% of the area), in some municipalities even exceeding 80% (such high values have been reached in the area of interest since 1896 to the present). In 1896, some cadastres had the smallest share of arable land around 40–45% (in the northeast and south of the area of interest). Nowadays the minimum share of arable land in some cadastres reached less than 20% of the land area. This development was mainly influenced by changes in the organization and structure of agricultural activities in the fertile areas in Czechia. At the same time, it should be emphasized that the data after 1990 does not always correspond with the situation in the field, because part of the abandoned arable land remained fallow and spontaneously overgrown with grasses and weeds. In such a way, so-called new wilderness comes to existence. At the national level, the share of unused arable land (2004) reached almost 500,000 hectares, today this value is approximately one fifth.

Due to the nature of the area of interest, the area of forest areas there is very different. Approximately half of the cadastres have a long-term share of forest areas below 10% of its area, in the north-east with lower-quality natural conditions (in terms of agricultural usability) four cadastres have a share of forest areas above 50% of the cadastre area. Nowadays, the forest cover in the Kačina model area (about 18% of its area) is still well below the national average (almost 34%).

3. Results

3.1 Landscape and Land Use/Cover Changes

Figure 3 and Table 1 show how the landscape looked like in the 1st half of the 19th century (1825) and compare it with the present state (2018).

Large tracts of the Kačina area were covered by permanent grassland in early 19th century. In 1845, the proportion of grassland was about 17.4% on the area of present-day Czechia. In the area of interest, however, grassland covered almost 28% of its area. At present, the situation is very different – grassland cover only a fraction of the model area (about 3%), while in Czechia as a whole the corresponding share is almost 13%. In early 19th century, water bodies formed important elements in the landscape. The aristocratic-style man-made landscape, which has originated in the vicinity of the Nové Dvory manor since 17th century and later was extended also to the surroundings of the Kačina Castle (early 19th century), was characterized by intricate landscaping (parks creating) and countryside roads lined with alleys. Many water features and small buildings have fallen into disrepair since mid-19th century.

The character of local landscape changed dramatically during the so-called socialist collectivization in the second half of the 20th century. At present, farming is important in the model area. The contemporary landscape is enlivened also by vineyards and orchards (the area of permanent crops increased by 2.2% from 1845 to the present).

3D landscape models of the area (Figure 4) covering the Kačina Castle with the adjacent preserve, the village of Svatý Mikuláš and the agricultural landscape between Svatý Mikuláš and Rohozec near Žehušice, complements the above-mentioned land use/cover changes. Comparison of 3D landscape models from early 1950s and 1990s clearly shows that fields have been merged into larger blocks, deterioration of the Kačina Castle Park and the adjoining preserve, as well as residential development in Nové Dvory and Svatý Mikuláš. Current orthophotomaps show the ongoing rehabilitation of the Kačina Castle Park.

Figures 6–9 show wider perspective of land use/cover changes in STUs and describe changes over the time by comparing years 1845, 1896, 1948, 1990, and 2010.

The index of change shows (Figure 9) that the most intensive land use/cover changes in the Kačina model area were taking place in the period 1845–1896. In that time, many ponds were drained, especially in the lowlands between the Klejnárka and Doubrava rivers. In between 1948 and 1990, a similar intensity of changes was recorded, but these were of different character and occurred in different areas, especially around the town of Kutná Hora (these are mainly changes related to urbanization processes). Taking into consideration the whole period 1845–2010, one can say that changes were quite intensive – in most municipalities, evidence of land use/cover change was recorded on at least 15% of its area.

3.2 Landscape Memory

The landscape memory of the Kačina area is shown in four maps (Figures 10–13) described in following sections 3.2.1–3.2.3 (for more details about methodology of mapping see Chapter 1 of Atlas).

3.2.1 Places and Institutions of Memory

The landscape around the Kačina Castle had a character of rural agricultural landscape until mid-19th century and the onset of industrialization. However, the immediate vicinity of the Kačina Castle was transformed into an aristocratic-style man-made landscape meeting contemporary aesthetic requirement. Nowadays, the castle hosts the exhibition of the Czech Countryside Museum, the branch of the National Museum of Agriculture (Figure 13) – its exhibition primarily focuses on the life in pre-industrial age when agriculture still was the crucial economic activity. The museum presents the history of rural life with special regard to the panství rodu Chotků (House of Chotek) in

the 19th century. It presents architecture, landscape, important personalities, and also the everyday lives of ordinary people. The second branch of National Museum of Agriculture – Museum of Agricultural Technology – is located in the nearby town of Čáslav. It shows machinery used in the past by farmers and in forestry. Čáslav also has the Municipal Museum with exhibitions focused on regional topics ranging from archaeology to natural science and ethnography. The exhibits related to the medieval town are especially interesting, including crafts from 13th to 17th centuries.

The last museum, which has some indirect links to the Kačina model area, is located in the town of Kolín. Different branches of the Regional Museum in Kolín can be found in a number of historic buildings throughout the town and provide visitors with information on medieval architecture.

3.2.2 Regional and Local Symbols

References of the Labe (Elbe) River and of fertile landscapes are the most common symbols used (pictured) in municipality emblems in the area (Figures 10 and 11). The Labe (Elbe) River is a dominant feature in emblems especially in the northern part of the area through which the river flows. Blue tincture (colour) is found in the municipality emblems of Bílé Podolí, Chvaletice, Kojice, Konárovice, Týnec nad Labem, and Záboří nad Labem. Stylized waves in blue or white, again representing the Labe (Elbe) River, form part of emblems of Kladruby nad Labem, Starý Kolín, and Tři Dvory. Alternatively, the river can be depicted also by corrugated bars (Labské Chrčice, Litošice, Řečany nad Labem). Emblems of Týnec nad Labem includes a bridge – another feature related to the Labe (Elbe) River.

Fertile soils are symbolized, for example, by golden mane (Konárovice) – it represents the so-called "Golden strip of the Labe". Similarly, the emblem of Litošice includes golden maiden hair. The golden colour as symbols for fertile soil and agricultural tradition is also present in emblems of Chotusice, Němčice, Trnávka, Úmonín, and Vlačice. Rural character of the landscape is represented by the green colour (Krakovany, Křesetice, Litošice, Ovčáry, Morašice, and Vlačice) and also by different agricultural symbols (ear of grain or scythe – Horka I, Křesetice, Žehušice).

Landscape around the Labe (Elbe) River is reflected also in the emblem of Vlačice (stork plus silver and green wavy logs – reference to local ponds and wetlands), and Záboří nad Labem (oak, acorn). Oak wreath placed on the head of a wild man refers to oak forests in the emblem of Bílé Podolí. The symbol of Vrdy includes willow rods – these trees are common along the banks of the Doubrava River. Linden (again, typical tree of the area) can be found in the emblem of Úmonín.

3.2.3 Heritage Sites

The Kačina Castle, which has the status of National Cultural Monument, is the most important cultural monument in the area of interest (Figure 12). The area surrounding the castle has a great historical importance, too. Jan Rudolf Chotek, the supreme burgrave of the Bohemian Kingdom, had the castle built in pure Empire style. The design was carried out by Dresden architect Christian Franz Schuricht.

Nové Dvory, located near Kačina, has several cultural monuments including the local castle, the St. Martin's church, the Dominican monastery with the St. Anne's church, and the Holy Cross burial chapel (of Chotek family). The manor house in Nové Dvory used to be a listed monument until 1984. However, the original structure had been badly affected by modern modifications and therefore it was stripped of the protection. The nearby village of Rohozec has two religion monuments – the Church of Mary Magdalene and a small chapel. There are many more churches that are protected throughout the area. Most of them enjoy legal protection since 1950s.

4. Summary

The Kačina model area is located in the fertile lowlands of the Labe (Elbe) River, near the major socio-economic axis Prague–Kolín–Pardubice. Intensive farming prevails in the area. Aristocratic-style man-made landscape has originated around the Kačina Castle since late 17th century. In the 19th century, however, this great landscape complex gradually deteriorated. Major land use/cover changes occurred in the second half of the 20th century when socialist-style collectivization and agricultural intensification arrived. Many centuries old roads disappeared, small fields were merged into large blocks. Thus, many elements of the aristocratic-style man-made landscape disappeared or became less visible in the landscape.

Almost one half of the area has experienced some kind of land use/cover change since the middle of the 19th century. The other half remained more or less stable in terms of land cover. The vast majority of "stable" areas are covered by arable land. Shift towards a more intensive land use/cover was significant – large tracts of former permanent grassland were converted into arable land and the same applies to former ponds. In some parts of the area, with less fertile sandy soils, the opposite process of agricultural extensification was taking place – agricultural land was replaced by forests.

Meadows, wetlands, and forests are the most important biotopes in terms of biodiversity. Some original meadows have survived in the Kačina Preserve. Most species that require wet environment or slightly saline soils have disappeared. The original meadow habitats were altered by farming – succession and general eutrophication was taking place in the landscape.

In the surroundings of the Kačina area, forests have expanded since mid-19th century. Rejuvenation of heart-lime and expansion of rather mesophilic shrubs indicate a gradual change in the character of forest vegetation towards oak and hornbeam forests. Patches of original riparian forests, with massive old oaks, survived in the floodplains. Scattered thickets form important landscape elements – these are often found along rivers, creeks, and roads.

The Žehušicko Landscape Conservation Zone was established in 1996 due to high aesthetic values of the local landscape and well-preserved traces of the aristocratic-style man-made aristocratic landscape.

Extensive rehabilitation of the Kačina Preserve was carried out in the period 2011–2013. It was chiefly intended to recreate the landscape around the castle as it had looked like in early 19th century. This process, however, did not affect the area beyond the preserve, which is under intensive farming.

Acknowlegment

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References and Data Sources

BALATKA, B., KALVODA, J. (2006): Geomorfologické členění reliéfu Čech. Kartografie, Praha.

DEMEK, J. (ed.) a kol. (1987): Zeměpisný lexikon ČSR. Hory a nížiny. Academia, Praha.

NEUHÄUSLOVÁ, Z., MORAVEC, J. (eds.) a kol. (1997): Mapa potenciální přirozené vegetace České republiky. Map of potential natural vegetation of the Czech Republic. Kartografie, Praha.

PLÍVA, K., ŽLÁBEK, I. (1986): Přírodní lesní oblasti ČSR. SZN, Praha.

QUITT, E. (2009): Klimatické oblasti. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SEDLÁČEK, J., JANDERKOVÁ, J., ŠEFRNA, L. (2009): Půdní asociace. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SKALICKÝ, V. et al. (2009): Fytogeografické členění. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

Archive Maps of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK), Central Archive of Surveying and Cadastre. https://archivnimapy.cuzk.cz/uazk/pohledy/archiv.html (1. 10. 2019).

Czech Association of Museums and Galleries (Asociace muzeí a galerií České republiky). https://www.cz-museums.cz/web/amg/titulni (1. 10. 2019).

Do muzea. https://www.do-muzea.cz (1. 10. 2019).

eKatalog BPEJ. https://bpej.vumop.cz/ (1. 10. 2019)

Geologická mapa ČR 1 : 50 000. https://mapy.geology.cz/geocr50/ (1. 10. 2019).

Geoportal of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK). https://geoportal.cuzk.cz/ (1. 10. 2019).

Land Use Land Cover Czechia Database. https://www.lucccz.cz/databaze/ (1. 10. 2019).

Museum.cz. https://www.museum.cz/ (1. 10. 2019).

National Heritage Monument Catalogue, The National Heritage Institute (Národní památkový ústav – NPÚ). https://pamatkovykatalog.cz/ (1. 10. 2019).

Portál informačního systému ochrany přírody. http://webgis.nature.cz/mapomat/ (1. 10. 2019).

Půdní mapa ČR 1 : 50 000. https://mapy.geology.cz/pudy/ (1. 10. 2019).

Register of communal symbols (Registr komunálních symbolů), Chamber of Deputies of the Czech Republic. https://rekos.psp.cz (1. 10. 2019).

Ústřední seznam ochrany přírody. http://drusop.nature.cz/ (1. 10. 2019).

CHAPTER 4

Krkonoše: Disappeared Landscape of Mountain Farming

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1. Introduction

The Krkonoše Mountains (known also as The Giant Mountains) have been a traditional area of mountain farming in the past centuries. Of the mountains in Czechia, the Krkonoše Mountains have always had less arable land, therefore pastoralism and forestry are traditionally very widespread. Industry developed in the valley settlements, and activities related to tourism have long history in the area.

Since the 16th century, higher mountain locations above the tree line (edge of the habitat at which trees are capable of growing) have been used for seasonal mountain pastoralism, which represented an analogy of alpine pastoralism adapted to local conditions. Experiences with mountain pasture were brought to the Krkonoše Mountains by the colonists, who were called in here as lumberjacks from Alpine countries. They developed pastoralism, mainly cattle grazing, on forest-free areas. Since the 17th century, but mostly in the 18th century, summer mountain huts were built (e.g. the Dvoračky, the Martinova bouda, huts in Rokytno, and many others). Most of them appeared at an altitude of 1,000–1,300 metres a.s.l. The mountain huts were used not only for grazing, but also for harvesting of hay.

The decline and disappearance of mountain pastoralism occurred in the middle of the 19th century in connection with the prohibition of grazing in the forest (1866) and the ban on grazing above the tree line (1897). At the end of the 19th century, it was decided to plant mountain pines to prevent avalanches from falling. Occasional mowing and harvesting of hay, which was still common during the First Czechoslovak Republic period (1918–1938), was maintained longer than the pastoralism. Mountain huts have been transformed into holiday cottages for summer and winter tourism, many of them also disappeared. The expulsion of the original Czech German population immediately after World War II (1945–1946) and the proclamation of the Krkonoše Mountains National Park (1963) contributed to the complete cessation of agricultural use of the Krkonoše Mountains.

The change of the Krkonoše Mountains landscape can be characterized as follows:

A. The original natural forest landscape with subalpine vegetation in the highest altitudes above the tree line changed from

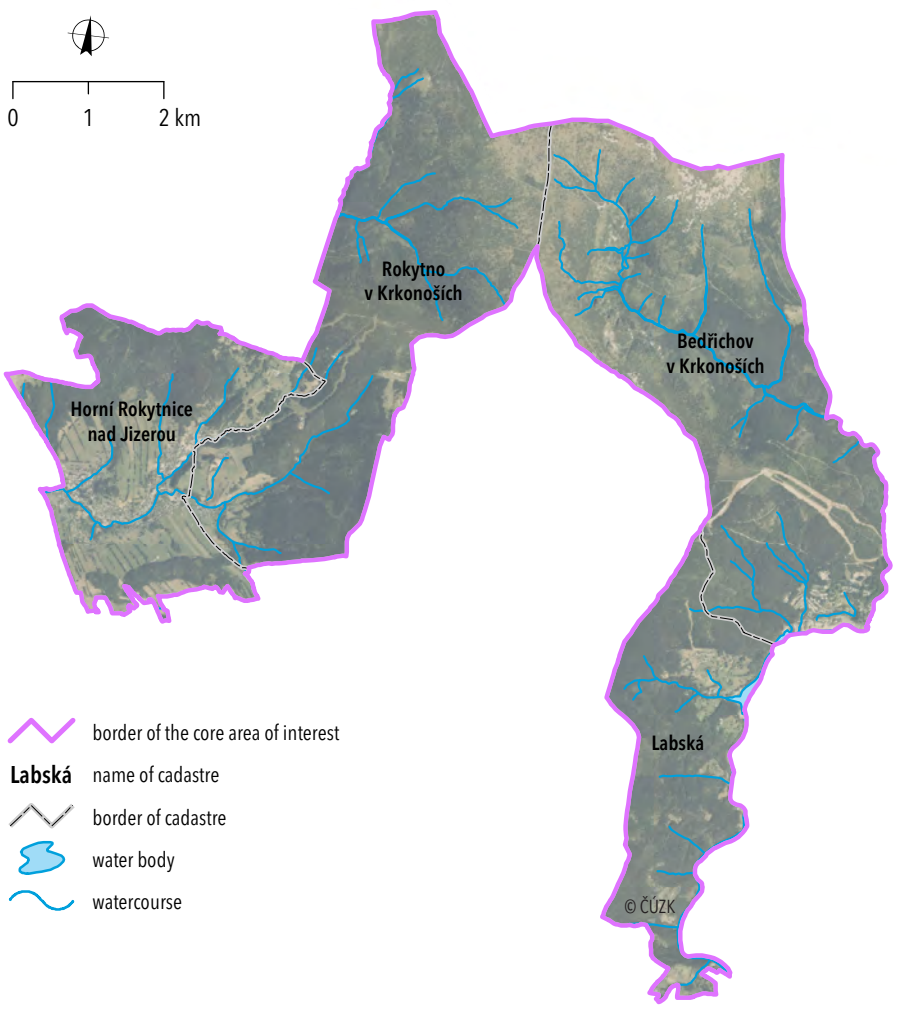


Fig. 1 – The core area of interest. Map basis: Data50; Orthophoto © The State Administration of Land Surveying and Cadastre, 2019.

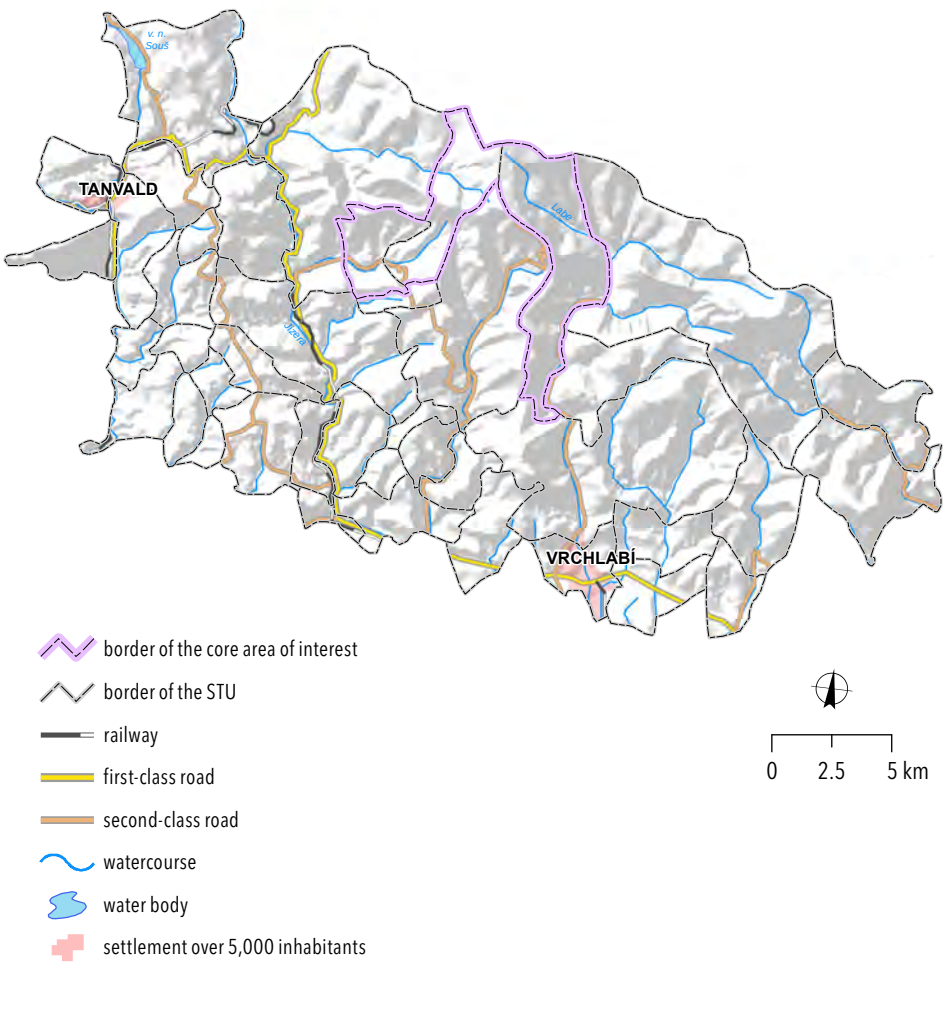


Fig. 2 – The wider area of interest. Map basis: Data50.

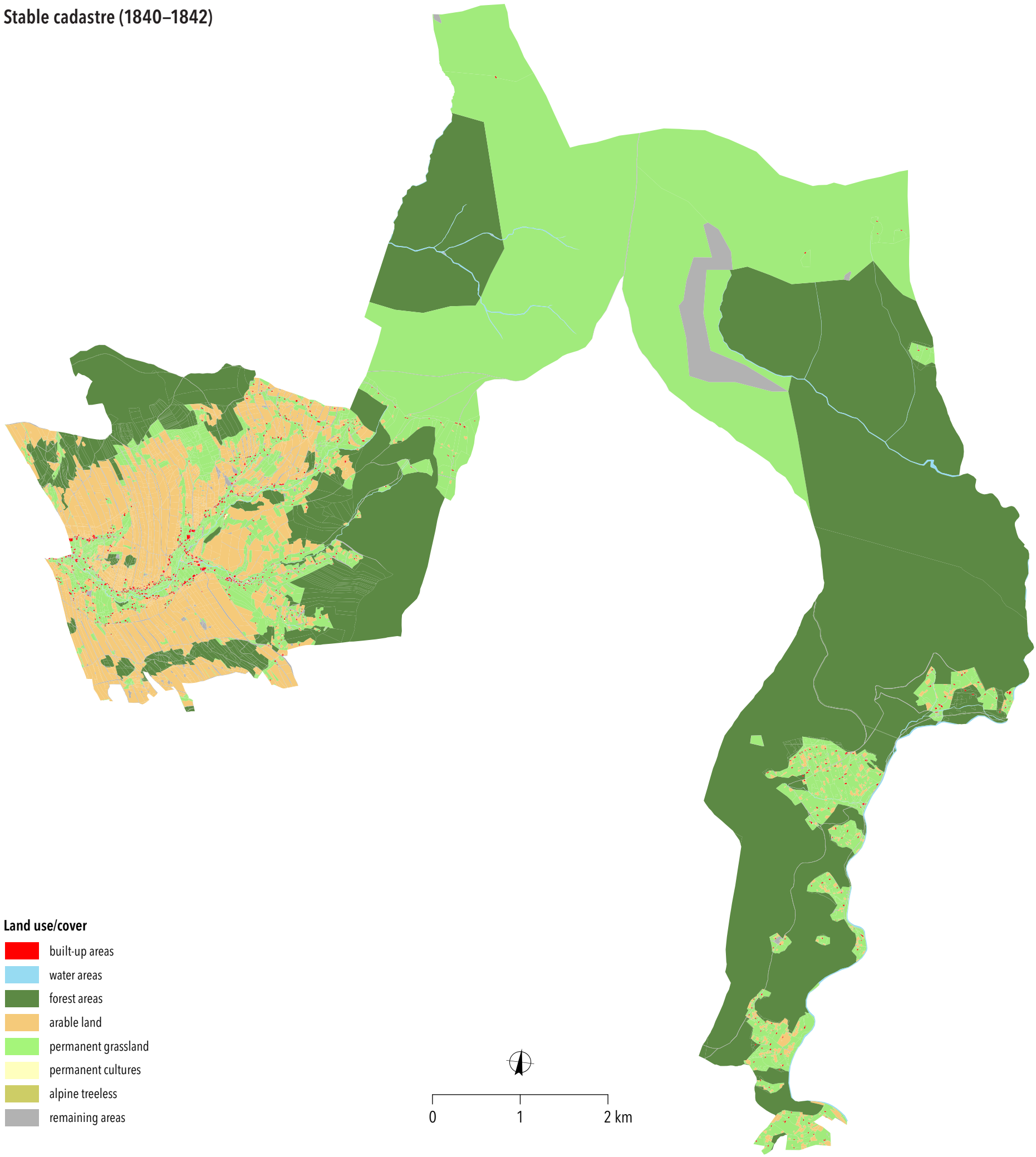
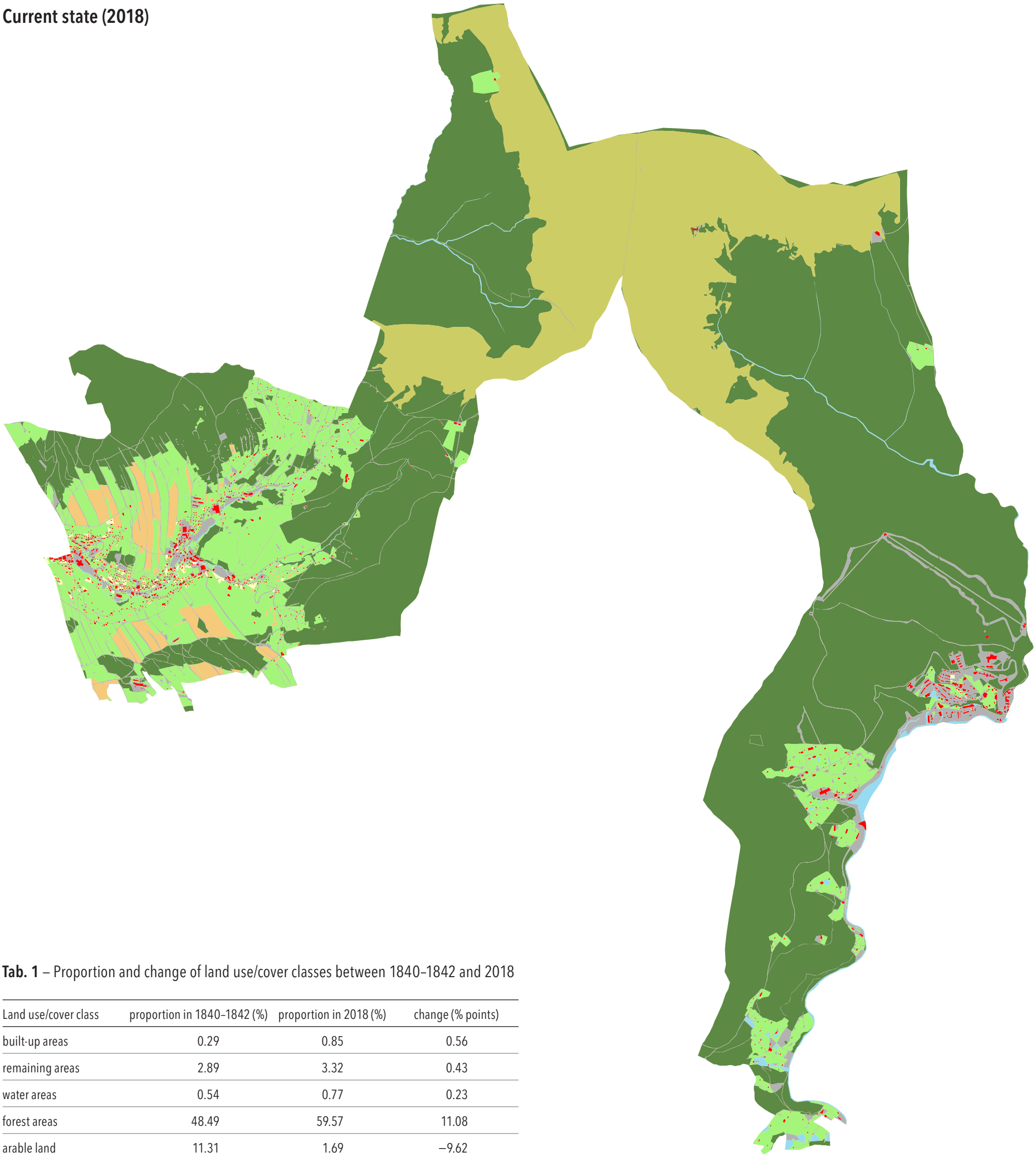


Fig. 3 – Land use/cover in cadastres Horní Rokytnice nad Jizerou, Rokytno v Krkonoších, Bedřichov v Krkonoších and Labská in 1840–1842 and 2018. Map basis: The State Administration of Land Surveying and Cadastre.

Current state (2018)



Tab. 1 – Proportion and change of land use/cover classes between 1840–1842 and 2018

Land use/cover class	proportion in 1840–1842 (%)	proportion in 2018 (%)	change (% points)
built-up areas	0.29	0.85	0.56
remaining areas	2.89	3.32	0.43
water areas	0.54	0.77	0.23
forest areas	48.49	59.57	11.08
arable land	11.31	1.69	−9.62
permanent grassland	36.47	13.58	−22.89
permanent cultures	0.01	0.17	0.16
alpine treeless	0.00	20.05	20.05

the 16th to the 18th century into the landscape of mountain farming (tillage and pastoralism, in higher altitudes exclusively pastoralism), with a high proportion of forest;

B. mountain farming and deforestation peaked in the 18th century and mid-19th century; since the middle of the 19th century there has been a decline in mountain farming, arable land and grassland decline, the share of forests has increased, the function of the landscape has changed from the productive forest and agricultural landscape to the recreational landscape;
C. tourism and sport prevail in the present landscape and its nature protection is important.

For the purposes of this project, the so-called core area has been delimited and most analyses are carried out in this core area (Figure 1). It includes the municipal areas of Horní Rokytnice nad Jizerou, Rokytno, and Bedřichov v Krkonoších. The wider area of interest (see Chapter 1 of Atlas for more details) is shown in Figure 2.

2. Area of Interest: Main Features

The Krkonoše area of interest is part of the geomorphological unit of the Krkonoše, which is the highest mountain range in Czechia. Geological bedrock consists mostly of metamorphic rocks, only the highest positions of the ridge (close to the Czech-Polish state border) are built of deep igneous rocks. Quaternary coverings consist mainly of slopes with a high proportion of rough skeleton, steep slopes and exposed mountain lands, stone debris, blockfields and block streams.

The relief of the highest Czech mountain range typologically corresponds to a highland with an altitude difference of 450–600 m, exceptionally up to a high mountain. The elevation of the core area ranges between 500–1,509 m a.s.l. The relief of the mountain range contains remnants of flattened surfaces in the top parts of the border and inner ridge, while the southern slopes are intensely disaggregated by deep erosive cuts of slope streams. Numerous glacial and periglacial relief forms, such as karsts, structural soils, isolated rocks and rock walls, occur at high altitudes of the range. The relief is generally very rugged and sloping (slopes inclined 10–25° dominate, steep slopes inclined more than 25° are no exception).

The Krkonoše model area lies in a cold to a very cold climatic area rich in precipitation. The average annual temperature drops with altitude (from 6 °C in the Jizera River valley to 1–2 °C on the ridges of the Krkonoše Mountains above the tree line). The average annual precipitation also varies depending on altitude and exposure to prevailing winds from 800 to 1,300 mm. Winter is characterized by permanent snow cover. However, the duration of snow cover varies greatly depending on altitude and slope exposure and ranges from 90 to 150 days per year.

The area lies in the phytogeographical area of the Czech Oreophyticum (mountain flora area), specifically the phytogeographical district of the Krkonoše Mountains). In the Krkonoše Mountains, there are 5 forest vegetation levels (according to altitude) – fir-beech, spruce-beech, beech-spruce, spruce, and mountain pine. Potential natural vegetation is formed by the beech, spruce beech, climax spruce and altogether a complex of mountain pine and alpine vegetation above the tree line, which lies at the average altitude of 1,250–1,300 m a.s.l. On the flattened surface in the spring areas of the Labe (Elbe) and Úpa rivers, areas of mountain bogs can be found.

Cultivated spruce monocultures predominate in the current vegetation cover. A mixed forest with beech is rare. Arable land, which was an integral part of mountain farming in the area in the past, is no longer to be found here. Non-forest areas mainly consist of permanent grassland, which mostly lost their production function. These grasslands are cut as part of landscape maintenance and are used for skiing in winter, only to a small extent they are used as pastures. Pasture above the tree-line of the Krkonoše Mountains peaks ceased long ago – these localities have been gradually overgrown by mountain pines or stunted spruce trees. Nevertheless, significant and vast areas of forest-free subalpine meadows are maintained especially on the peaks of the ridges. The forest-free area is also maintained on avalanche tracks, rocky outcrops, karst walls, blockfields and wet areas of mountain bogs. Recreational areas of ski resorts are constantly expanding.

The model area is part of the Krkonoše Mountains National Park, the oldest and most important national park in Czechia of international importance. The most valuable localities are those in the first zone of the national park in the subalpine zone above the tree line (the so-called Krkonoše Mountains tundra).

The Krkonoše area of interest has mostly peripheral location with a low density of transport lines of national importance. However, the peripheral position and relief (from 500 m a.s.l. to 1,300 m a.s.l.) are an advantage from the viewpoint of the prevailing recreation and sports functions on most of the model area. In the area of interest, fundamental change in the number of residents and the disappearance of mountain farming occurred. Along with the increase in the number of visitors, water requirements grew and problems with waste disposal increased. Ski lifts, cable cars and other technical facilities were built to ensure the recreational function. This has created demands for the construction of new and reconstruction of existing access roads, parking lots and a wide range of service facilities. Land use/cover in the Krkonoše Mountains, and thus its landscape, has completely changed.

About 75% of the area of interest has an agricultural land with a value below 1.1 CZK per square metre. Even the rest of the area has an official price of agricultural land fund far below the profitability limit of agricultural management. In addition, the area of agricultural land in this area is very low in all cadastres and consists mainly of permanent grassland. If there are agricultural farms, their focus is clearly on cattle grazing and hay production. Throughout the model area, a high proportion of forest areas has been increasing since 1896.

The Krkonoše Mountains area of interest is characterized by a fundamental change in its functions during the monitored years. In traditional society, the function was residential and productive (agriculture and forestry). At present, the key functions are environmental protection (the Krkonoše Mountains National Park and Protected Landscape Area), water management and recreation and the original functions diminished or mostly disappeared. In the past, this model area was relatively overpopulated, so the population worked hard to maintain their livelihood through agriculture even in very inhospitable conditions. At present, there is a significantly smaller number of residents living in the area and the overall focus of the area is determined primarily by the needs of tourists and holidaymakers. Various sources mention around 10 million visitors a year in the Krkonoše Mountains per year, which, due to the size of the protected landscape area or the national park, represents a significant threat to its environment. It can be assumed that in the future the current focus of residential and recreational functions in this area will rather strengthen while environmental functions will be threatened.

1936

1953

2018

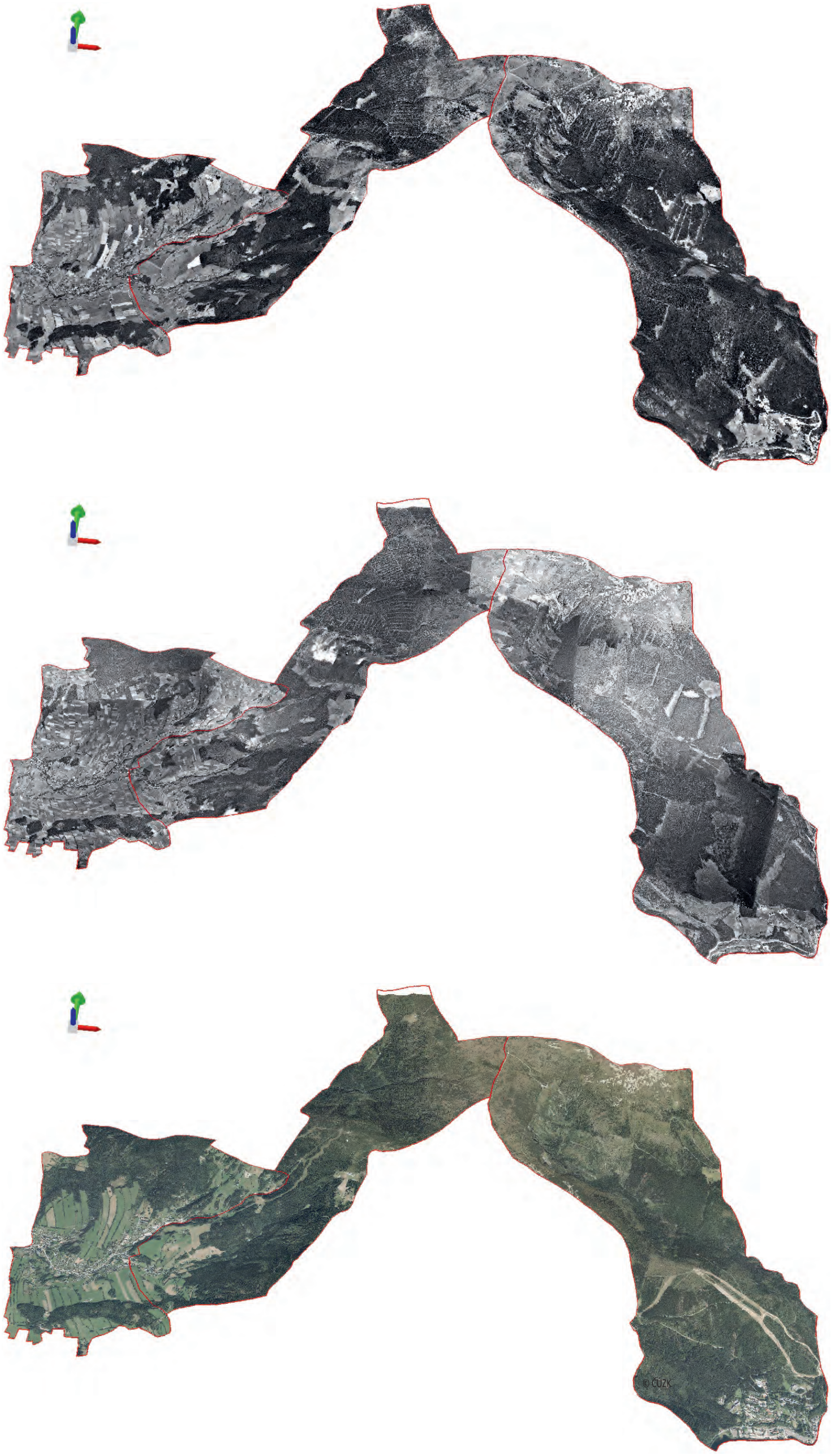


Fig. 4 – Models of landscape – Krkonoše in 1936, 1953 and 2018. Source: Aerial photos © Military Geographical and Hydrometeorological Office in Dobruška, Ministry of Defence, 2018; Orthophoto © The State Administration of Land Surveying and Cadastre, 2018.

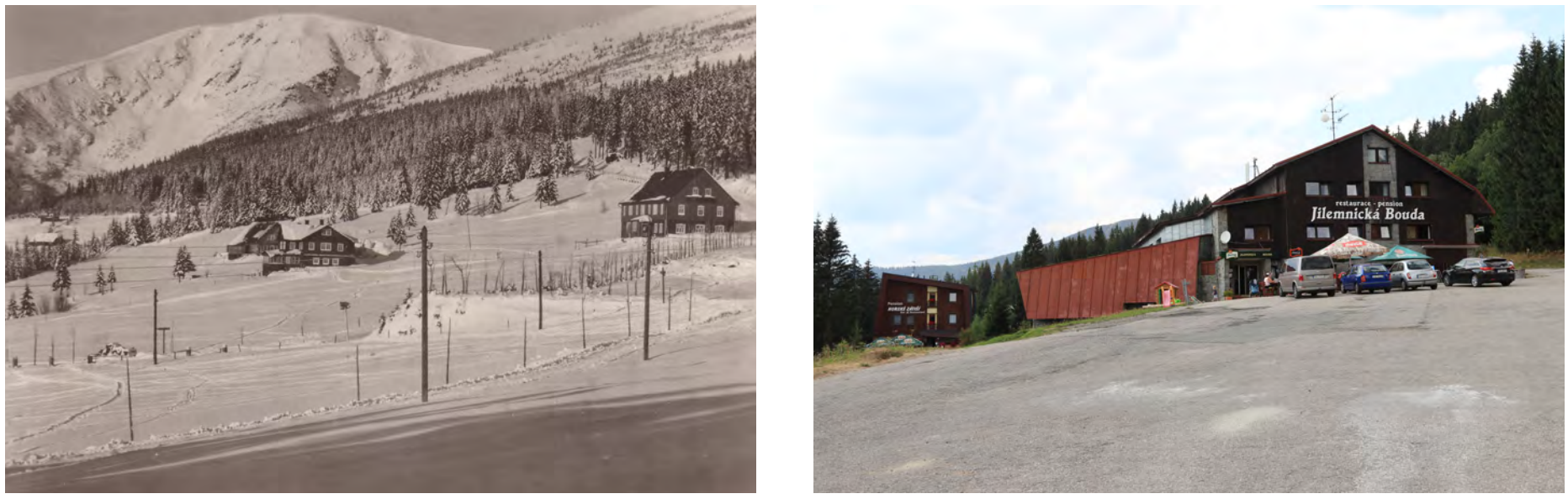


Fig. 5a – Horní Mísečky with Kotel in the background. Source: Archive of the NAKI project no. DG18P02OVV008. Photo (2018): Zdeněk Kučera.

Fig. 5b – Labská Bouda. Source: Archive of the NAKI project no. DG18P02OVV008. Photo (2018): Zdeněk Boudný.

3. Results

3.1 Landscape and Land Use/Cover Changes

Figure 3 and Table 1 compare how the landscape looked like in the 1st half of the 19th century (1840) and its state at the present (2018).

The landscape of mountain farming in the Krkonoše Mountains has changed significantly since 1840. The changes led to an extensification and overall decline or disappearance of agricultural function. Arable land, which in the period of stable cadastre covered a small area, but e.g. in Horní Rokytnice could be found also on steep slopes in higher altitudes, until 2018 practically disappeared. In Horní Rokytnice it was replaced by permanent grassland, the area of the forest increased. In Rokytno and Bedřichov, the situation was different, as farming was completely discontinued, and forests expanded. In some places (zone I of the Krkonoše Mountains National Park) in accordance with the Nature Protection Act, non-intervention areas have been defined (they are left to spontaneous development without any management activities). Forests in large areas prevail at the present time, and in the highest parts (above the tree line from about 1,300 m a.s.l.), where previously farming (especially grazing) was commonly practiced, there is a non-intervention zone – a rare relict arctic-alpine tundra with mountain pine, herbaceous communities, lichens, mosses, peat bogs and springs, glacial karsts and rocks (also called as an alpine forest-free zone).

The original mountain agricultural landscape on the ridges of the Krkonoše Mountains is disappeared, but speculations about the suitability of farming in these areas continue until nowadays. Despite the absence of detailed knowledge about the state of nature during the era of intensive farming (say, for example, 100 years ago), it is supposed that the biodiversity was higher than it is today. However, is the (undocumented) decline in biodiversity at present related predominantly to the lack of management? And is such a decline necessarily a negative phenomenon? For example, by comparing aerial photographs from the 1930s with hundreds of contemporary ones, one can see huge changes in the landscape of the Krkonoše Mountains ridges (and of course not only of them). On those pre-war photographs, areas where mowing (grazing was already quite marginal affair) are commonly found. Significantly lower occurrence of mountain pines is interesting, and on the other hand, you can see a greater degree of disturbance in the form of dense network of roads.

The above-described land use/cover changes are complemented by the 3D landscape models of the area of interest (Figure 4). The models show changes in the landscape, such as the development of built-up areas (Bedřichov, Horní Rokytnice) associated with recreational use of the area, including the development of winter sport resorts (Medvědín, Lysá Hora). Significant changes of the landscape structure are visible especially between 1936 and the 1950s. Extensification of landscape management is also reflected in a significant increase of forest area,

Fig. 5c – Centre of Špindlerův Mlýn. Source: Archive of the NAKI project no. DG18P02OVV008. Photo (2018): Zdeněk Boudný.

Fig. 5d – Svatý Petr. Source: Archive of the NAKI project no. DG18P02OVV008. Photo (2018): Zdeněk Boudný.

mainly in the northern part of Horní Rokytnice nad Jizerou. There are also noticeable changes in afforestation at the expense of grassed areas, forest regeneration (Bedřichov) and spreading of the mountain pine in the top parts of the depicted area.

Figures 6–9 show wider perspective of land use/cover changes in STUs and describe changes over the time by comparing years 1845, 1896, 1948, 1990, and 2010.

In the years 1845, 1896 and 1948, the share of arable land in the southern part of the area was above 40%, the displacement of Czech Germans, and the loss of an opportunity to farm individually led to a large decrease in the share of arable land in 1990, and this decline is also recorded in 2010. Agricultural function of the area has significantly weakened. Agriculture was replaced by recreational functions within most settlements in the area.

Between 1845 and 1896, the change index was the lowest. The highest changes occurred at the border area at the highest altitude. In 1990–2010 period, land use/cover changes were also negligible. The changes in land use/cover were highest in the period 1845–2010 due to the fundamental change of functions of the area. The landscape in valleys and foothills changed the most, where the agricultural-residential function was replaced by recreational, service and residential functions, with a significantly lower number of permanent residents.

3.2 Landscape Memory

The landscape memory of the Krkonoše area of interest is shown in four maps described in following sections 3.2.1–3.2.3 (for more details about methodology of mapping see Chapter 1 of Atlas).

3.2.1 Places and Institutions of Memory

The Krkonoše Mountains are presented by 12 museums, respectively museum expositions. Four of them are located outside the area of interest but are among the most important institutions which represent the area. These are the Krkonoše Museum in Vrchlabí, the Krkonoše Museum in Jilemnice and the Podkrkonoší Museum in Trutnov. Museums focusing on the Krkonoše Mountains aim mostly on traditional expositions on the history of municipalities in the area, agriculture, forestry and traditional folk crafts. The disappeared landscape of mountain farming and the typical architecture of rural and agricultural buildings are shown by 9 institutions in its collections. Making products of flax and skiing belongs also to important topics related with the Krkonoše Mountain area – these are addressed by institutions in Vrchlabí, Jilemnice and Vysoké nad Jizerou. Mining, as another typical historical aspect of the Krkonoše Mountains, is presented in two specialized museums (in Černý Důl and Harrachov) and marginally in the Municipal Museum in Žacléř.

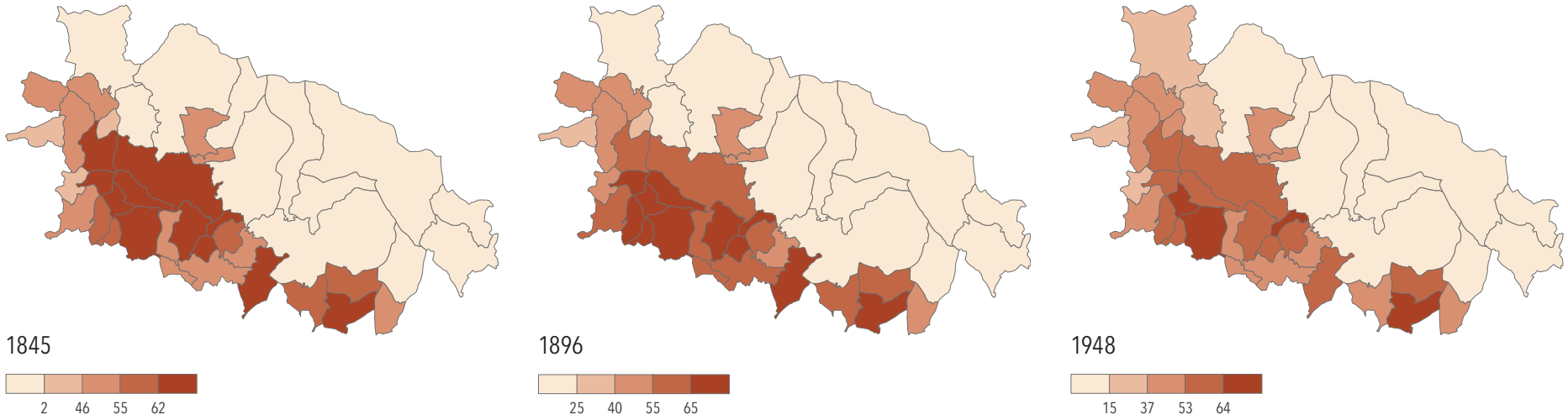


Fig. 6 – Proportion of arable land by STUs (% of STU area). Source: LUCC Czechia Database.

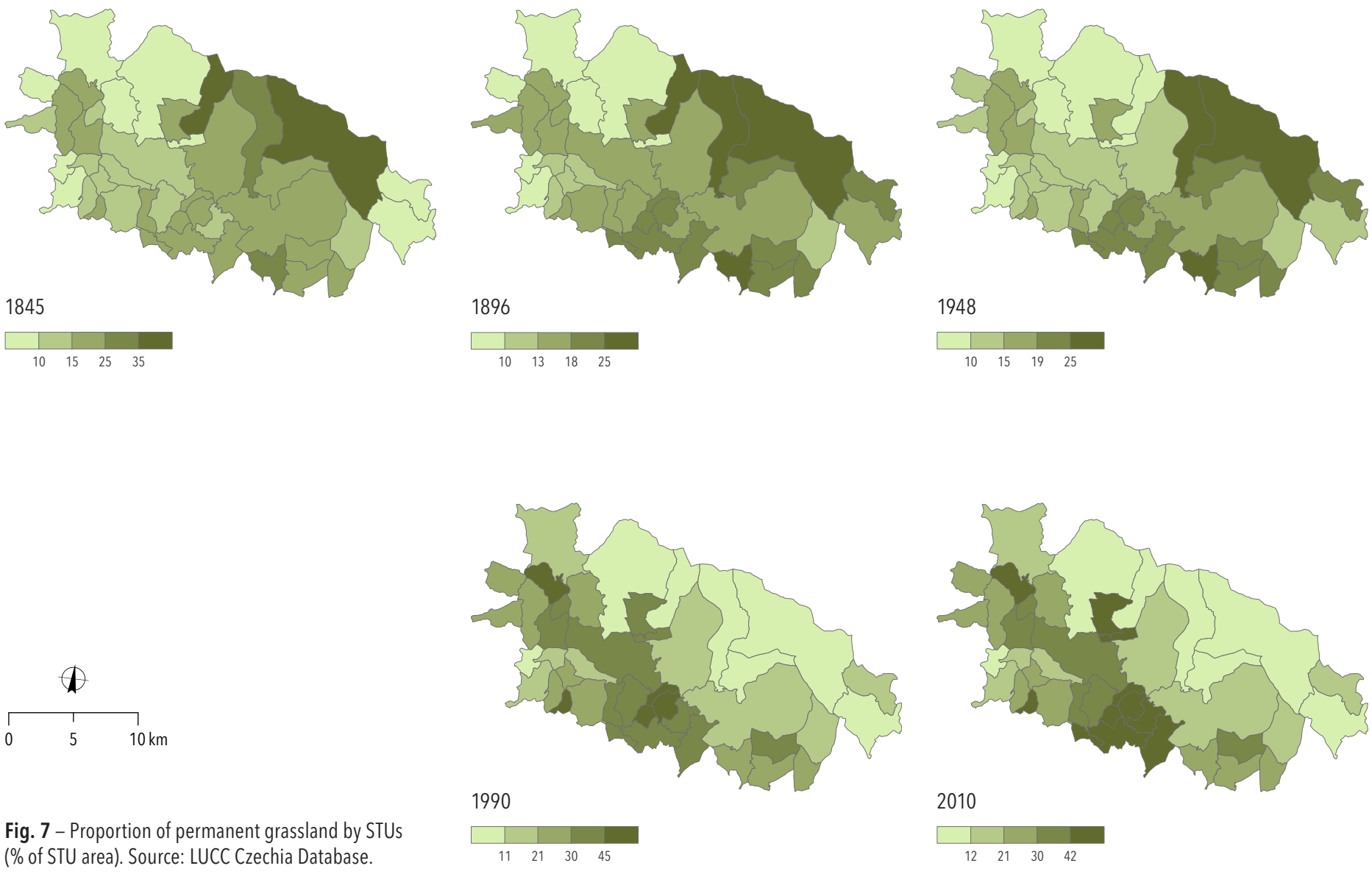


Fig. 7 – Proportion of permanent grassland by STUs (% of STU area). Source: LUCC Czechia Database.

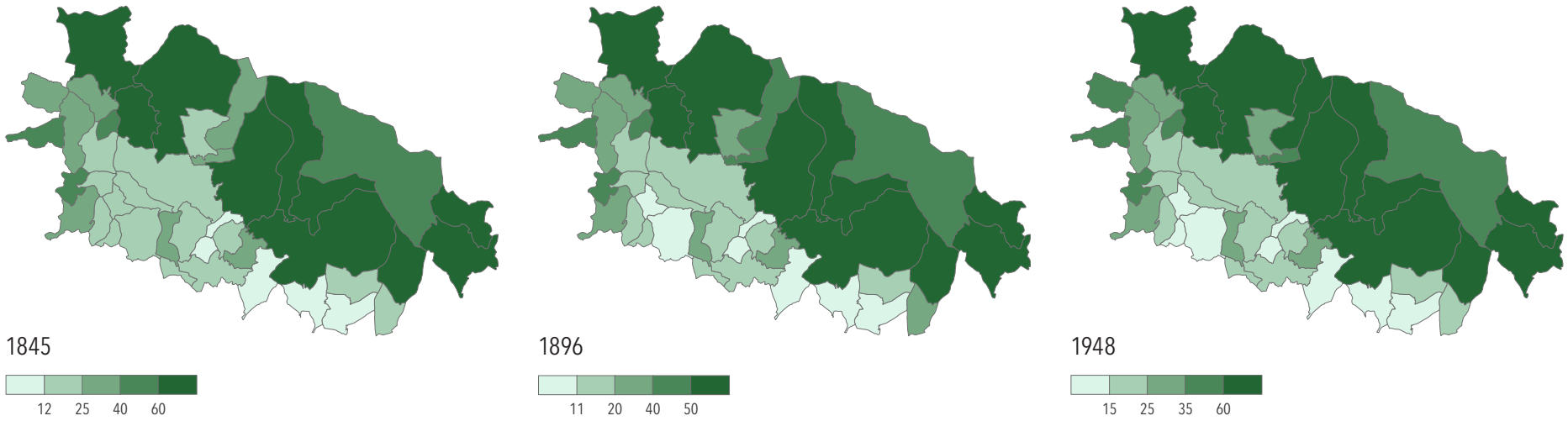


Fig. 8 – Proportion of forest areas by STUs (% of STU area). Source: LUCC Czechia Database.

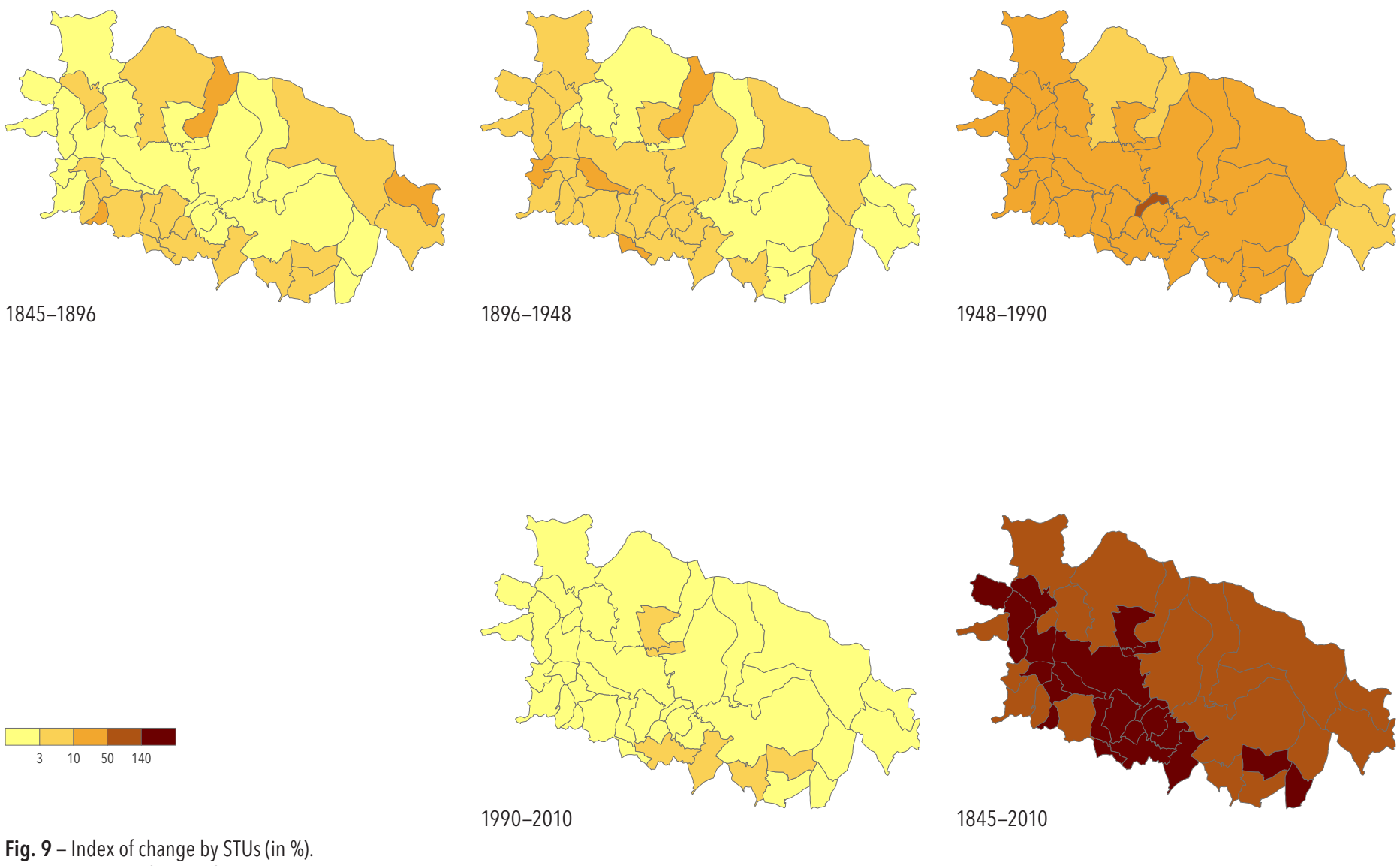


Fig. 9 – Index of change by STUs (in %). Source: LUCC Czechia Database.

Fig. 10 – Municipality emblems.
Source: Register of municipal symbols, Chamber of Deputies of the Czech Republic (https://rekos.psp.cz; as of 1 October, 2018).

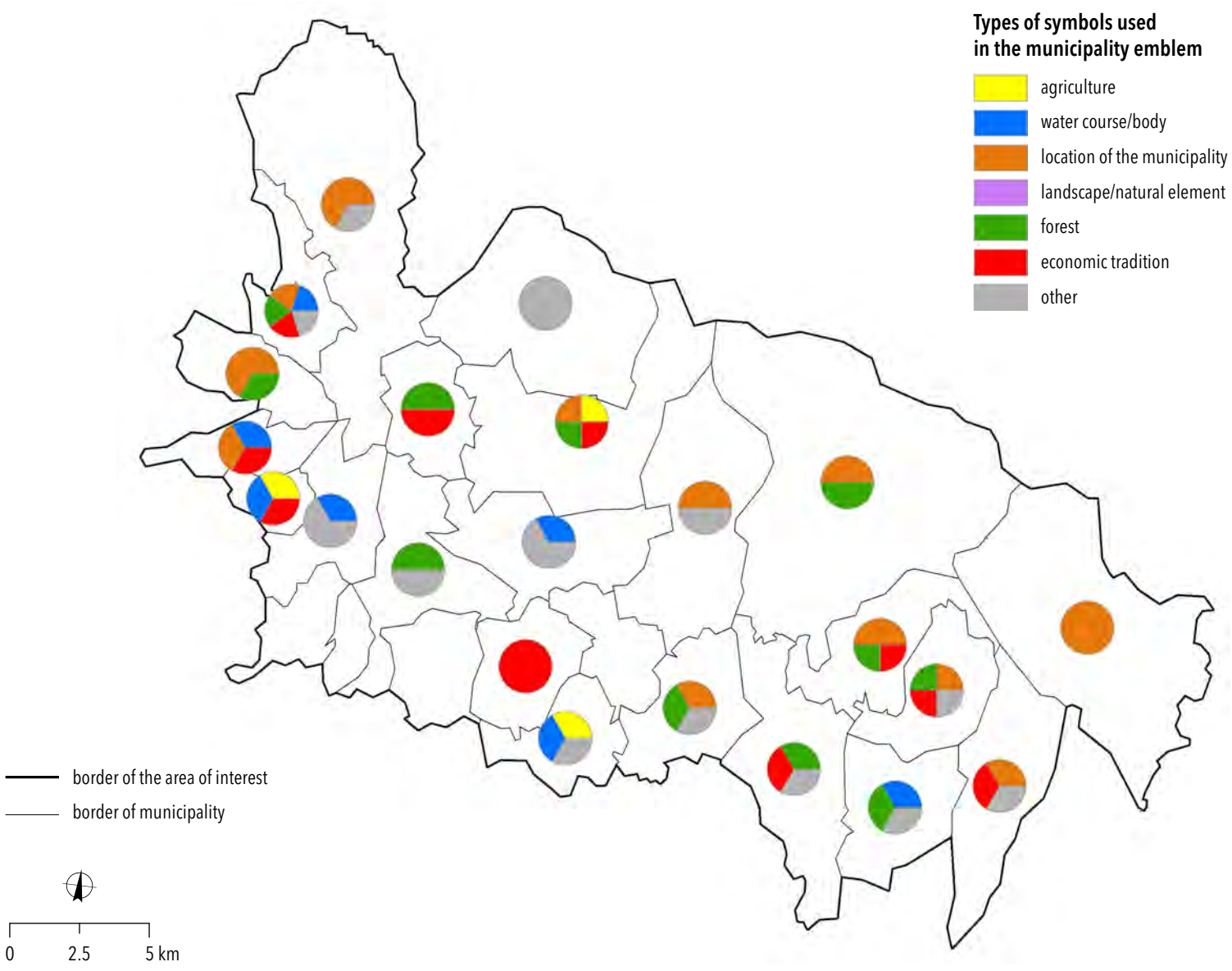


Fig. 11 – Types of symbols used in the municipality emblems.
Data source: Contant analysis of the municipality emblems (as of 1 October, 2018).

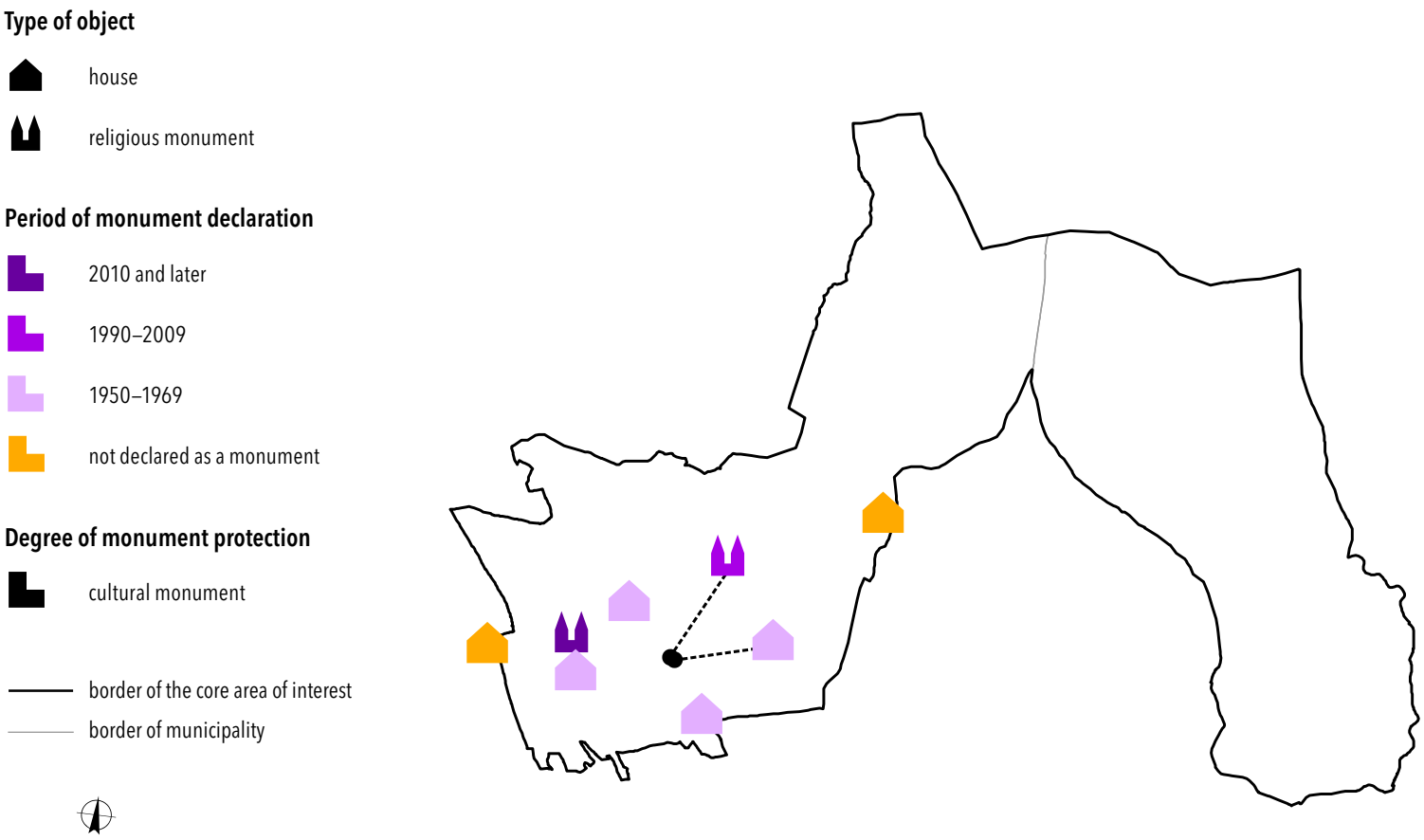


Fig. 12 – Cultural monuments and heritage areas.
Data source: National Heritage Monument Catalogue, National Heritage Institute (https://pamatkovykatalog.cz; as of 1 October, 2018).

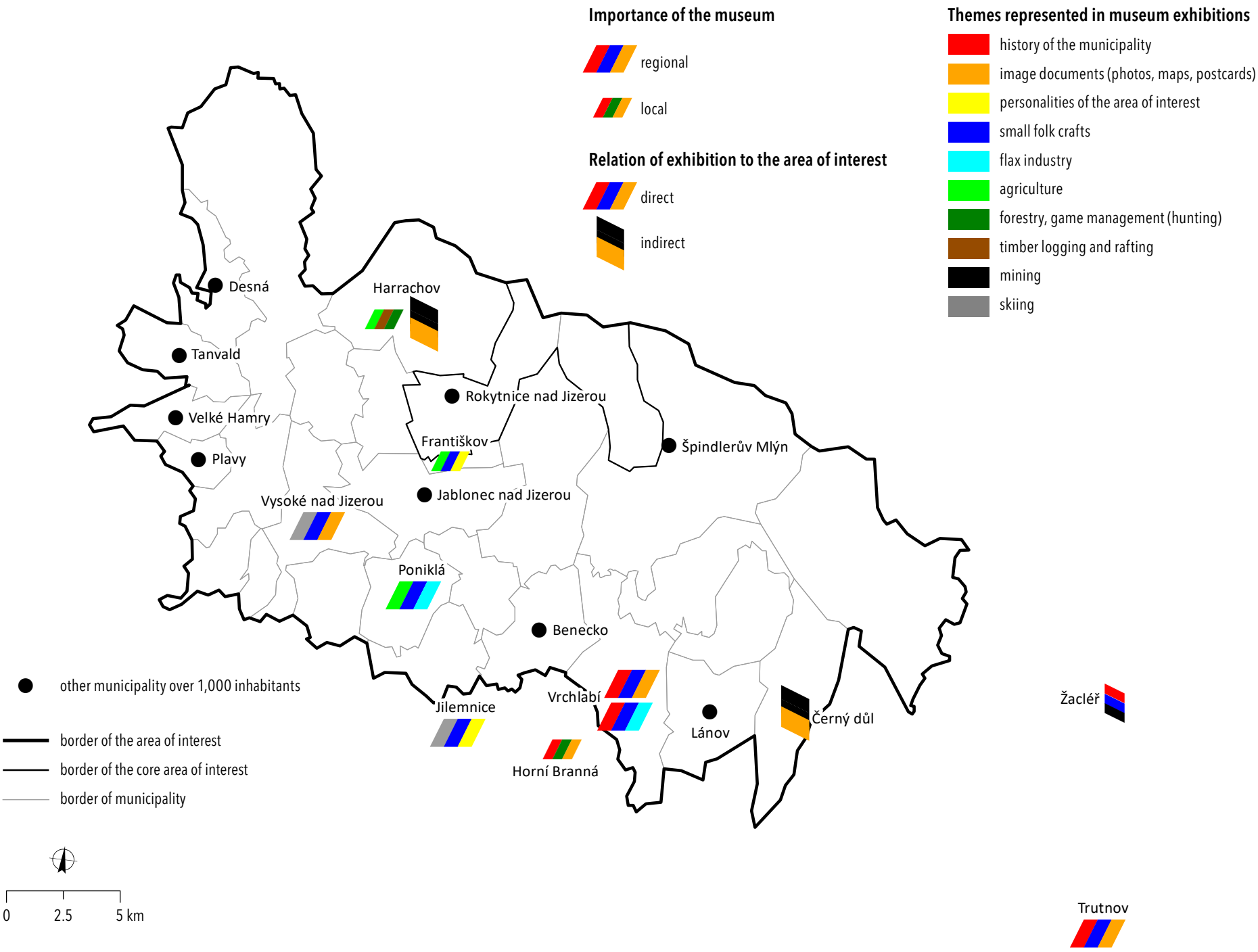


Fig. 13 – Museum exhibitions.
Data source: Czech Association of Museums and Galleries (https://www.cz-museums.cz/web/amg/titulni; as of 1 October, 2018), Webportal Do muzea (https://www.do-muzea.cz; as of 1 October, 2018), Webportal Museum.cz (https://www.museum.cz; as of 1 October, 2018).

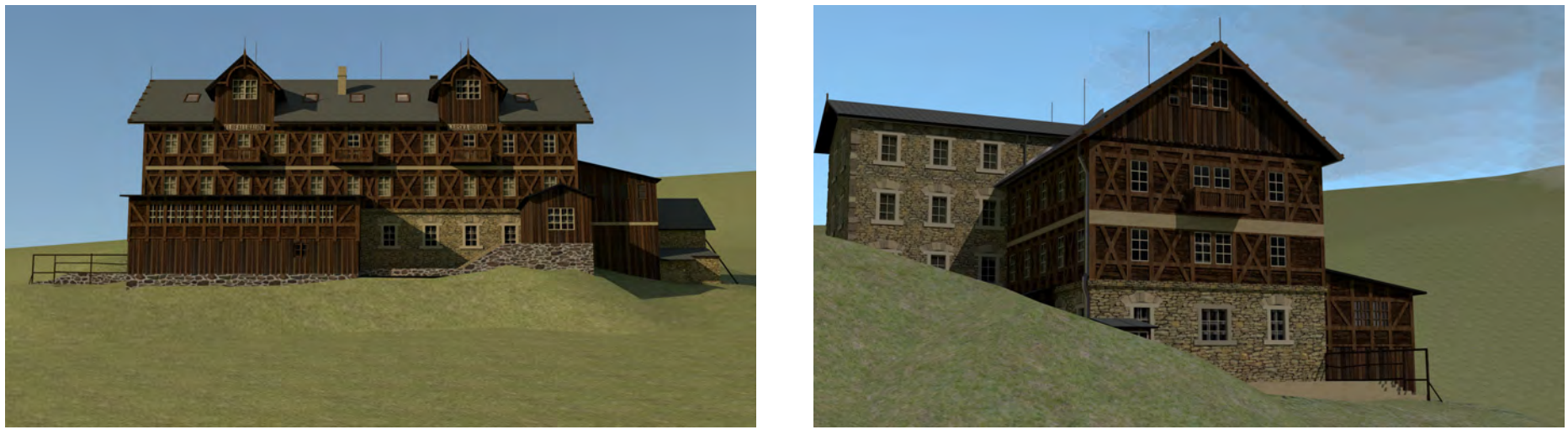


Fig. 14 – 3D photorealistic model of Labská bouda – based on available archive photographs and period postcards. The building was modeled in its form around 1930.

3.2.2 Regional and Local Symbols

In municipality emblems in the area of interest symbols referring to the mountain and forest character of the area are typically pictured. The emblems of Desná, Tanvald, Špindlerův Mlýn, Strážný, Dolní Dvůr, and Vrchlabí depict conifers. Forestry-related timber production is presented by symbol of a saw in the emblem of Paseky nad Jizerou. The emblems of Benecko, Rokytnice nad Jizerou, Vysoké nad Jizerou, and Lánov picture forest animals and hunting. Winter and snow which are typical for the mountainous area are represented by the silver tincture (colour) in emblems of Velké Hamry and Benecko, the figure of snowflakes and the Sněžka Mountain covered by snow is found in the emblem of Pec pod Sněžkou. There is even a reference to a healthy mountain climate in the emblems of the municipalities in the area of interest: Kořenov and Tanvald have sun and sun rays in their emblems, the blue tincture symbolizes the "climatic spa".

In the eastern part of the area of interest, there are symbols of mining in the municipality emblems – Poniklá (black shaft, winch – graphite mining), Paseky nad Jizerou – silver tincture, Vítkovice – silver goat and gold mountain, Plavy – gold tincture refers to panning for gold.

In the mountain and foothill parts of the area there are also references to agriculture and grazing (Víchová nad Jizerou – golden bundle of straw, Paseky nad Jizerou – green tincture, Rokytnice nad Jizerou – sheep as a symbol of pastoralism, Benecko and Plavy – green tincture symbolizes meadows and pastures).

3.2.3 Heritage Sites

In the Krkonoše Mountains area of interest, there are six buildings under cultural heritage protection (cultural monuments). Two others (a country house in Rokytno v Krkonoších, and a mountain hut – the Dvoračky in the Horní Rokytnice cadastre) are included in the National Heritage Monument Catalogue administered by the National Heritage Institute, however, these two buildings were not officially declared cultural monuments.

State-protected cultural monuments in the core area have the character of individual buildings, houses or religious monuments (chapels). Houses represent mainly examples of local form of settlement in the Krkonoše Mountains associated with agricultural production – these are wooden timbered cottages with well-preserved interiors and some of them has still an original farming parts. Most of the surviving agricultural buildings date back to the 18th or 19th centuries and became cultural monuments in the 1950s and 1960s.

4. Summary

The Krkonoše Mountains area of interest represents an area of dramatic changes in terms of land use/cover and changes in functions. Despite the high altitude and generally unfavourable natural conditions, the area has traditionally been used for agriculture (with only a small extent of arable land), even in the highest altitudes (mainly for cattle pasture). Until the mid-20th century, the area had a relatively stable structure of use. Since the 1950s (after the expulsion of Czech Germans after World War II) and the proclamation of the Krkonoše Mountains National Park (1963), the recreational use of the landscape has developed rapidly. In landscape of the Krkonoše Mountains we can observe contradictory trends in its use – on the one hand, the agricultural use of the landscape has been extensified and the areas of permanent grassland and forest have increased, on the other hand, we can observe the development of built-up areas and other anthropogenic structures penetrating the slopes and ridges of mountains (ski slopes, cable cars, cross-country and hiking trails, etc.).

Location in the regional system of Czechia and physical-geographical conditions have become decisive factors of development – climatic conditions allow the development of ski resorts; mountain location attracts high numbers of visitors who require appropriate infrastructure. At present, the traditional agricultural function is significantly reduced, a timber harvesting in local vast forest and water management are enabled. Nowadays, recreational and environmental functions of the area are of key importance.

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References and Data Sources

BALATKA, B., KALVODA, J. (2006): Geomorfologické členění reliéfu Čech. Kartografie, Praha.

DEMEK, J. (ed.) a kol. (1987): Zeměpisný lexikon ČSR. Hory a nížiny. Academia, Praha.

NEUHÄUSLOVÁ, Z., MORAVEC, J. (eds.) a kol. (1997): Mapa potenciální přirozené vegetace České republiky. Map of potential natural vegetation of the Czech Republic. Kartografie, Praha.

PLÍVA, K., ŽLÁBEK, I. (1986): Přírodní lesní oblasti ČSR. SZN, Praha.

QUITT, E. (2009): Klimatické oblasti. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SEDLÁČEK, J., JANDERKOVÁ, J., ŠEFRNA, L. (2009): Půdní asociace. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SKALICKÝ, V. et al. (2009): Fytogeografické členění. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

Archive Maps of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK), Central Archive of Surveying and Cadastre. https://archivnimapy.cuzk.cz/uazk/pohledy/archiv.html (1. 10. 2019).

Czech Association of Museums and Galleries (Asociace muzeí a galerií České republiky). https://www.cz-museums.cz/web/amg/titulni (1. 10. 2019).

Do muzea. https://www.do-muzea.cz (1. 10. 2019).

eKatalog BPEJ. https://bpej.vumop.cz/ (1. 10. 2019)

Geologická mapa ČR 1 : 50 000. https://mapy.geology.cz/geocr50/ (1. 10. 2019).

Geoportal of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK). https://geoportal.cuzk.cz/ (1. 10. 2019).

Land Use Land Cover Czechia Database. https://www.lucccz.cz/databaze/ (1. 10. 2019).

Museum.cz. https://www.museum.cz/ (1. 10. 2019).

National Heritage Monument Catalogue, The National Heritage Institute (Národní památkový ústav – NPÚ). https://pamatkovykatalog.cz/ (1. 10. 2019).

Portál informačního systému ochrany přírody. http://webgis.nature.cz/mapomat/ (1. 10. 2019).

Půdní mapa ČR 1 : 50 000. https://mapy.geology.cz/pudy/ (1. 10. 2019).

Register of communal symbols (Registr komunálních symbolů), Chamber of Deputies of the Czech Republic. https://rekos.psp.cz (1. 10. 2019).

Ústřední seznam ochrany přírody. http://drusop.nature.cz/ (1. 10. 2019).

CHAPTER 5

Kutnohorsko: Mining Landscapes of the Past

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1. Introduction

Silver mining used to be the crucial economic activity in the Kutnohorsko area of interest in the past. First mines were opened in the 13th century and intensive mining was going on for centuries. Most mines closed down centuries ago with the exception of the Kaňkovské vrchy (Kaňk Hills) where underground mines (for the extraction of polymetallic ores) operated until 1980s. A large waste pond collecting waste water from the mines was built close to the Kaňk Hills during the socialist era in the 2nd half of 20th century. Later, the area of the waste pond was repeatedly reclaimed and afforested.

The landscape of the Kutnohorsko area was completely deforested between late Middle Ages and the 19th century. During the course of time, residential zones of mining towns Kutná Hora and Kaňk originated spontaneously in mining areas. Thus, many of former mining landforms were covered by houses and constructions in these settlements, however, a 1.5 km long belt of tailings heaps retains that marks the most important argentiferous zone.

The deforested landscape was mainly used for farming during the past centuries. From the land use/cover perspective, arable land prevailed in the area until the 19th century. Soils in the mining-affected parts of the landscape, however, were rather poor. Major land use/cover changes have been taking place since the mid-19th century with afforestation being the key process. A ring of small forests was created around Kutná Hora – these are nowadays primarily used for sport and recreation. Arable land has been gradually shrinking in the 20th century. In many places, fields were replaced by orchards during the 20th century and also the urban expansion required more and more place. Vast orchards covered the entire southern slope of the Kaňk Hills.

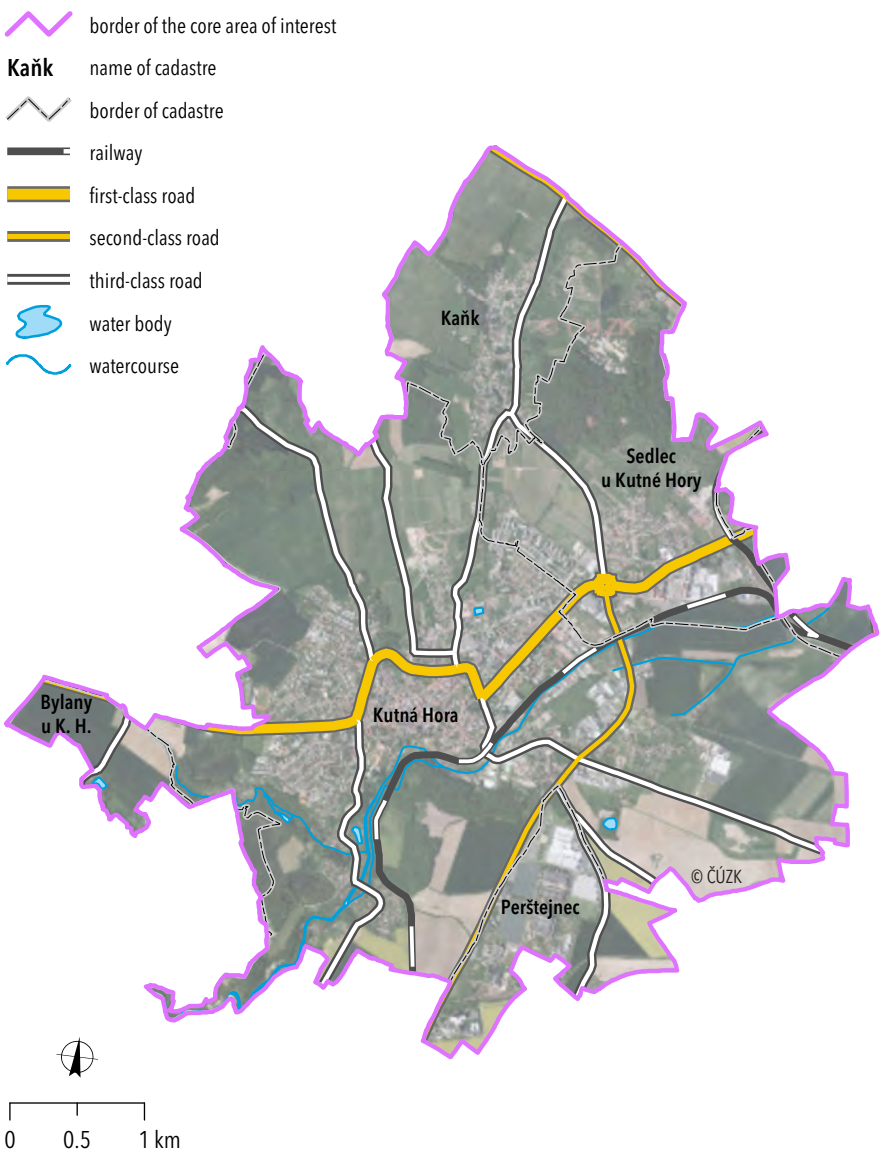


Fig. 1 – The core area of interest. Map basis: Data50; Orthophoto © The State Administration of Land Surveying and Cadastre, 2019.

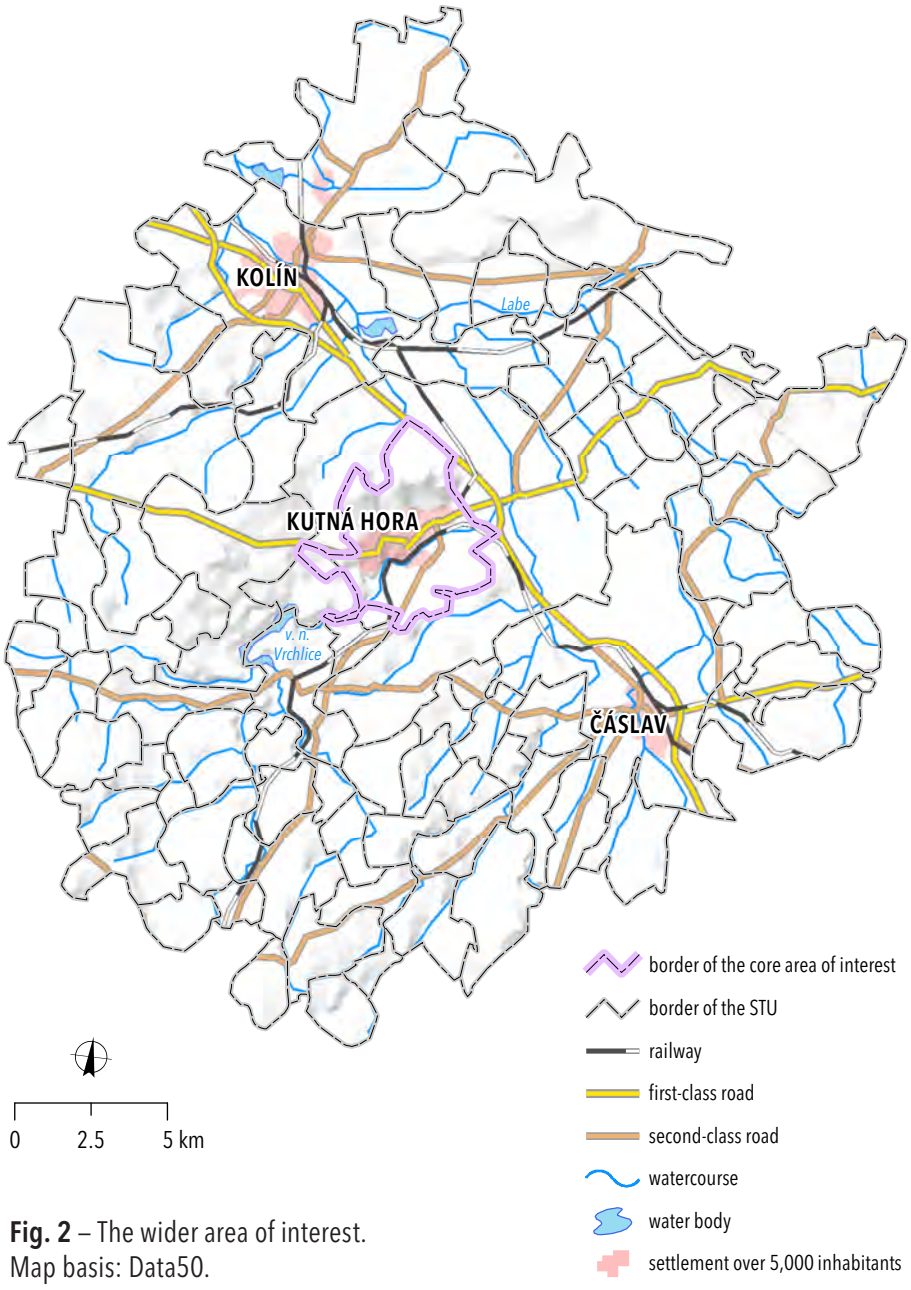


Fig. 2 – The wider area of interest. Map basis: Data50.

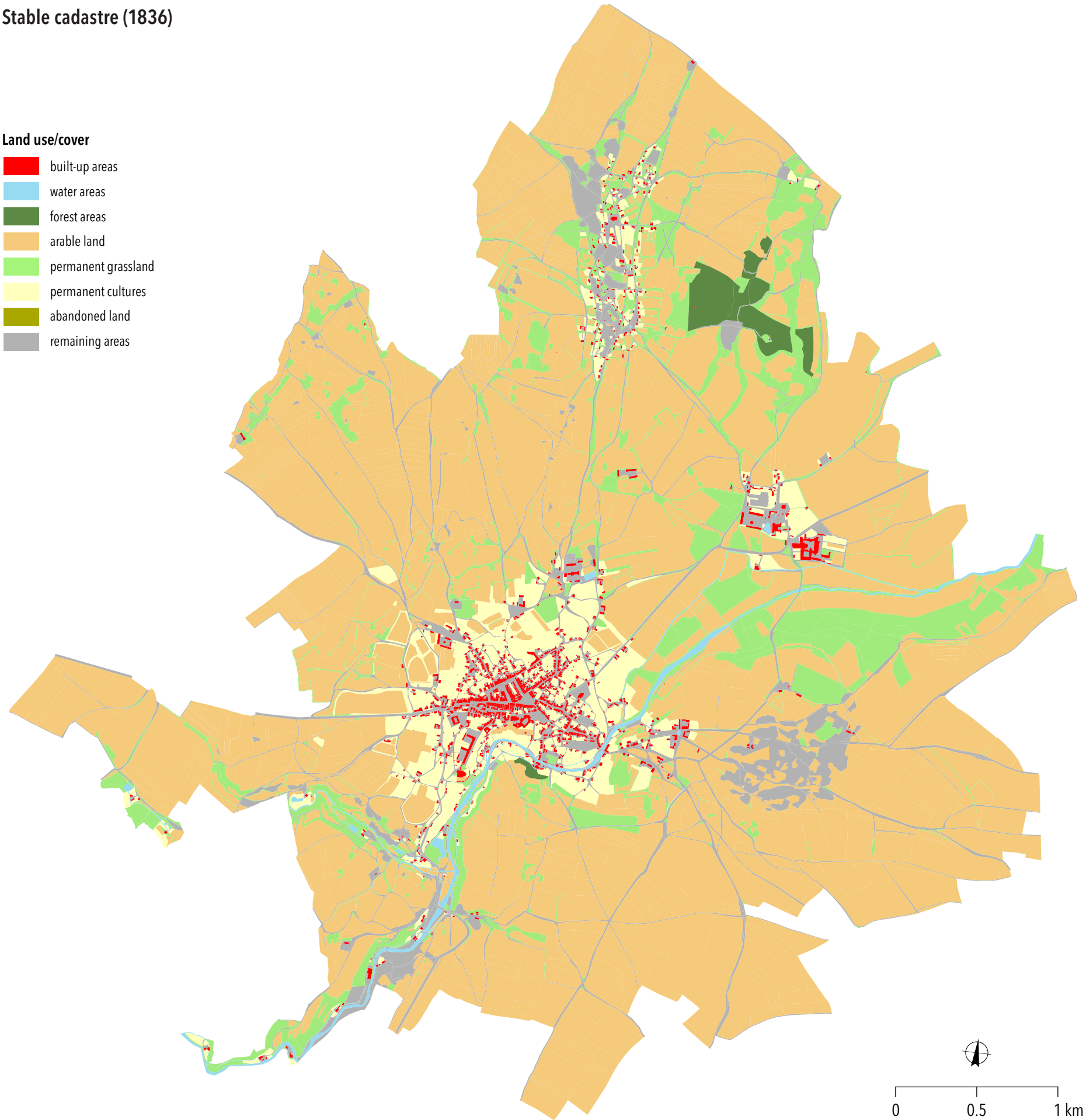
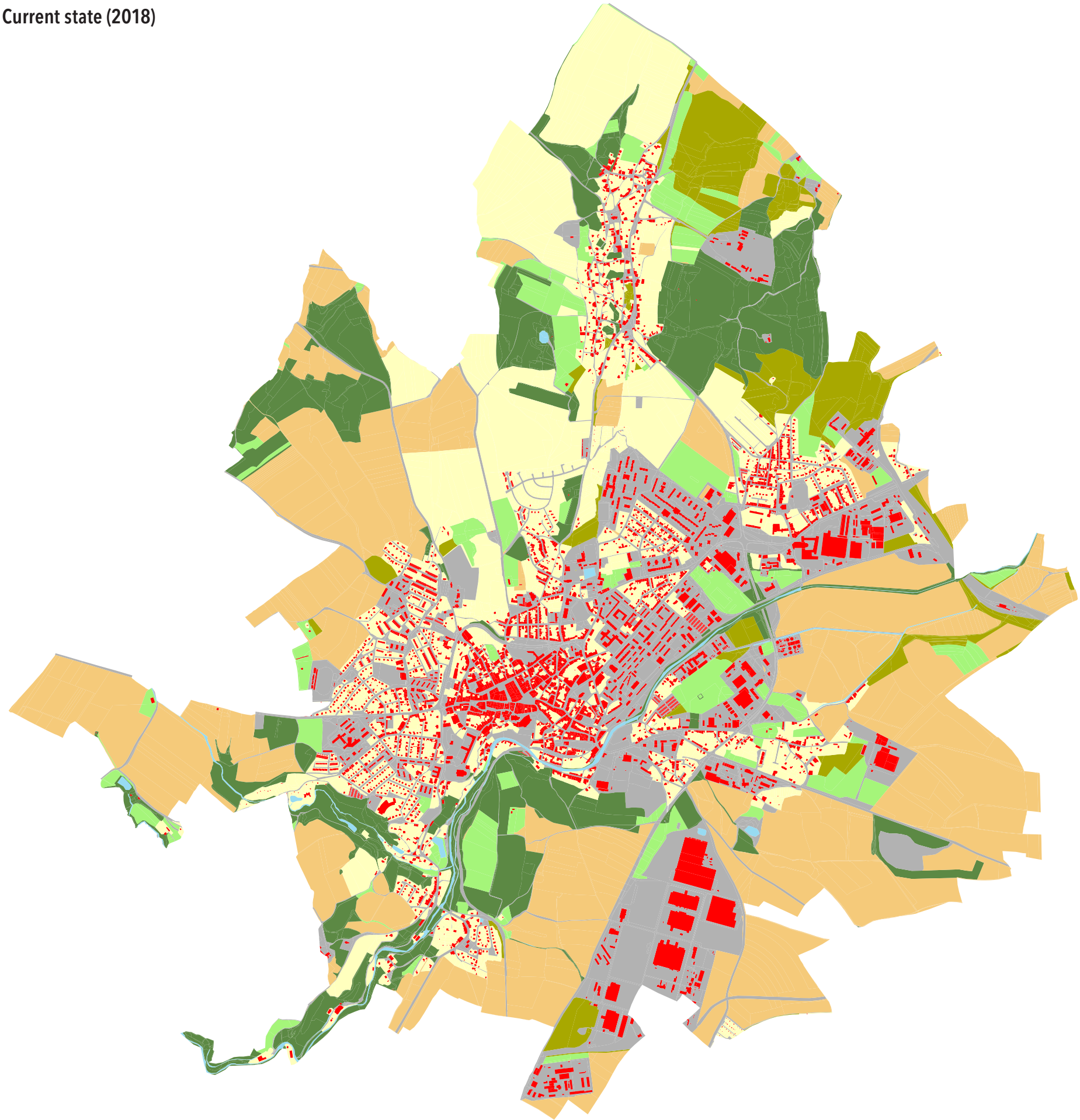


Fig. 3 – Land use/cover in cadastres Kutná Hora, Kaňk, Sedlec, Perštejnec and Bylany in 1836 and 2018.
Map basis: The State Administration of Land Surveying and Cadastre.

Current state (2018)

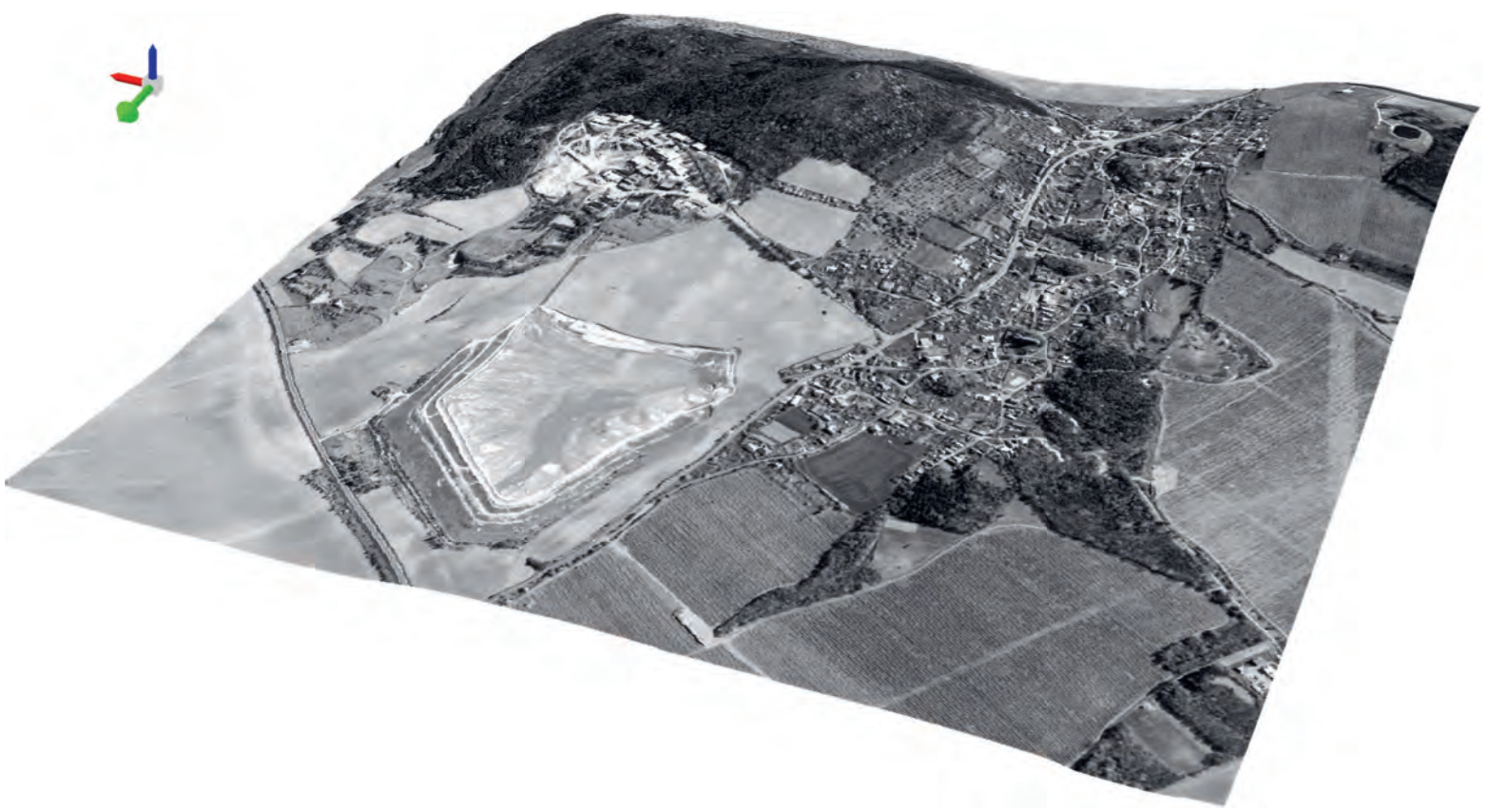


Tab. 1 – Proportion and change of land use/cover classes between 1836 and 2018

Land use/cover class	proportion in 1836 (%)	proportion in 2018 (%)	change (% points)
built-up areas	1.27	6.62	5.35
remaining areas	8.99	19.25	10.26
water areas	0.83	0.63	−0.20
forest areas	1.03	12.95	11.92
arable land	71.05	29.36	−41.69
permanent grassland	11.06	6.02	−5.05
permanent cultures	5.76	20.35	14.60
abandoned land	0.00	4.81	4.81

1954

1990



2018

Fig. 4 – Models of landscape – hill Kaňk in 1954, 1990 and 2018. Source: Aerial photos © Military Geographical and Hydrometeorological Office in Dobruška, Ministry of Defence, 2018; Orthophoto © The State Administration of Land Surveying and Cadastre, 2018.

Fig. 5a – The centre of Kutná Hora. Source: Archive of the NAKI project no. DG18P02OVV008. Photo (2018): Silvie R. Kučerová.

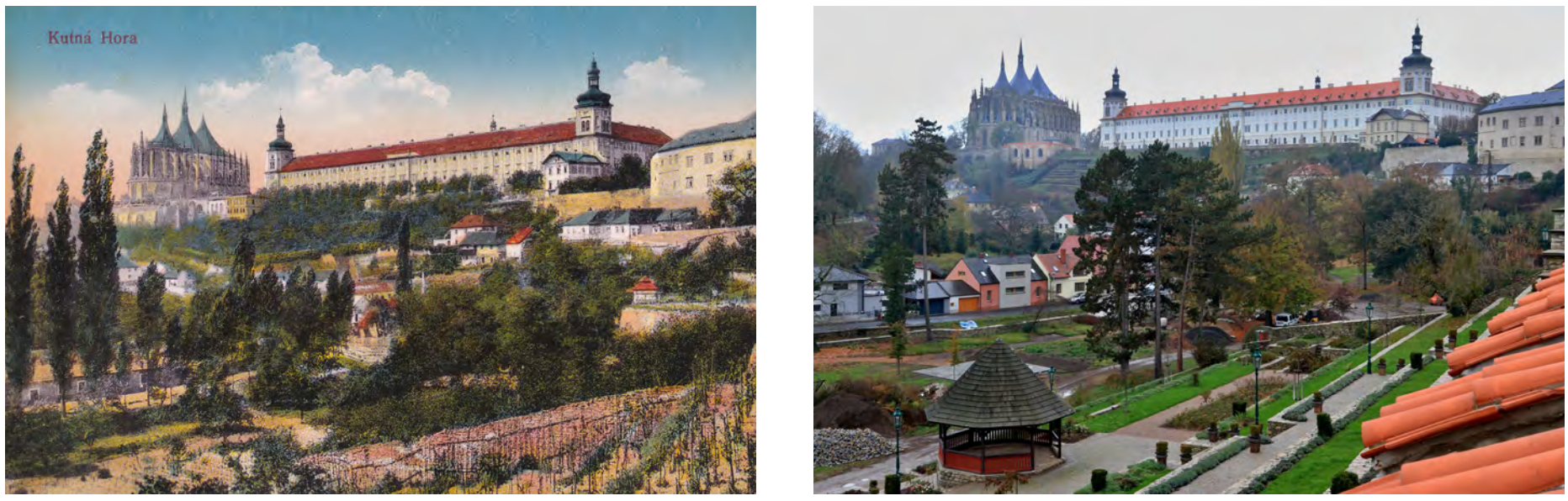


Fig. 5b – Jesuit college and St. Barbara's Cathedral in Kutná Hora. Source: Archive of the NAKI project no. DG18P02OVV008. Photo (2019): Zdeněk Kučera.

The State Farm focused on fruit-growing was established in Kutná Hora in the socialist era. Consequently, Kutná Hora became encircled by hundreds of hectares of orchards containing apple, peach and cherry trees and currant plantations. After 1990, however, most of these orchards were abandoned and gradually disappeared. Parts of this area were transformed back to arable land; vineyards (now covering more than 50 hectares) have been planted. Some parts of the former orchards now lie fallow and are being overgrown by "new wilderness", some are gradually being developed as part of urban sprawl.

For the purpose of this project, the so-called core area has been delimited and most analyses are carried out in this core area (Figure 1). It includes cadastral areas of Kutná Hora, Sedlec, and Kaňk. The wider area of interest (see Chapter 1 of Atlas for more details) is shown in Figure 2.

2. Area of Interest: Main Features

Kutnohorsko is located in the northernmost part of the Českomoravská vrchovina (Bohemian-Moravian Highlands) – the geomorphological unit of the Hornosázavská pahorkatina (Upper Sázava Upland), the sub-unit of the Kutnohorská plošina (Kutná Hora Plateau), the sub-unit of the Malešovská pahorkatina (Malešov Upland). Small part of the area extends into the geomorphological unit of the Česká tabule (Czech Plateau). Rich argentiferous zones were formed on the tectonically broken northern edge of the Bohemian-Moravian Highlands in distant past. These zones formed the base for silver mining in the Kutnohorsko area and also determined the development of local landscapes since late Middle Ages.

Geological bedrock consists mostly of hard metamorphic rocks of the Kutná Hora Crystalline Complex including orthogneiss, paragneiss, migmatite, mica schist, amphibolite, and occasional patches of serpentine. Upper Cretaceous calcareous sandstones form the most important part of the overlying sedimentary formations. These merge with sandy limestones and organodetritic limestones containing numerous fossils. Quaternary is represented by loess and loess loam in most parts of the area; recent alluvia are found in the floodplains. Numerous stone quarries (orthogneiss, migmatite, and sandstones) and brickfields making use of local clay were opened.

Typical altitude differences in the area range between 30 and 150 metres. Gentle and rather long slopes as well as planed surface are found on the territory of Kutná Hora and in immediate surrounding. Steep slopes occur only in the valley of the Vrchlice River, with some rocky outcrops. In the core area (Kutná Hora, Kaňk, and Sedlec), the landscape has been significantly altered by mining activities. The surface is rugged, with several pits, artificial depressions, heaps and artificial hills. Altitudes within the core area range between 210 to 359 metres a.s.l.

The area is situated in a warm climatic region with an average annual temperature of about 9 °C; the average annual precipitation is 570 mm. Winters tend to be mild and short, especially in recent decades, with unstable snow cover. Summers are usually quite long and often dry. The immediate surrounding of Kutná

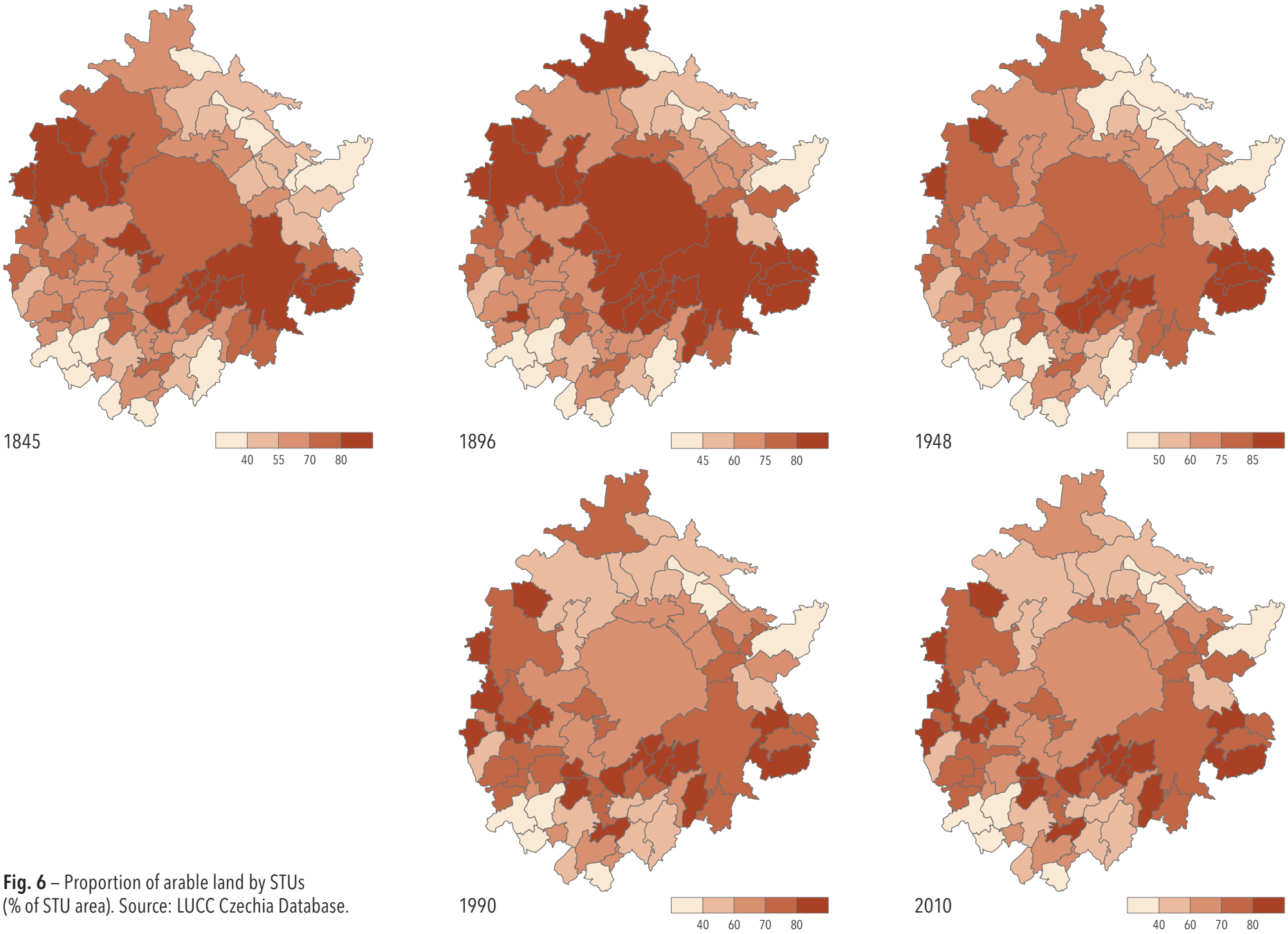


Fig. 6 – Proportion of arable land by STUs (% of STU area). Source: LUCC Czechia Database.

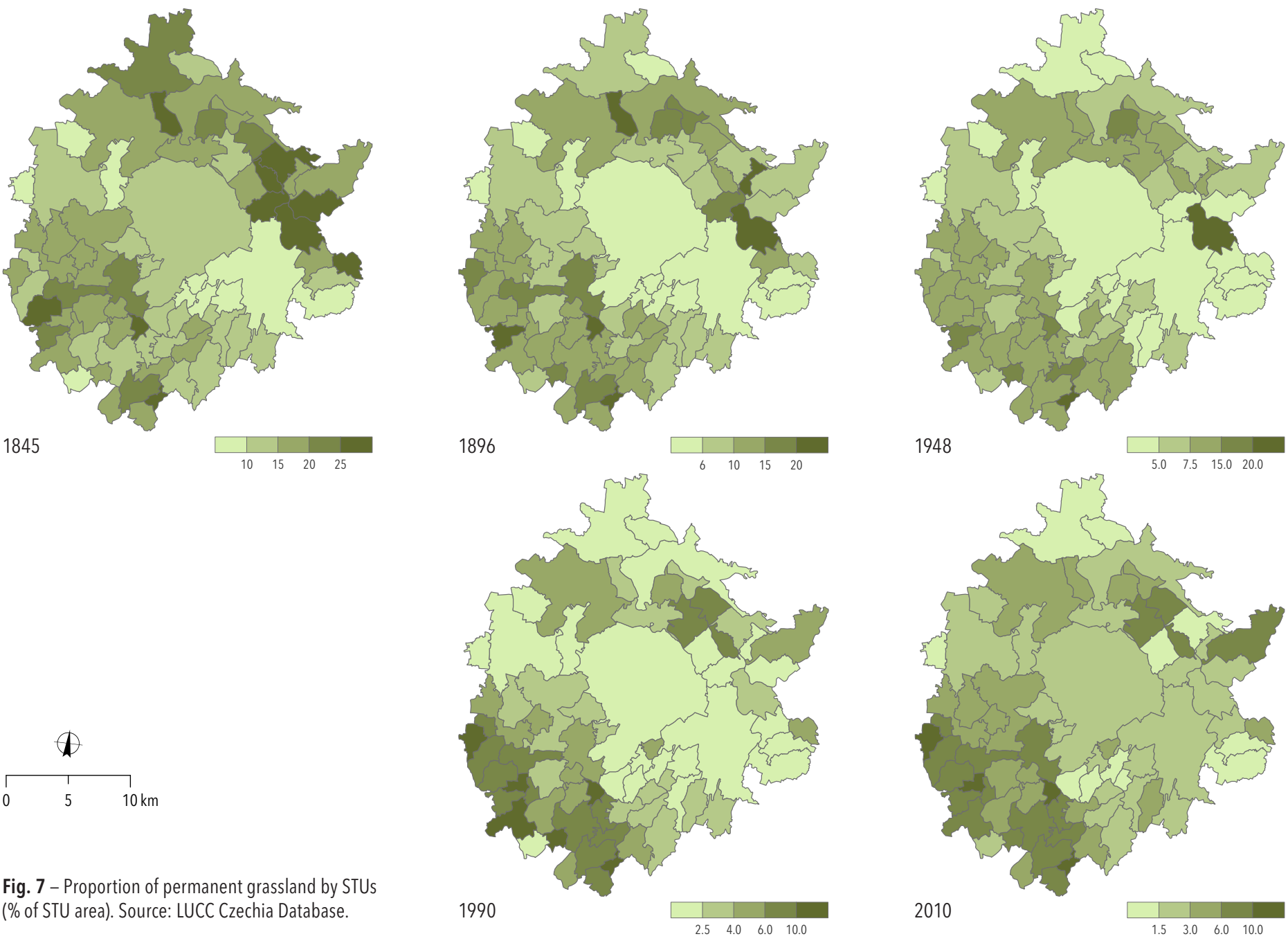


Fig. 7 – Proportion of permanent grassland by STUs (% of STU area). Source: LUCC Czechia Database.

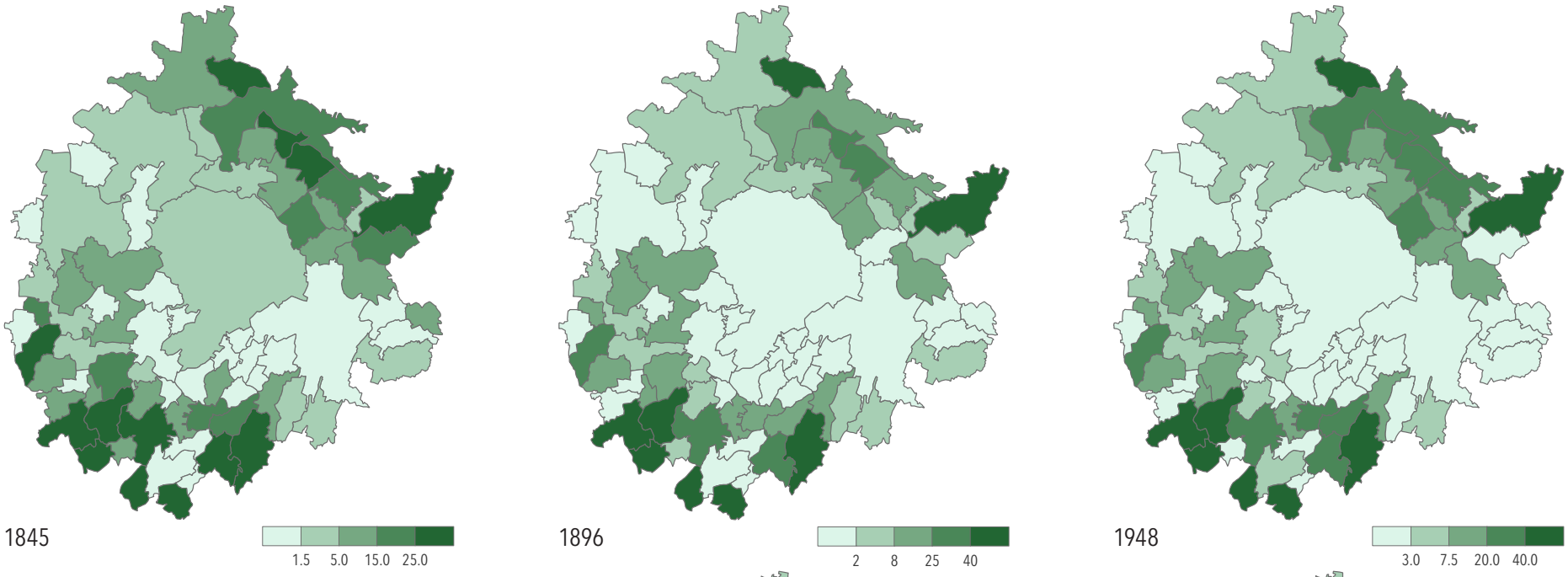


Fig. 8 – Proportion of forest areas by STUs (% of STU area). Source: LUCC Czechia Database.

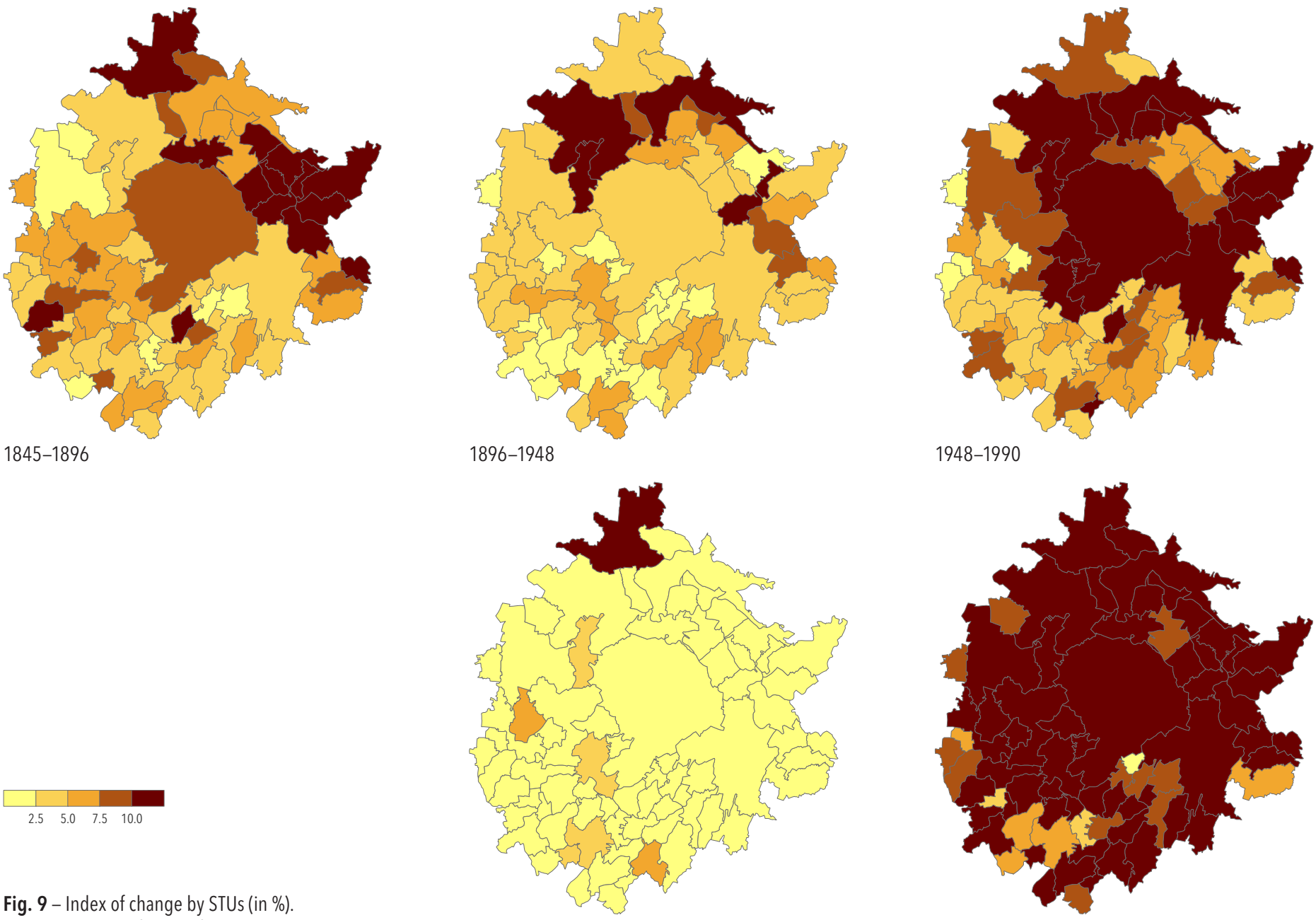


Fig. 9 – Index of change by STUs (in %). Source: LUCC Czechia Database.

Fig. 10 – Municipality emblems.
Source: Register of municipal symbols, Chamber of Deputies of the Czech Republic (https://rekos.psp.cz; as of 1 October, 2018).

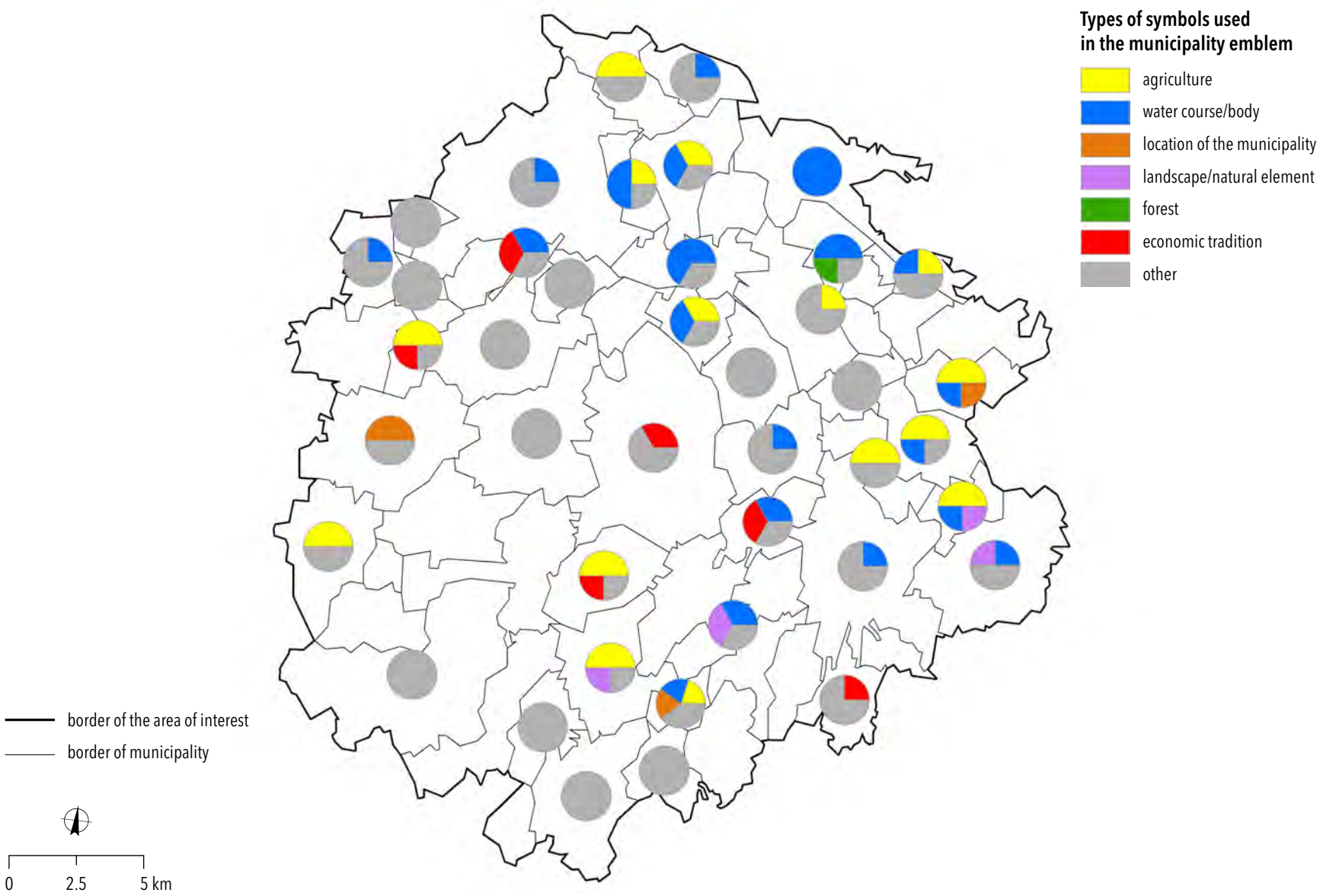


Fig. 11 – Types of symbols used in the municipality emblems.
Data source: Contant analysis of the municipality emblems (as of 1 October, 2018).

Fig. 12 – Cultural monuments and heritage areas.
Data source: National Heritage Monument Catalogue, National Heritage Institute (https://pamatkovykatalog.cz; as of 1 October, 2018).

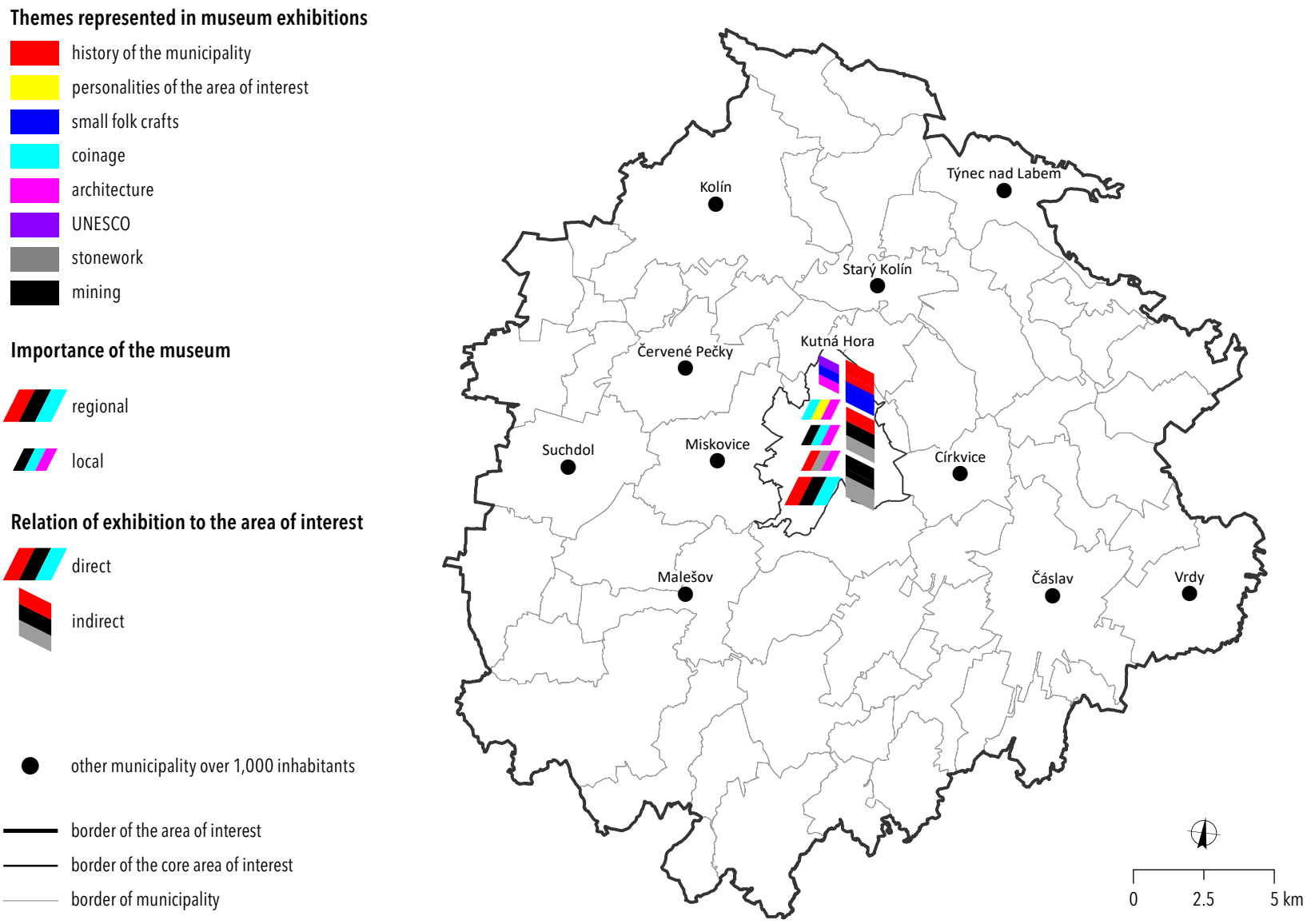


Fig. 13 – Museum exhibitions.
Data source: Czech Association of Museums and Galleries (https://www.cz-museums.cz/web/amg/titulni; as of 1 October, 2018), Webportal Do muzea (https://www.do-muzea.cz; as of 1 October, 2018), Webportal Museum.cz (https://www.museum.cz; as of 1 October, 2018).

Hora enjoys special climatic conditions and thus belongs among the warmest regions in Bohemia. As a result, thermophilic fruits (peaches, apricots) and also grapes are cultivated there.

The Kutnohorsko area is part of the phytogeographical area of the Czech Thermophyticum, phytogeographical district of the Střední Polabí (Central Elbe Plain). Oak prevails in local forests. Xerothermic organisms populate the steppe-like sections on southern slopes of the Kaňk Hills. The areas south and west of Kutná Hora (outside the core area) belong to the phytogeographical area of the Czech Mesophyticum, phytogeographical district of the Kutnohorská pahorkatina (Kutná Hora Upland), with altitudes between 300 and 450 metres a.s.l.

In the current landcover of the core area, urban built-up areas prevail, with fruit orchards and secondary suburban forests classified as "special-purpose forests". Expanding vineyards, spontaneously overgrown areas of the so-called "new wilderness", and also temporary pastures used for sheep grazing are among the recent elements of land cover. One small, yet important protected area (the National Natural Monument Kaňk) was declared on the south-eastern slope the Kaňk Hills as early as 1933. It is aimed to protect the most valuable palaeontological locality of whole Bohemian Cretaceous. At the present time, the protection also covers valuable steppe vegetation on the site. The partial natural rehabilitation of some parts of mining areas and dumps was important fact for the development of the area after mining.

The Kutnohorsko area is currently on the border of the peripheral and core areas following the Prague agglomeration. From the economic perspective, Kutná Hora is nowadays overshadowed by nearby Kolín which has strong industrial and service sectors. Until the 16th century, however, Kutná Hora used to be much more important thanks to the silver mines – in that period, the town even competed with Prague. Mass import of silver from South America that had started in early 16th century caused gradual decline of the mines as the silver from local mines could no longer compete.

The area has good transport links. One of the major railway lines connecting Prague and Brno passes through Kutná Hora, the other one (via Pardubice) is nearby. Companies based in Kutná Hora include Foxconn (electronics), a foundry, and a brewery. At present, however, tourism and culture are the most important elements of local economy.

3. Results

3.1 Landscape and Land Use/Cover Changes

Figure 3 and Table 1 compare how the landscape looked like in the 1st half of the 19th century (1836) and the present state (2018).

The landscape of the Kutnohorsko area has changed significantly since 1836. Arable land has shrunk significantly, having been largely replaced by orchards and vineyards (permanent crops increase by almost 15%), forests, built-up areas, and remaining areas (roads, parking lots, etc.). There are large tracts of unused land in the area at the moment.

In 1836, only the historic centre of Kutná Hora was built-up. The town was surrounded by many gardens. There used to be farming land between Kutná Hora on one side and Kaňk and Sedlec on the other side. Interestingly, the area had almost no forests in early 19th century which makes a big difference compared to the current state. Still, the landscape of that time was probably more ecologically balanced than today. This was due to the natural character of agricultural production which utilized no artificial substances (e.g. pesticides or fertilizers). The landscape structure of early 19th century was quite varied, consisting of a mosaic of tiny fields with a diverse composition of crops, small patches of meadows, pastures, etc.

The map of stable cadastre (1838) shows the present-day Sedlec as a group of outstanding buildings including the Schwarzenberg Castle, farmhouse, cemetery church (the famous ossuary), and the former Cathedral of the Assumption of Virgin Mary. Already in that time there was a tobacco factory on the grounds of the Cistercian monastery (nowadays owned by Philip Morris). Ordinary houses were rare and much of the surrounding was covered by fields. At the present time, the prefab housing estate Na studních dominates this area.

There used to be fields on the southern slopes of the Kaňk Hills, in some parts alternating with pastures. Nowadays, this area is covered by the largest suburban forest called the Macháčkův háj (Macháček Grove). Tailings – historic landmarks of Kaňk – were identified on the early 19th century maps as infertile soil (ödland – see the class remaining areas in the centre of Kaňk; Figure 2). Today, Kaňk is surrounded by forests, orchards, and there is also one vineyard.

Gradual afforestation of medieval man-made landscape forms in Kaňk and elsewhere in the vicinity of Kutná Hora is an important factor that has shaped the environment of the Kutnohorsko area in the post-mining era. The beginnings of afforestation of the Kaňk Hills date back to the first half of the 19th century, when the territory belonged to the noble family of Chotek. Today, the environs of Kutná Hora abound with orchards and vineyards that replaced the former fields, especially on sunny (southern) slopes. Planting of fruit trees started at the turn of the 19th and 20th centuries due to agricultural intensification – steep slopes with thin soil cover were no more used for cultivation of crops. In 1980s, however, cherry plantations started to decline, and many orchards became gradually overgrown with dense thorny shrubs of hawthorn, rose hip, blackthorn, and blackberry – the so-called "new wilderness" was created.

From the scientific perspective, the environment of the abandoned orchards covering the southern slopes of the Kaňk Hills is in many ways unique. This part is populated by rare steppe and forest-steppe species that are not found elsewhere in the area. It is the domain of many xerothermal plants like the steppe grass Orphan Maidenhair, St Bernard's Lily, or the critically endangered German Stachys. The protected Cornelian Cherry, which spontaneously invades the abandoned orchards, is often found here, too. However, thermophilous and photophilus steppe species require some form of landscape management including gentle mowing or grazing. The town authorities keep clearing shrubs and trees and temporarily introduced sheep grazing at selected localities to prevent land from being completely overgrown by "new wilderness".

The above-described land use/cover changes are complemented by a 3D model of the area. It shows (Figure 4) the Kaňk Hills, the locality most affected by mining. While the environment of the mining plant remained unchanged, the northern slopes, originally covered by tailings, have undergone significant changes. In early 1950s, this area was under cultivation. The picture from 1990s, however, shows a waste pond here. The area was later reclaimed as shown in the current picture: forestry plantations are clearly visible and "new wilderness" began to grow in some places.

Figures 6–9 show wider perspective of land use/cover changes in STUs and describe changes over the time by comparing years 1845, 1896, 1948, 1990, and 2010.

The official price of agricultural land is well above the national average at the Kutnohorsko area. There have always been very

good conditions for farming. In some areas in the south-east, the official price of agricultural land is three times higher than the national average. The proportion of land under cultivation is logically high (in all recorded years). The highest values were achieved in 1896, when about two thirds of area were above 60% of agricultural land was used as an arable land. The lowest portion of arable land was reached in 2010, which was the result of turbulent processes in agriculture after 1990 and the general decline of farming intensity in Czechia. This process was also associated with agricultural restructuring, which also affected the Kutnohorsko area and its fertile soils.

The share of permanent grassland of the agricultural land area rarely exceeded 20% in the past, and it is only ca. 10% at the present time. Many municipalities have only tiny patches of permanent grassland (less than 5%). These numbers document the high intensity of crop farming.

The structure of agricultural production at the Kutnohorsko area has also changed significantly over the decades. Sugar beet has somewhat lost ground while the share of rapeseed has increased markedly since 1990. The town authorities of Kutná Hora have paid considerable attention to renewal of bio-corridors and to creation of new ones, possibly indicating future trends of landscape changes.

Figure 9 describe the index of change (in terms of land use/cover changes). The core area is the town of Kutná Hora, place of fluctuating fortunes over the centuries. In the past, the town was mainly associated with silver mining and also with intensive agriculture in the surrounding area. The economic downturn of Kutná Hora was indirectly linked with the industrial boom in nearby Kolín. The most important land use/cover changes occurred within the period 1948–1990: in that time, the index of change ranged between 8 and 12% on more than 40% of the area. The intensity of changes outside Kutná Hora was slightly lower during the first examined period (1845–1896). The index of change calculated for the whole period 1845–2010 was higher than 10% in 90% of territorial units.

3.2 Landscape Memory

The landscape memory of the Kutnohorsko area is shown in four maps in sections 3.2.1–3.2.3 (for more details about methodology of mapping see Chapter 1 of Atlas).

3.2.1 Places and Institutions of Memory

There are eight exhibitions of various types devoted to historical memory within the area of interest. All of these institutions are located in Kutná Hora: scattered throughout the town centre, the local part Vrchlice, on the Kaňk Hills, and in the immediate vicinity (Figure 13). Since the Middle Ages, Kutná Hora has been a major centre of economic, cultural, and social events. Thus, traces of the past are concentrated directly in Kutná Hora.

The Czech Museum of Silver is the most important museum dedicated to the mining heritage in the area. It brings together exhibitions in the Medieval mansion Hrádek and Medieval Mine), the Kamenný dům (Stone House), Tylův dům (Tyl's House) scattered throughout the centre of Kutná Hora. The Museum presents the history of mining and coinage in Kutná Hora and describes the life in medieval town. The Dačického dům (Dačický's House) has an interactive exhibition focused on the history of Kutná Hora which has been inscribed on the list of the UNESCO World Heritage.

Some exhibitions located in the peripheral parts of the Kutnohorsko area of interest deal with the mining landscape in an indirect way. These include the Geological Exposition of the Čížkova skála (Čížek's Rock) in the town of Kutná Hura focusing on geological diversity of the Kutnohorsko area and neighbouring regions Kolínsko and Vysočina. The Kaňkovský hornický jarmark (Kaňk Mining Fair), (irregularly) organized by the locals in cooperation with the Hornický spolek Barbora (Mining Association Barbora), shows local traditional crafts. The area of former Rudné doly (Ore Mines) at the Kaňk Hills is open to the public and offers demonstrations of mining equipment. The educational trail Stříbrná stezka (Silver Trail) is also related to the historical memory of the Kutnohorsko area.

3.2.2 Regional and Local Symbols

Municipal symbols often include references to the Labe (Elbe) River and surrounding fertile landscapes (Figures 10 and 11), especially in the north-western part of the Kutnohorsko area. Municipal symbols of Konárovice, Týnec nad Labem, and Záboří nad Labem include blue colour, reflecting the river. Corrugated gables are found in the symbols of Starý Kolín and Tři Dvory. Interestingly, the municipal symbol of Týnec nad Labem includes a bridge – another reference to the river.

Fertility of the local soils is symbolized by golden mane (Konárovice). There are also many references to agriculture: it may be green colour (Ovčáry, Vlačice, Křesetice, Ratboř, Onomyšl), ear of grain (Horka I, Křesetice, Žehušice), or scythe.

Landscape themes, again reflecting the Labe (Elbe River) and tributaries, are found e.g. in the symbols of Vlačice (stork plus silver-green wavy strip as a symbol of local lakes and wetlands), Záboří nad Labem (oak and acorn as symbols of local forests, plus blue colour as a symbol of the confluence of Labe/Elbe and the Doubrava rivers), and Vrdy (willow branch as a symbol of typical tree lining the banks of Doubrava River).

One would expect that emblems of municaplities in the Kutnohorsko area would include numerous references to mining. There are, however, relatively few of them. The symbol of Kutná Hora includes hammer and pick; Ratboř has a red garnet (this mineral used to be found in the environs), and there is also a reference to mining in the symbol of Křesetice (hammer).

3.2.3 Heritage Sites

Kutná Hora used to be the second most important town in the Kingdom of Bohemia between 14th and early 16th century, surpassed only by Prague. Central part of the town has undergone crucial changes in that period. The urban structure, comprising a number of high-quality architectural ensembles, nowadays forms an impressive complex with high aesthetic values. There are more than 300 listed monuments in the town, some of them enjoying the status of National Cultural Monument. The town centre plus the Church of St. Barbara and the Cathedral of the Assumption of Virgin Mary in Sedlec have been inscribed on the List of UNESCO World Heritage Sites.

Most monuments in Kutná Hora are somehow related to the mining heritage. The map (Figure 12), however, shows also nine objects that are not direct remnants of mining activities and yet reflect the history of mining. Most of these are religious monuments as religion played a very important role in the lives of miners. The church of St. Barbara is undoubtedly the most important and most famous monument in the area. It is the symbol of affluent medieval town and was supposed to compete with the nearby Sedlec Cathedral and even with the St. Vitus Cathedral in Prague. The church is dedicated to St. Barbara, patron saint of miners. Statues of St. Barbara can be found in many other places throughout Kutná Hora. The Hrádek Palace, one of the most important places in the historic centre, is also worth mentioning. This palace nowadays houses the Czech Museum of Silver.

4. Summary

In land use/cover terms, two contradictory trends are typical for the Kutnohorsko area of interest. First, agricultural extensification was taking place (arable land being transformed into permanent crops, forests, and permanent grassland). Second, urban areas (especially the town of Kutná Hora) were expanding – this has been an ongoing process since mid-19th century.

In the past, farming used to be the chief activity in largely deforested landscape – with the exception of mining zones. In land use/cover terms, fertile arable land prevailed until the 19th century. Major land use/cover changes have been taking place since mid-19th century. These include gradual afforestation of less fertile zones; the last major planned afforestation scheme was carried out in the 1950s. After 1990, most orchards disappeared. Some of them (more than 50 hectares) have been recently replaced by vineyards, which helped to restore the faded glory of local winemaking. Some of the former orchards are being gradually developed (usually residential housing as part of urban sprawl).

In general, the Kutnohorsko area has relatively varied landscapes with diverse vegetation cover. This is formed by a mosaic of forests, shrubs, and grassland, with a number of orchards and gardens.

At present, the Kutnohorsko area benefits from rich historical heritage, which includes a number of outstanding sites in Kutná Hora and its surroundings. These monuments attract large numbers of domestic and foreign visitors. It is tourism and some of the newly established industrial enterprises that can boost economic progress of the area in future.

Acknowlegment

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References and Data Sources

BALATKA, B., KALVODA, J. (2006): Geomorfologické členění reliéfu Čech. Kartografie, Praha.

DEMEK, J. (ed.) a kol. (1987): Zeměpisný lexikon ČSR. Hory a nížiny. Academia, Praha.

NEUHÄUSLOVÁ, Z., MORAVEC, J. (eds.) a kol. (1997): Mapa potenciální přirozené vegetace České republiky. Map of potential natural vegetation of the Czech Republic. Kartografie, Praha.

PLÍVA, K., ŽLÁBEK, I. (1986): Přírodní lesní oblasti ČSR. SZN, Praha.

QUITT, E. (2009): Klimatické oblasti. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SEDLÁČEK, J., JANDERKOVÁ, J., ŠEFRNA, L. (2009): Půdní asociace. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SKALICKÝ, V. et al. (2009): Fytogeografické členění. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

Archive Maps of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK), Central Archive of Surveying and Cadastre. https://archivnimapy.cuzk.cz/uazk/pohledy/archiv.html (1. 10. 2019).

Czech Association of Museums and Galleries (Asociace muzeí a galerií České republiky). https://www.cz-museums.cz/web/amg/titulni (1. 10. 2019).

Do muzea. https://www.do-muzea.cz (1. 10. 2019).

eKatalog BPEJ. https://bpej.vumop.cz/ (1. 10. 2019)

Geologická mapa ČR 1 : 50 000. https://mapy.geology.cz/geocr50/ (1. 10. 2019).

Geoportal of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK). https://geoportal.cuzk.cz/ (1. 10. 2019).

Land Use Land Cover Czechia Database. https://www.lucccz.cz/databaze/ (1. 10. 2019).

Museum.cz. https://www.museum.cz/ (1. 10. 2019).

National Heritage Monument Catalogue, The National Heritage Institute (Národní památkový ústav – NPÚ). https://pamatkovykatalog.cz/ (1. 10. 2019).

Portál informačního systému ochrany přírody. http://webgis.nature.cz/mapomat/ (1. 10. 2019).

Půdní mapa ČR 1 : 50 000. https://mapy.geology.cz/pudy/ (1. 10. 2019).

Register of communal symbols (Registr komunálních symbolů), Chamber of Deputies of the Czech Republic. https://rekos.psp.cz (1. 10. 2019).

Ústřední seznam ochrany přírody. http://drusop.nature.cz/ (1. 10. 2019).

CHAPTER 6

Podbořansko: Peripheral Landscapes with Intensive Hop Farming

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1. Introduction

Podbořansko is a peripheral area in North-western Bohemia, not far from the state border. In the past, the local landscape was under intensive cultivation. In the course of time, however, many farms ceased to exist. Hop production and orchards still form special features typical for the countryside, though these used to be much more widespread. The area was part of the Sudetenland, area that was annexed by the Nazi Germany in 1938.

Peripheral character of the area plus its modern history (post-war expulsion of the Czech Germans) are well reflected in the appearance of settlements. Throughout the area, one can see many desolated and decaying buildings dotting the countryside, crumbling German graves in local cemeteries. Hop fields and tall hop driers are still there. Many of them, however, are now abandoned and slowly disintegrating.

Gradual deterioration of formerly intensively cultivated landscape started in the second half of the 20th century. The current land use/cover patterns much depend on the character of the landscape. In the plains, notably in the western part of the core area (west of Blšany and Sířem in the direction towards Podbořany), vast fields are found. On the contrary, the landscape east of Blšany is more hilly, nowadays partially covered by forests. Fields and some orchards have disappeared over the time. Instead, bush and the so-called "new wilderness" invaded these areas, especially on sloping land and in valleys. Some slopes in the basin of the Černocký potok (Černocký Creek) were later transformed into pastures and currently are frequented by sheep and cattle. Thus, the landscape is used in a less intensive way compared with the past, which contributes to environmental stabilization.

For the purposes of this project, the so-called core area has been delimited and most analyses are carried out in this core area (Figure 1). It includes the municipal areas of Stachov u Blšan and Soběchleby u Blšan. The wider area of interest (see Chapter 1 of Atlas for more information) is shown in Figure 2.

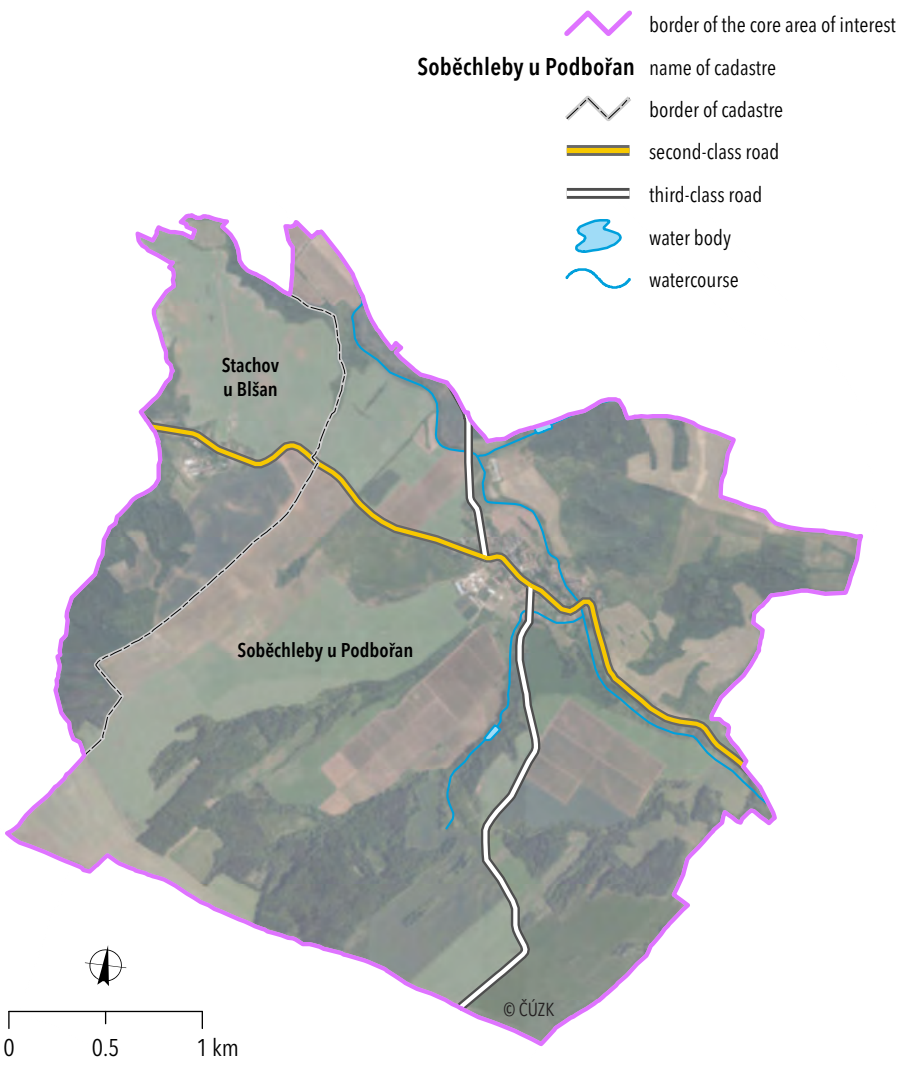


Fig. 1 – The core area of interest. Map basis: Data50; Orthophoto © The State Administration of Land Surveying and Cadastre, 2019.

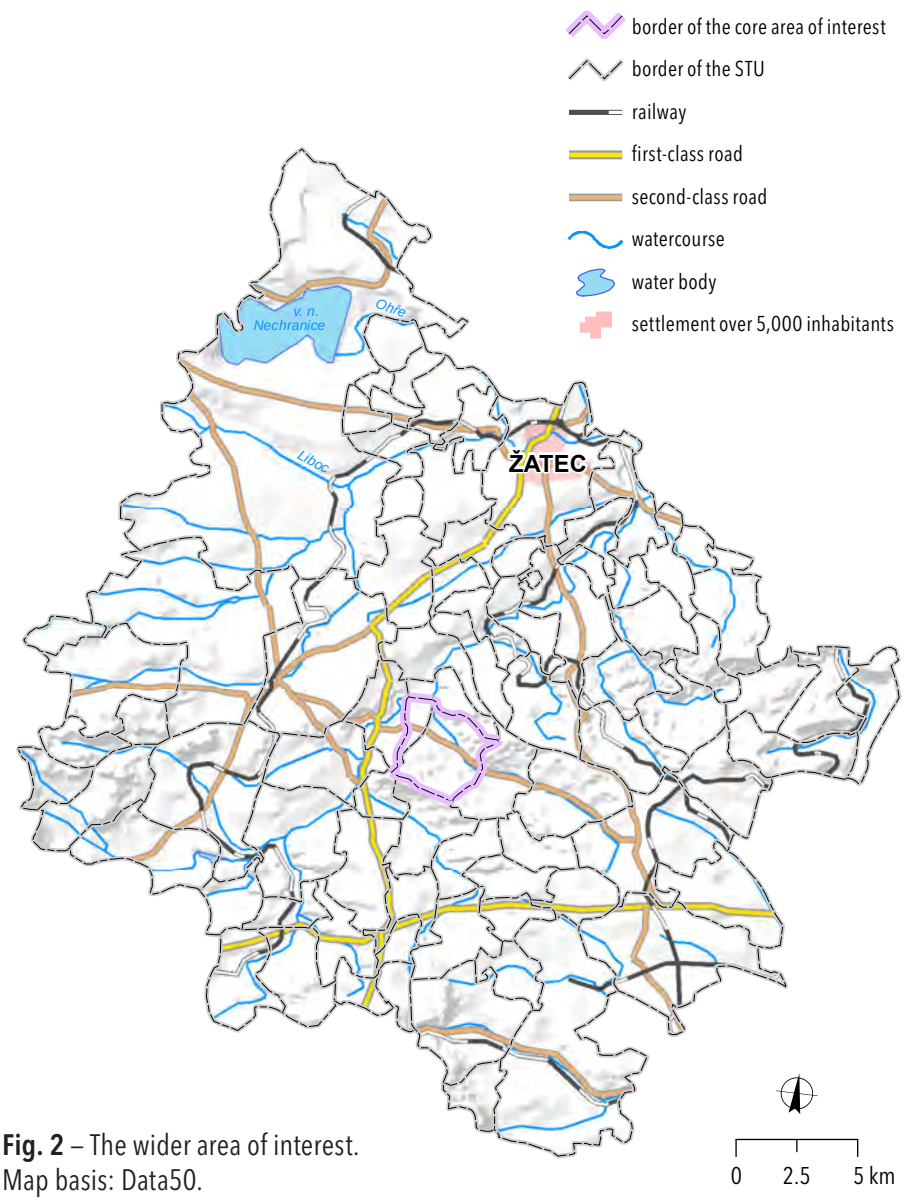


Fig. 2 – The wider area of interest. Map basis: Data50.

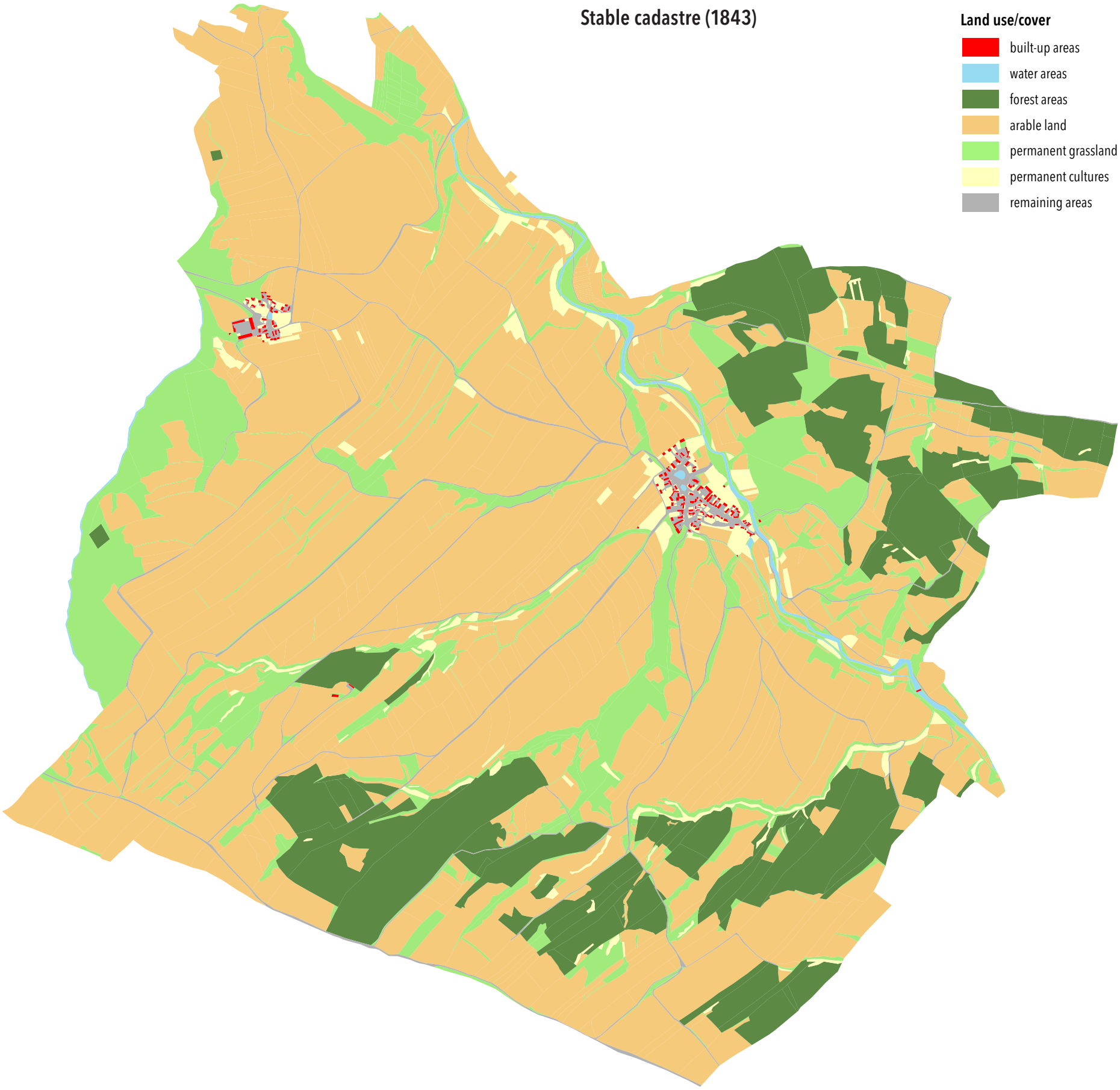
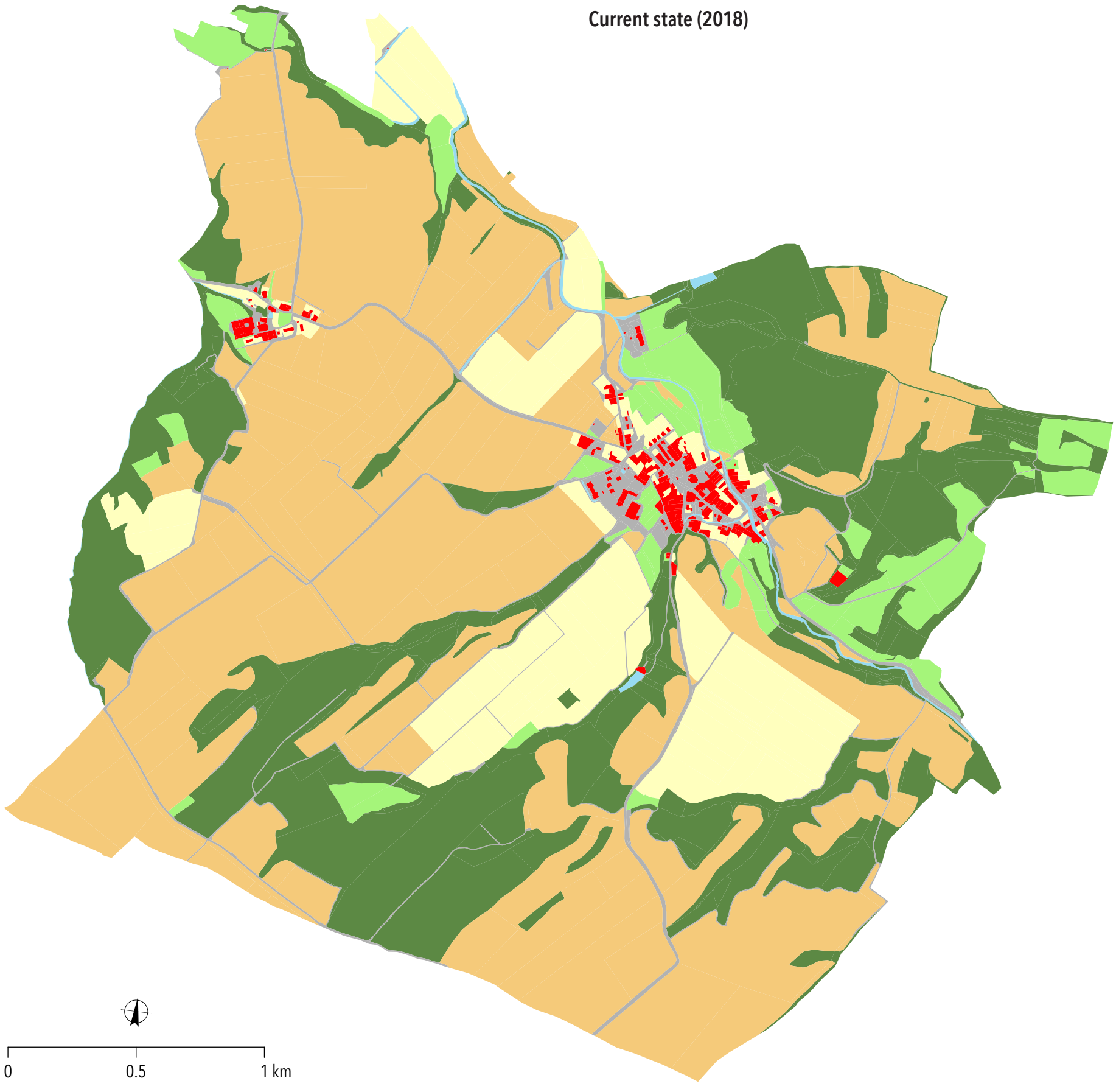


Fig. 3 – Land use/cover in cadastres Stachov u Blšan and Soběchleby u Podbořan in 1843 and 2018.
Map basis: The State Administration of Land Surveying and Cadastre.



Tab. 1 – Proportion and change of land use/cover classes between 1843 and 2018

Land use/cover class	proportion in 1843 (%)	proportion in 2018 (%)	change (% points)
built-up areas	0.19	1.04	0.85
remaining areas	2.23	3.88	1.64
water areas	0.52	0.54	0.03
forest areas	15.87	28.10	12.23
arable land	64.42	48.52	−15.90
permanent grassland	14.51	6.26	−8.25
permanent cultures	2.25	11.66	9.40

1938

1953

2018

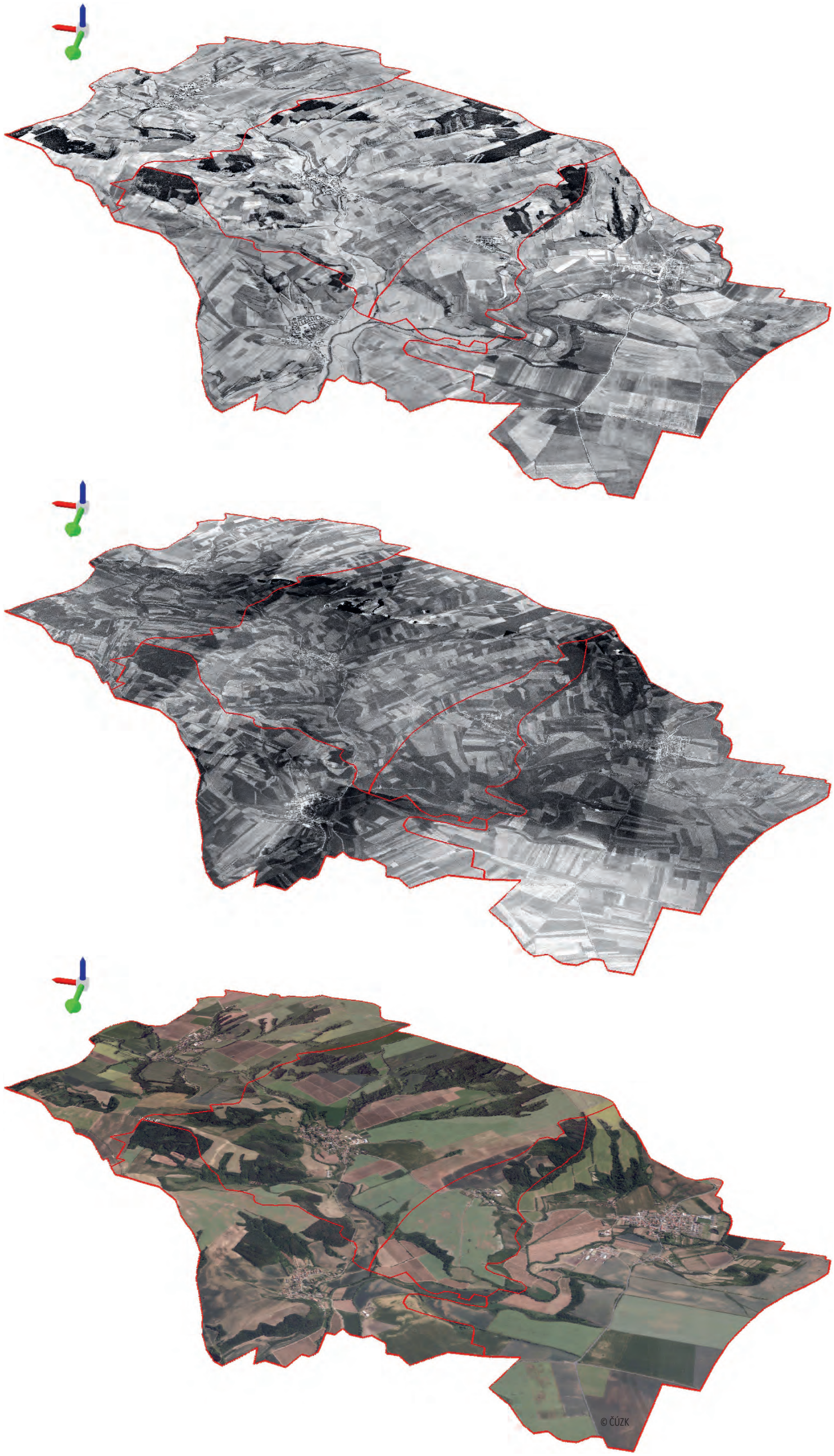


Fig. 4 – Models of landscape – Podbořansko in 1938, 1953 and 2018. Source: Aerial photos © Military Geographical and Hydrometeorological Office in Dobruška, Ministry of Defence, 2018; Orthophoto © The State Administration of Land Surveying and Cadastre, 2018.

Fig. 5 – The view of Velká Černoc. Source: Archive of the NAKI project no. DG18P02OVV008. Photo (2019): Zdeněk Kučera.

2. Area of Interest: Main Features

The wider area of interest Podbořansko extends from the lowlands along the Ohře River with an altitude of about 300 metres a.s.l. up to the wooded slopes of the Slavkovský les (Slavkov Forest) in the south-west where altitudes exceed 500 m a.s.l. In general, the location can be described as peripheral or even strongly peripheral (in the west). The industrial and mining region between Chomutov and Kadaň only touches from the north. The northern and eastern parts of the Podbořansko area have intensive farming. Transport lines are largely on the local level, with only one major railway connecting Chomutov and Žatec with Plzeň.

Podbořansko used to be on the former Czech-German ethnic divide and as such, the area was subject to strong depopulation after World War II. Many locals also moved to the nearby industrial plants and coal mines in the Podkrušnohoří (foothills of Ore Mountains/Krušné hory). Most villages throughout the model area retain its traditional agricultural character. Podbořany – the only town in the area – has some industry and basic services too. The evaluation of following population development shows the increasing share of the population of the core (the town of Podbořany itself).

From the physical-geographical perspective, Podbořansko is part of two geomorphological sub-provinces: the Krušné hory (Ore Mountains) – in geomorphological units of the Mostecká panev (Most Basin) and the Doupovské hory (Doupov Mountains); and the Poberounská subprovincie (area along the Berounka River) – in the geomorphological unit of the Rakovnická pahorkatina (Rakovník Hills). The area has a quite complex geological structure. The Doupovské hory (Doupov Mountains) in the west are formed by neo-volcanic and pyroclastic rocks (basalt, tephrite, andesite, trachyte, and phonolite). Lower parts, the Mostecká pánev and the Žatecká pánev (Most Basin and Žatec Basin), are composed by Neo-genic sands and clays, with some volcanic rocks, Cretaceous sediments, and old crystalline rocks. Most of the Žatec Basin is covered by Quaternary sediments of various origin – mostly eolian loess, fluvial alluvium in the floodplains, and river terraces. The Rakovnická pahorkatina (Rakovník Hills) in the eastern part of the area contains Palaeozoic sediments, especially siltstone, claystone, clay, sandstone, conglomerate, and arkose.

The core area east of Blšany has undulating landscapes of altitudes ranging between 270 and 435 m a.s.l. The Blšanka River and its tributary, the Černocký potok (Černocký Creek), have formed wide, shallow valleys with a well-developed floodplain. There are numerous erosion grooves and ravines. The western edge of the core area is covered by flat, open landscape that was deforested in the past. The Žatec Basin has altitudes between 270 and 360 m a.s.l. It is a largely flat area with some gentle slopes. The Doupovské hory (Doupov Mountains) touch the western extreme of the model area. This is an area of ragged hills with altitudes of up to 550 m a.s.l. Artificial "mountains" found near local kaolin mines form special type of anthropogenic landscape.

Podbořansko is located in a warm and dry area with an average annual temperatures between 8 and 9 °C. The effects of rain shadow caused by the Krušné hory (Ore Mountains) and the Doupovské hory (Doupov Mountains) are significant – annual precipitation amounts to 450–500 millimetres only which makes the Podbořansko area one of the driest areas in Czechia. Winters were usually mild and short in recent years, with very low and unstable snow cover. In autumn and winter, however, inversions occur frequently due to the low-lying terrain. Summers tend to be long, sunny, and dry.

Phytogeographically, Podbořansko is part of the Czech Thermophyticum, the phytogeographical district of the Central Poohří. As regards forests, oak-hornbeam and oak forests prevail. Natural vegetation would consist of oak-hornbeam alternating with thermophilic oak forests. The peripheral parts were originally covered by acidophilous oak forests. In the floodplains, alluvial woodlands would have grown potentially.

3. Results

3.1 Landscape and Land Use/Cover Changes

Figure 3 and Table 1 compare how the landscape looked like in the 1st half of the 19th century (1843) and its state at the present (2018). Two maps containing the core area are compared. These maps and Table 1 indicate that the major land use/cover changes since early 19th century in the Podbořansko area were similar to those recorded on the national level – arable land and permanent grassland have been gradually decreasing (arable land even by about 16%). These land use/cover classes were replaced mainly by forests, especially on sloping grounds. Of all land use/cover classes, forests have seen the highest increase over the examined period. Nevertheless, arable land in Podbořansko still covers 48.5% of the total area, which is well above the national average (approximately 37.5%). On the other hand, forest cover in the Podbořansko area is below the Czech average (33.9%). Permanent cultures, namely hop fields and orchards, are quite

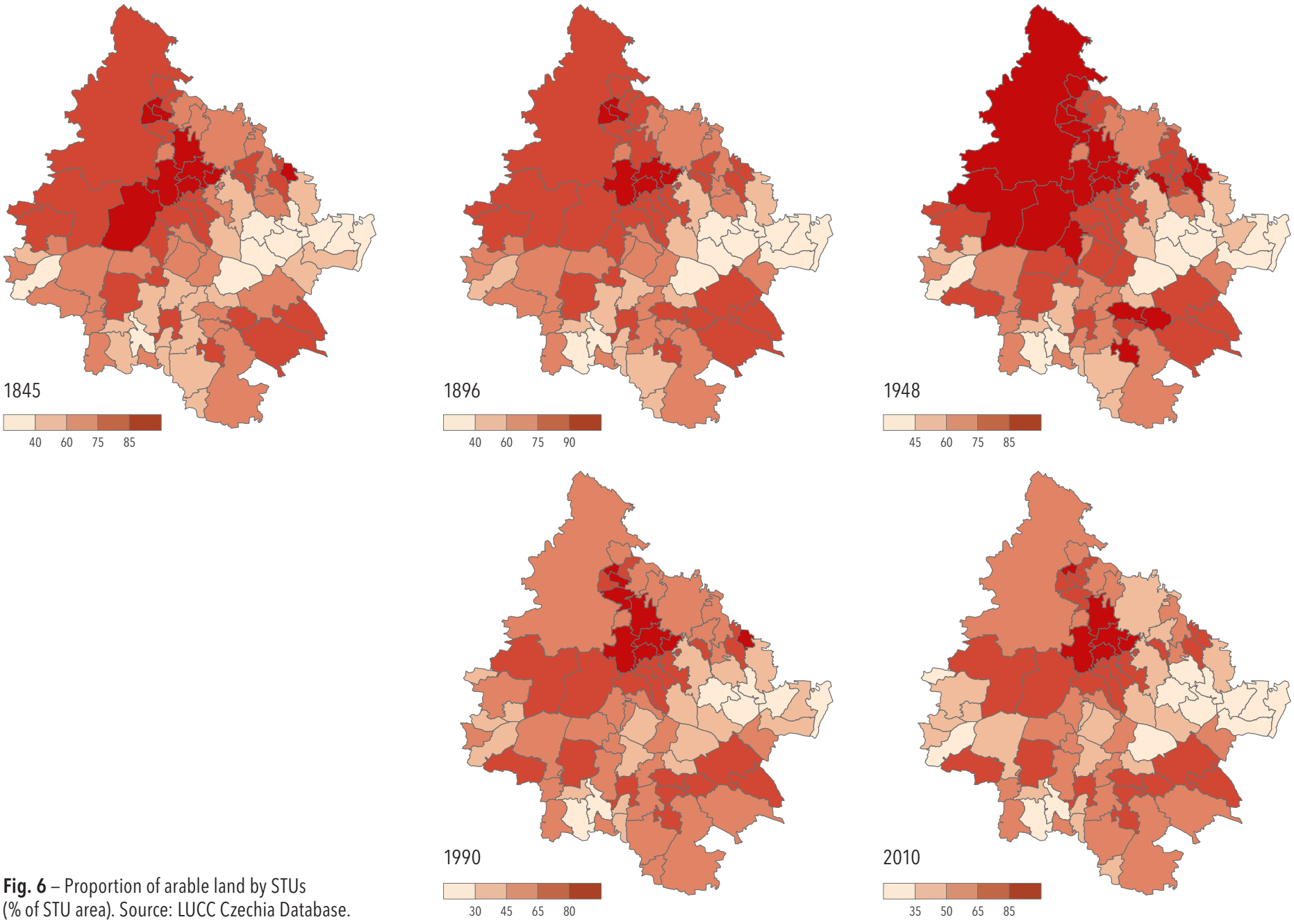


Fig. 6 – Proportion of arable land by STUs (% of STU area). Source: LUCC Czechia Database.

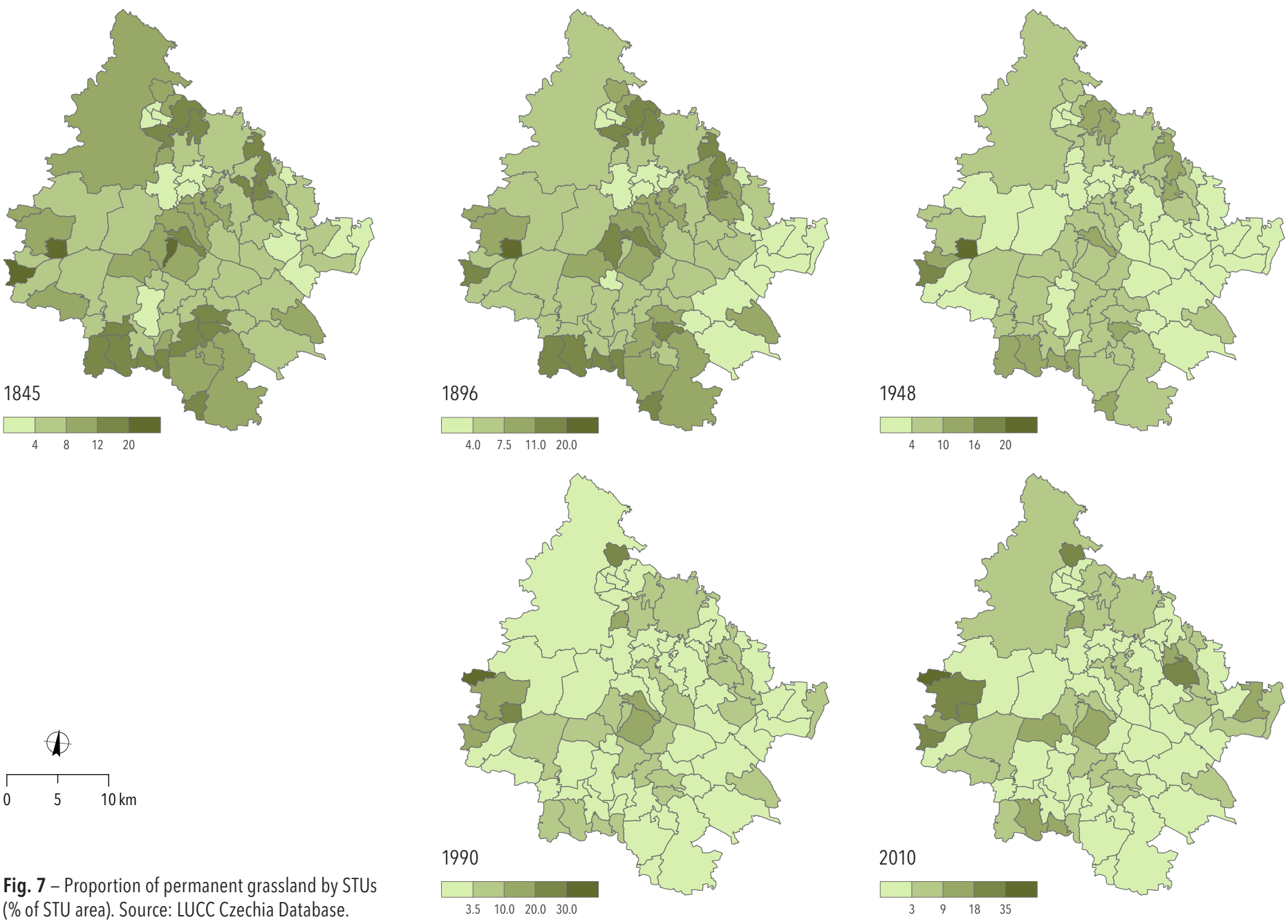


Fig. 7 – Proportion of permanent grassland by STUs (% of STU area). Source: LUCC Czechia Database.

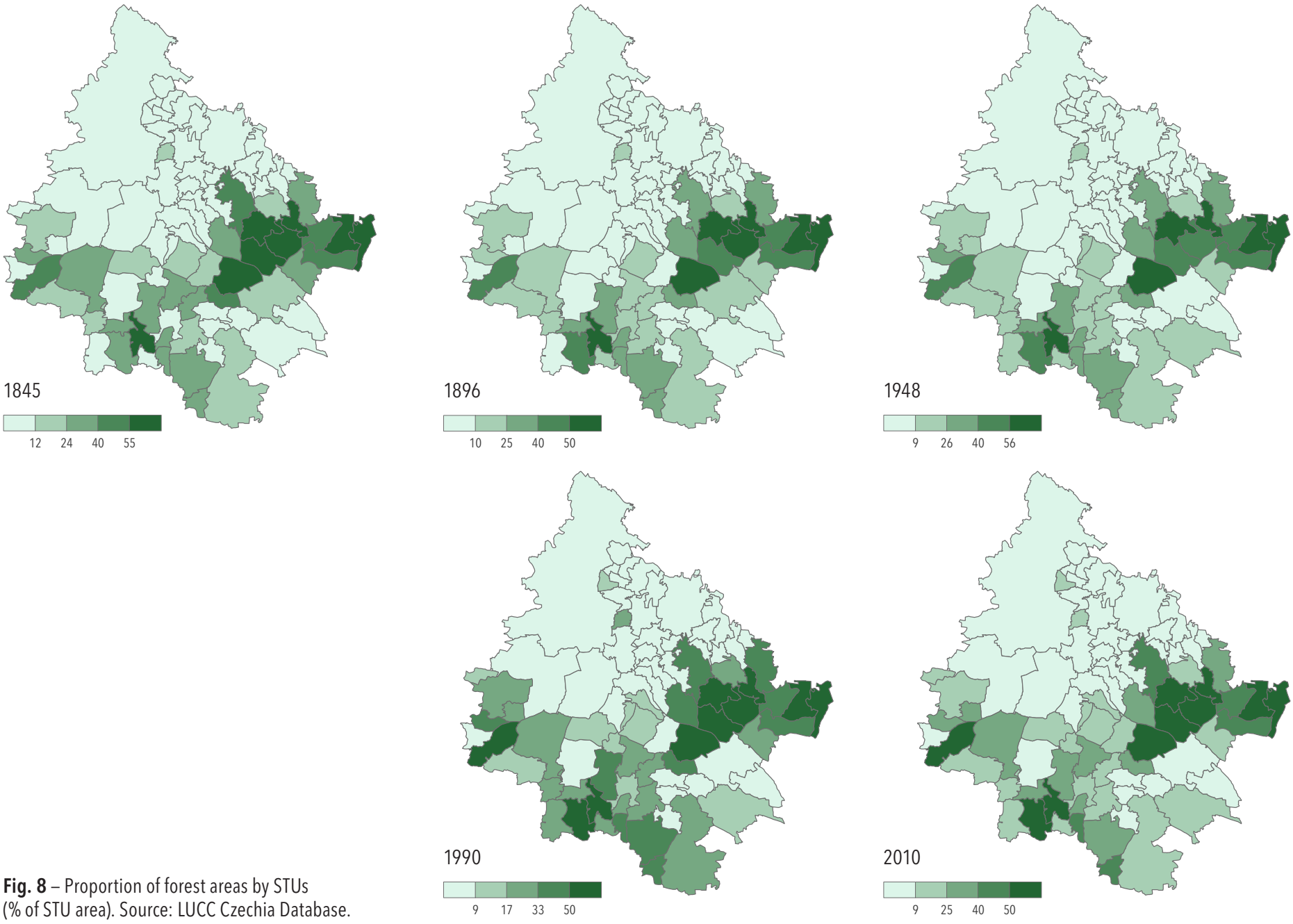


Fig. 8 – Proportion of forest areas by STUs (% of STU area). Source: LUCC Czechia Database.

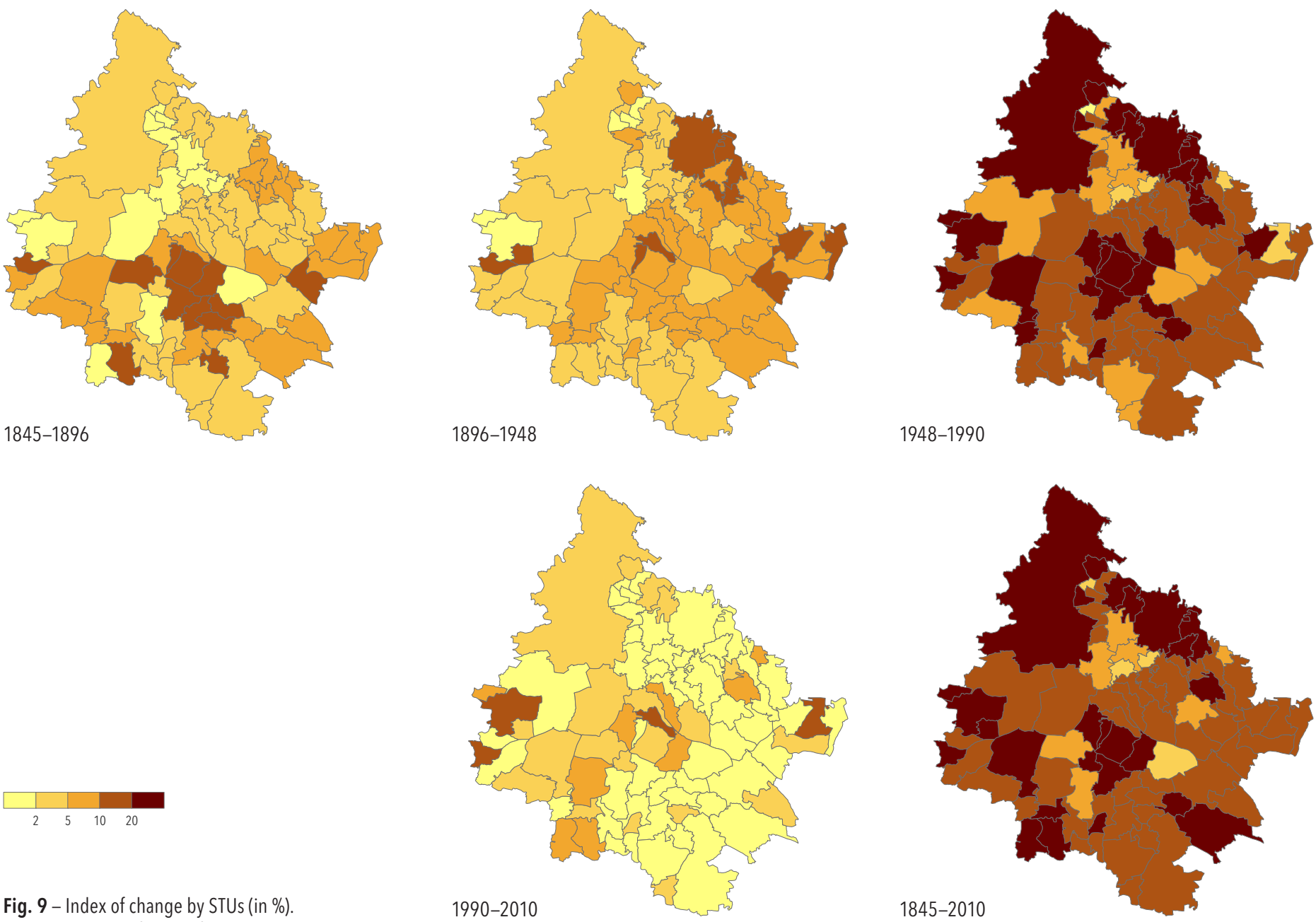


Fig. 9 – Index of change by STUs (in %). Source: LUCC Czechia Database.

Fig. 10 – Municipality emblems.
Source: Register of municipal symbols, Chamber of Deputies of the Czech Republic (https://rekos.psp.cz; as of 1 October, 2018).

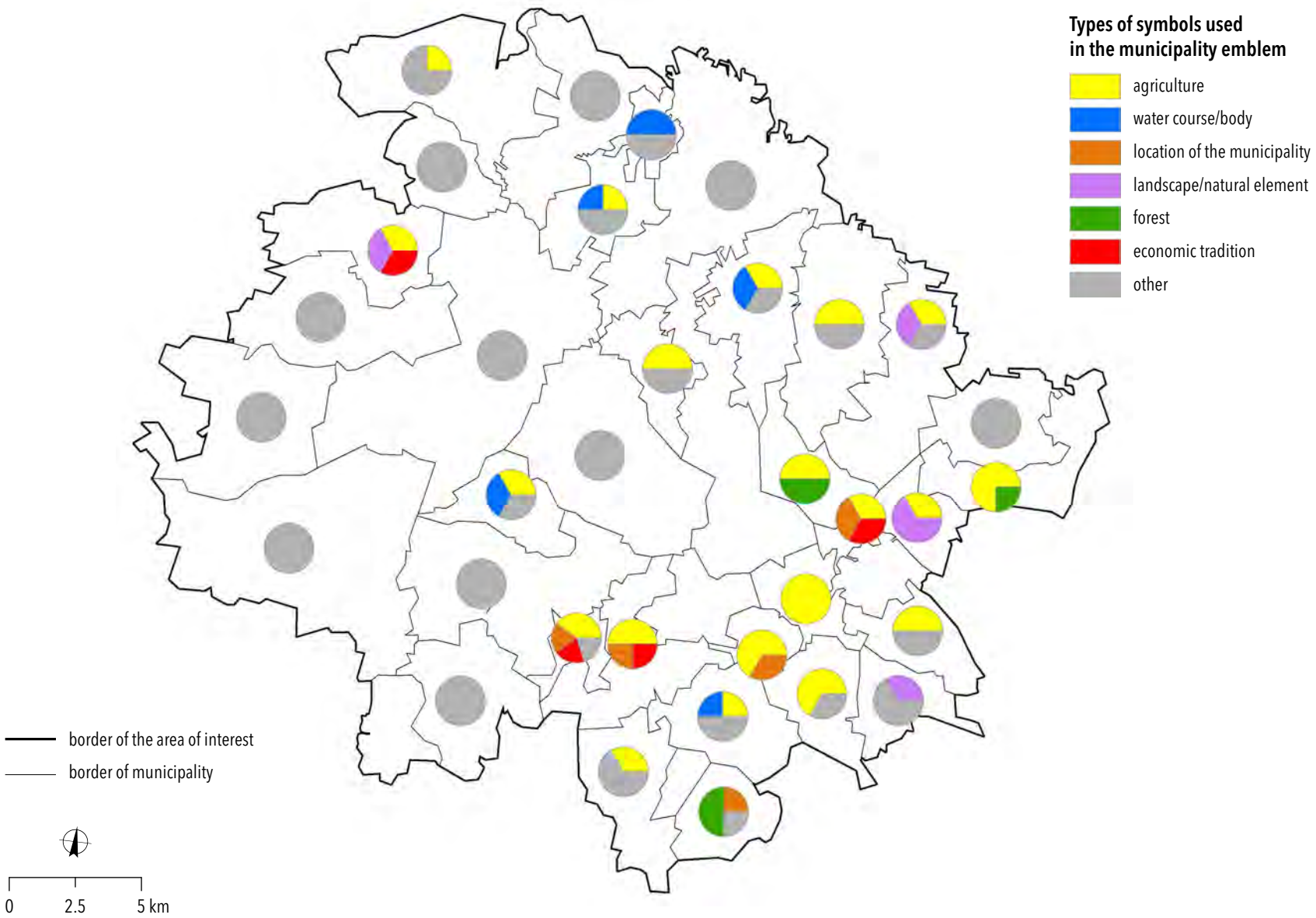


Fig. 11 – Types of symbols used in the municipality emblems.
Data source: Contant analysis of the municipality emblems (as of 1 October, 2018).

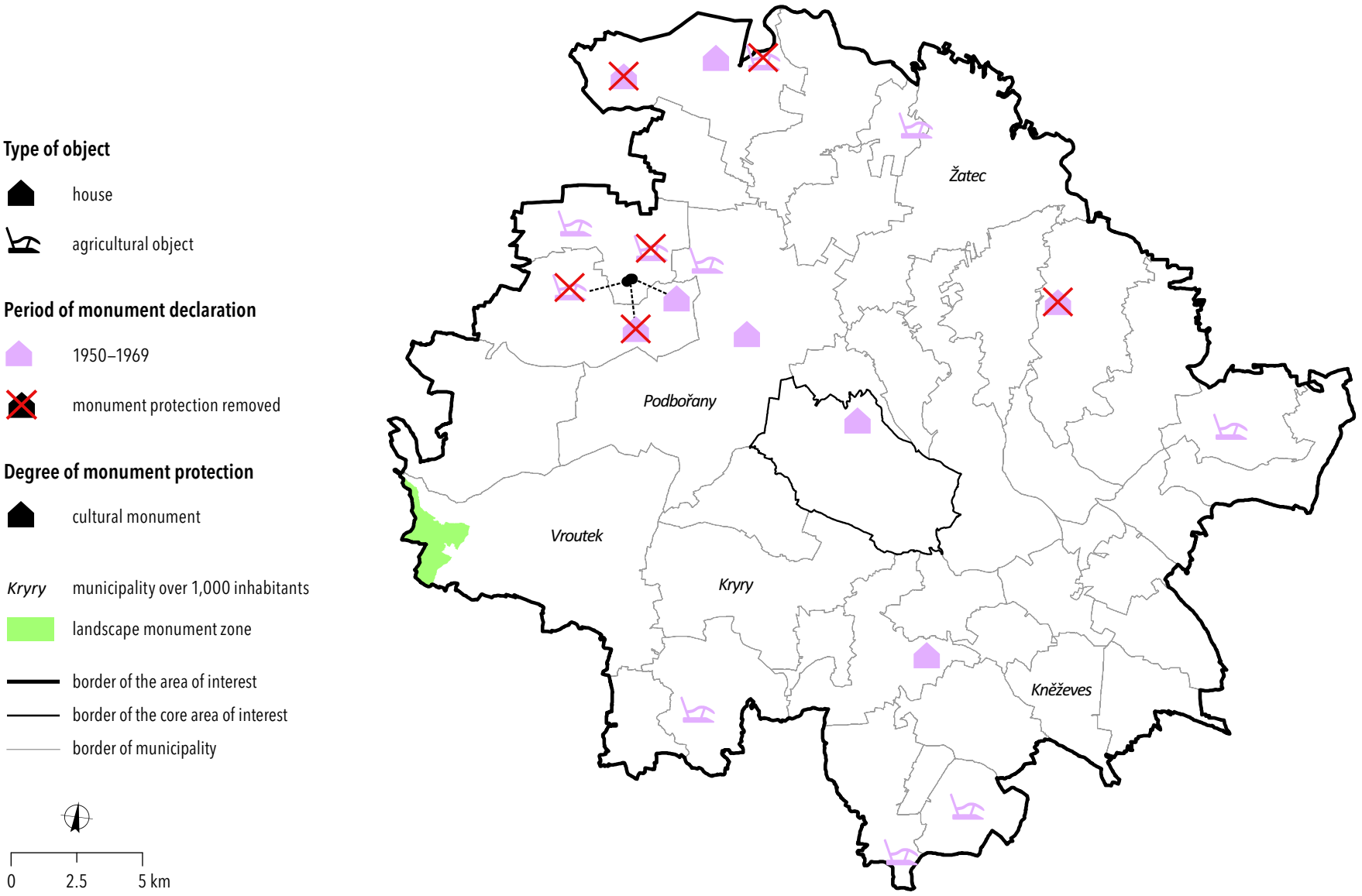


Fig. 12 – Cultural monuments and heritage areas.
Data source: National Heritage Monument Catalogue, National Heritage Institute (https://pamatkovykatalog.cz; as of 1 October, 2018).

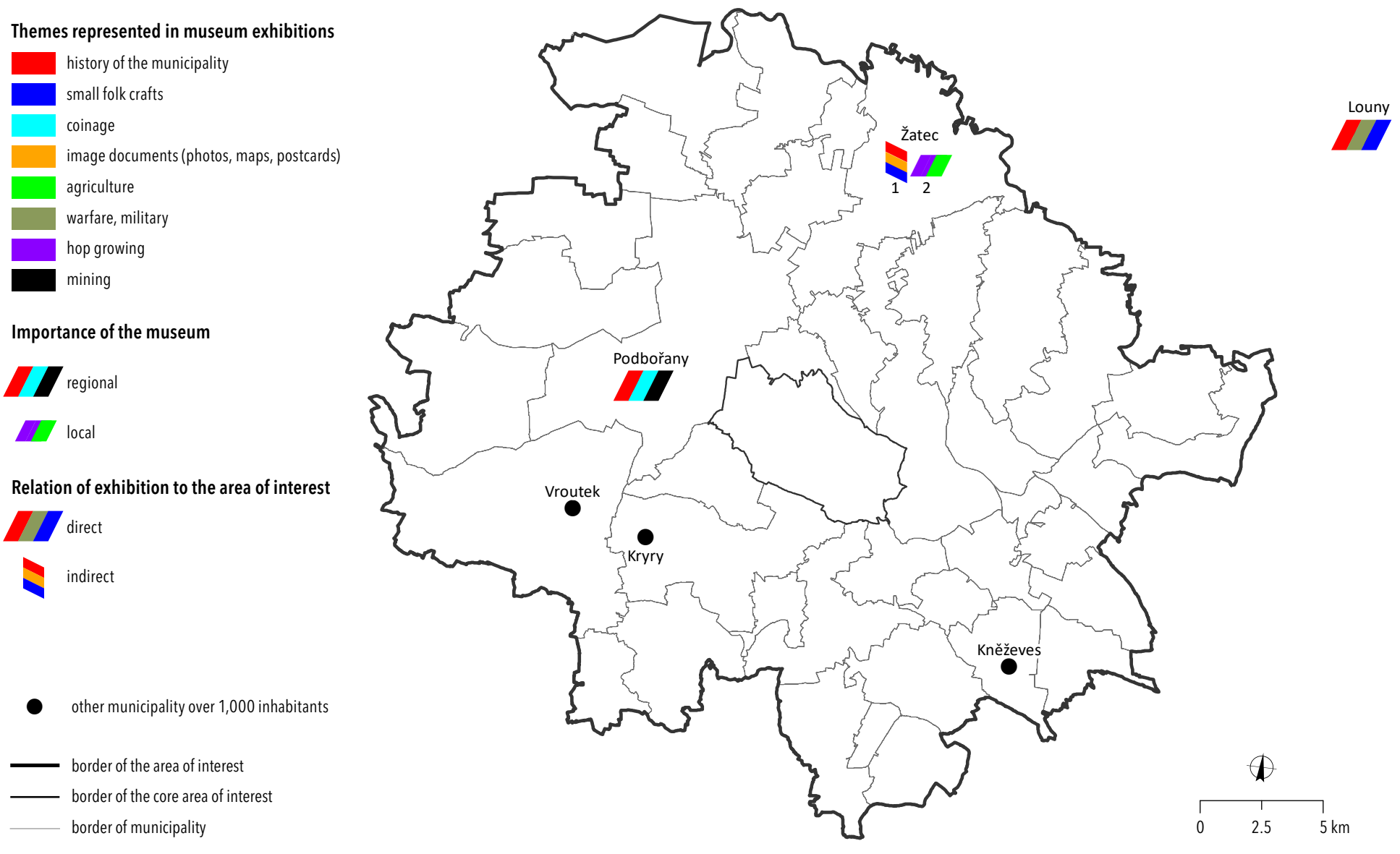


Fig. 13 – Museum exhibitions.
Data source: Czech Association of Museums and Galleries (https://www.cz-museums.cz/web/amg/titulni; as of 1 October, 2018), Webportal Do muzea (https://www.do-muzea.cz; as of 1 October, 2018), Webportal Museum.cz (https://www.museum.cz; as of 1 October, 2018).

widespread in Podbořansko, covering more than 9% of the area (the national average is about 3%).

The above-described changes in land use/cover patterns is in detail completed by models of the disappeared intensive agriculture landscape of the area of interest (Figure 4). 3D models document that during World War II, and during the post-war era, the land was under intensive cultivation and no significant changes in the nature and management of the landscape occurred. The current picture, however, clearly illustrates that agricultural blocks were merged. Thus, the model shows enlarging of blocks of agricultural land, but simultaneously, decrease of agricultural land, which was partly replaced by forests.

Figures 6–9 show wider perspective of land use/cover changes in STUs and describe changes over the time by comparing years 1845, 1896, 1948, 1990, and 2010.

The figures show that arable land covers 85–95% of the total area in the most fertile parts of the area. High proportion of arable land is typical for the whole area of interest. On the other hand, permanent grassland is rare. In the north-eastern part of the Podbořansko area, however, the proportion of arable land ranged only between 28 and 40% at the beginning of the monitoring period. In other words, conditions for farming varied considerably from area to area, being the best in the north-western part. At the same time, it should be emphasized that the proportion of arable land has decreased in most areas over the time, mainly due to development (housing, stables, and workshops were built). In general, the Podbořansko area of interest can be described as peripheral area, with dominating agricultural function supplemented by residential function. The strong role of farming is confirmed by a rather small proportion of forests.

Regarding forests, roughly one half of the municipalities have a very low proportion of forest areas (0–10%) over the entire monitoring period. On the other hand, there are a few isolated parts of Podbořansko where forest cover exceeds 50% of its area.

Depopulation has been an important driver of the above-mentioned changes. Population has decreased significantly practically in all municipalities of the Podbořansko area of interest. The post-war expulsion of ethnic Germans was the main factor. The repopulation schemes proved to be largely unsuccessful is this area (mainly because of its peripheral character). Population decline was further fuelled by the proximity of the Severočeská uhelná pánev (North Bohemian Coal Basin) in the foothills of the Krušné hory (Ore Mountains) where more jobs and higher wages in local industrial plants were available during the socialist era in the 2nd half of 20th century, as well as better housing and services. For these reasons, many former residents of the Podbořansko area moved there.

The index of change shows (Figure 9) that in the area of interest the most significant changes in land use/cover were recorded in the period 1948–1990. The index of change in cadastres in the north of the area ranges between 20–50% as well as in the core area. The overall change of the Podbořansko area was strongly influenced by the strengthening of the military function in the neighbouring Military Training Area Hradiště/Doupov. The former (pre-war) residential-agricultural function of the area was considerably weakened and the industrial and service functions were strengthened in the post-war era (but only in the core area).

3.2 Landscape memory

The landscape memory of the Podbořansko area is shown in four maps described in following sections 3.2.1–3.2.3 (for more details about methodology of mapping see Chapter 1 of Atlas).

3.2.1 Places and institutions of memory

There are four institutions in the area of interest that deal with the transformation of local agricultural landscape (Figure 13). The Podbořany Municipal Museum shows the history of Podbořany from different perspectives. The exhibitions include geological and palaeontological features, natural attractions, and also the fate of so-called Volhynian Czechs who, in the second half of the 19th century, were leaving Bohemia for Tsarist Russia in search of prosperity and fertile agricultural land. Podbořansko was one of the regions within former Czechoslovakia where many Volhynian Czechs returned to after the end of World War II.

The Louny Municipal Museum offers visitors exhibitions focused on local geology and nature. Permanent exhibitions are complemented by smaller exhibitions of folk crafts from the Louny area.

Two museums are in the centre of Žatec. The Hop Museum, reportedly the biggest one of its kind in the whole world, shows the history of hop growing from early Middle Ages to the present time. Hop growing significantly shaped the character of the local landscape and it also used to be an important source of income for local farmers. The exhibition in this museum provides information on hop growing, related beer production, and displays historical machinery. The second museum in Žatec, The Regional Museum of K. A. Polák, presents Žatec and its surrounding area as a whole and includes exhibits on historical and urban development and folk crafts. Images (photographs, historic pictures, and postcards) of disappeared buildings are also shown.

3.2.2 Regional and local symbols

Symbols used (pictured) in municipality emblems in the Podbořansko area (Figures 10 and 11) show very clearly that this is an area with intensive hop cultivation. 16 out of 34 emblems include a reference to hop. Typically, hop cultivation is depicted by hop plant with leaves and cones, sometimes just by a single cone (for example emblem of Deštnice). There are also other symbols referring to farming – let it be grain ear (Čeradice, Libořice) or sheaf (Hořovičky). Some local symbols include references to local rivers and creeks, for instance to the Blšanka River. This is the case of Holedeč – half of its emblem is blue and has a stylized coloured wave. The Ohře River is represented in the lower part of the Libočany emblem (blue wave).

The character of some municipality emblems reflects distinctive features of local landscapes. This is the case of Hořesedly and Hořovičky – hill or hills refer to nearby Doupov Mountains. The symbol of Pšovlky includes two green hills with coniferous trees (hilly region with vast forests), and, interestingly, also figure of wolf (this animal supposedly roamed the countryside in the past).

Only few references to mining are found in the emblems. One example is a black dot in the middle of emblem of Janov. Silver spikes in the emblem of Kolešov may refer to the extraction of granite.

Even references to local historical and natural sites are found on some municipal symbols. The one of Kounov includes a number of silver stones depicting the local peculiarity – long parallel rows of unknown origin and purpose. Black-and-white chevron, part of the symbol of Tuchořice, symbolizes the local travertine outcrop.

3.2.3 Heritage sites

There are many farm buildings and private houses that have been declared cultural monuments in the Podbořansko area of interest. All places shown in the map (Figure 12) used to

be under legal protection in the 1950s and 1960s. However, in some cases the status of listed monument has been revoked recently – one building in 1998 and five more in 2009. Poor state and inadequate technical conditions were among the reasons; some isolated buildings were even demolished. The sites that enjoy legal protection include granaries, farmsteads, country houses, farms or their remains (e.g. gate of a former farmhouse in Dolánky near Kaštice).

4. Summary

The Podbořansko area of interest lies in a fertile area suitable for agriculture and its area is densely populated since the Neolithic period. Therefore, there are not many natural forests stands here and the most valuable types of vegetation are forest-free biological communities, closely related to human activity.

The area of stable areas with unchanged use reaches 54%. This means that less than half of the area has changed its use during the reporting period. The traditional agricultural area shows stable and continuous coverage by arable land. Despite its decline, the share of arable land in the area is still far above the national average. Similarly, significantly higher than the national average is the share of permanent crops which are represented by traditional hop growing fields and orchards in the area.

The extensification of land use/cover, which is the dominant process of recent development landscape, begins in the 2nd half of the 20th century. After that, mainly in 1990s, some orchards have been abandoned, and the bushes of the "new wilderness" have spread on their slopes and erosion ravines. The current grazing areas were established mainly on sloping land, previously used as arable land. Livestock grazing contributes to ecological stabilization of the landscape and changes its character.

The location of the Podbořansko area near the former border of the Protectorate, as well as the strongly industrial and mining area of the Podkrušnohoří, led to strong depopulation of the area in the 2nd half of the 20th century. The former traditional agricultural-residential function of the municipalities in the area is largely preserved even until today, apart from Podbořany itself with a relatively strong industrial service function. The former landscape of intensive agriculture should be reminded by protection of residential and farm buildings remaining in the rural parts of the Podbořansko area of interest.

References and Data Sources

BALATKA, B., KALVODA, J. (2006): Geomorfologické členění reliéfu Čech. Kartografie, Praha.

DEMEK, J. (ed.) a kol. (1987): Zeměpisný lexikon ČSR. Hory a nížiny. Academia, Praha.

NEUHÄUSLOVÁ, Z., MORAVEC, J. (eds.) a kol. (1997): Mapa potenciální přirozené vegetace České republiky. Map of potential natural vegetation of the Czech Republic. Kartografie, Praha.

PLÍVA, K., ŽLÁBEK, I. (1986): Přírodní lesní oblasti ČSR. SZN, Praha.

QUITT, E. (2009): Klimatické oblasti. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SEDLÁČEK, J., JANDERKOVÁ, J., ŠEFRNA, L. (2009): Půdní asociace. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SKALICKÝ, V. et al. (2009): Fytogeografické členění. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

Archive Maps of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK), Central Archive of Surveying and Cadastre. https://archivnimapy.cuzk.cz/uazk/pohledy/archiv.html (1. 10. 2019).

Czech Association of Museums and Galleries (Asociace muzeí a galerií České republiky). https://www.cz-museums.cz/web/amg/titulni (1. 10. 2019).

Do muzea. https://www.do-muzea.cz (1. 10. 2019).

eKatalog BPEJ. https://bpej.vumop.cz/ (1. 10. 2019)

Geologická mapa ČR 1 : 50 000. https://mapy.geology.cz/geocr50/ (1. 10. 2019).

Geoportal of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK). https://geoportal.cuzk.cz/ (1. 10. 2019).

Land Use Land Cover Czechia Database. https://www.lucccz.cz/databaze/ (1. 10. 2019).

Museum.cz. https://www.museum.cz/ (1. 10. 2019).

National Heritage Monument Catalogue, The National Heritage Institute (Národní památkový ústav – NPÚ). https://pamatkovykatalog.cz/ (1. 10. 2019).

Portál informačního systému ochrany přírody. http://webgis.nature.cz/mapomat/ (1. 10. 2019).

Půdní mapa ČR 1 : 50 000. https://mapy.geology.cz/pudy/ (1. 10. 2019).

Register of communal symbols (Registr komunálních symbolů), Chamber of Deputies of the Czech Republic. https://rekos.psp.cz (1. 10. 2019).

Ústřední seznam ochrany přírody. http://drusop.nature.cz/ (1. 10. 2019).

Acknowlegment

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CHAPTER 7

Rosicko-Oslavansko: Former Mining and Industrial Landscapes

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1. Introduction

The post-industrial landscape of the Rosicko-Oslavansko area of interest is an example of originally agricultural landscape that was later transformed by industries based on black coal as a main energy source. Metallurgy and related industrial branches made advantage of local sources of iron ore. Over the past 250 years, the area had undergone several stages of industrialization – and eventually saw the decline of local industry. Before the commencement of coal mining, the fertile area around Oslavany was largely deforested and used for agriculture.

Fundamental land use/cover changes occurred after the discovery of coal deposits in the late 18th century and especially in the 19th century. There were eight complexes of coal mines (and many more small pits) in the 19th century in Zbýšov, Oslavany, Padochov, Zastávka, and Babice. Ironworks and steelworks were founded in Zastávka and Oslavany. Coal mining and industrial exploitation caused far-reaching changes in the landscape: working class districts were built on former agricultural land, grassland disappeared as did all ponds. Water streams were carefully monitored so that the water would not penetrate into the mines.

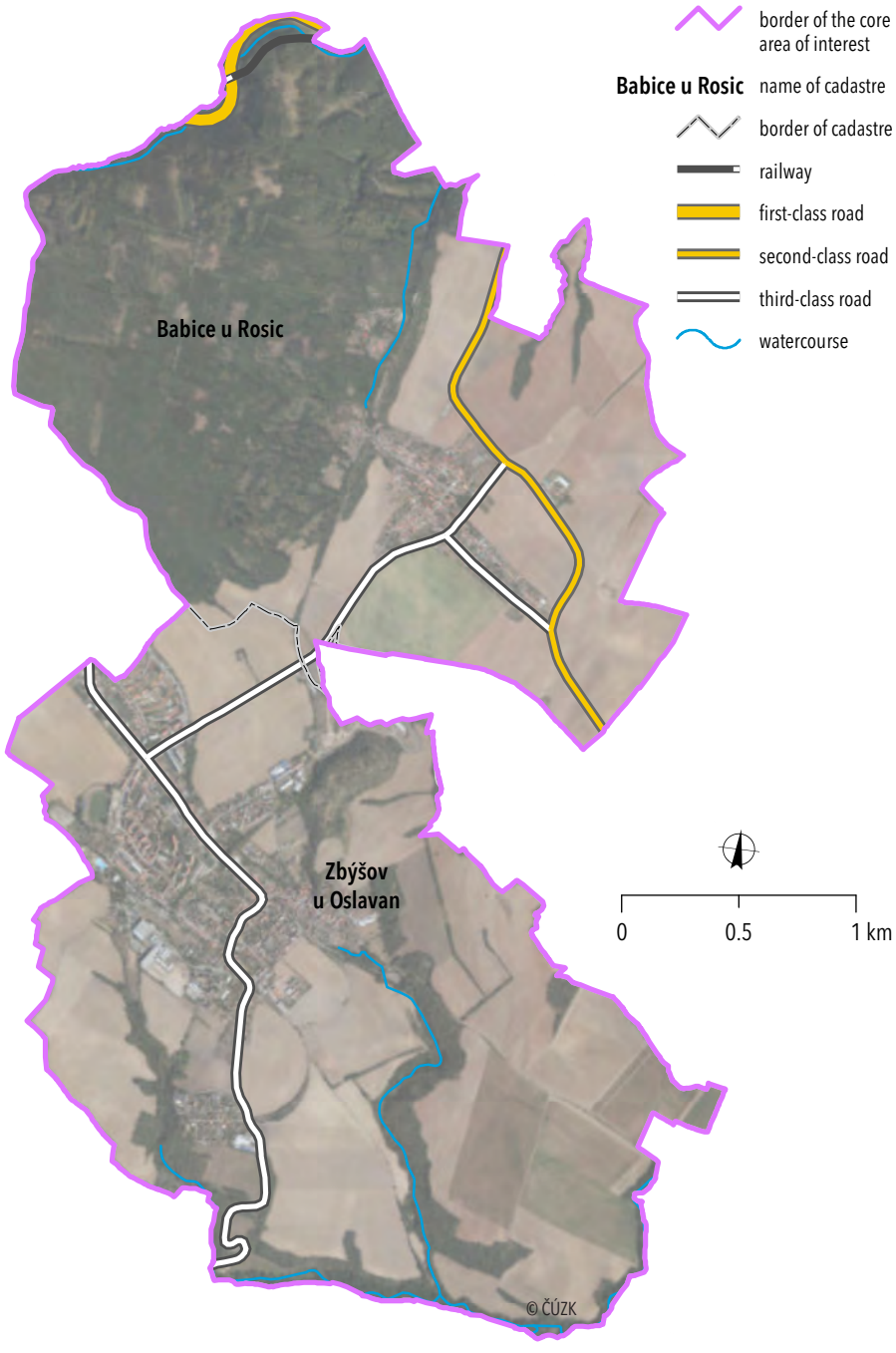


Fig. 1 – The core area of interest. Map basis: Data50;
Orthophoto © The State Administration of Land Surveying and Cadastre, 2019.

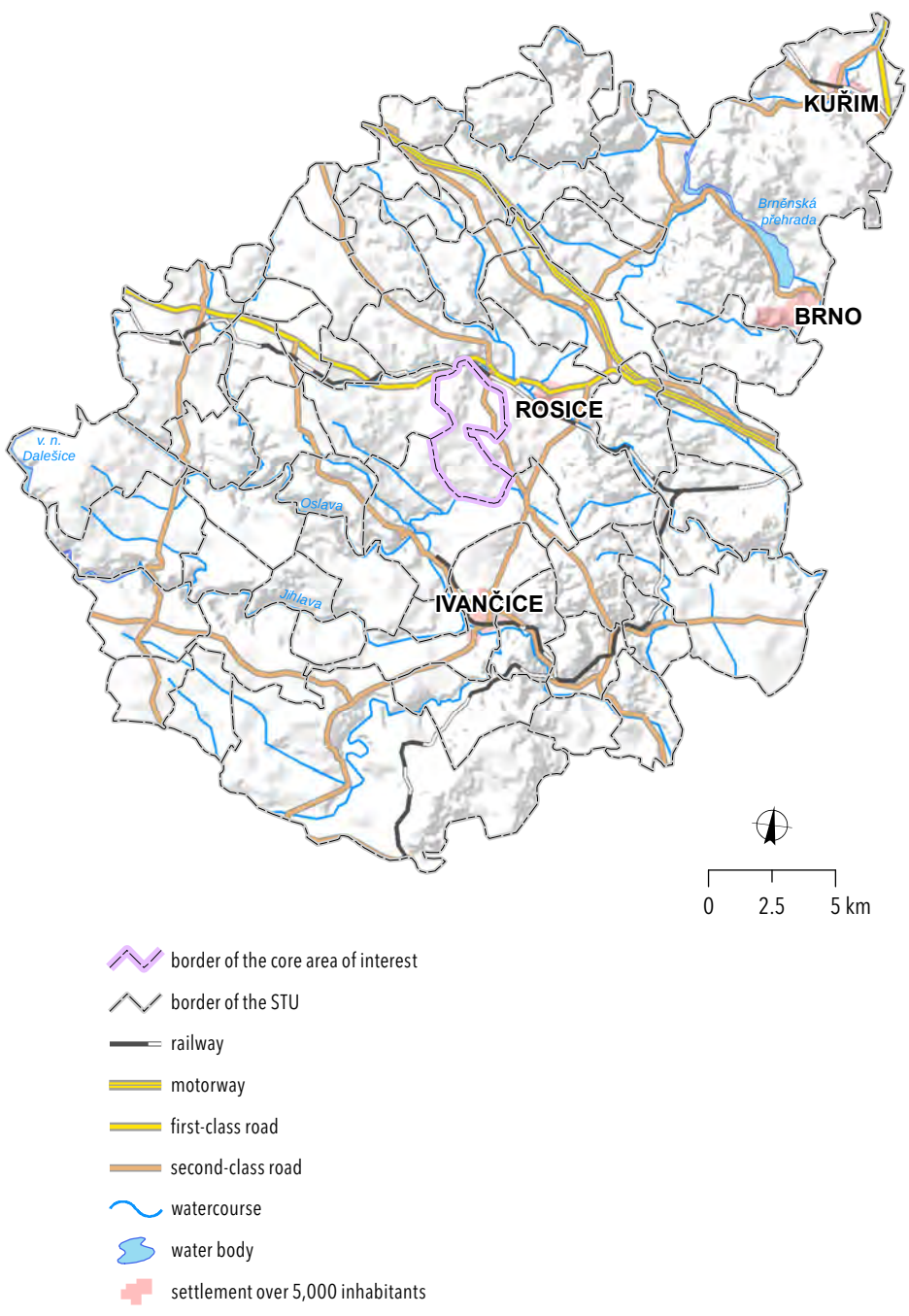


Fig. 2 – The wider area of interest.
Map basis: Data50.

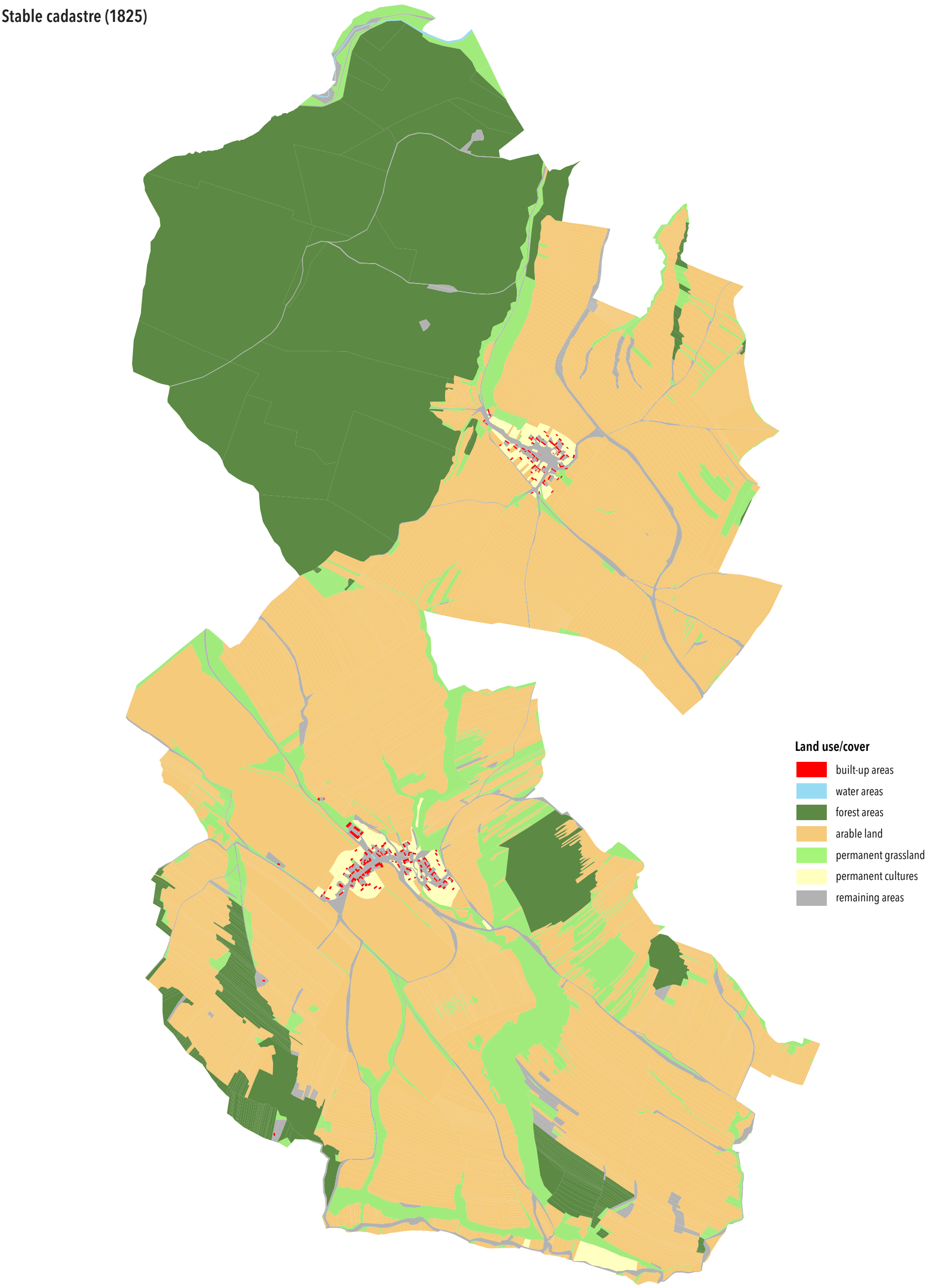
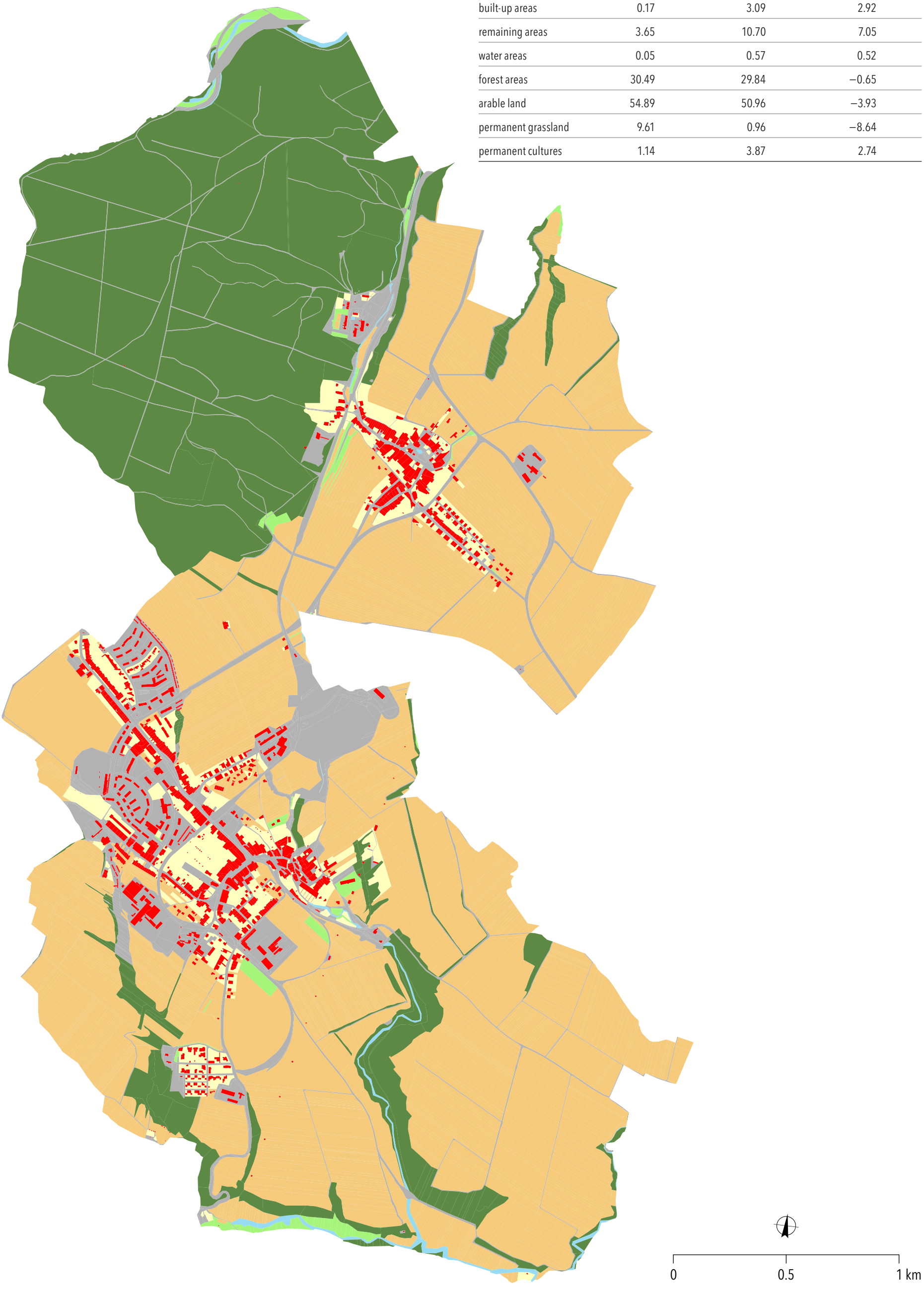


Fig. 3 – Land use/cover in cadastres Babice u Rosic and Zbýšov u Oslavan in 1825 and 2018.
Map basis: The State Administration of Land Surveying and Cadastre.

Current state (2018)

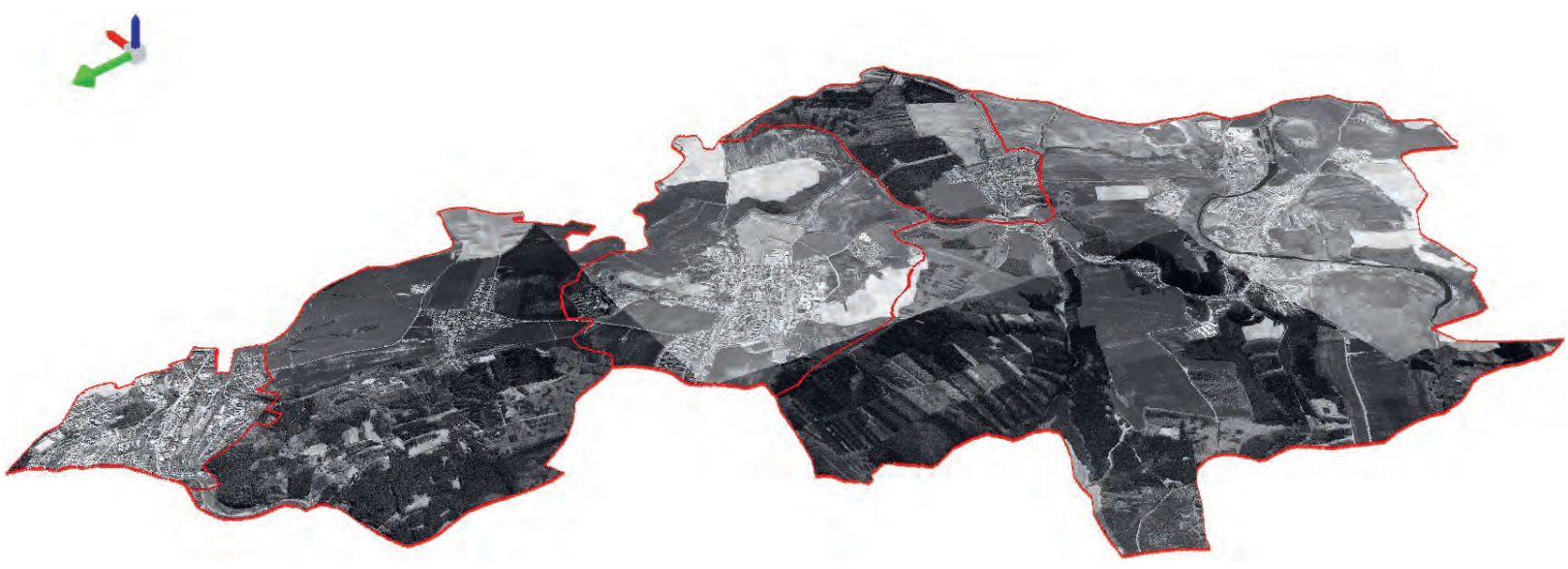


Tab. 1 – Proportion and change of land use/cover classes between 1825 and 2018

Land use/cover class	proportion in 1825 (%)	proportion in 2018 (%)	change (% points)
built-up areas	0.17	3.09	2.92
remaining areas	3.65	10.70	7.05
water areas	0.05	0.57	0.52
forest areas	30.49	29.84	−0.65
arable land	54.89	50.96	−3.93
permanent grassland	9.61	0.96	−8.64
permanent cultures	1.14	3.87	2.74

1953

1990



2018

Fig. 4 – Models of landscape – Rosicko-Oslavansko in 1953, 1990 and 2018. Source: Aerial photos © Military Geographical and Hydrometeorological Office in Dobruška, Ministry of Defence, 2018; Orthophoto © The State Administration of Land Surveying and Cadastre, 2018.

Fig. 5a – The centre of Oslavany. Source: Archive of the NAKI project no. DG18P02OVV008. Photo (2018): Zdeněk Kučera.

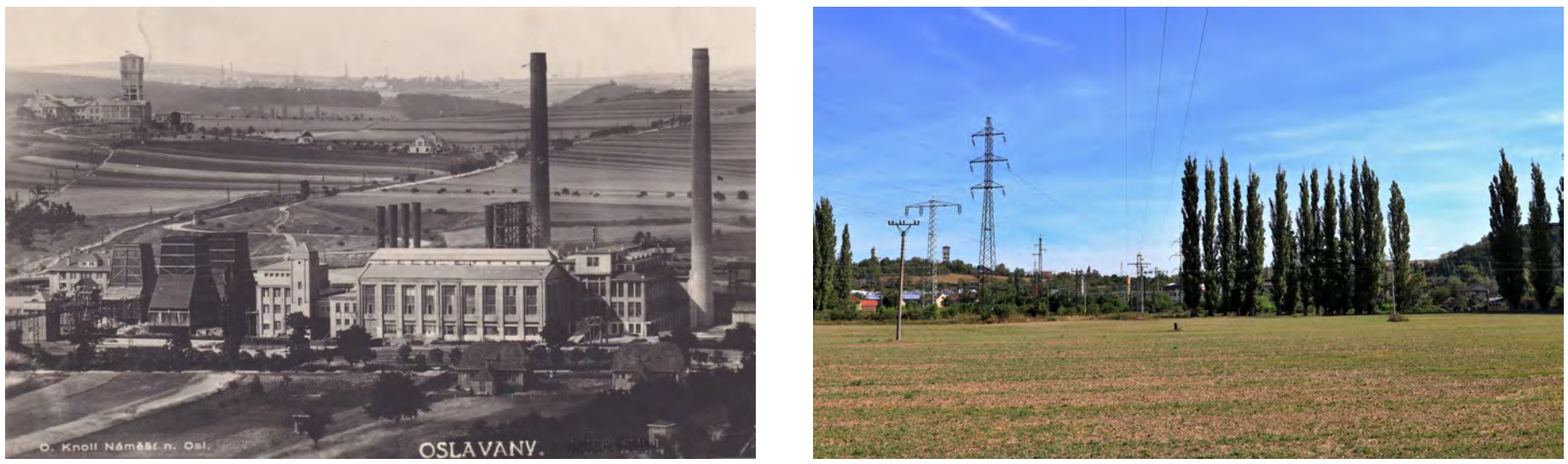


Fig. 5b – Former power plant in Oslavany. Source: Archive of the NAKI project no. DG18P02OVV008. Photo (2018): Zdeněk Kučera.

The Rosicko-Oslavansko area established close links with the nearby booming urban area of Brno. Coal mining had culminated in the first half of the 20th century; however, downturn was gradually taking place since 1960s, and mining eventually stopped in 1980s. Local ironworks closed down as did sugar refineries in Rosice and Oslavany. In early 1990s, mining facilities and industrial complexes were largely abandoned. At the present time, pits are filled up. The area between Babice and Zastávka is a typical example of a brownfield site full of dilapidated industrial buildings, overgrown by vegetation, with man-made tailings. Some of the former mines and tailings have been reclaimed; photovoltaic plant and an amusement park also came to existence in these areas. Railway lines serving the mines and plants have been mostly dismantled.

A number of former mining facilities and industrial buildings survived in the Rosicko-Oslavansko area of interest. These form typical examples of heritage sites reflecting the times of industrial heydays. At present, farming is becoming more important again. Recently, the area has also experienced a lot of residential development as it is easy to commute on every day basis to Brno where many jobs are concentrated. From the visual point of view, the countryside has become more “rural” over the past three decades: many railway lines, cable cars, power lines, and factory chimneys were demolished, tailings reclaimed and planted by trees and shrubs. Industrial heritage sites are nowadays found mostly within the limits of urbanized areas. In the open landscape, the history of mining area is represented only by anthropogenic relief forms.

For the purposes of this project, the so-called core area has been delimited; most analyses are carried out here (Figure 1). The core area includes the municipal areas of Babice u Rosic and Zbýšov u Oslavan. The wider area of interest (see Chapter 1 of Atlas for more details) is shown in Figure 2.

2. Area of Interest: Main Features

The model area of post-industrial landscape of the Rosicko-Oslavansko is located in the geomorphological area of the Brněnská vrchovina (Brno Highlands). The core area lies in the geomorphological unit of the Boskovická brázda (Boskovice Depression), the sub-unit of the Oslavanská brázda (Oslavany Depression), the district of the Zbýšovská pahorkatina (Zbýšov Hills). Towards east, the wider area extends into the geomorphological unit of the Bobravská vrchovina (Bobrava Highlands).

The geological bedrock of the core area in the Oslavany Depression is formed by Carboniferous, Permian, and Neogene sediments (clay shales, claystones, arkoses, conglomerates, wackes). The Quaternary Era is represented by loess and loess loam on plateaus and gentle slopes and also by fluvial sediments in the floodplains. Metamorphic rocks (orthogneisses, migmatites, granulites, sometimes serpentine) prevail in the wider area of interest west of the Oslavany Depression on the edges of the Bohemian-Moravian Highlands (Bíteš Highlands). In the wider area east of the Oslavany Depression (Bobrava Highlands), the bedrock consists of deep igneous rocks belonging to Brno Pluton

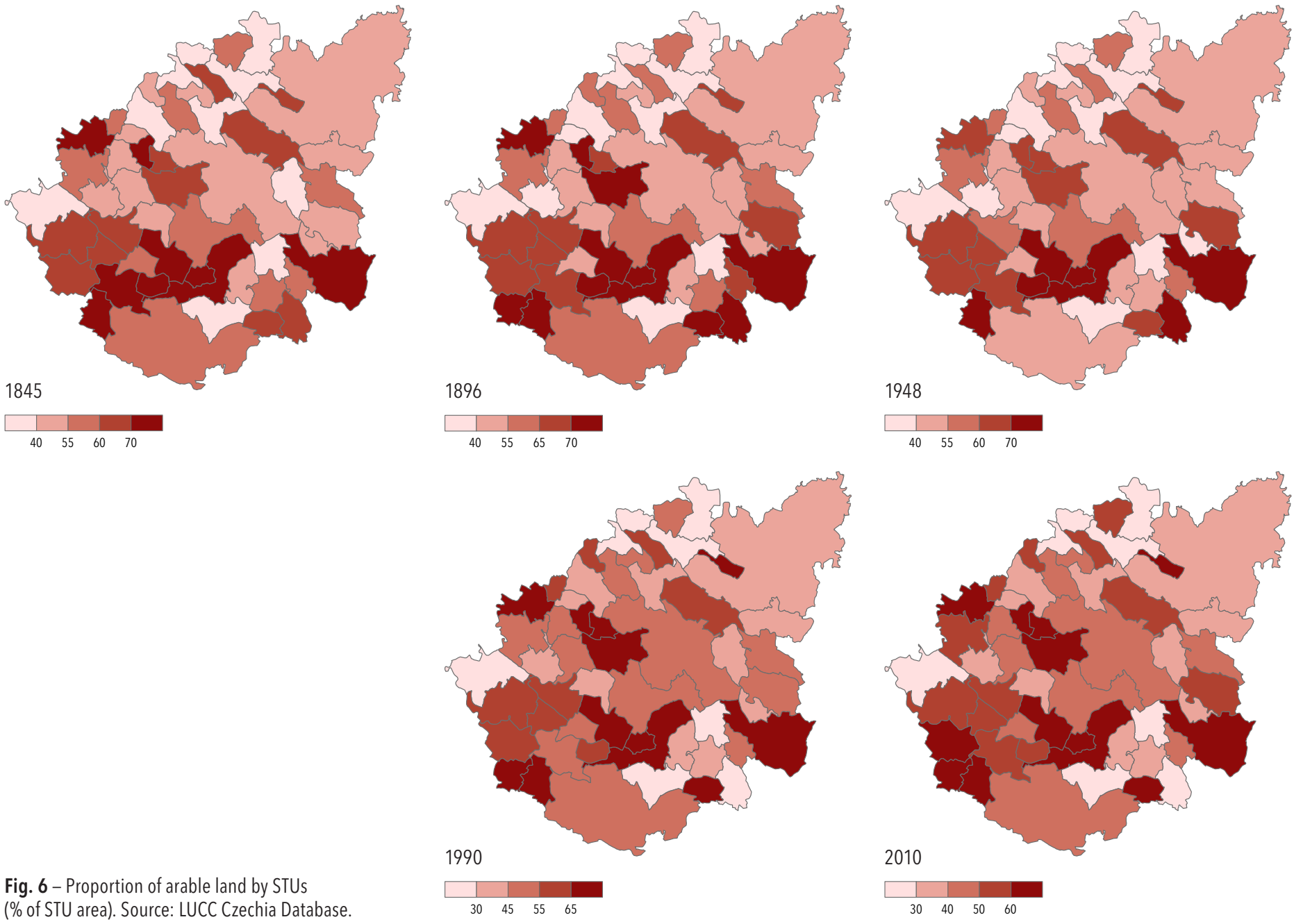


Fig. 6 – Proportion of arable land by STUs (% of STU area). Source: LUCC Czechia Database.

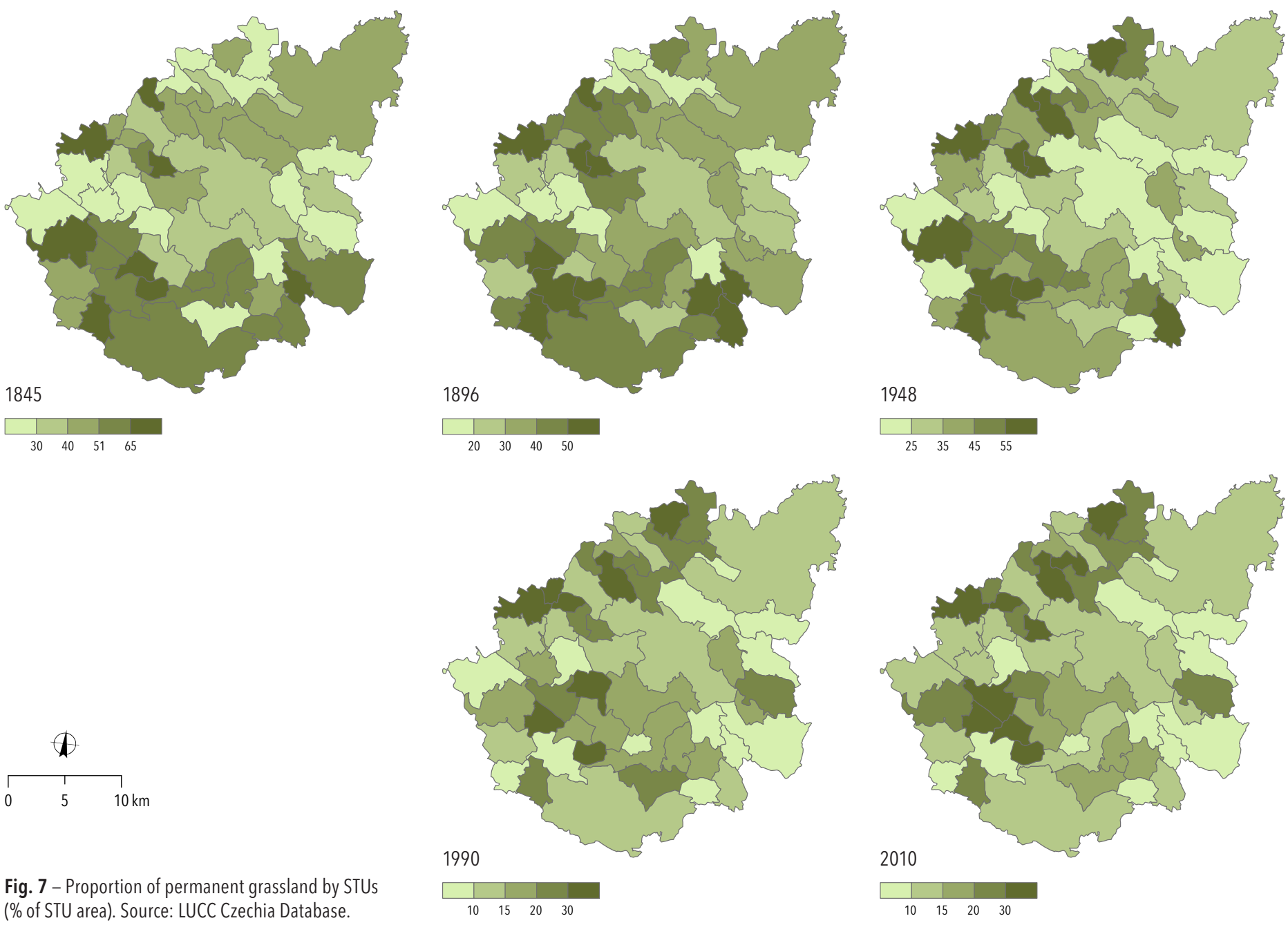


Fig. 7 – Proportion of permanent grassland by STUs (% of STU area). Source: LUCC Czechia Database.

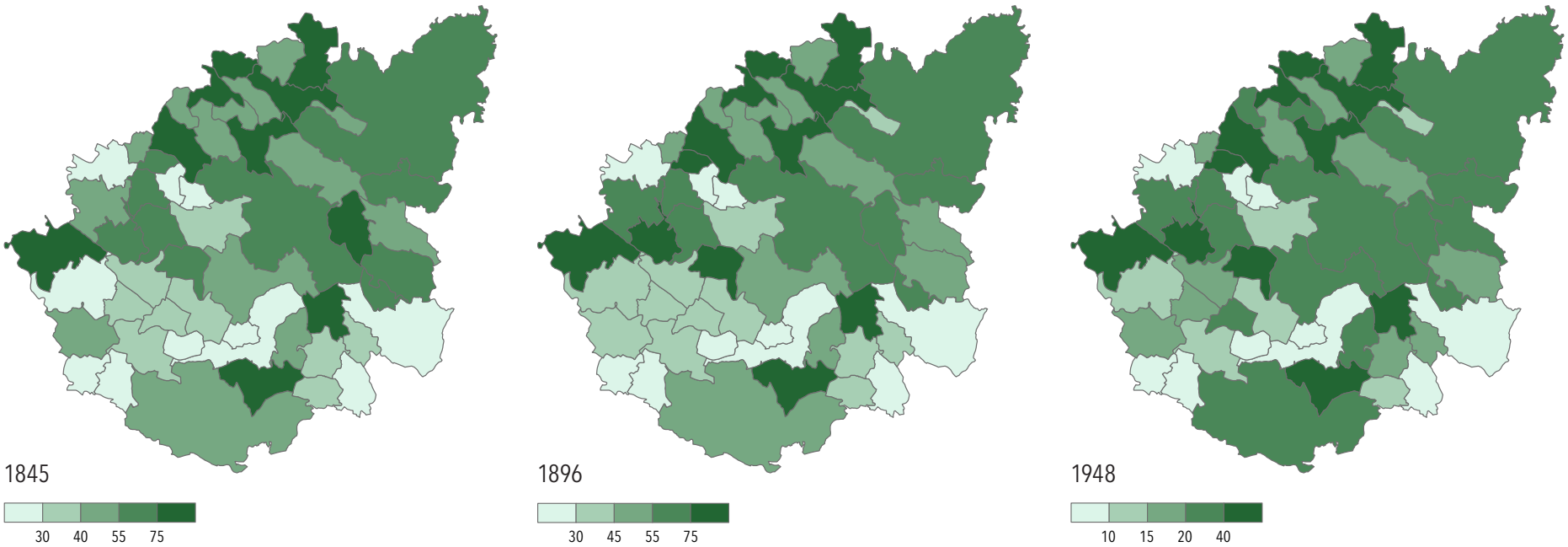


Fig. 8 – Proportion of forest areas by STUs (% of STU area). Source: LUCC Czechia Database.

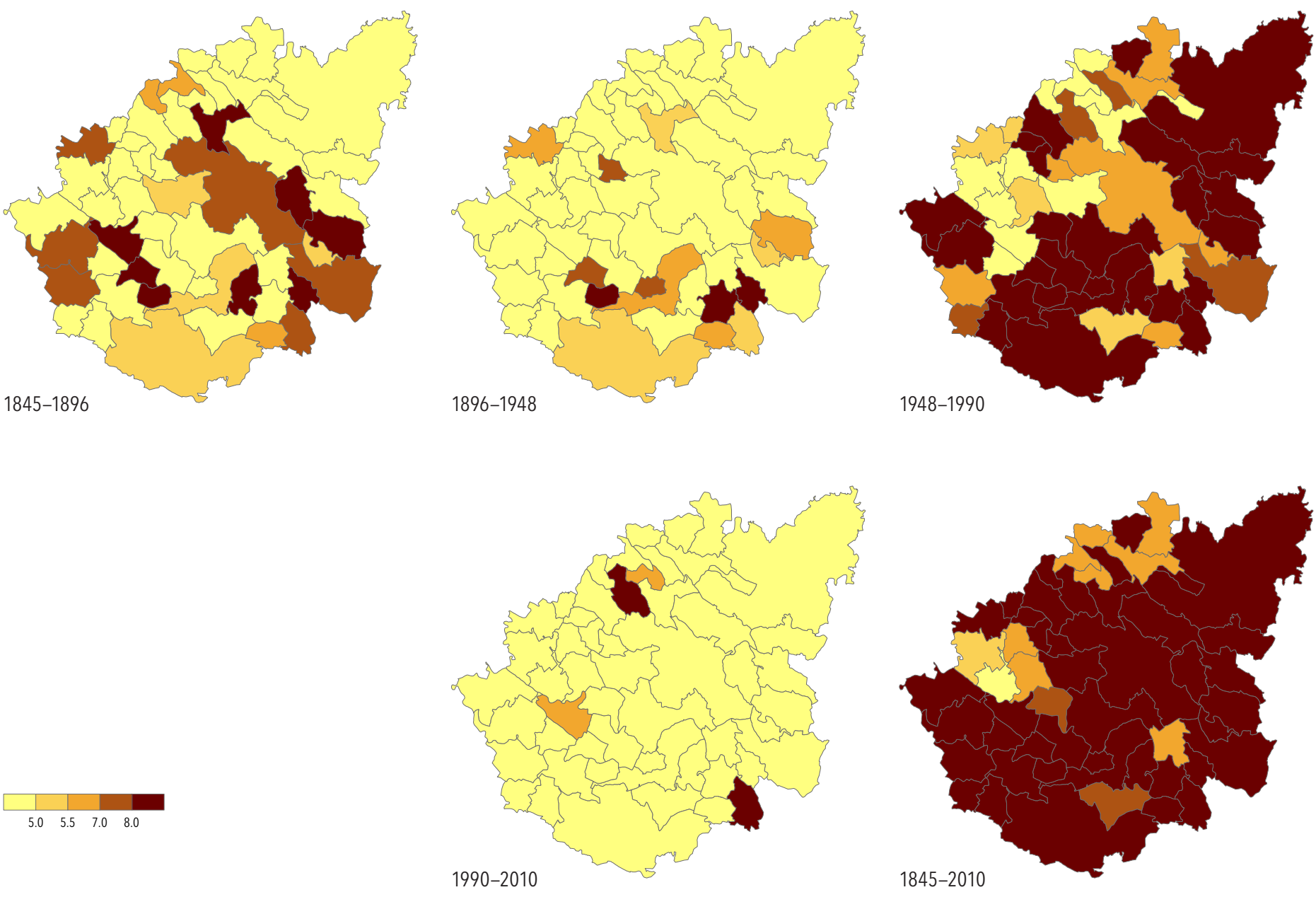


Fig. 9 – Index of change by STUs (in %). Source: LUCC Czechia Database.

Fig. 10 – Municipality emblems.
Source: Register of municipal symbols, Chamber of Deputies of the Czech Republic (https://rekos.psp.cz; as of 1 October, 2018).

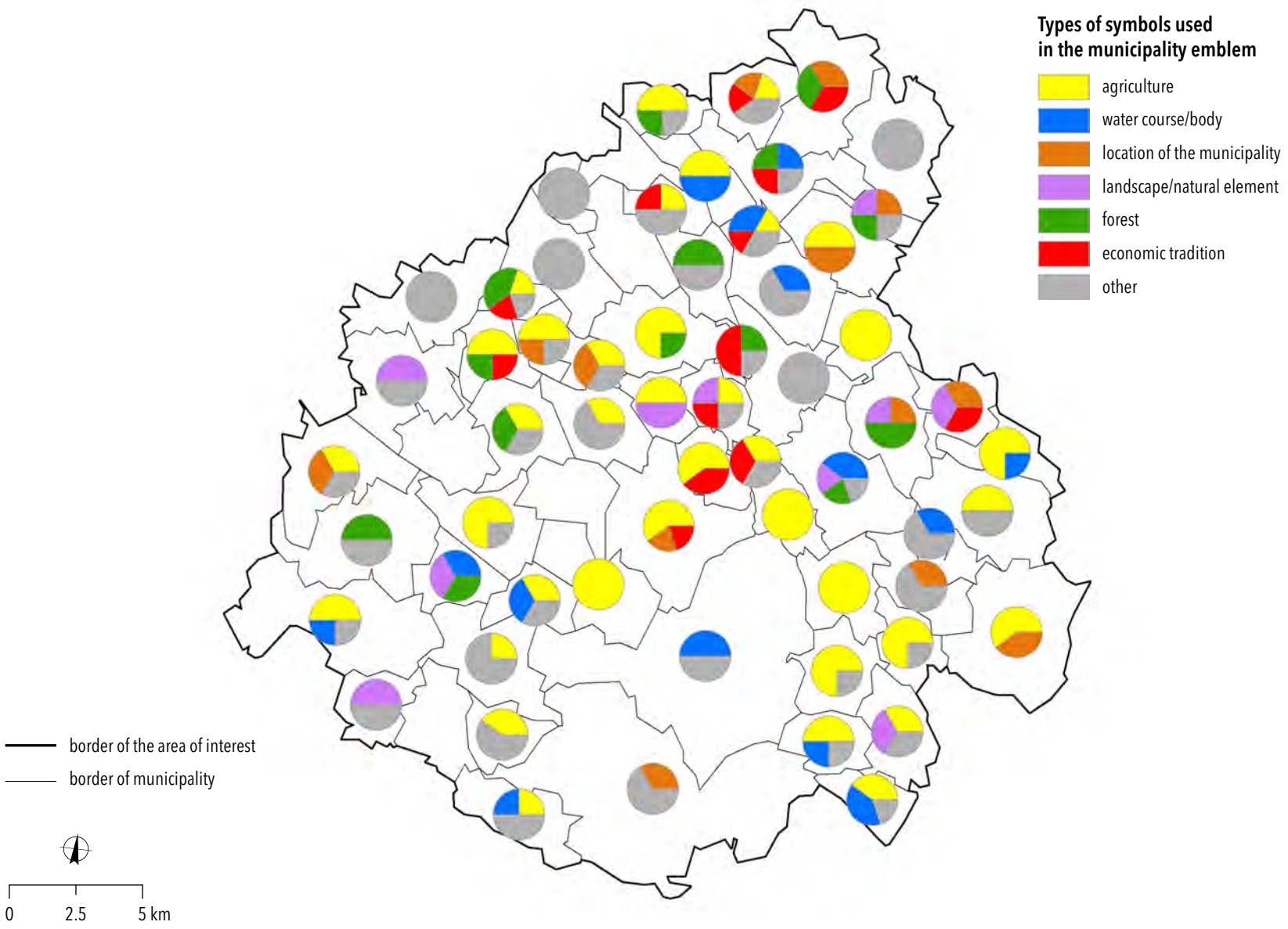


Fig. 11 – Types of symbols used in the municipality emblems.
Data source: Contant analysis of the municipality emblems (as of 1 October, 2018).

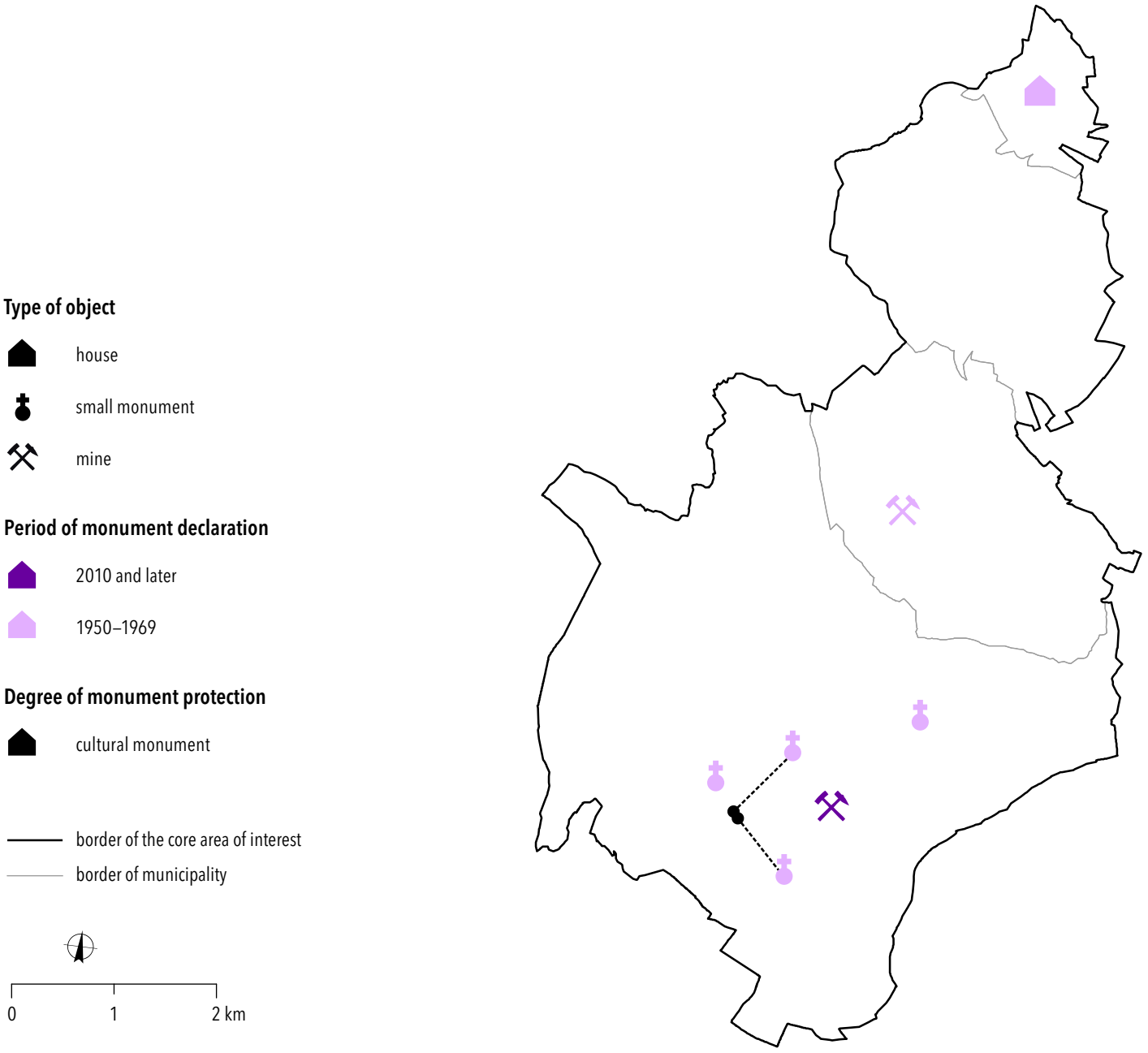


Fig. 12 – Cultural monuments and heritage areas.
Data source: National Heritage Monument Catalogue, National Heritage Institute (https://pamatkovykatalog.cz; as of 1 October, 2018).

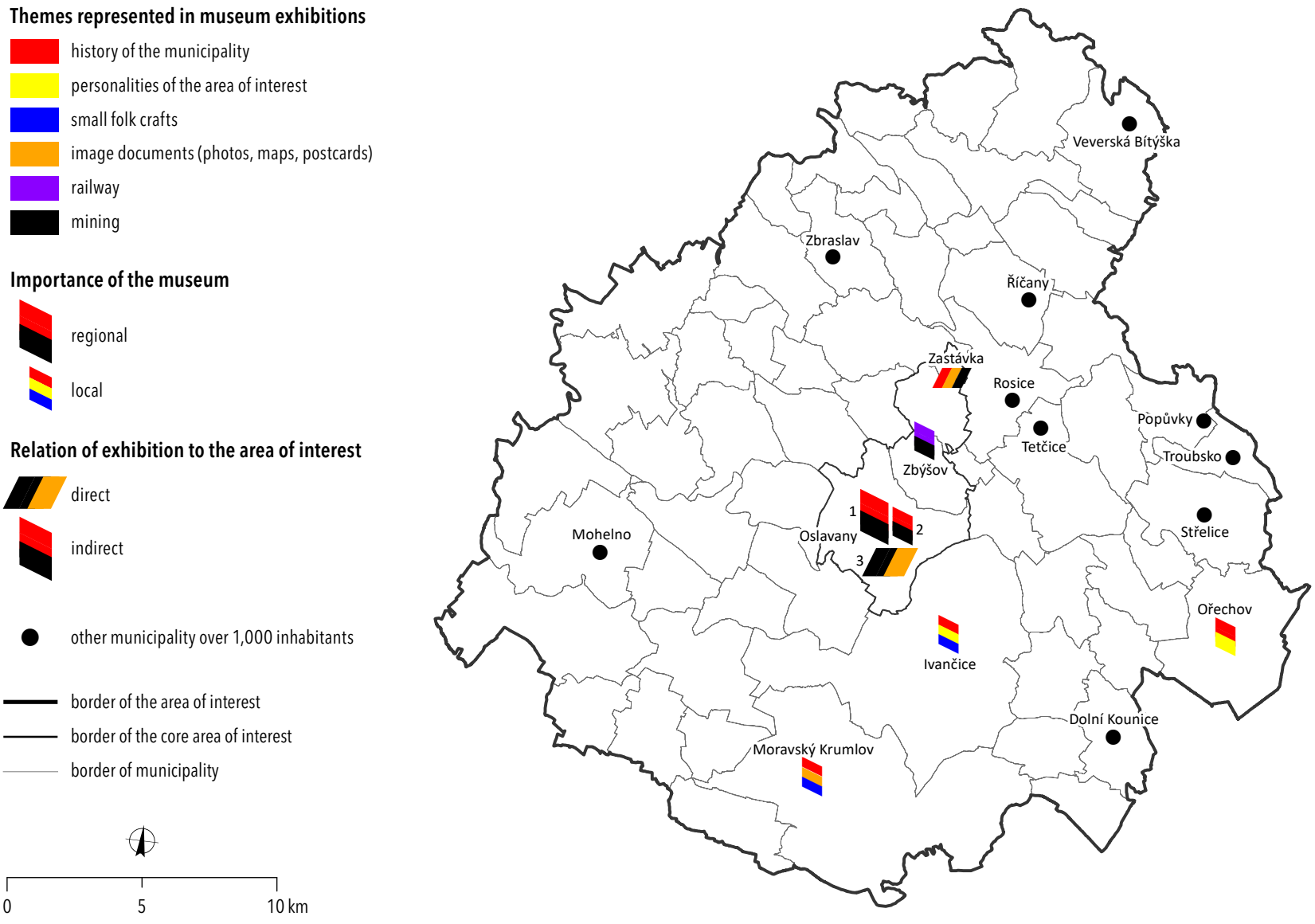


Fig. 13 – Museum exhibitions.
Data source: Czech Association of Museums and Galleries (https://www.cz-museums.cz/web/amg/titulni; as of 1 October, 2018), Webportal Do muzea (https://www.do-muzea.cz; as of 1 October, 2018), Webportal Museum.cz (https://www.museum.cz; as of 1 October, 2018).

(granite, granodiorite). Carboniferous and Permian sediments of the Oslavany Depression include layers of coal – the coal that used to be mined in the past and shaped the unique landscape.

The landscape of the Zbýšov Hills in the core area (municipal areas Zbýšov u Oslavan, Babice u Rosic, Zastávka, Padochov, and Oslavany) has a character of undulating, sometimes rugged hills at the altitudes of 300–400 metres a.s.l. The Ivančice Basin in the south lies somewhat lower (altitudes 200–300 m a.s.l.), has no forests, and, apart from the Oslava River valley, is rather flat, similar to the landscape of the Rosice Basin north of the Bobrava River. There are numerous anthropogenic relief forms in the area such as tailings, waste heaps, and small artificial lakes. These testify about the mining history of the region.

The Oslavany Depression is clearly bordered in west and east by the slopes of the Bohemian-Moravian Highlands and the Bobrava Highlands. The altitude difference is 50–100 metres.

The Rosicko-Oslavansko has warm climate with an average annual temperatures between 8 and 9 °C. The average annual precipitation ranges between 500 and 550 mm only: the area lies in a rain shadow and periods of drought, especially during summers, are frequent. Winters tend to be mild, with occasional snow cover only; on the contrary, summers are usually long and rather dry. Numerous atmospheric inversions occur in autumn and winter especially in low-lying areas.

The area is part of the phytogeographical area of the Czech Mesophyticum, the district of the Moravian foothills. There are mostly mixed oak and beech forests; in lower altitudes, beech prevails. Potential natural vegetation would have been formed almost in the entire area by oak-hornbeam woodlands, with small patches of xerothermic rock steppes. The floodplains of the Oslava River and the Bobrava River and their tributaries were naturally covered by narrow strips of alluvial woodlands and alder carrs in the past.

At the present time, the local landscape resembles a mosaic of farming landscape (mostly arable land), forests, urban areas, and a dense network of transport lines including power lines and pipelines. Peripheral parts of the area of interest, especially the Bobrava Highlands, are less populated and have a higher proportion of forests. Pine and oak stands predominate in the forests, spruce, which suffers from drought, is less abundant.

The Bobrava Nature Park forms the eastern part of the wider area of interest. It is a large forest complex with remnants of natural oak forests and beech forests.

The Rosicko-Oslavansko belongs among one of the first areas in Czechia where industrialization based on mineral deposits (coal) occurred. The local energy base also influenced the advance of several industrial branches in the 20th century (until 1970). In the same time there has been a significant population increase in the zone Ostrovačice – Rosice – Zbýšov – Oslavany – Ivančice. The area benefited from the proximity of Brno, the main industrial and urban development centre of South Moravia; transport links were boosted by the early construction of railway line. After World War II, however, difficult mining conditions affected the profitability of the mines and their gradual closure. Still, rather intensive mining and industrial activities carried out over the period of one hundred years have caused significant landscape changes: several industrial complexes, residential and service areas as well as dump sites came to existence.

The Rosicko-Oslavansko represents an industrial area where a rapid industrial development based on local coal mines was taking place from late 19th century until 1970s. At present, the local landscape can be labelled as a post-industrial one. It is expected that certain changes that would highlight and strengthen natural components of the local landscape will take place in the future.

3. Results

3.1 Landscape and Land Use/Cover Changes

Figure 3 and Table 1 show how the landscape looked like in the 1st half of the 19th century (1825) and compare it with the present situation (2018).

The Rosicko-Oslavansko is an area with a high proportion of arable land and remaining areas. At the present time, the proportion of grassland is extremely low. These were scarce already in early 19th century; coal mining and related industrial activities, however, led to a further decrease of grassland. After mining and large-scale industrial exploitation had ceased in 1970s, agricultural and settlement functions began to prevail. From the land use/cover perspective, the landscape is still dotted by many remaining areas: abandoned quarries, overgrown dumps, and brownfields are ubiquitous. Forests are rare, with a marked exception of large forest complex near Babice, which has been a stable element of the landscape since early 19th century. Built-up areas cover almost 3% of the area of interest, more than the national average (currently about 1.7%). On the contrary, there are only few water bodies.

The model area is located between two deep valleys of the Bobrava River and the Oslava River. The Boskovice Depression has a gently undulating landscape. The bedrock especially in the western half of the area did not allow creation of very fertile soils. South-eastern and north-eastern areas have relatively good conditions for farming (the official price of agricultural land exceeds 7.40 CZK per square metre), while in the northwest there are many municipalities with an official price below 4.40 CZK per square metre. On the whole, the area of interest has relatively good conditions for agricultural production if compared to other regions throughout Czechia. The areas covered by permanent grassland have been shrinking since long ago. Forests decreased significantly in the period 1896–1948 (by almost 50%). This process is obviously linked to the boom of mining and industrial activities.

The above-described changes in land use/cover are complemented by the 3D landscape model (Figure 4), which shows land reclamation in some former mining areas (the Ferdinand Mine near Babice), and also the growth of commercial and residential areas in the wider area of interest (Zastávka, Oslavany). The comparison of pictures from 1953 and 1990 also documents amalgamation of fields into bigger blocks of agricultural land (result of the so-called collectivization), which was a significant change in the landscape structure.

Figures 6–9 show wider perspective of land use/cover changes in STUs and describe changes over the time by comparing years 1845, 1896, 1948, 1990, and 2010.

3.2 Landscape Memory

The landscape memory of the Rosicko-Oslavansko area of interest is shown in four maps described in sections 3.2.1–3.2.3 (for more details about methodology of mapping see Chapter 1 of Atlas).

3.2.1 Places and Institutions of Memory

The Rosicko-Oslavansko area of interest is represented several "institutions of memory". The major change observed in the area of interest is the transformation of the former mining and industrial landscape (which was typical for this area until 1980s). As mining has a long tradition in this area, it is also reflected by memory institutions from various points of view. The Museum

of Mining and Energy at the Oslavany Castle and the exhibition at the Regional Information Centre in Zastávka focus on mining. Both institutions describe how mining developed in the Rosicko-Oslavansko area, including geological predispositions, mining crafts, and the everyday lives of miners. Other institutions are indirectly related to the past industrial era: The Museum of Industrial Railways in Babice, and two popular educational exhibitions located in Oslavany – the Educational trail through Carboniferous and Permian, and the Permonium amusement park located in the former mine Kukla (Nosek). There are also other local museums in the Rosicko-Oslavansko, mostly focused on folk crafts and important historical persons.

3.2.2 Regional and Local Symbols

The mining history of the region is also reflected in local symbols. However, mining symbols are not that frequent as the above-mentioned symbol related to wine-making (mainly because mining was not perceived as positively as wine). Mining hammers can be found in the emblems of Zastávka, Zbýšov, Kratochvilka, and Rudka. The black colour also refers to mining (Oslavany, Popůvky).

Some municipal symbols reflect the physical features of respective municipalities. This may include hills or hilly country: Omice (the Bučín Hill), Ořechov and Prštice (location at the edge of the Bobrava Highlands), Vysoké Popovice (the Křižany Highlands), Popůvky (the Bohemian-Moravian Highlands).

However, the most common symbol seen in municipality emblems in the area of interest is vine and viniculture. Vine as a crop and also wine as a product are symbolized e.g. by billhooks (knifes of different shapes used in wine-making) that appear in the emblems of Moravské Bránice, Silůvky, Trboušany, Biskoupky, and Troubsko. Grapes are found in the emblems of Čučice, Rapotice, Moravské Bránice, Ostrovačice, Zbýšov, Oslavany, and other municipalities.

3.2.3 Heritage Sites

In the core area, there are a total of seven monuments related to local mining and industrial landscape. Most of them refer to former mining sites (e.g. the Simson mine tower or the Kukla mine tower). Some of the monuments commemorate the life of miners in designated working-class districts (Zastávka). One also can find monuments recalling accidents and tragedies that happened in the mines; important persons associated with local mines are also represented. As an example, the monument in Oslavany (built in 1860) commemorates the disaster in the František Mine – 52 miners lost their lives that time. Jan Baptist Müller, founder of the local mines, has a monument too.

Such monuments provide valuable evidence of the historical memory in the former mining district. There are many listed monuments in the area including certain cultural monuments, solitary buildings, and former mining towers.

4. Summary

The post-industrial landscape of the Rosicko-Oslavansko is an example of originally agricultural landscape markedly transformed by industry. Before the commencement of coal mining, the fertile Oslavany Depression was deforested and intensively farmed. Fundamental land use/cover changes occurred after the discovery of coal deposits in the late 18th century and especially during the 19th century. Opening of coal mines was followed by arrival of metallurgy, working class quarters were established, and all lakes disappeared. Mining was experiencing a gradual decline since 1960s and local ironworks and sugar refineries in Rosice and Oslavany closed down. For a long period of time, the area has been deforested and subject to intensive industrial use. Consequently, there is just a handful of natural or semi-natural habitats in the area.

From the land use/cover perspective, agriculture is again the dominant activity in the Rosicko-Oslavansko at the present time. The area benefits from the vicinity of Brno, the biggest urban centre in Moravia.

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References and Data Sources

BALATKA, B., KALVODA, J. (2006): Geomorfologické členění reliéfu Čech. Kartografie, Praha.

DEMEK, J. (ed.) a kol. (1987): Zeměpisný lexikon ČSR. Hory a nížiny. Academia, Praha.

NEUHÄUSLOVÁ, Z., MORAVEC, J. (eds.) a kol. (1997): Mapa potenciální přirozené vegetace České republiky. Map of potential natural vegetation of the Czech Republic. Kartografie, Praha.

PLÍVA, K., ŽLÁBEK, I. (1986): Přírodní lesní oblasti ČSR. SZN, Praha.

QUITT, E. (2009): Klimatické oblasti. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SEDLÁČEK, J., JANDERKOVÁ, J., ŠEFRNA, L. (2009): Půdní asociace. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SKALICKÝ, V. et al. (2009): Fytogeografické členění. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

Archive Maps of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK), Central Archive of Surveying and Cadastre. https://archivnimapy.cuzk.cz/uazk/pohledy/archiv.html (1. 10. 2019).

Czech Association of Museums and Galleries (Asociace muzeí a galerií České republiky). https://www.cz-museums.cz/web/amg/titulni (1. 10. 2019).

Do muzea. https://www.do-muzea.cz (1. 10. 2019).

eKatalog BPEJ. https://bpej.vumop.cz/ (1. 10. 2019)

Geologická mapa ČR 1 : 50 000. https://mapy.geology.cz/geocr50/ (1. 10. 2019).

Geoportal of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK). https://geoportal.cuzk.cz/ (1. 10. 2019).

Land Use Land Cover Czechia Database. https://www.lucccz.cz/databaze/ (1. 10. 2019).

Museum.cz. https://www.museum.cz/ (1. 10. 2019).

National Heritage Monument Catalogue, The National Heritage Institute (Národní památkový ústav – NPÚ). https://pamatkovykatalog.cz/ (1. 10. 2019).

Portál informačního systému ochrany přírody. http://webgis.nature.cz/mapomat/ (1. 10. 2019).

Půdní mapa ČR 1 : 50 000. https://mapy.geology.cz/pudy/ (1. 10. 2019).

Register of communal symbols (Registr komunálních symbolů), Chamber of Deputies of the Czech Republic. https://rekos.psp.cz (1. 10. 2019).

Ústřední seznam ochrany přírody. http://drusop.nature.cz/ (1. 10. 2019).

CHAPTER 8

Střední Povltaví: Disappeared Landscape of Deep Vltava Valley

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1. Introduction

The area of Střední Povltaví lies in the long stretch along the Vltava River, approximately from Týn nad Vltavou to Slapy. The area of interest represents, in the context of Czechia and the whole of Central Europe, a unique phenomenon of a canyon-like valley of a large river, which disappeared irreversibly under the surface of two large dams Orlík and Slapy after 1950. Not only the landscape, but also traditional economic activities and life of the people for centuries connected to the river (such as rafers, millers, fishermen, etc.) ceased to exist.

After the construction of the Vltava River Dam Cascade during the socialist era in the 1950s and 1960s, a new water-management type of landscape was created. The river landscape lost its original function and landscape character, but gained a new attractiveness associated with the recreational use of large water bodies. Recreation areas, the largest one in Živohošť, were gradually built in the core area of the Slapy Dam.

The wider area of interest on both banks of the central Vltava bears some features of the inland periphery of Central Bohemia, although it is not too far from Prague. This is especially case of Neveklovsko, which was affected already after the occupation of the area of Czechia in 1939, when the German army established a vast military training area here – it was associated with the displacement of the population from the area, of course.

For the purposes of this project, the so-called core area has been delimited and most analyses are carried out in this core area (Figure 1). It includes the municipal areas Křeničná and Živohošť. The wider area of interest (see Chapter 1 of Atlas for more details) is shown in Figure 2.

2. Area of Interest: Main Features

The Střední Povltaví area on both sides of the Vltava valley south of Prague lies in the geomorphological unit of the Středočeská pahorkatina (Central Bohemian Upland), in the geomorphological sub-unit of the Benešovská pahorkatina (Benešov Upland), and the geomorphological sub-unit of the Dobříšská pahorkatina (Dobříš Upland), which is further subdivided into several smaller districts.

Fig. 1 – The core area of interest. Map basis: Data50; Orthophoto © The State Administration of Land Surveying and Cadastre, 2019.

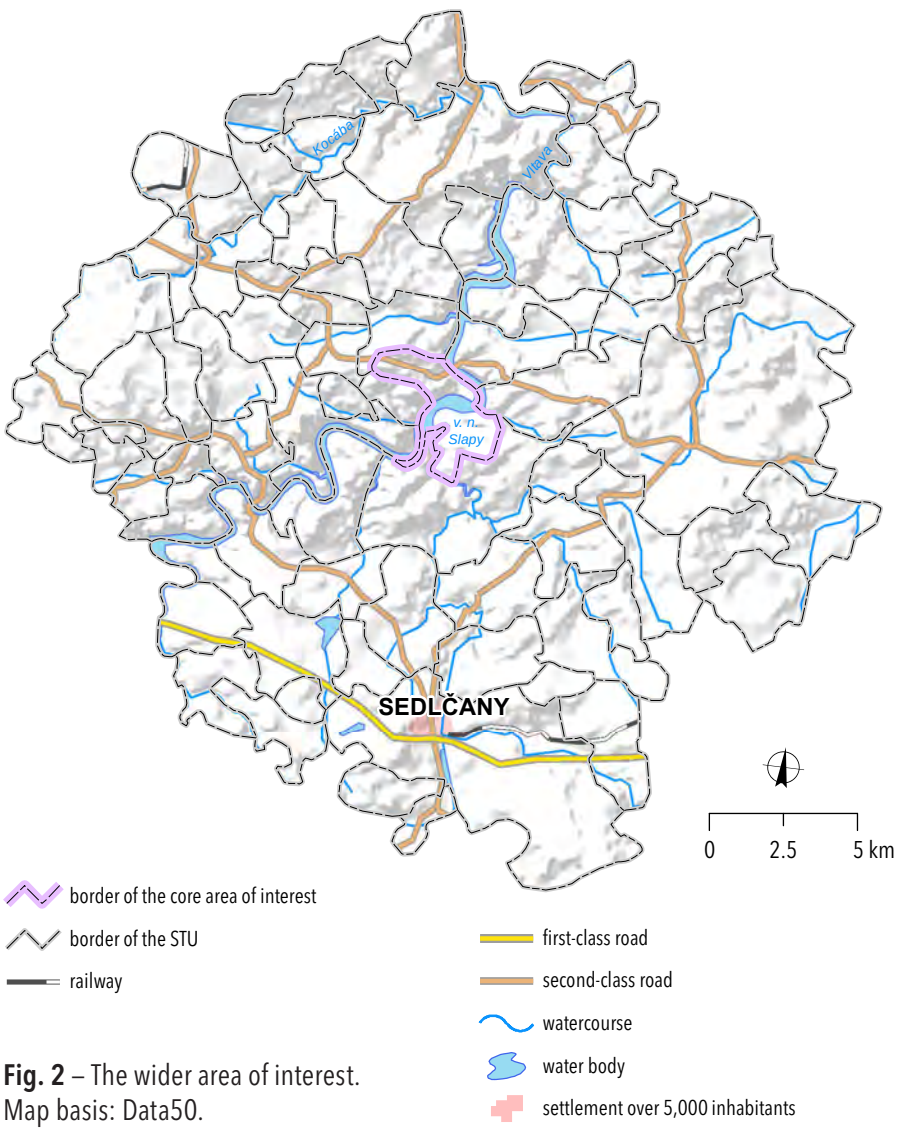


Fig. 2 – The wider area of interest. Map basis: Data50.

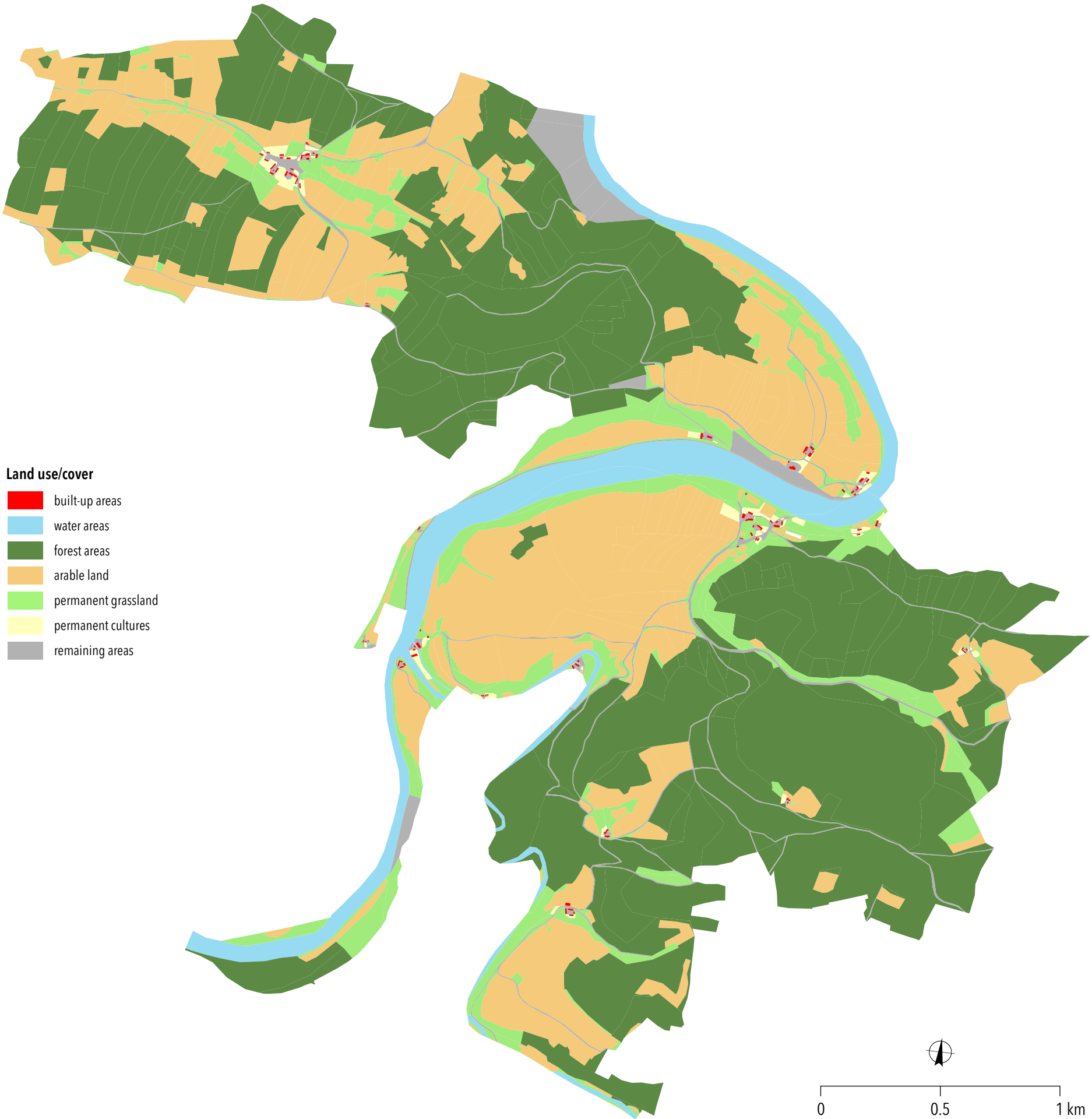
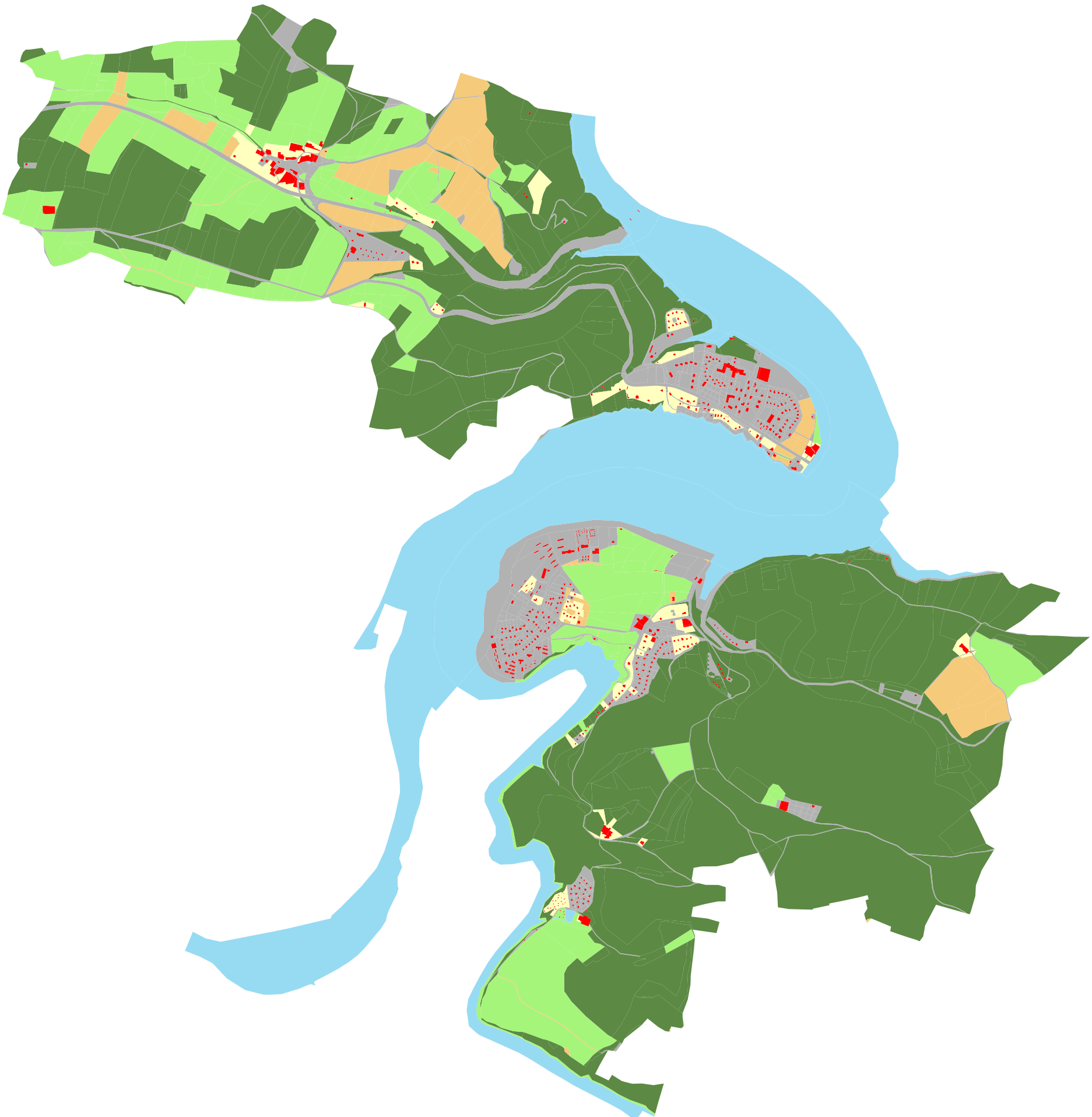


Fig. 3 – Land use/cover in cadastres Křeničná and Živohošť in 1840 and 2018.
Map basis: The State Administration of Land Surveying and Cadastre.

Current state (2018)



Tab. 1 – Proportion and change of land use/cover classes between 1840 and 2018

Land use/cover class	proportion in 1840 (%)	proportion in 2018 (%)	change (% points)
built-up areas	0.13	0.78	0.65
remaining areas	3.71	8.97	5.26
water areas	6.47	23.68	17.21
forest areas	51.41	45.97	−5.44
arable land	28.15	4.24	−23.91
permanent grassland	9.64	14.64	5.00
permanent cultures	0.49	1.72	1.23

1947

1953

2018

Fig. 4 – Models of landscape – Střední Povltaví in 1947, 1953 and 2018. Source: Aerial photos © Military Geographical and Hydrometeorological Office in Dobruška, Ministry of Defence, 2018; Orthophoto © The State Administration of Land Surveying and Cadastre, 2018.

Fig. 5 – The Slapy river dam. Source: Archive of the NAKI project no. DG18P02OVV008. Photo (2018): Zdeněk Kučera.

The geological bedrock consists of metamorphic rocks and deep igneous rocks of Central Bohemian Pluton – granite, granodiorite and diorite and their vein equivalents (pegmatite and aplite), orthogneisses, meta-basalts and meta-morphed offal and clay shale. The core area is dominated by orthogneisses, granulites, migmatites, phyllites, mica schists, and paragneisses. Quaternary sedimentary cover is thin, slopes dominate, in the valley floodplains of streams sediments prevail. The soils are shallow or medium-deep, and rocky. Quarries were established in places with hard crystalline rocks. The area is also known for its historical gold-mining (Nový Knín, Chotilsko-Mokrsko).

The rugged erosion-denudation relief typologically corresponds to a flat highland. The main macroform of relief is the deep erosion cut of the Vltava River, which reaches a depth of up to 200 m. The Vltava valley slopes have the character of steep cliffs with a slope of over 20°, with numerous rock outcrops, cliffs and debris on the slopes. Outside the Vltava valley, the altitudinal differences are lower (approximately 100–150 metres) and the relief typologically corresponds to the rugged upland. Several structural ridges and knots are in the relief. The altitude ranges from 250–500 m a.s.l.

The area of interest lies in a warm climate area with an average annual temperature of around 8 °C. The average annual precipitation is around 580 mm. Winter is mild with unstable snow cover, summer is medium long and relatively dry.

The area belongs to the phytogeographical area of the Czech Mesophyticum, the phytogeographical district of the Střední Povltaví. Potential natural vegetation consists of acidophilic beech and/or fir oak forests in most of the area, and oak-hornbeam forests on the dry cliffs of the Vltava River valley.

The present landscape is a mosaic of forests and agricultural areas. The forest areas are dominated by cultivated pine monocultures, as well as oak and mixed forest. Spruce is less common because it suffers from drought. In recent years, pine trees have also dried up. Fragments of relict pine trees grow on the rocks, and on the steep cliffs, there are remnants of the original oak-hornbeam, sometimes. The non-forest areas consist mainly of arable land. In floodplains, there are meadows. Nowadays, however, arable land has been extensively grassed and large pasture areas for sheep, cattle and horses were created. In recreational areas near the Slapy Dam, vast recreational areas were established already in the socialist era – in the core area mainly in Živohošť, Ždáň, Nová Živohošť, and Cholín.

The northern part of the wider area of interest extends to the Central Bohemia Nature Park. In the cut valley of the Vltava River there are several small-scale specially protected areas (the Drbákov – Albertovy skály, the Na skalinách, the Vymyšlenská pěšina) in the category of nature reservation or national nature reservation, which protect oak forests with the occurrence of red yew, juniper, pasque flower and other protected species of xerothermic flora on the rocky cliffs of the valley above the river.

The area is located in the wider hinterland of Prague, which, due to its attractiveness, significantly influenced the local decline of the permanent population after the World War II. Part of the area was influenced by the eviction of the Czech population during the Second World War, when the SS military training area was established here. Its creation in the heart of Bohemia is used by some historians as evidence for the planned Germanization of the area of today's Czechia. This was probably the primary reason for the population decline after 1945. Moreover, the heavily depopulated countryside attracted the purchase of empty rural buildings for recreational purposes of urban residents (especially from Prague). This was a similar trend to Czech borderland where many buildings were abandoned after the expulsion of Czech Germans. Also, the process of socialization of countryside led to the departure of many small farmers to towns. The construction of dam reservoirs after World War II made this area more attractive for recreation, thus the recreational functions of the area (many forms of tourism – one-day visits, second homes, bicycle touring, etc.) have begun to develop. The fact that the picturesque canyon of the Vltava River, with its numerous ravines of small tributaries, as well as the average quality of soils for agricultural management, has also played a role in the landscape transformation processes in this area.

The official price of agricultural land ranges from CZK 2.10 per square metre in the northwest of the area to land with the price above CZK 5 per sq. m in the middle of the area. Overall, these conditions for agriculture can be assessed as slightly below average. This corresponds with the intensity of agricultural activities. The proportion of arable land in the 19th century ranged from 35 to about 75% of the land area. As in the whole area of Czechia, there has been a decrease in ploughing. Nowadays, the share of land which is used to ploughing varies in the range of 20–60%. Until the end of the 19th century the share of permanent grassland (mainly by extinction of pastures) declined, after 1948 due to rural socialization and increased use of mechanization the share of arable land decreased, and the area of permanent grassland increased. On average, the share of permanent grassland ranges between 10–15% of the cadastre area. The share of forest areas in the area has been increasing partly by using subsidies for afforestation of less fertile agricultural land. About one third of the cadastres dispone by share of forest areas over 50%, which

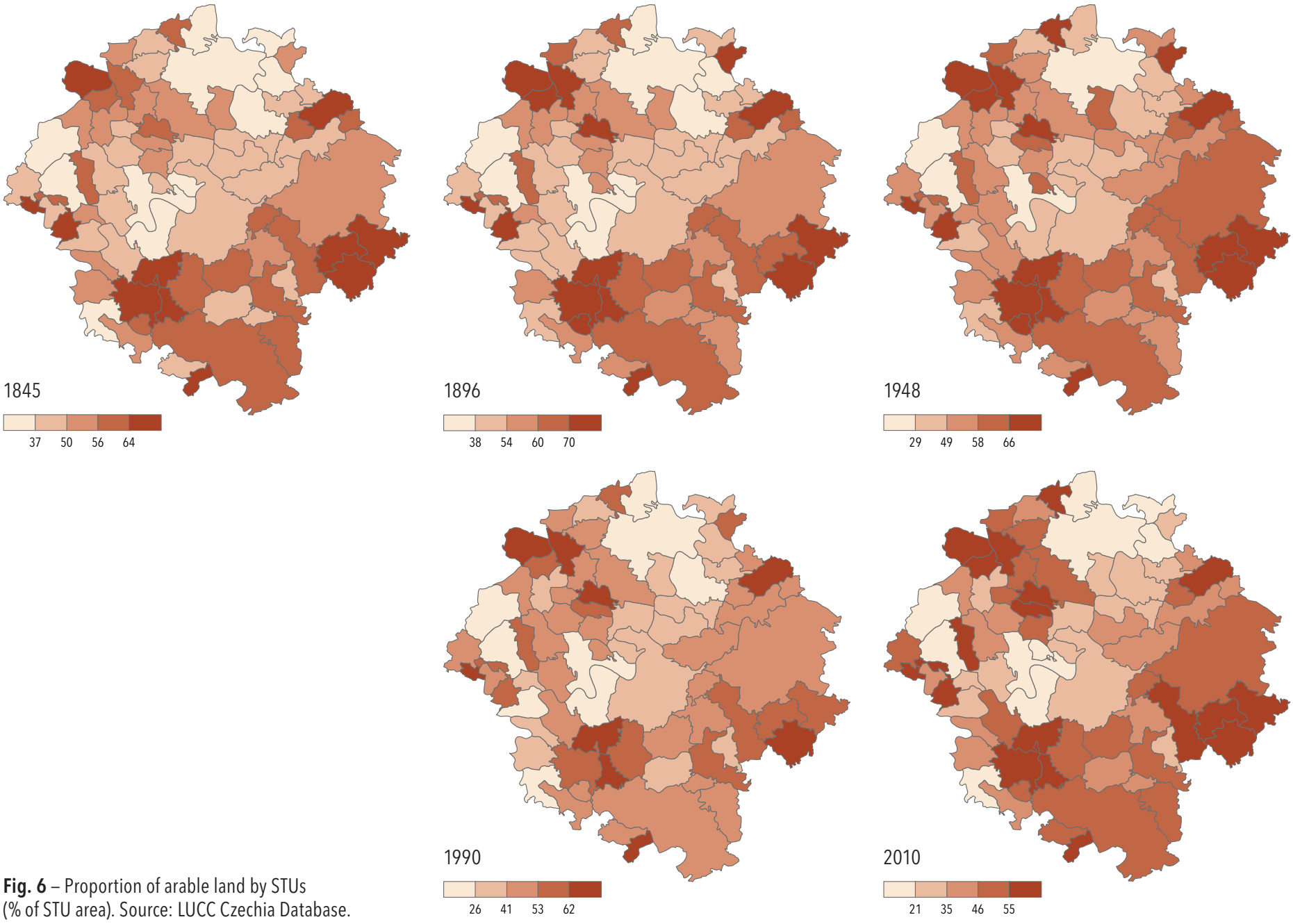


Fig. 6 – Proportion of arable land by STUs (% of STU area). Source: LUCC Czechia Database.

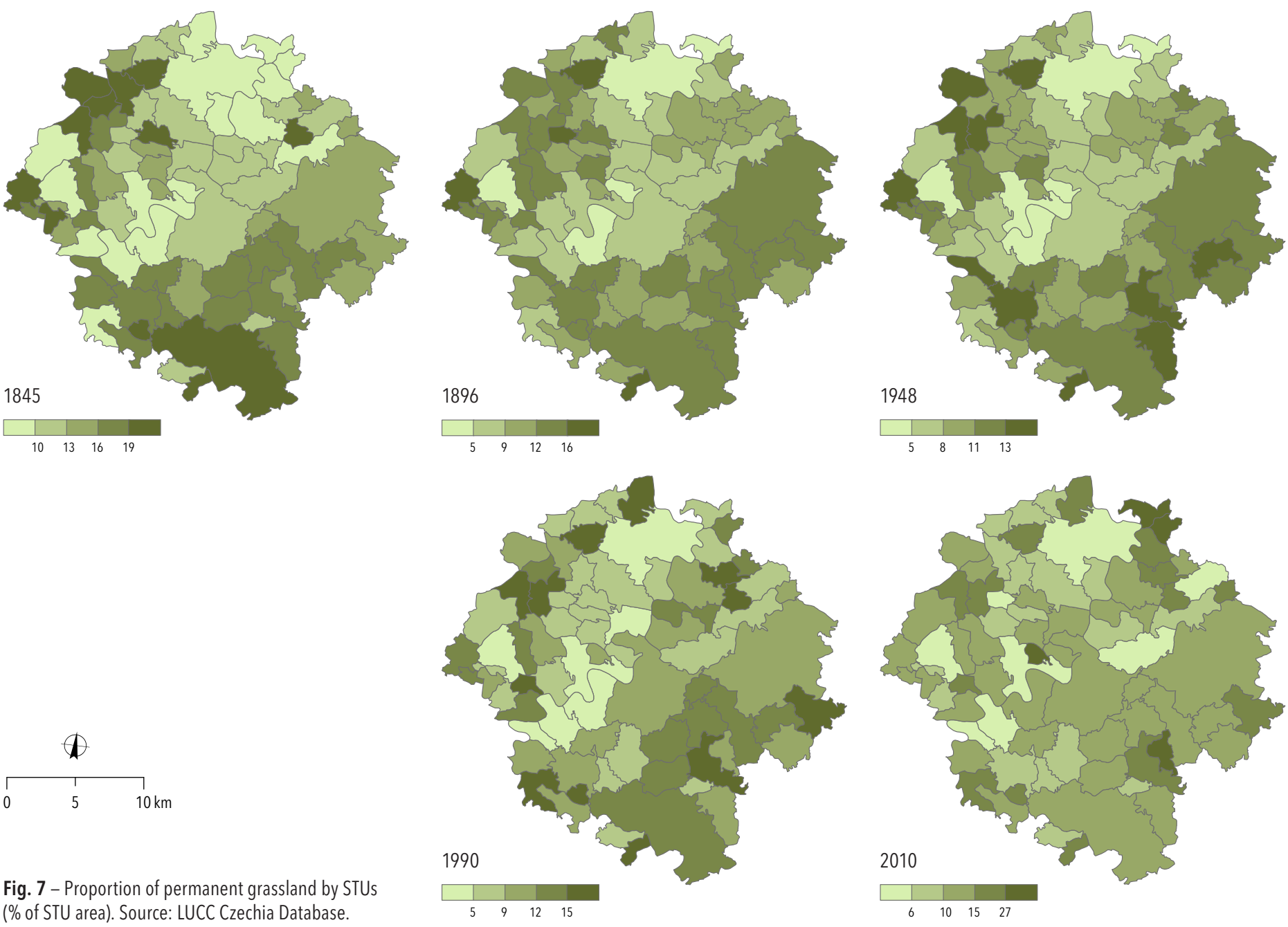


Fig. 7 – Proportion of permanent grassland by STUs (% of STU area). Source: LUCC Czechia Database.

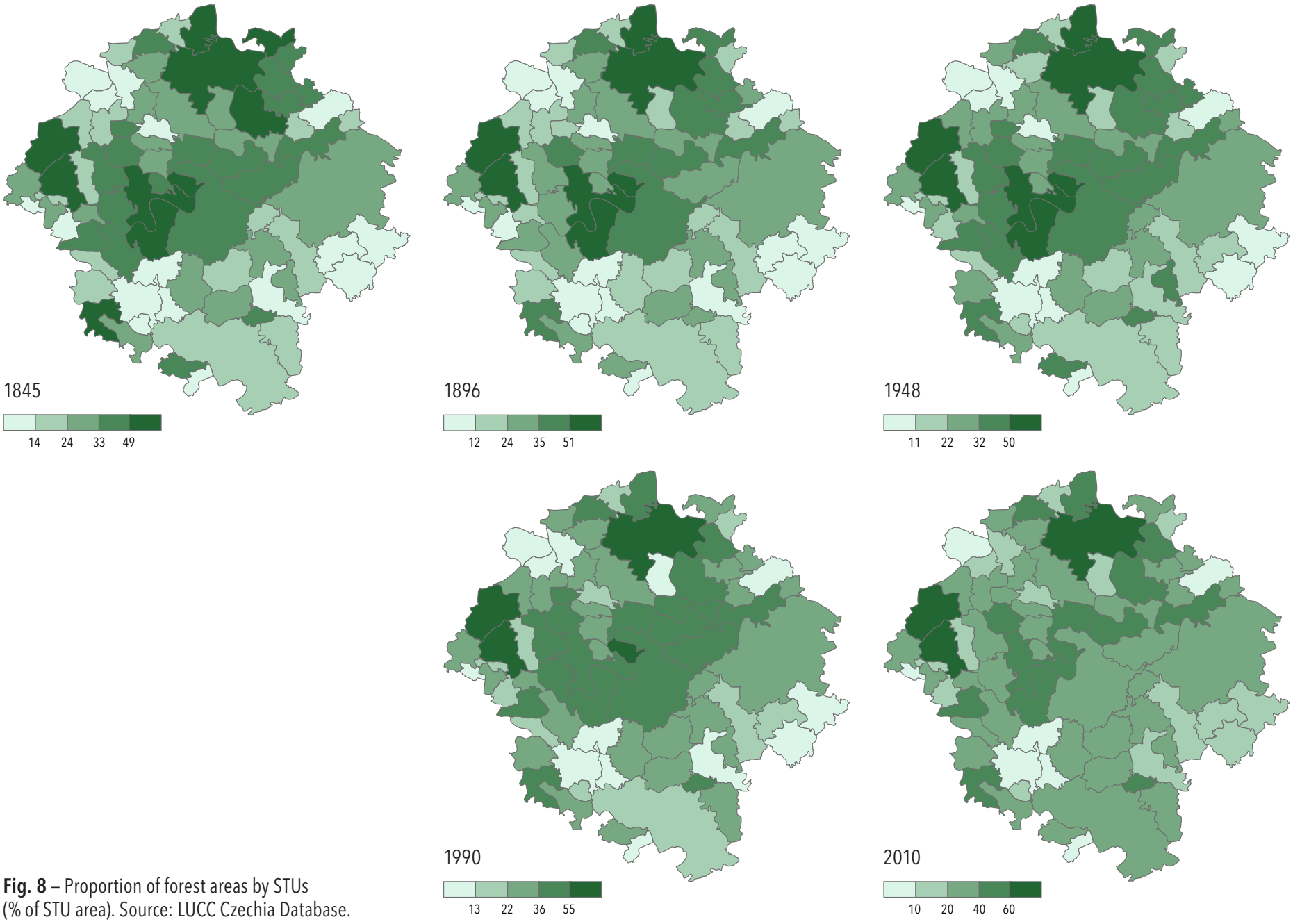


Fig. 8 – Proportion of forest areas by STUs (% of STU area). Source: LUCC Czechia Database.

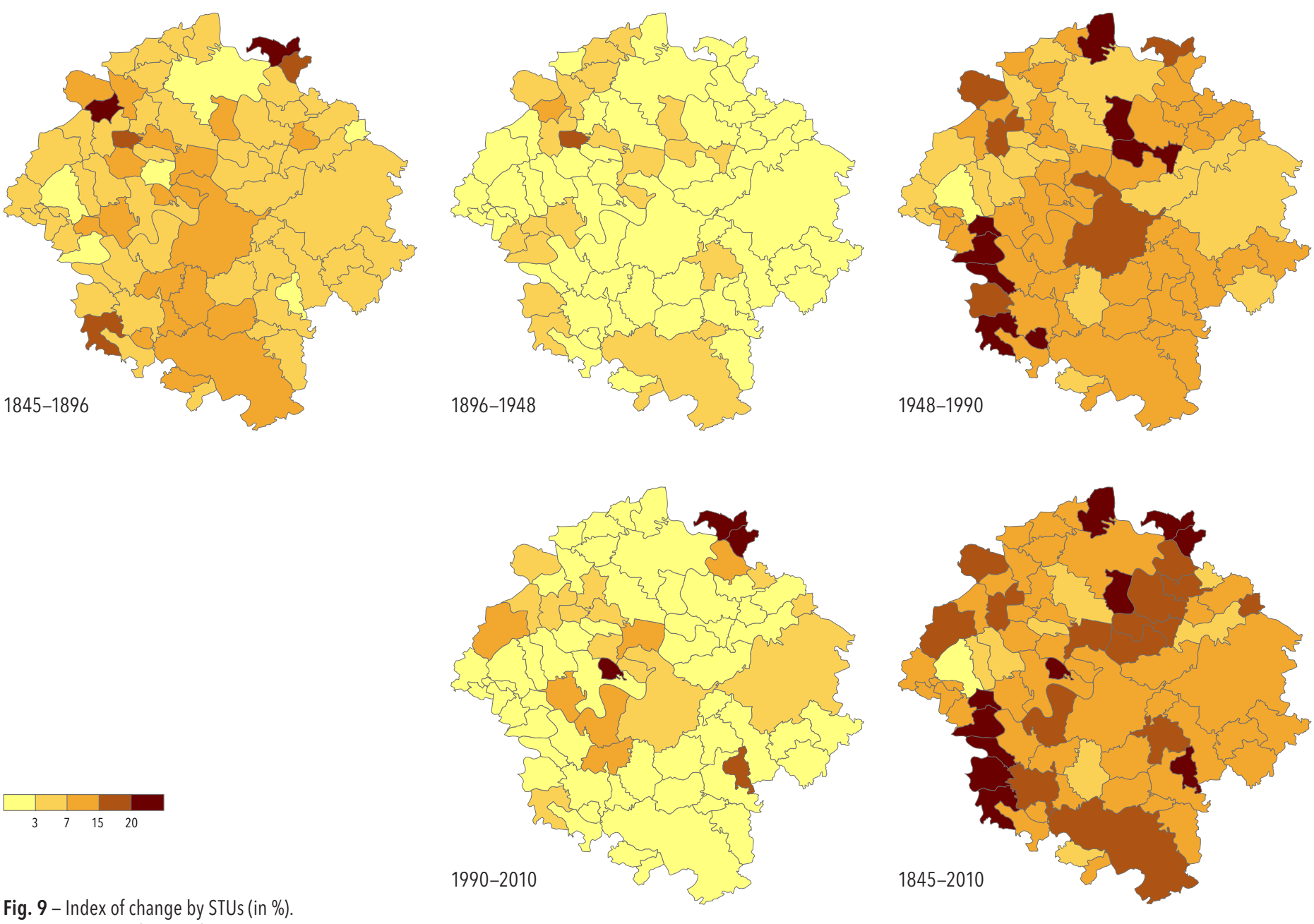


Fig. 9 – Index of change by STUs (in %). Source: LUCC Czechia Database.

Fig. 10 – Municipality emblems.
Source: Register of municipal symbols, Chamber of Deputies of the Czech Republic (https://rekos.psp.cz; as of 1 October, 2018).

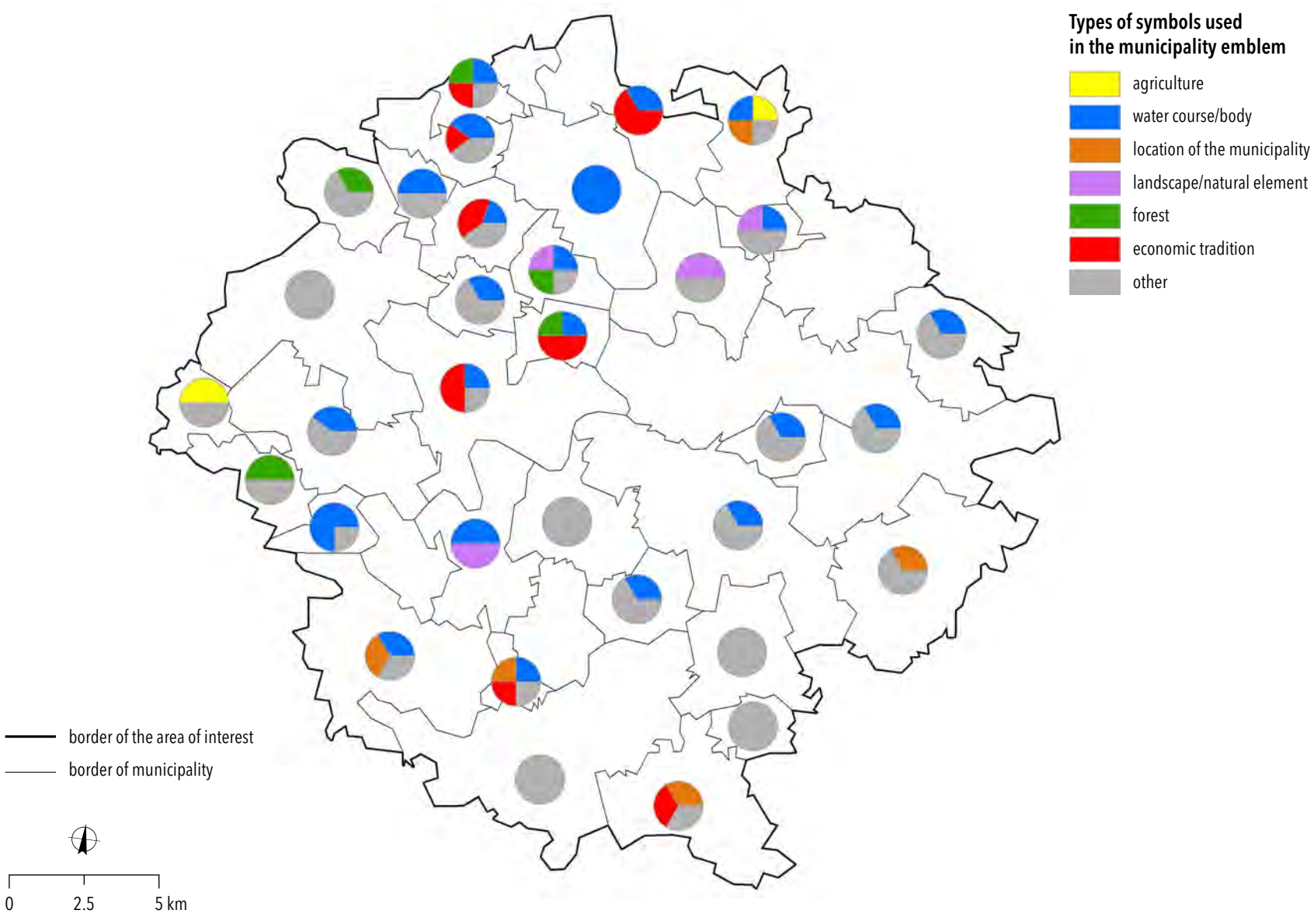


Fig. 11 – Types of symbols used in the municipality emblems.
Data source: Contant analysis of the municipality emblems (as of 1 October, 2018).

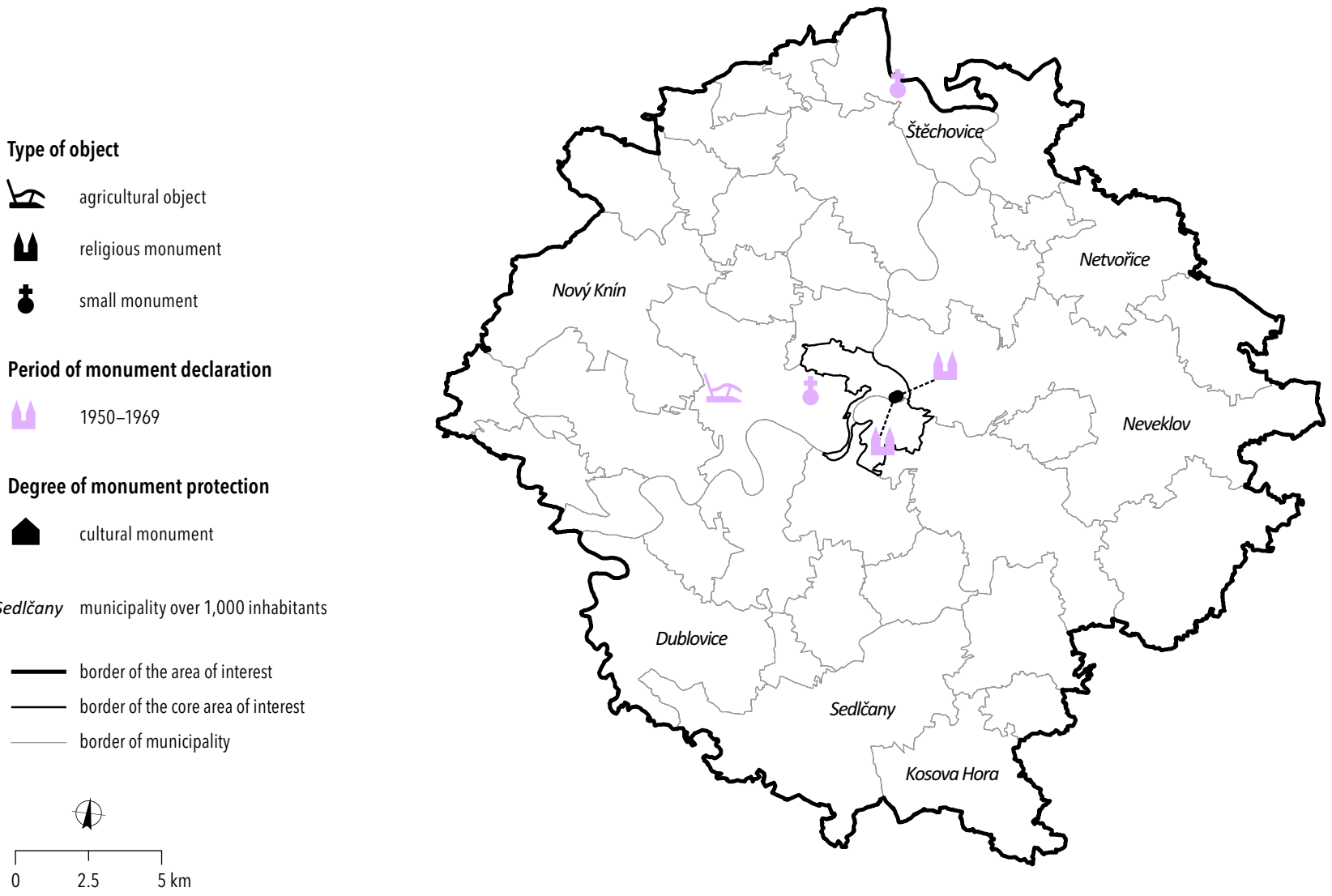


Fig. 12 – Cultural monuments and heritage areas.
Data source: National Heritage Monument Catalogue, National Heritage Institute (https://pamatkovykatalog.cz; as of 1 October, 2018).

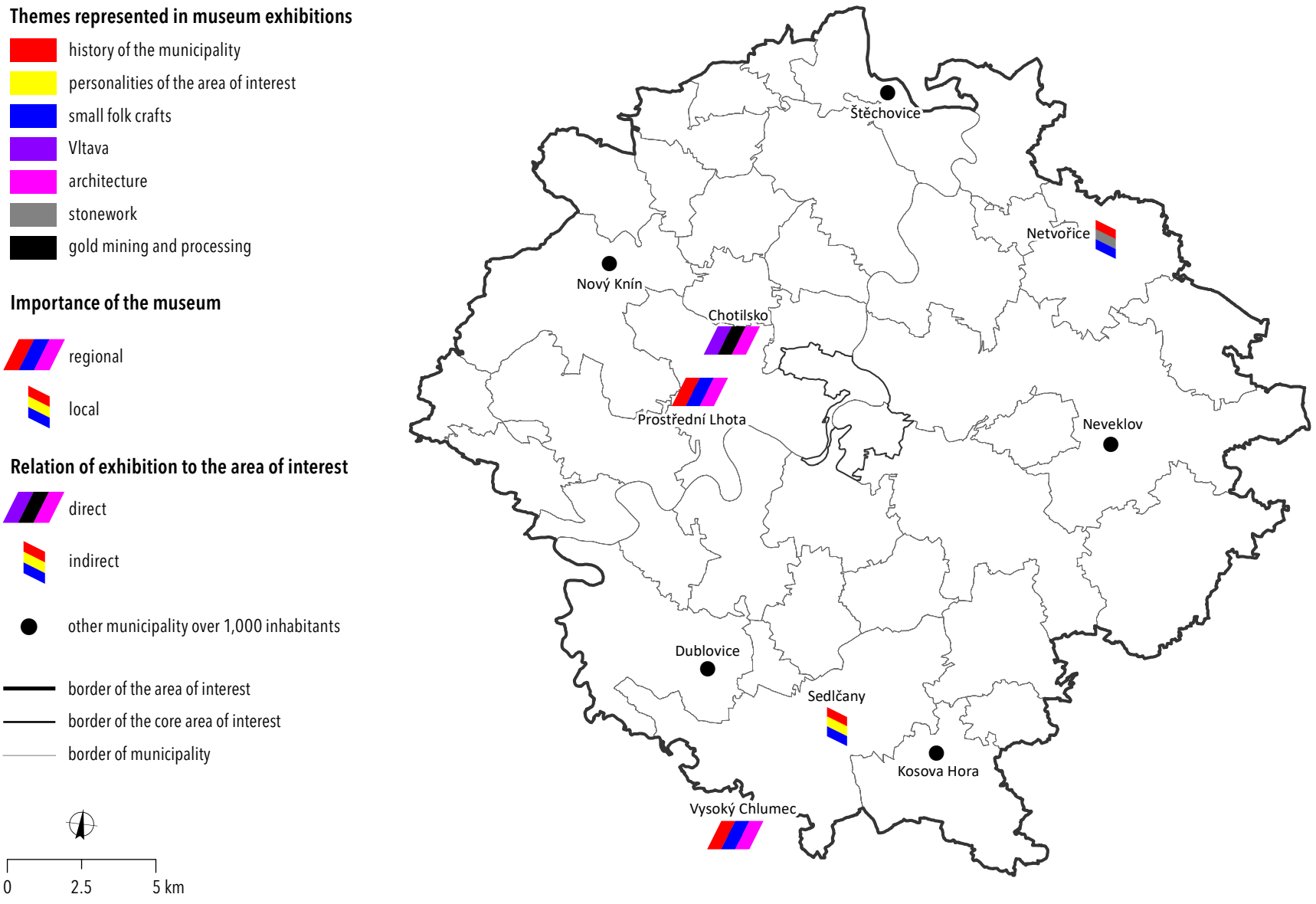


Fig. 13 – Museum exhibitions.
Data source: Czech Association of Museums and Galleries (https://www.cz-museums.cz/web/amg/titulni; as of 1 October, 2018), Webportal Do muzea (https://www.do-muzea.cz; as of 1 October, 2018), Webportal Museum.cz (https://www.museum.cz; as of 1 October, 2018).

is fully in line with both natural conditions and the importance of the recreational function of the area. The area of Střední Povltaví, in Czechia and even in the European context, represents an area with an extraordinary density of objects of individual recreation. The area has not only the recreational function, but also the residential one (suburbanization of Prague), the productive one (agriculture, small industrial operations,) and also very important water management function.

3. Results

3.1 Landscape and Land Use/Cover Changes

Figure 3 and Table 1 compare how the landscape looked like in the 1st half of the 19th century (1840) and its state at the present (2018). Both the maps and the table show a fundamental change in the landscape caused by the rise of water level and the widening of the Vltava riverbed after the construction of the Slapy Dam. The water area in this area expanded by 17.2% and the landscape was partially flooded, settlements disappeared, and new buildings were created in other places. The share of arable land (which was lost flooded too, of course) in the area of interest is currently very low – approximately 5.4%. It is also due to the fact that in many places, especially in the northern part of the area, but partly also in the south, arable land has been replaced by grassland. Water partially flooded the forests. However, the forest area has also decreased in other places, where forests were replaced mainly by permanent grassland. Built-up areas increased overall, as did "remaining areas".

The above-described changes in land use/cover are complemented by a 3D model of the disappeared landscape of the Vltava River valley in the Střední Povltaví area (Figures 4). The models document the disappearance of agricultural land (the right bank of the Vltava River in the cadastral area of Živohošť and on the left bank in the arch of the river in the cadastral area of Křeničná) as a result of the construction of the Slapy Dam. The extinction of the original village of Živohošť and the development of built-up areas constituting the hinterland of this recreational area, where the land was previously used for agriculture (Živohošť and Nová Živohošť), are evident.

Figures 6–9 show wider perspective of land use/cover changes in STUs and describe changes over the time by comparing years 1845, 1896, 1948, 1990, and 2010.

Figure 9 show index of change (in terms of land use/cover changes). In the past, land use/cover was influenced mainly by the location in the wider hinterland of the Prague metropolis but also by the fact that during the World War II a military training area for the SS was built in this area, which meant the forced eviction of about 23,000 Czech inhabitants. As a result of both of these driving forces, the Střední Povltaví is an area with a relatively high rate of landscape change between 1845 and 2010 and at the same time with large differences between particular cadastres. The change index was the highest in the period 1948–1990 due to large differences between cadastres, which was mainly influenced by the construction of dams (also with related development of recreational function). The subsequent period after 1990 also showed large differences in the change index between cadastral areas. The overall change index between 1845–2010 documents a great change in the functions of the area. The former residential and productive function (especially agriculture) has been transformed into a residential and recreational function, especially near the Vltava River (even already in period between World War I and World War II). Today, the recreational and residential function completely dominate in the Střední Povltaví area of interest.

3.2 Landscape Memory

The landscape memory of the Střední Povltaví model area is shown in four maps described in following sections 3.2.1–3.2.3 (for more details about methodology of mapping see Chapter 1 of Atlas).

3.2.1 Places and Institutions of Memory

Five museums deal with the memory of the landscape in the area (Figure 13). The main exposition of Muzeum střední Vltavy (Museum of centre part of Vltava) in Chotilsko show the landscape and life in the Vltava River valley before it was flooded. This museum presents the history of the from prehistoric settlement, through mining and processing of gold to flooding the valley due to the construction of the Vltava River Dam Cascade, and traditional crafts associated with the river.

The Muzeum Špýchar (Šprýchar Muzeum) in Prostřední Lhota acquaints visitors with the past of the area too. Its location in the Baroque granary building illustrates the architecture of local rural and farm buildings. The museum exhibitions in the interior represent the life of the rural inhabitants of the Střední Povltaví area in the 19th and 20th centuries. The village architecture of the 19th and 20th centuries is also presented by the Skanzen Vysoký Chlumec (Open-Air Museum in Vysoký Chlumec). The more distant town museums in Sedlčany and Netvořice are also indirectly focused on the area of interest. Both include traditional expositions on the history of the area, and small folk crafts.

3.2.2 Regional and Local Symbols

In the area of interest, watercourses and water bodies are most often symbolized in municipality emblems (Figures 10 and 11). Mostly, of course, the Vltava River is depicted (the wavy shapes in emblems of Čím, Chotilsko, Slapy; blue tincture/colour in emblems of Korkyně, Neveklov). The tributaries of the Vltava are also often symbolized (e.g. the Kocába River in emblems of Velká Lečice, Bojanovice, Bratřinov). There are also references to the Slapy dam (blue tincture and figure of the anchor in Županovice emblem) and Štěchovice Dam (blue tincture in same-named municipality Štěchovice).

The river is closely related to the symbol referring to the historical panning for gold in the area. Gold panning is symbolized by a golden tincture (Bojanovice, Bratřínov). Gold mining is referred by the figures of the hammer and pick (in combination with the golden sun figure in emblems of Chotilsko and Štěchovice, and together with the golden tincture in the emblem of Nové Dvory). The figure of the sun, the blue tincture or even the figure of the anchor, which are mentioned above, are often interpreted also as symbols for the recreational character of the area. Except the gold panning, there are references to modern history prevail in emblems of municipalities in the area rather than other historical symbols (e.g. rafting, mills on water courses – the mill is part only of the emblem of Příčovy).

3.2.3 Heritage Sites

In the area of interest, the landscape of the Vltava River valley is monitored as a result of the construction and operation of the Slapy Dam. The opening of the water reservoir was related not only to the physical change of the landscape (flooding of the river valley), but also to the importance of the recreational function of the local landscape. There are no state-protected

monuments in the core area, but five objects have been identified in the wider area of interest, representing the changes in the landscape (Figure 12). These are mainly religious monuments and small objects that gained the status of monuments already in the 1950s and 1960s. It is a set of diverse buildings, such as the late Baroque one-storey granary in Chotilsko, or an interesting industrial monument is the bridge connecting the villages of Štěchovice and Brunšov, located in the valley of the Vltava River. All examined objects in the area of interest have the status of a cultural monument.

4. Summary

The Střední Povltaví area represents the extinction of a unique natural river phenomenon, a narrow, canyon-like valley, which disappeared due to the construction of a system of dams (in this case the Slapy Dam). With the construction of the dam, a number of buildings scattered along both banks of the Vltava canyon (fishing and ferry houses, etc.) and smaller settlements (the Ústí at the estuary of the Mastník Brook) disappeared. Only some buildings located higher on the bank remained (the Church of Saints Fabian and Sebastian in Stará Živohošť). The dam terminated a typical mode of transport – rafting and pubs linked to it, as well as the cruise restaurants near the watercourse. Recently, the construction of the dam and the emergence of a large water body attracted mass recreation, which was reflected in the increased attendance of the area and the construction of cottages and other recreational facilities. The Střední Povltaví has thus become one of the most important centres of recreation on the Vltava River, whether in terms of the number of objects of second housing or the number of people spending their summer holidays here. In addition to the recreational function, the residential function and production (agriculture, small industrial operations), and the water management function are also important. A slight increase in the residential function can be expected, since the area has a great potential for further development as a suburban zone of Prague.

Acknowlegment

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References and Data Sources

BALATKA, B., KALVODA, J. (2006): Geomorfologické členění reliéfu Čech. Kartografie, Praha.

DEMEK, J. (ed.) a kol. (1987): Zeměpisný lexikon ČSR. Hory a nížiny. Academia, Praha.

NEUHÄUSLOVÁ, Z., MORAVEC, J. (eds.) a kol. (1997): Mapa potenciální přirozené vegetace České republiky. Map of potential natural vegetation of the Czech Republic. Kartografie, Praha.

PLÍVA, K., ŽLÁBEK, I. (1986): Přírodní lesní oblasti ČSR. SZN, Praha.

QUITT, E. (2009): Klimatické oblasti. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SEDLÁČEK, J., JANDERKOVÁ, J., ŠEFRNA, L. (2009): Půdní asociace. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SKALICKÝ, V. et al. (2009): Fytogeografické členění. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

Archive Maps of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK), Central Archive of Surveying and Cadastre. https://archivnimapy.cuzk.cz/uazk/pohledy/archiv.html (1. 10. 2019).

Czech Association of Museums and Galleries (Asociace muzeí a galerií České republiky). https://www.cz-museums.cz/web/amg/titulni (1. 10. 2019).

Do muzea. https://www.do-muzea.cz (1. 10. 2019).

eKatalog BPEJ. https://bpej.vumop.cz/ (1. 10. 2019)

Geologická mapa ČR 1 : 50 000. https://mapy.geology.cz/geocr50/ (1. 10. 2019).

Geoportal of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK). https://geoportal.cuzk.cz/ (1. 10. 2019).

Land Use Land Cover Czechia Database. https://www.lucccz.cz/databaze/ (1. 10. 2019).

Museum.cz. https://www.museum.cz/ (1. 10. 2019).

National Heritage Monument Catalogue, The National Heritage Institute (Národní památkový ústav – NPÚ). https://pamatkovykatalog.cz/ (1. 10. 2019).

Portál informačního systému ochrany přírody. http://webgis.nature.cz/mapomat/ (1. 10. 2019).

Půdní mapa ČR 1 : 50 000. https://mapy.geology.cz/pudy/ (1. 10. 2019).

Register of communal symbols (Registr komunálních symbolů), Chamber of Deputies of the Czech Republic. https://rekos.psp.cz (1. 10. 2019).

Ústřední seznam ochrany přírody. http://drusop.nature.cz/ (1. 10. 2019).

CHAPTER 9

Suburban landscape in the hinterland of Prague: Disappeared landscape of intensive agriculture

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1. Introduction

The landscape on the south-eastern outskirts of Prague is an example of fast-paced, apparently unplanned, and unregulated suburbanization in the immediate hinterland of the city. Originally the landscape was intensively used agricultural landscape with the overwhelming majority of arable land, cultivating fertile soils covering the Pražská plošina (Prague Plateau). In the 1950s and 1960s, as elsewhere in Czechia, collectivization took place, merge of agricultural land into large soil blocks and, in part, the displacement of the largest farmers, nevertheless, the landscape remained unchanged until the 1980s. The relatively strict law for the protection of agricultural land also contributed to this. The agricultural villages in the area near Prague became neglected (e.g. Pitkovice, Benice, Lipany, Čestlice, Nupaky, Dobřejovice, Osnice, Zdiměřice) and, despite their location in the central part of Czechia, resembled borderland settlements.

In the valleys of streams unsuitable for large-scale agricultural production – such as the Botič (Botič Brook) or the Pitkovický potok (Pitkovice Brook), areas of abandoned soil were overgrown with the so-called "new wilderness". The only exception was the Průhonický park (Průhonice Park) with its extensive and valuable landscaped park in the Botič Brook valley, which has already been a popular destination with a residential function. The situation changed in the 1980s after the construction of the D1 highway and especially after 1990, when the "wild" residential and commercial suburbanization has started.

For the purposes of this project, the so-called core area has been delimited and most analyses are carried out in this core area (Figure 1). It includes the municipal areas of Čestlice,

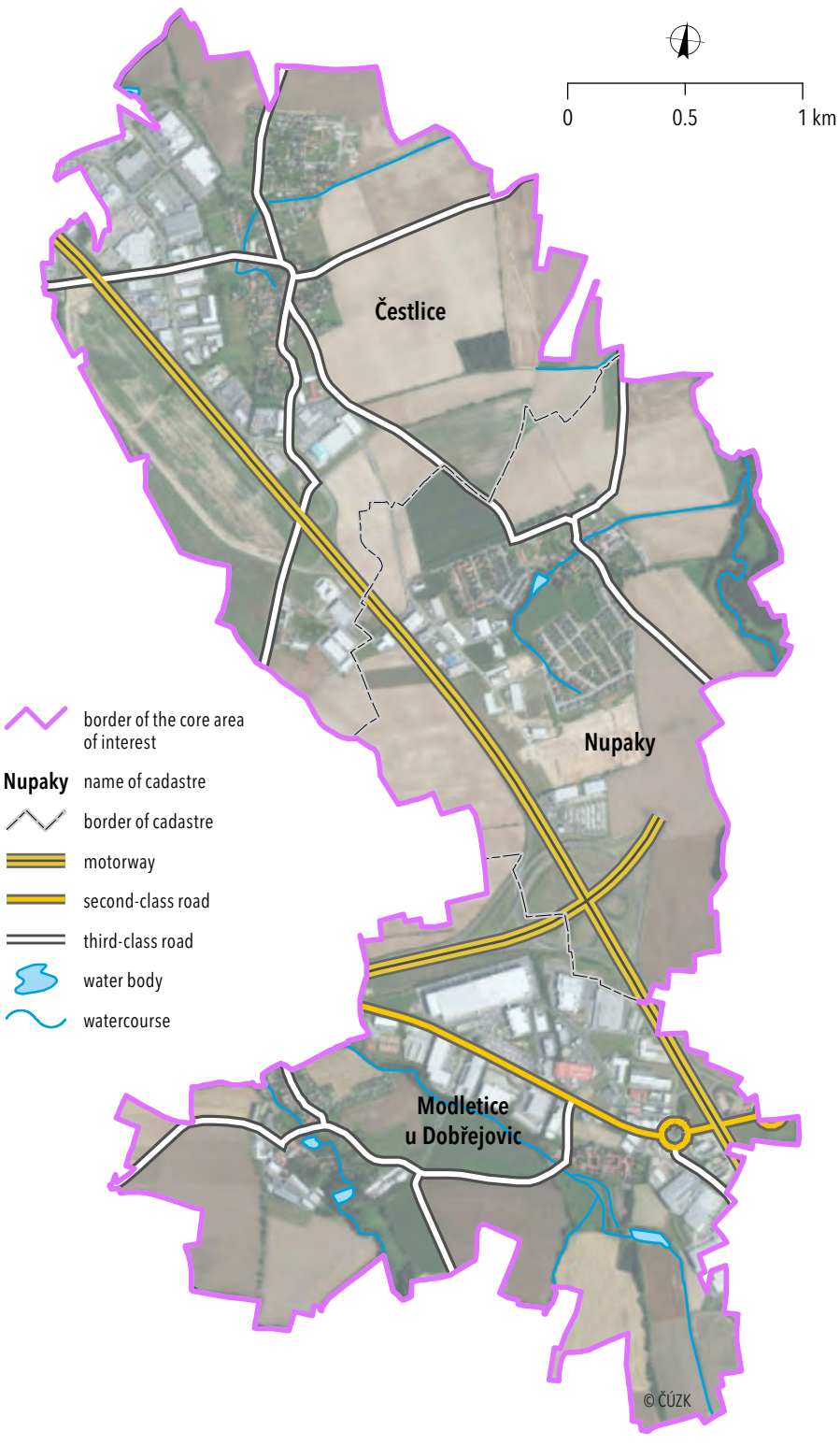


Fig. 1 – The core area of interest. Map basis: Data50; Orthophoto © The State Administration of Land Surveying and Cadastre, 2019.

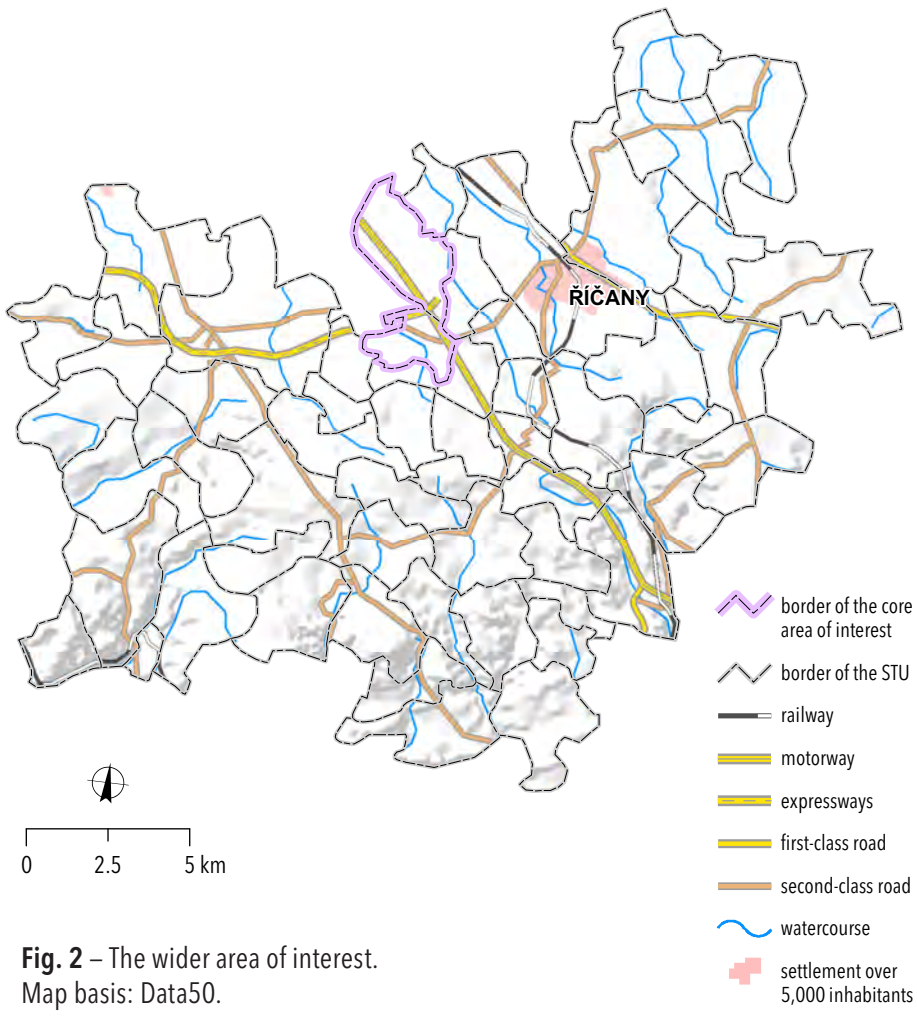


Fig. 2 – The wider area of interest. Map basis: Data50.

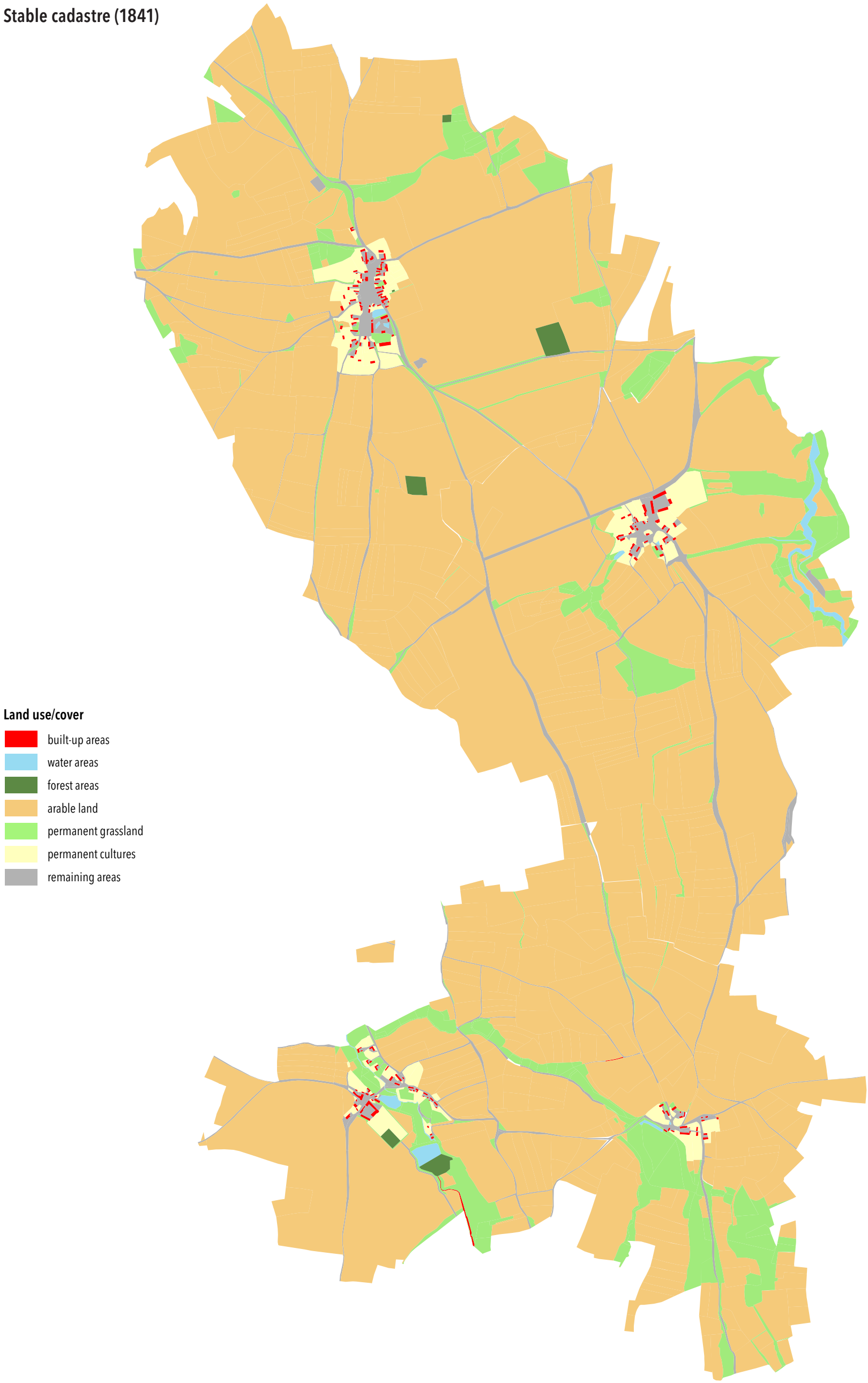
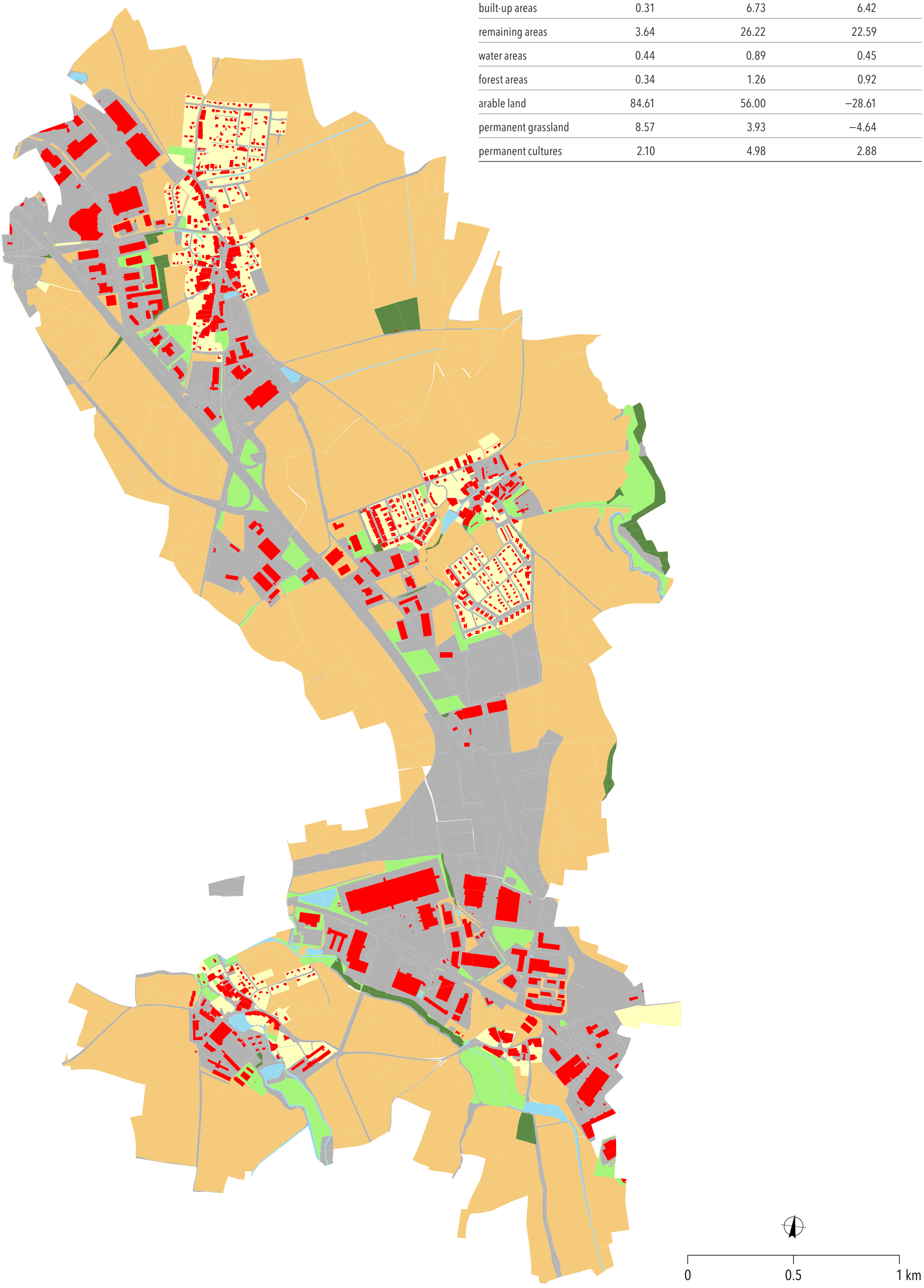


Fig. 3 – Land use/cover in cadastres Čestlice, Nupak and Modletice u Dobřejovic in 1841 and 2018.
Map basis: The State Administration of Land Surveying and Cadastre.

Current state (2018)



Tab. 1 – Proportion and change of land use/cover classes between 1841 and 2018

Land use/cover class	proportion in 1841 (%)	proportion in 2018 (%)	change (% points)
built-up areas	0.31	6.73	6.42
remaining areas	3.64	26.22	22.59
water areas	0.44	0.89	0.45
forest areas	0.34	1.26	0.92
arable land	84.61	56.00	−28.61
permanent grassland	8.57	3.93	−4.64
permanent cultures	2.10	4.98	2.88

1953

1983

2018

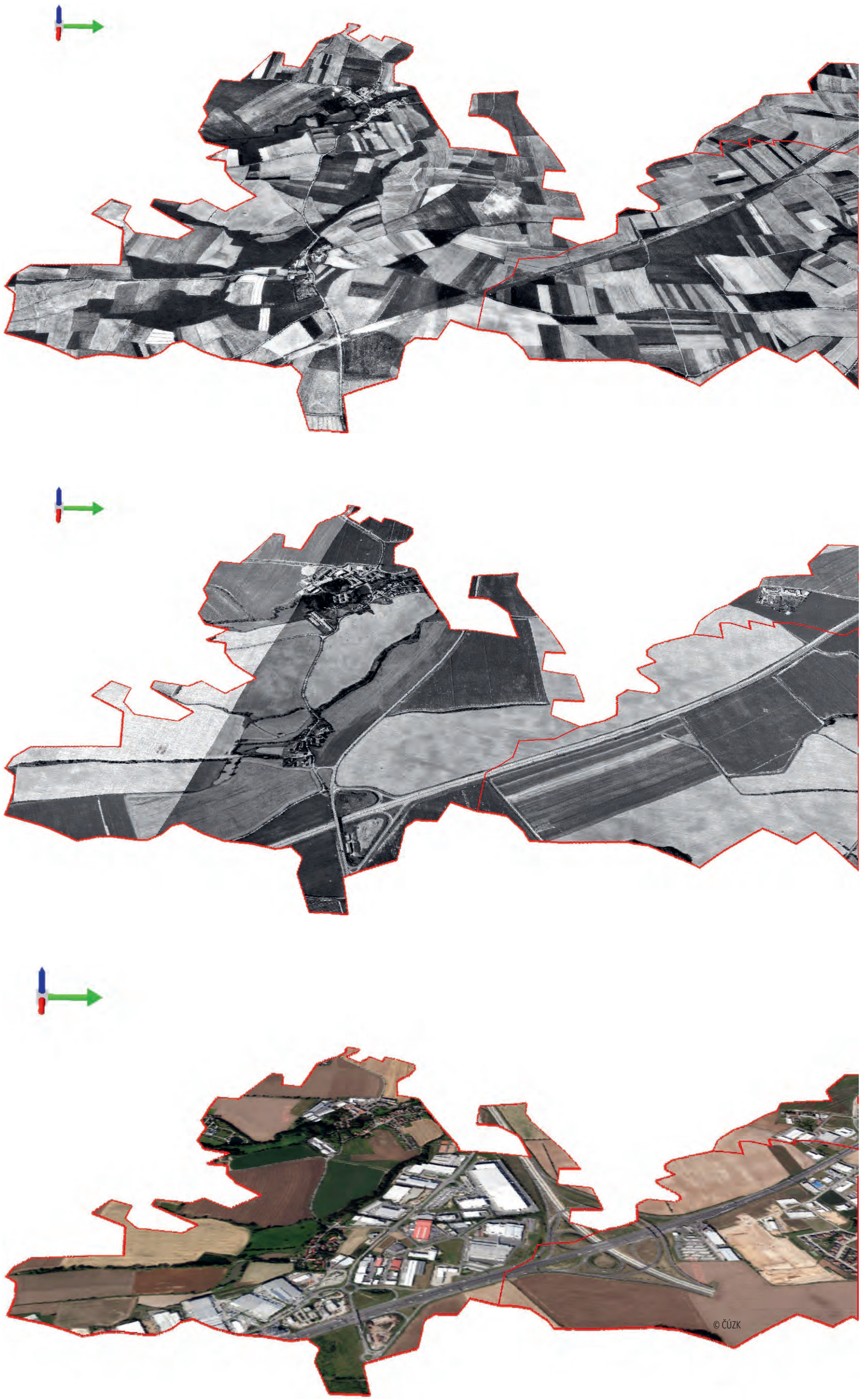


Fig. 4 – Models of landscape – Suburban landscape in the hinterland of Prague in 1947, 1983 and 2018. Source: Aerial photos © Military Geographical and Hydrometeorological Office in Dobruška, Ministry of Defence, 2018; Orthophoto © The State Administration of Land Surveying and Cadastre, 2018.

Fig. 5 – The centre of Říčany. Source: Archive of the NAKI project no. DG18P02OVV008. Photo (2019): Zdeněk Kučera.

Nupaky and Modletice. The wider area of interest (see Chapter 1 of Atlas) is shown in Figure 2.

2. Area of Interest: Main Features

The area of interest in the suburban landscape of the city on the south-eastern Prague hinterland of lies on the boundary of two different geomorphological units – sub-provinces. The northern part is occupied by the Poberounská sub-province (area along the Berounka River), represented by the geomorphological unit of the Prague Plateau. The southern and eastern parts belong to the Česko-moravská subprovincie (Bohemian-Moravian sub-province), the geomorphological unit of the Středočeská pahorkatina (Central Bohemian Upland), the geomorphological sub-unit of the Benešovská pahorkatina (Benešov Upland), and the geomorphological sub-unit of the Dobříšská pahorkatina (Dobříš Upland), which is further subdivided into several smaller districts. The two sub-provinces are separated by a distinct terrain step, which by the Central Bohemian Upland raises towards the south above the Prague Plateau.

The geological bedrock of the Říčanská plošina (Říčany Plateau) is formed by Proterozoic clay shales and Greywackes of the eastern wing of Barrandien. Vast areas of planation surfaces and gentle slopes are covered by loess and loess like deposits, the floodplains are filled by the Holocene alluvial sediments. In the area of Benešov Upland in the south and east (outside the core area), in the area from Říčany to Škvorec in the north, and Mirošovice and Mnichovice in the south, coarse-grained "říčanská žula" (Říčany granite) is formed with the appearance of a vein aplite and pegmatite. In the southern part towards the Posázaví (area along the Sázava River) there are gabbro bodies. The area of the Jílovské pásmo (Jílové zone) consists of old Proterozoic volcanic rocks – basalts, andesites, dacites, rhyolites, tufas, which were later penetrated by the granodiorites of the Central Bohemian Pluton during the Variscan orogeny and contact metamorphosed. The Jílové zone was historically famous for gold mining around Jílové u Prahy.

The relief of the Uhříněveská plošina (Uhříněves Plateal) is only slightly rugged, typologically corresponding to a flat upland with elevations of 30–75 m. Vast planation surfaces are covered with loess deposits. The valleys of the streams are mostly shallow, wide and not much deep. Numerous local small or large (in Uhříněves) brickworks were established in loess deposits in the past. The present relief is increasingly affected and formed by anthropogenic, mainly urban activities, but also the transport infrastructure shapes the relief (road embankments and cuts created by, or because of, the D1 highway, Prague Ring highway, etc.) are important.

The relief of the Central Bohemian Upland is much more varied and rugged, but it lies outside the core area. The ragged relief typologically corresponds to the ragged upland or flat highland with predominant height differences of 100–200 m. The highest altitudes exceed 500 metres a.s.l. Structural-erosion-denudation relief is the result of different resistance of rocks to weathering. Resistant rocks form morphologically distinct elevations on which boulders of deep igneous rocks appear.

The core area on the outskirts of Prague lies in a warm climate. The average annual temperature ranges from 8 to 9 °C. The average annual precipitation is 550–600 mm. The wider area of interest in the south and east lies in the slightly warm climate area with an average annual temperature of around 8 °C and an annual precipitation of over 600 mm.

The area belongs to the phytogeographical area of the Czech Mesophyticum, the phytogeographical district of the Říčany Plateau. Potential natural vegetation in the area of the Prague Plateau is represented by linden-oak forests or oak-hornbeam forests. In the area of Dobříš Upland acidophilous beech and/or fir-oak forests and acidophilous linden or beech forests grow.

The landscape of the area is currently used predominantly as an arable land, which, however, gives way to the growing urban and suburban development of Prague's hinterland. New residential complexes and commercial buildings of service and logistics infrastructure are being built here, the latter mainly in the belt along the D1 highway. The landscape is also fragmented by many new transport constructions. The forests are very few in the area. Small areas of mostly deciduous forests and shrubbery areas occur only fragmentarily on valley slopes or along streams. The "oasis" of greenery is represented by the Průhonice Park, situated on an area of 250 ha in the ragged valley of the Botič Brook. The Průhonice Park has been declared a National Cultural Monument and since 2012 has been registered in the UNESCO World Heritage List.

The area of the Dobříš Upland on the southern and southwestern edges of the wider area of interest is much more forested and significantly less covered by built-up area. The landscape is a mosaic of forests, farmland, smaller settlements and holiday (second) homes and plays an important role as a recreational area for the capital city of Prague.

The area of interest is internally differentiated into a more fertile northwest with higher creditworthiness and average price of agricultural land and a less fertile southeast.

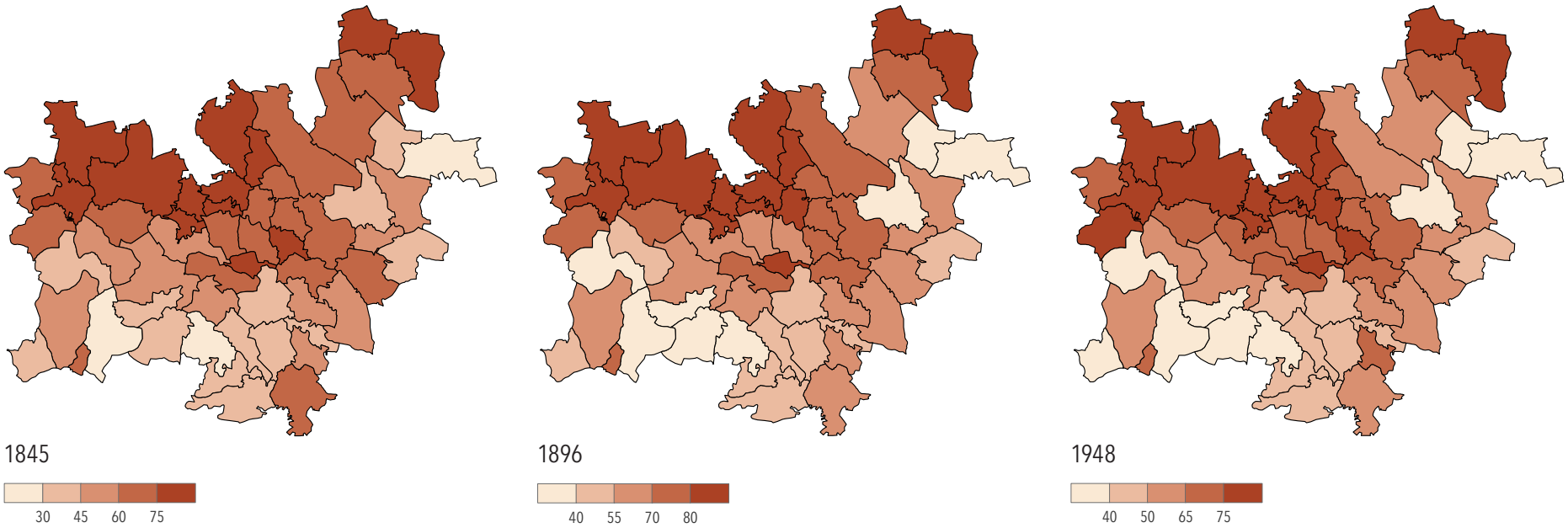


Fig. 6 – Proportion of arable land by STUs (% of STU area). Source: LUCC Czechia Database.

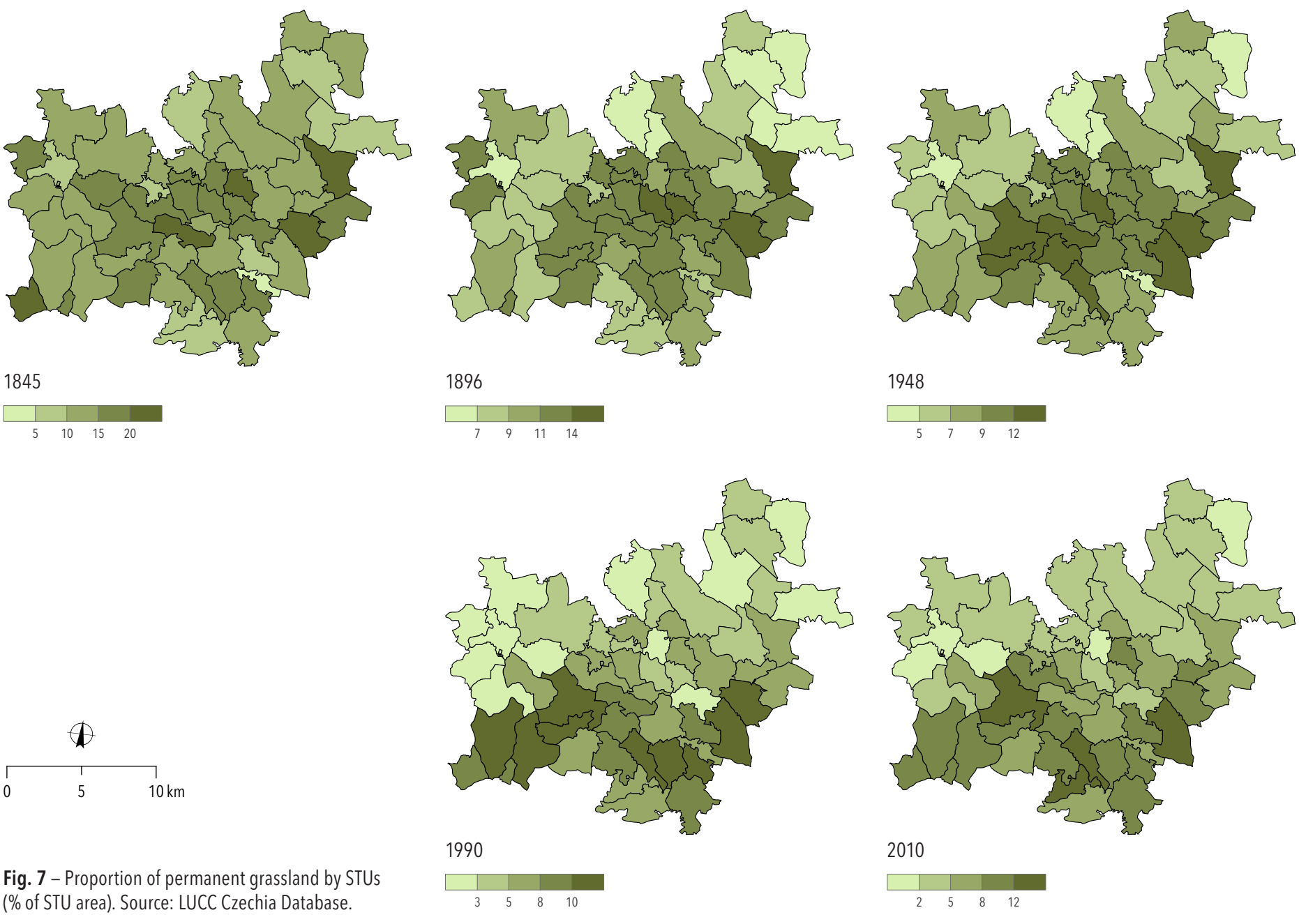


Fig. 7 – Proportion of permanent grassland by STUs (% of STU area). Source: LUCC Czechia Database.

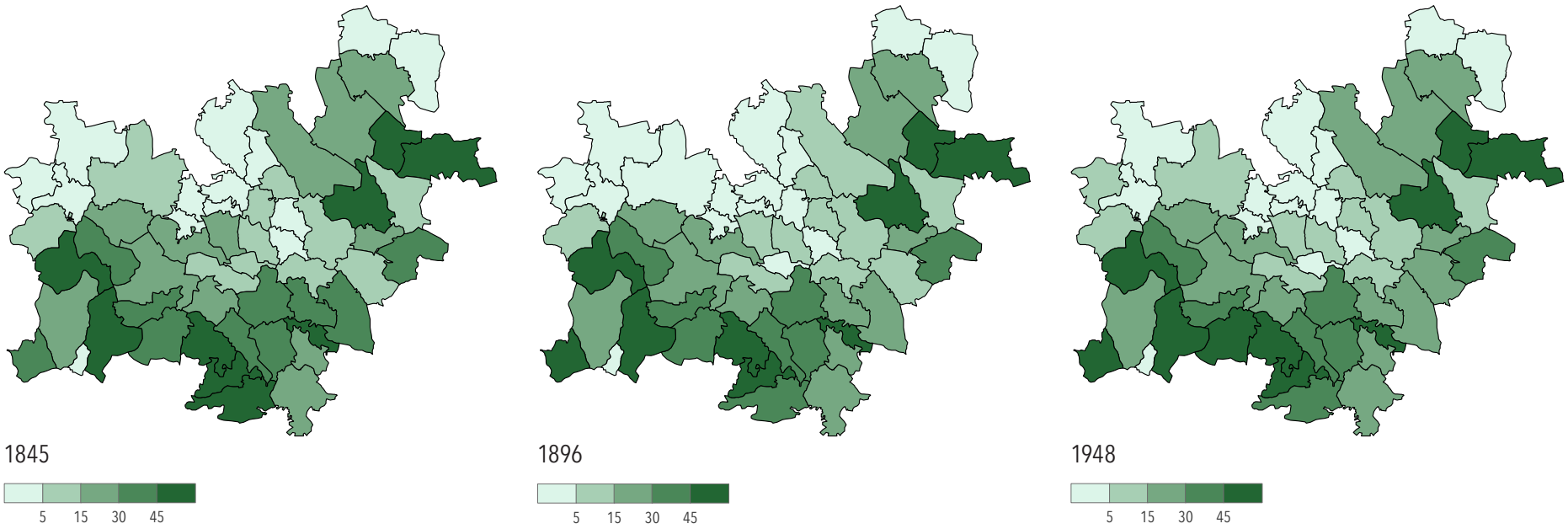


Fig. 8 – Proportion of forest areas by STUs (% of STU area). Source: LUCC Czechia Database.

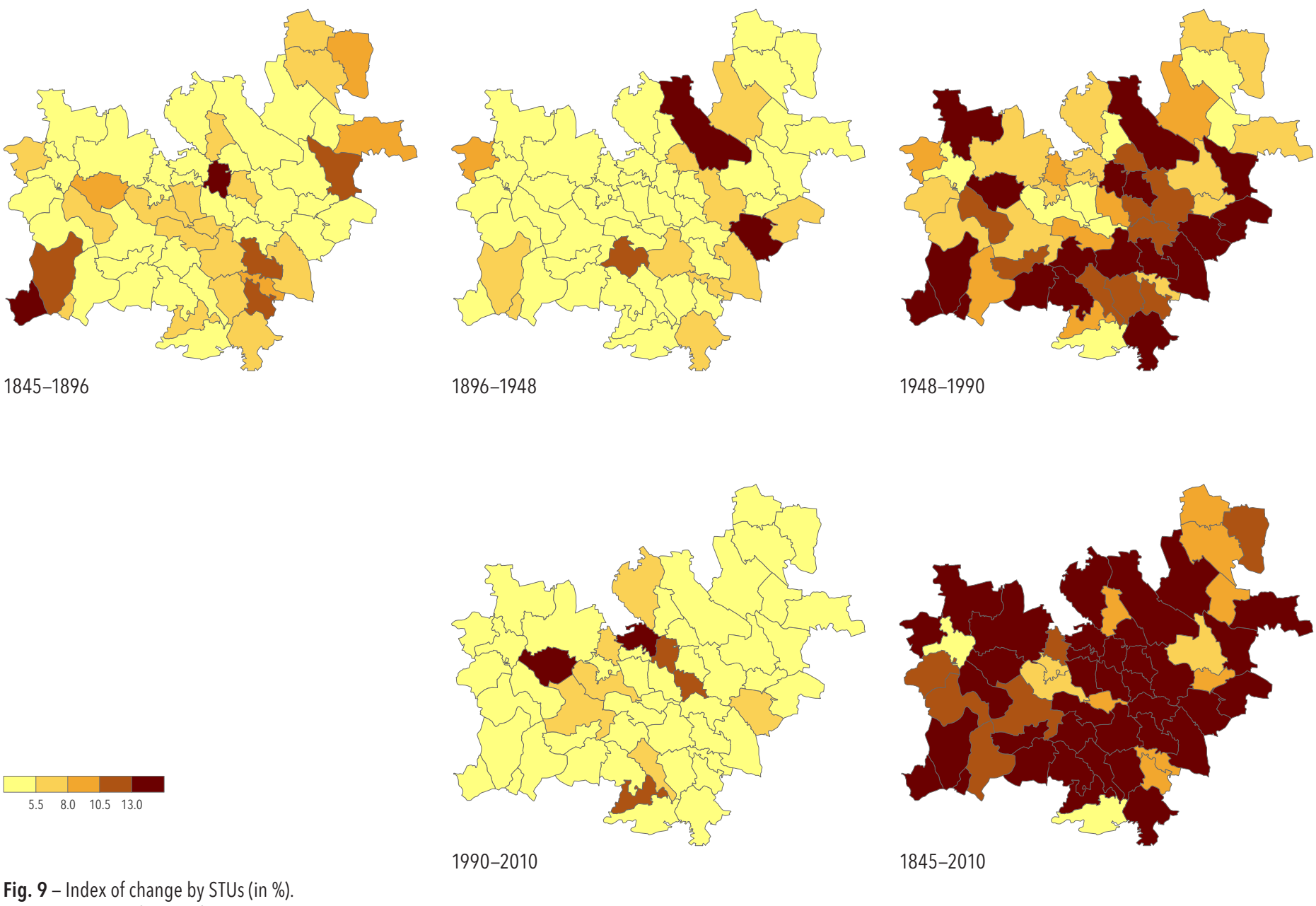


Fig. 9 – Index of change by STUs (in %). Source: LUCC Czechia Database.

Fig. 10 – Municipality emblems.
Source: Register of municipal symbols, Chamber of Deputies of the Czech Republic (https://rekos.psp.cz; as of 1 October, 2018).

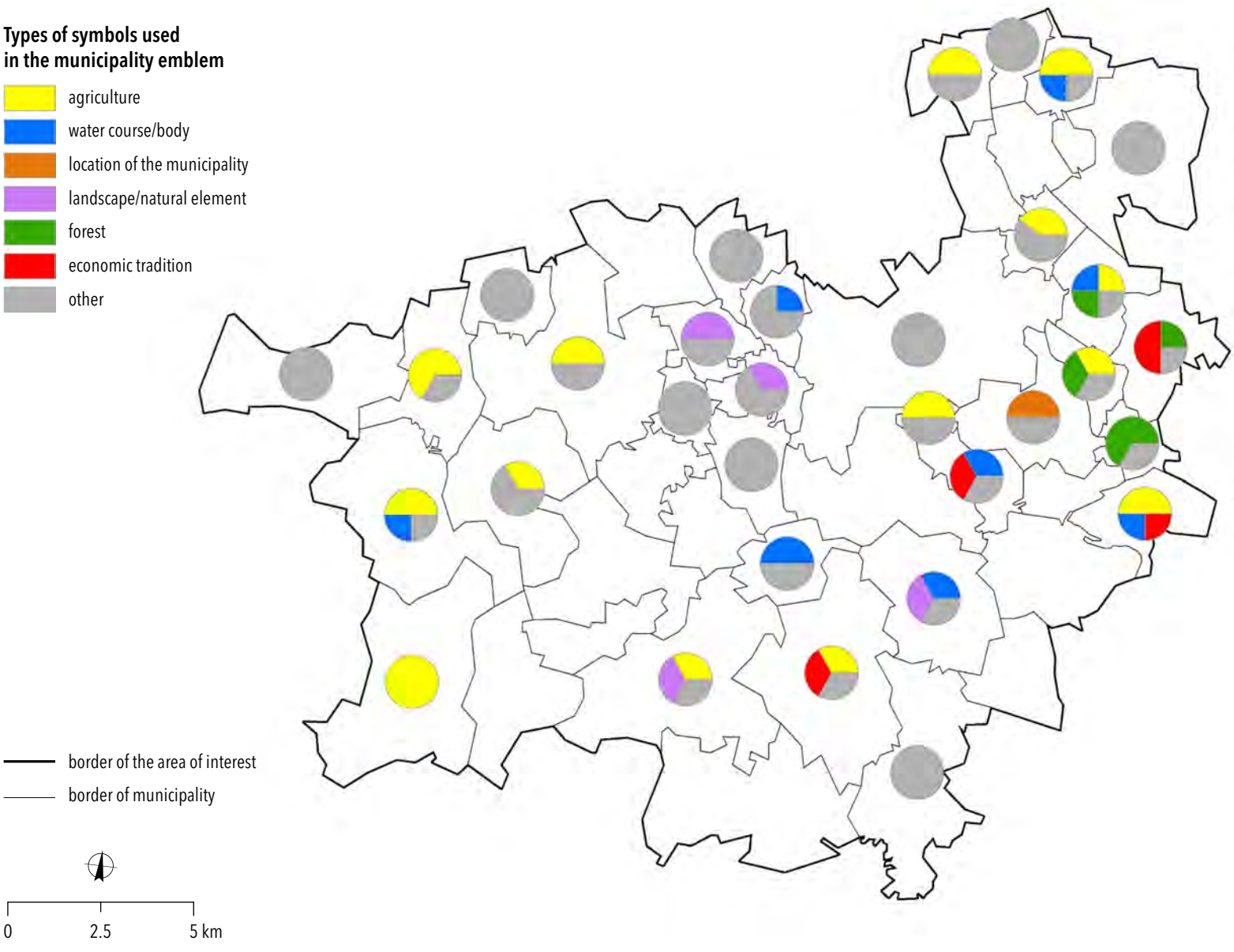


Fig. 11 – Types of symbols used in the municipality emblems.
Data source: Contant analysis of the municipality emblems (as of 1 October, 2018).

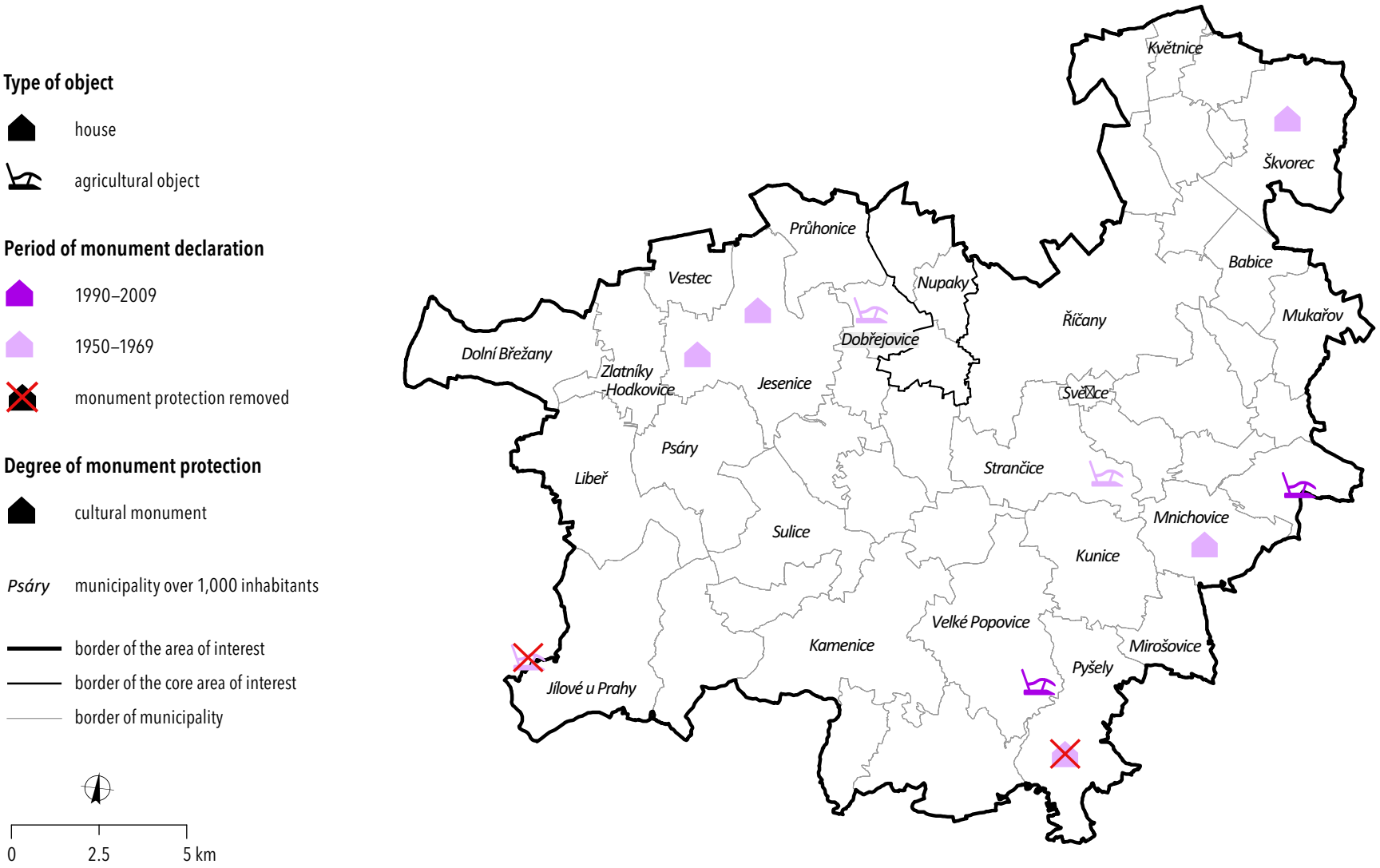


Fig. 12 – Cultural monuments and heritage areas.
Data source: National Heritage Monument Catalogue, National Heritage Institute (https://pamatkovykatalog.cz; as of 1 October, 2018).

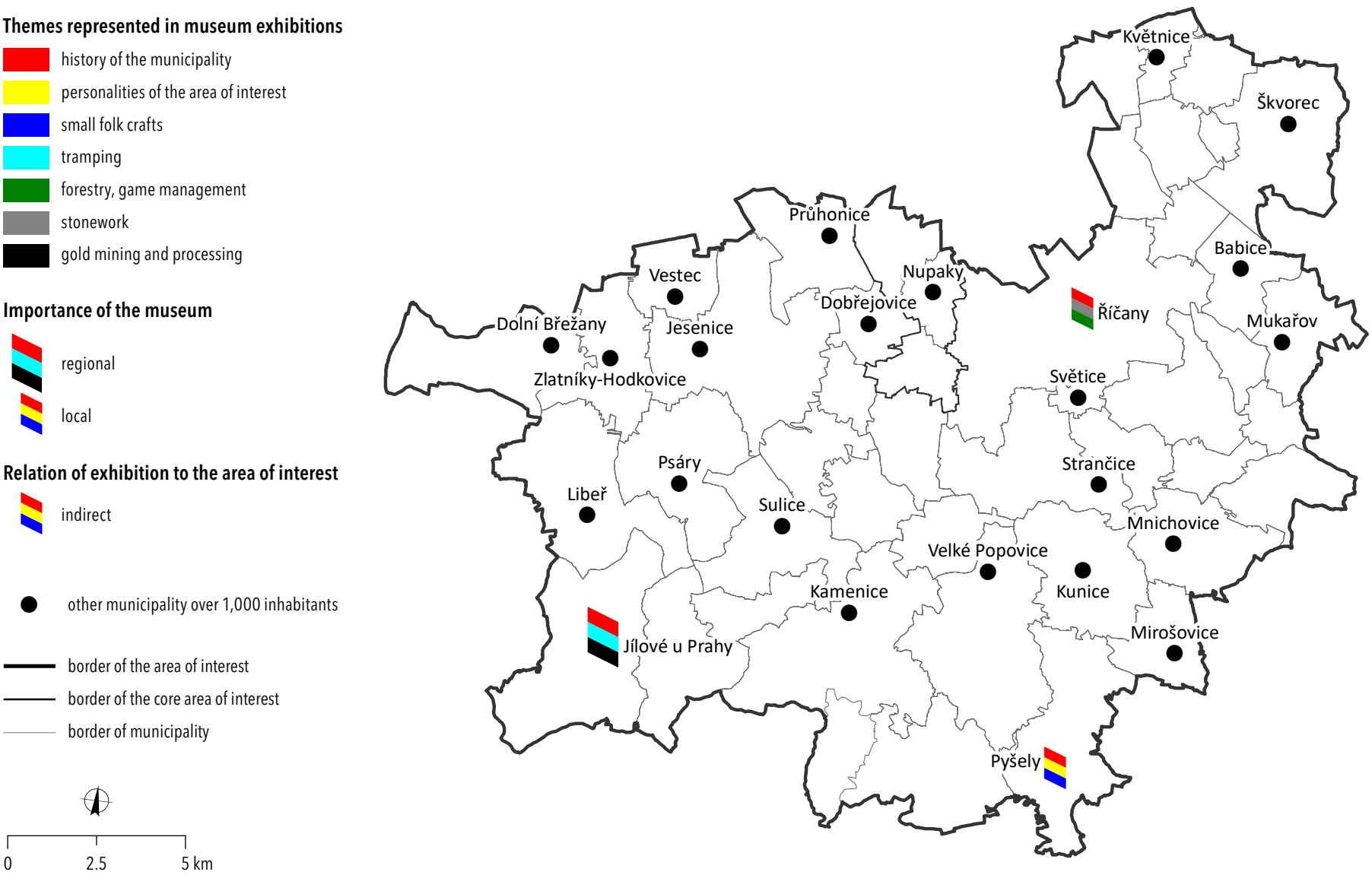


Fig. 13 – Museum exhibitions.
Data source: Czech Association of Museums and Galleries (https://www.cz-museums.cz/web/amg/titulni; as of 1 October, 2018), Webportal Do muzea (https://www.do-muzea.cz; as of 1 October, 2018), Webportal Museum.cz (https://www.museum.cz; as of 1 October, 2018).

The almost continuous belt on both sides of the D1 highway stretching up to 20 km from Prague has attracted large commercial suburbanization buildings (warehouses, logistics centres, shopping centres), while residential suburbanization, the construction of new residential settlements, has concentrated on the, at that time mostly small, agricultural villages. In several cases, new units designed for residential housing were also created in the agricultural landscape without a link to the existing settlement structure. The landscape has undergone a profound change in appearance, structure, use and function. Suburbanized (largely built-up) landscape emerged from the former agricultural landscape with village settlements.

3. Results

3.1 Landscape and Land Use/Cover Changes

Figure 3 and Table 1 compare how the landscape looked like in the 1st half of the 19th century (1841) and its state at the present (2018).

The enormous change in land use/cover of the suburban landscape of Prague over the past 177 years is evident at first sight from the comparison of the stable cadastre map and the current cadastre map (Figure 1). The change did not occur gradually over the studied period, but mostly only during the last 28 years. The increase of "remaining areas" is obvious. Their current share (more than 26% in the area of interest) is extreme and almost three times bigger than the average at the national level (which is now about 9%). The proportion of built-up areas is also high. The significant increase in the extent of remaining and built-up areas is due to suburbanization, commercial suburbanization in particular, which currently dominates the area of interest and is the main process of landscape change. Large areas of warehouses, logistic centres, production and sale facilities, including accompanying transportation networks were built after 1990 as a part of uncontrolled suburbanization and significantly burden the area with the occupation of quality agricultural land, permanent hardening of areas, dense transportation, and architecturally specific, unsightly developments (a number of large halls with surrounding concrete and asphalt surfaces).

The character of the landscape in the area was disturbed and completely changed from the time of the stable cadastre. It is also interesting that in the time of the stable cadastre, arable land covered almost 85% of the area, represented by especially fertile land, which is currently being covered by buildings without any compensation. Despite these significant occupations, the share of arable land still remains very high (56%) in the area, but in the future, this will certainly be under pressure thanks to further increase of the built-up areas. On the contrary, there is a very small, practically zero share of forest areas and very low share of permanent grassland (4.6%). There are also very few water bodies. The landscape is strongly anthropogenically affected and irreversibly damaged.

The above-described changes in land use/cover patterns is completed by models of the disappeared intensive agriculture landscape of the area of interest (Figure 2). The comparison of the pictures from 1953 and 1983 shows a change in the landscape structure from "fine-grained" mosaic to large blocks of agricultural land and as a major change can also be seen the construction of the shooting range in Čestlice. The present picture documents the development of commercial suburbanization – manufacturing, storage and other commercial halls in the northern part of the cadastre of Modletice and also growth of the residential suburbanization here. It is also possible to observe a large, newly built transportation service network (including the D1 highway) and vast areas with arable land (with fertile soils) already prepared for further construction in the Nupaky cadastre.

Figures 6–9 show wider perspective of land use/cover changes in STUs and describe changes over the time by comparing years 1845, 1896, 1948, 1990, and 2010.

The highest quality agricultural lands in this area are located near the south-eastern border of Prague. The majority of cadastres have the price of agricultural land on the average of Czechia, in eight cadastres it is below the average. This also corresponds with a very low share of land which is used for ploughing. More ploughed soil is only in cadastres with a higher price of agricultural land fund (more than 5.5 CZK per square metre, where it reaches values above 70%); while in the southeast of the area of interest it is currently below 40%. This situation is probably related to the fact that after World War II there was no link to the previous system of family farms, and after the loss of subsidies after 1990, considerable areas of arable land were left to grassing, both officially and without any adequate documentation by the Cadastral Office.

Figure 9 show the index of change (in terms of land use/cover changes). In the area of interest, the most significant changes in land use/cover were recorded in the period 1948–1990, when an index of change of 13% applies to about half of the area. In the other time periods, the intensity of the changes was significantly lower. The cartogram (Figure 9) shows the changes for the whole monitored period (1845–2010), in most cadastres of the area of interest the changes were very intense (change index above 13%). The high intensity of changes is due to the large exposure of the area, which lies in the hinterland of the capital city of Prague. Changes in the index of change thus document changes in the functions of the area extending along the most frequented road route in Czechia – highway D1.

3.2 Landscape Memory

The landscape memory of the area is shown in four maps described in following sections 3.2.1–3.2.3 (for more details about methodology of mapping see Chapter 1 of Atlas).

3.2.1 Places and Institutions of Memory

The suburban landscape in hinterland of Prague is one of the typical suburban areas. Until the 1980s, however, the landscape of this area was rather agricultural. So far, no memory institutions deal directly with the changing landscape of the area of interest. Three nearby museums (Figure 13) focus on the changed landscape of the area, but only in the wider context. All museums shown in the map contain expositions on the history of the area and the municipalities in which they are located. However, other expositions are very different. The Říčany Museum is dedicated to palaeontology, geology, the history of forestry, and the role of the forest in the lives of local people. The Pyšely Museum deals with small folk crafts and important personalities of the region. The museum in Jílové u Prahy is one of the largest museums in the area, and it mainly presents the history of gold mining and gold processing in Říčany. This museum also deals with the history of tramping, which in the southern surroundings of Prague began to develop significantly after 1918.

3.2.2 Regional and Local Symbols

The most frequent symbols depicted in municipality emblems in the suburban landscape in hinterland of Prague area of interest

are references symbolizing the agricultural tradition of the area and the agricultural character of the local landscape (Figure 10). Agricultural tradition is symbolized mostly by yellow and green tincture (colour) – e.g. Zlatníky-Hodkovice, Psáře, Světice, Březí etc. Figures of agricultural crops (grain cob in emblems of Jesenice, Sibřina, Tehovec) and tools (the stamper in the Tehovec emblem; the plough and others agricultural tools in the emblem of Libeř) are also often used.

The forests (even though they are rare in the whole area) are evident in the eastern part of the area (trees figures – Mukařov, Tehovec, Svojetice; green tincture – Babice; figure of the wood scraper – Struhařov). A unique symbol that is pictured in emblems of municipalities in the area is a reference to the traditional brewery in Velké Popovice.

3.2.3 Heritage Sites

Ten relevant heritage objects are located in the area of interest (Figure 12). Two of these buildings lost heritage protection due to their destruction in the past (the barn in Petrov u Prahy), or due to unsuitable construction-technical modifications (as in the case of rural homestead in Pyšely). The rest of the buildings were declared cultural monuments at different time periods – the first "wave" occurred in the 1950s and 1960s and others followed after 1989. Among these monuments, other agricultural buildings (barns, granaries, farmsteads) were registered, which relate to the agricultural activities in the area especially in the 18th and 19th centuries.

4. Summary

A specific feature of the area of interest is its gradual connection to the metropolitan area of Prague, the main concentration core of Bohemia and the entire Czechia. Because of that, the area acquired new functions, which have deeply impacted its land use/cover (and consequently its landscape). A fundamental functional transformation from the agricultural landscape, utilizing the high production capabilities of soils in the hinterland of Prague, to the urbanized landscape with a large concentration of commercial and residential buildings and with a high traffic network load and realized transport, occurred. These changes resulted in extensive land grabbing, increase of concreted surfaces, increase of noise pollution and significant fragmentation of the landscape due to the construction of the transportation infrastructure (mainly the construction of the D1 highway and part of the Prague Ring highway).

Changes took place in 44% of the area, while 56% did not change the land cover compared to the state recorded on the maps of the stable cadastre. Stable areas are predominantly those of arable land. The changes in the agricultural use of the landscape (decrease in farming intensity and arable land area) led to the disappearance of traditional forms of local settlements. The question is whether some of the residential and agricultural buildings should not be protected as reminders of the former functions of the local landscape.

Acknowlegment

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References and Data Sources

BALATKA, B., KALVODA, J. (2006): Geomorfologické členění reliéfu Čech. Kartografie, Praha.

DEMEK, J. (ed.) a kol. (1987): Zeměpisný lexikon ČSR. Hory a nížiny. Academia, Praha.

NEUHÄUSLOVÁ, Z., MORAVEC, J. (eds.) a kol. (1997): Mapa potenciální přirozené vegetace České republiky. Map of potential natural vegetation of the Czech Republic. Kartografie, Praha.

PLÍVA, K., ŽLÁBEK, I. (1986): Přírodní lesní oblasti ČSR. SZN, Praha.

QUITT, E. (2009): Klimatické oblasti. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SEDLÁČEK, J., JANDERKOVÁ, J., ŠEFRNA, L. (2009): Půdní asociace. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

SKALICKÝ, V. et al. (2009): Fytogeografické členění. In: Hrnčiarová, T. et al. (2009): Atlas krajiny České republiky. Ministerstvo životního prostředí České republiky, Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, Praha.

Archive Maps of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK), Central Archive of Surveying and Cadastre. https://archivnimapy.cuzk.cz/uazk/pohledy/archiv.html (1. 10. 2019).

Czech Association of Museums and Galleries (Asociace muzeí a galerií České republiky). https://www.cz-museums.cz/web/amg/titulni (1. 10. 2019).

Do muzea. https://www.do-muzea.cz (1. 10. 2019).

eKatalog BPEJ. https://bpej.vumop.cz/ (1. 10. 2019)

Geologická mapa ČR 1 : 50 000. https://mapy.geology.cz/geocr50/ (1. 10. 2019).

Geoportal of the State Administration of Land Surveying and Cadastre (Český úřad zeměměřický a katastrální – ČÚZK). https://geoportal.cuzk.cz/ (1. 10. 2019).

Land Use Land Cover Czechia Database. https://www.lucccz.cz/databaze/ (1. 10. 2019).

Museum.cz. https://www.museum.cz/ (1. 10. 2019).

National Heritage Monument Catalogue, The National Heritage Institute (Národní památkový ústav – NPÚ). https://pamatkovykatalog.cz/ (1. 10. 2019).

Portál informačního systému ochrany přírody. http://webgis.nature.cz/mapomat/ (1. 10. 2019).

Půdní mapa ČR 1 : 50 000. https://mapy.geology.cz/pudy/ (1. 10. 2019).

Register of communal symbols (Registr komunálních symbolů), Chamber of Deputies of the Czech Republic. https://rekos.psp.cz (1. 10. 2019).

Ústřední seznam ochrany přírody. http://drusop.nature.cz/ (1. 10. 2019).

II

International Contributions

Green Infrastructure and Land Cover Transformation in Latin American Cities

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1. Introduction

Modern Latin American cities are a product of numerous modifications and transformations during its vast history that influenced not only the cities' functions and specializations, but their comfortability as well. For the most part, the decreasing quality of urban environment in megacities all over the world is connected with their unstoppable population growth and agglomeration development, followed by immense land-sealing. Land-sealing means the conversion of open areas into built-up areas and their coverage with completely or partly impermeable artificial material (Artmann 2014). As a result, green infrastructure that fulfills a number of ecosystem services that improve urban environment and urban life in general, decreases and gradually degrades. Today, Latin America is the most urbanized continent with 83% of its population living in urban areas (PRB 2019). Forty-six cities have population over one million – they are the ones whose citizens may suffer the most due to the lack of green infrastructure.

The installation of green infrastructure as opposed to grey infrastructure (built-up and sealed territories) is identified as an alternative nature-based and cost-effective solution for improving the sustainability of the urban development (Ahern 2013, Alberti 2008). European Environment Agency describes green infrastructure as an integrated network of natural and semi-natural areas and features which deliver a variety of benefits to humans (Naumann 2011). There are different analogies for green infrastructure in Latin American countries that are to a certain degree regulated by cities' laws. In most cases, green infrastructure (or *area verde*) in this region implies parks and other public green zones, mainly created for recreation and aesthetics. In our research by green infrastructure we mean a complex of unsealed area, covered by vegetation of different types and density, including both tree and non-tree cover.

It is vital to understand that urban green infrastructure carries out different functions depending on a spatial level. While small and medium green elements (up to 25 km²) within the "urban core" (the most built-up and populated part of the city) usually perform aesthetic and recreational services, bigger elements (like urban forests, incorporated into the urban core) are responsible for biodiversity, habitat formation, climate and water regulation. A number of large Latin American cities are situated in mountainous areas and moist tropical climate. These geographical features poise a threat of destructive natural disasters like landslides and flashfloods. Slope and valley vegetation helps to prevent them. Hence, the demolishment and degradation of green infrastructure in these landscape parts trigger the disasters.

Moreover, green infrastructure in some Latin American cities still contains small areas of rare unique ecosystems and landscapes like restinga, mangroves, araucaria moist forests, lomas, Atlantic forests and others. While these parts of green infrastructure may play a minor role for urban comfortability, they are a crucial part of world biodiversity. For instance, over 50% of green infrastructure in Rio de Janeiro is Atlantic Forest – a biome with only 7% of its original surface left (WWF 2019). A similar case can be found in the region of Lima and other urban areas of Peruvian and Chilean west coast, where arid biomes of *lomas* were severely destructed throughout cities' development and occupy only 4,000 km² – less than 30% of its original size (Veblen 2015).

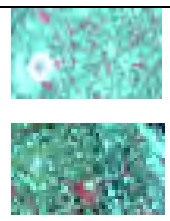
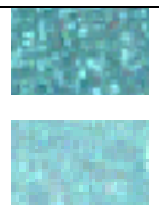
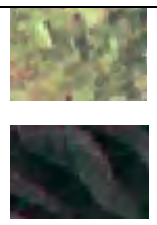
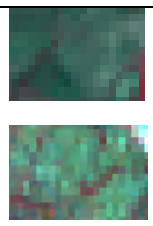
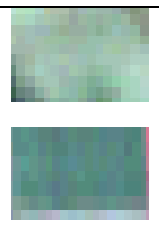
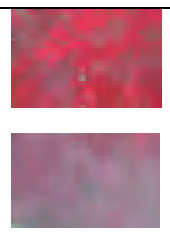
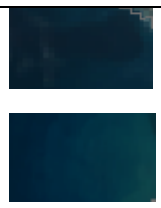
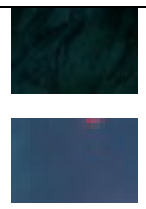
Thus, it is essential to determine the most vulnerable elements of green infrastructure to develop an effective course of action for urban spatial planning. The aim of our work is to assess the green infrastructure transformation in five Latin American cities (Lima, La Paz, Rio de Janeiro, Santiago de Chile, Buenos Aires) during the period between 1986 and 2016. In this contribution to LUCC we give results on urban vegetation change on different spatial levels and present the most outstanding transformation case for each city.

2. Study Area

Latin America is populated quite unevenly, so we roughly distinguish four main population axis: (1) north-west Andes and Caribbean coast, (2) south-west Andes, (3) Atlantic coast and (4) Pampa. For our study we chose a city with population over one million from each axis. Besides, we also took La Paz as an example of a high altitude city. Thus, there are different climatic and relief features in all five cities, where types of green infrastructure transformation vary depending on natural peculiarities and geographical position.

Lima belongs to the first axis and lies in the extra-arid desert zone. Most of the city lies on a marine accumulative plain, dissected alluvial fans of the Rimak River, Chilon River, Lurin River and their tributaries, except the east that occupies mountain valleys of the Andes at the altitude up to 600 m (Karakouzian 1997). Natural vegetation is formed by *lomas* – an ecosystem of fog-watered vegetation that appear on slopes higher than 150 m above the sea level (Arana 2005). La Paz belongs to the same population axis, but unlike Lima it presents high altitude cities as it is situate. Being situated on the Altiplano at the elevation of 2,900–4,100 meters above the sea level, La Paz has a harsh climate with the only natural vegetation of mountain shrubs and grasslands *puna* (Veben 2007). Santiago de Chile is a city of the second axis in the subtropical Mediterranean climate. It is located in the northern section of the Intermediate Depression (the Santiago Basin) – a denudation plain, interrupted by several volcanic outcrops and flanked by the Andes Main

Tab. 1 – Examples of signatures for supervised image classification for false-color band combination.

Class	Lima	La Paz	Buenos Aires	Rio de Janeiro	Santiago de Chile
Built-up area					
Non-vegetated area					
Non-tree vegetation					
Tree vegetation					
Water					

Cordillera and the Coastal Cordillera (Sepulveda 2006). The city occupies elevations between 500 and 1,000 meters above the sea level and sits in the ecoregion of evergreen woodlands and scrubs *matorral*, which is a native biome of the area (Maza 2002). Rio de Janeiro is situated in the third population zone on a coastal marine plain of the Guanabara Bay. Its surface is disrupted with granite and alkaline outcrops *serras* (up to 600 m), covered with moist Atlantic forests (Fernandes 2010). Buenos Aires is situated in Pampa with a humid subtropical climate. The agglomeration stretches from a lower terrace of Rio de la Plata to the south-west of the denudation plain Pampa Ondulada, partly formed by easily eroded loess (Morrás 2010). Natural vegetation of moist pampa was almost completely transformed by agriculture (Atlas Ambiental de Buenos Aires, http://www.atlasdebuenosaires.gov.ar). Small areas of wetlands still remain along the Rio de La Plata and are conserved in protected areas (Walker 1999).

3. Methods and Materials

To assess the transformation of green infrastructure, we used spectral satellite images of Landsat 5 for 1986 and Landsat 8 for 2016 with spatial resolution of 30 m. The images we chose had been made in the rain-season or the wettest and warmest month, during the most active vegetation period. We used combinations of bands 4-3-2 (for Landsat 5) and 5-4-3 (for Landsat 8) and then performed a supervised classification. At first, signatures for each city were created to define 5 classes: (1) built-up areas, (2) non-vegetated areas, (3) non-tree vegetation, (4) tree vegetation, (5) water (Tab. 1). Basing on them, we created land-cover maps that became a source for vegetation cover map, used for studying the change of green infrastructure (Fig. 1).

To conduct the research on different spatial levels and to determine the most transformed parts of green infrastructure, we defined four types of urban green infrastructure, depending on the elements size, position and composition.

1. Suburban green infrastructure. A vast belt around the urban core (including agricultural lands). Size and composition are not important. Main elements: agricultural lands, surrounding forests and other zonal ecosystems.
2. Urban forests and other massifs. Size: more than 25 km² (1 km² for arid zones). Vegetation: predominantly tree cover (for humid zones). Position: partly incorporated into the urban core. Main elements: protected areas, urban forests.
3. Urban parks and other green space. Size: 1–25 km² (0,5–1,0 km² for arid zones). Vegetation: predominantly grass and shrubs, sparse tree cover. Position: fully inside the urban core. Main elements: unused urban lands, covered with vegetation, bug urban parks, special polygons (airports, military areas, golf fields, football fields, industrial buffers, etc.).
4. Street vegetation and private gardens. Size: less than 1 km² (0,5 km² for arid zones). Composition is not important. Main elements: small parks, city squares, private gardens and orchards, street vegetation.

These spatial levels of green infrastructure were depicted manually by the indicators described above, according to the results of supervised classification and area calculation.

Geoecological problems, triggered by green infrastructure transformation, were studied by matching these types of green elements with their main functions in every city. In this contribution we demonstrate the transformation of lomas and matorral in Lima and Santiago respectively, the degradation of valley vegetation in La Paz and Santiago, the dynamics of slope vegetation in Rio de Janeiro and the change of inner (street) green infrastructure in Buenos Aires and Lima. Lomas and matorral coincide with the suburban green infrastructure (1) since the only existing natural vegetation in the cities occupies slopes outside the urban core. In La Paz case, we also studied suburban green infrastructure, because all valleys run up into the flanking mountains at the outskirts of the city. When dealing with Rio de Janeiro, we investigated the hills' slopes of both urban forests (2) and suburban green infrastructure (1). Finally, transformation of inner vegetation in Buenos Aires and Lima was assessed by studying two spatial levels: of urban parks (3) and street vegetation / private gardens (4). The first two scenarios are connected to flashfloods, while the next one is related with landslides and the last one with the comfortability of the urban environment. We intentionally present only the most outstanding cases even though all kinds of transformation took place in all cities, but the scope of change is less significant than with the types mentioned above.

4. Results

4.1 Lima

Being situated in the extra-arid climatic zone, Lima is especially vulnerable to droughts. On the one hand, rivers that run through the city have predominantly glacier and underground alimentation. But on the other hand, native dew-watered ecosystems *lomas* that cover the lower slopes also play role in the runoff formation as the catch about 0,01 m^3 of moisture from the air daily (Semenzato 1996). Agricultural lands in the lower course also increase evapotranspiration thus improving the groundwater flow (Sara 2014).

Our results show that *lomas* area, that actually form the city's suburban type of green infrastructure, has decreased by 45% since 1986 (Fig. 2). Moreover, only 10% of agricultural lands remained in 2016. By matching *lomas* zones and urban borders we concluded that urbanization is not the main cause for *lomas* degradation. Probably, these changes are connected to climatic fluctuations, particularly to La Nina effects. However, it is a tremendous urban expansion that has occupied former agricultural lands.

Street vegetation and small green elements that are especially important for the urban comfortability in the arid zone have greatly improved in Lima by 12%, considering that in total green infrastructure in central inner districts occupied more than 40% in the first place. This is the best result among all studied cities, proving that the development of urban green infrastructure does not depend only on natural conditions. Lima, having the harshest climate for vegetation, still manages to support the best level of street vegetation. We also mark a noticeable increase in the share of tree cover, which has also occurred on the level of inner green infrastructure. If the predominant type of vegetation was grass and shrubs, now trees form the most part of central green infrastructure, providing more shadow and evapotranspiration.

4.2 Rio de Janeiro

Unlike Lima, Rio de Janeiro has seasonal water surplus that causes landslides and flashfloods in the lower parts of river basins. Dense tree vegetation holds the soil and prevents these natural disasters. Artificial surfaces on the contrary increase the flow. Most rivers in Rio de Janeiro begin in the urban forests that occupy outcrops amidst the built-up part of the city (Tijuka, Mendania, Pedra Branka). During the studied period of 30 years, tree vegetation has increased by 52%. Northern and eastern slope were reforested by 25%, thus decreasing the possibility of mudflows and landslides in the area (Fig. 3). This is a result of numerous restoring projects that started in late 1980s, when eucalyptuses were planted in the most degraded and dangerous areas (Amorim 2012). Our research confirms the success of these programs. However, there is another picture, concerning the vegetation in the lower course. Lowlands and plain terrains, suitable and convenient for urban expansion, are densely built-up. These parts have lost up to 36% of vegetation since 1986. Hence, while the city has become more resistant to landslides, it is now simultaneously more vulnerable to flashfloods.

Even though the main increase in green infrastructure has happened on the levels of urban parks, inner vegetation has also improved by 22%, though the research shows that the improvement has touched the districts that were green in the first place, while the least vegetated districts remain the same. So, the increase concerns only the most prosperous regions in the city. The tree cover has also changed greatly in Rio de Janeiro, now forming more than 50% of total green infrastructure. The increase by 29% mostly occurred on the level of urban forests as many slopes were reforested and replanted by fast-growing tree species.

4.3 La Paz

In contrast to Rio de Janeiro, northern slopes and upper course in La Paz were significantly built up during 1986–2016. The urban area has expanded by 46% in the parts on the north of the city (Fig. 4). These valleys run into poorly consolidated deposits of Altiplano, which are easily eroded (O'Hare 2005). Hence, the decrease of vegetation in this region leads to powerful flashfloods and mudflows during the rain-season, considering that endangered valleys are densely populated. Puna itself in the unpopulated regions on high elevations within city borders has not changed much, meaning that climate here is quite stable, and other factors, beside human activities, are not responsible for green infrastructure transformation.

As to the inner green infrastructure (street vegetation, etc.), the research shows that the situation has improved in 2016. The greenness of built-up districts has increased by 18%. Considering, that in 1986 only 6% of urban core was covered with vegetation it can be considered a great success. Here tree cover has insignificantly decreased. However, it is important to remember that natural vegetation in this mountainous climate does not include trees in the first place. Thus, all tree cover concerns only the greening of the inner street vegetation. Considering that the total green area of this level has grown, we can draw a conclusion that the tree cover has not in reality changed a lot.

4.4 Santiago de Chile

The problem of mudflows and landslides in Santiago is also urgent, especially during the winter storms. Being a much more

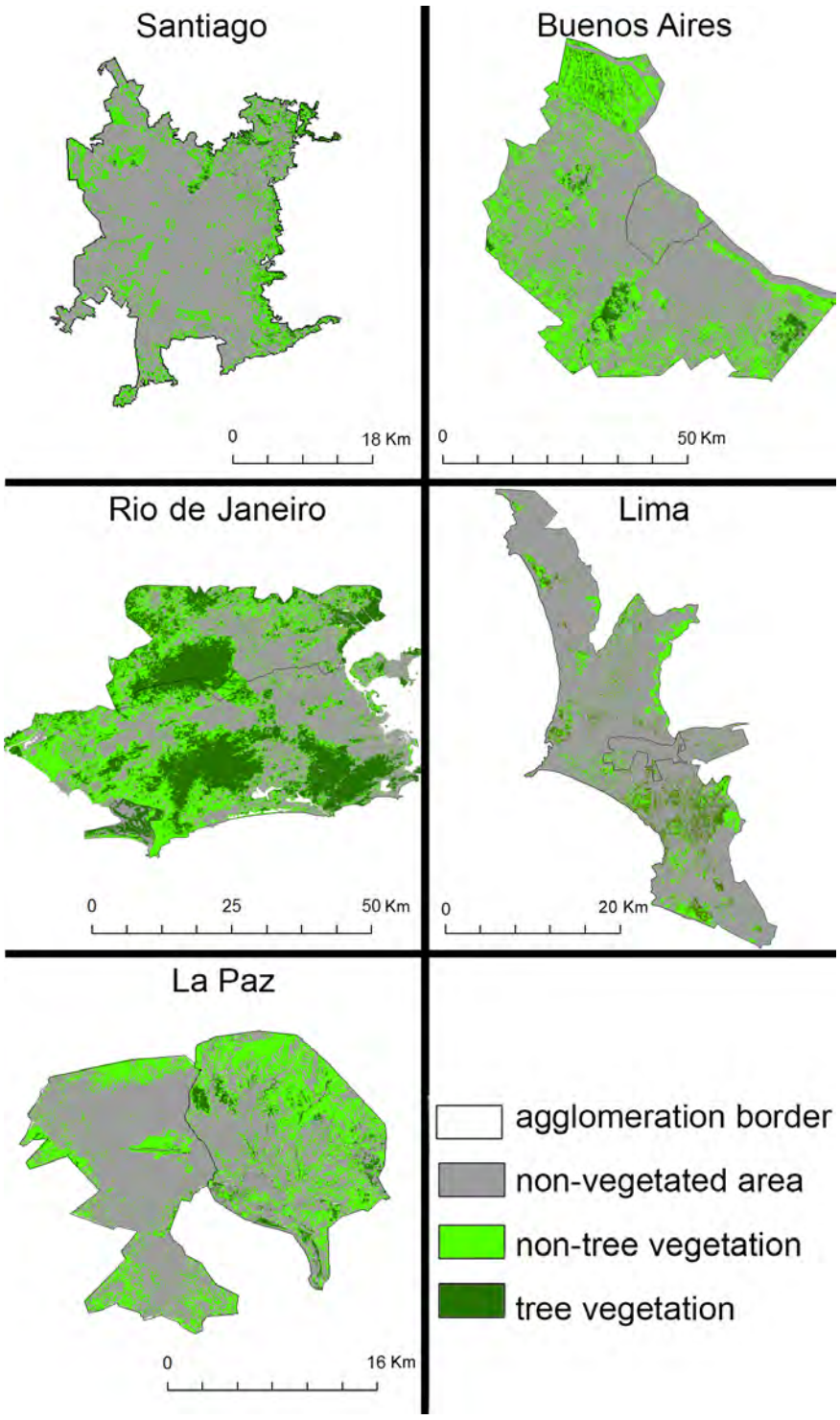


Fig. 1 – Green infrastructure in Santiago, Buenos Aires, Rio de Janeiro, Lima and La Paz in 2016.

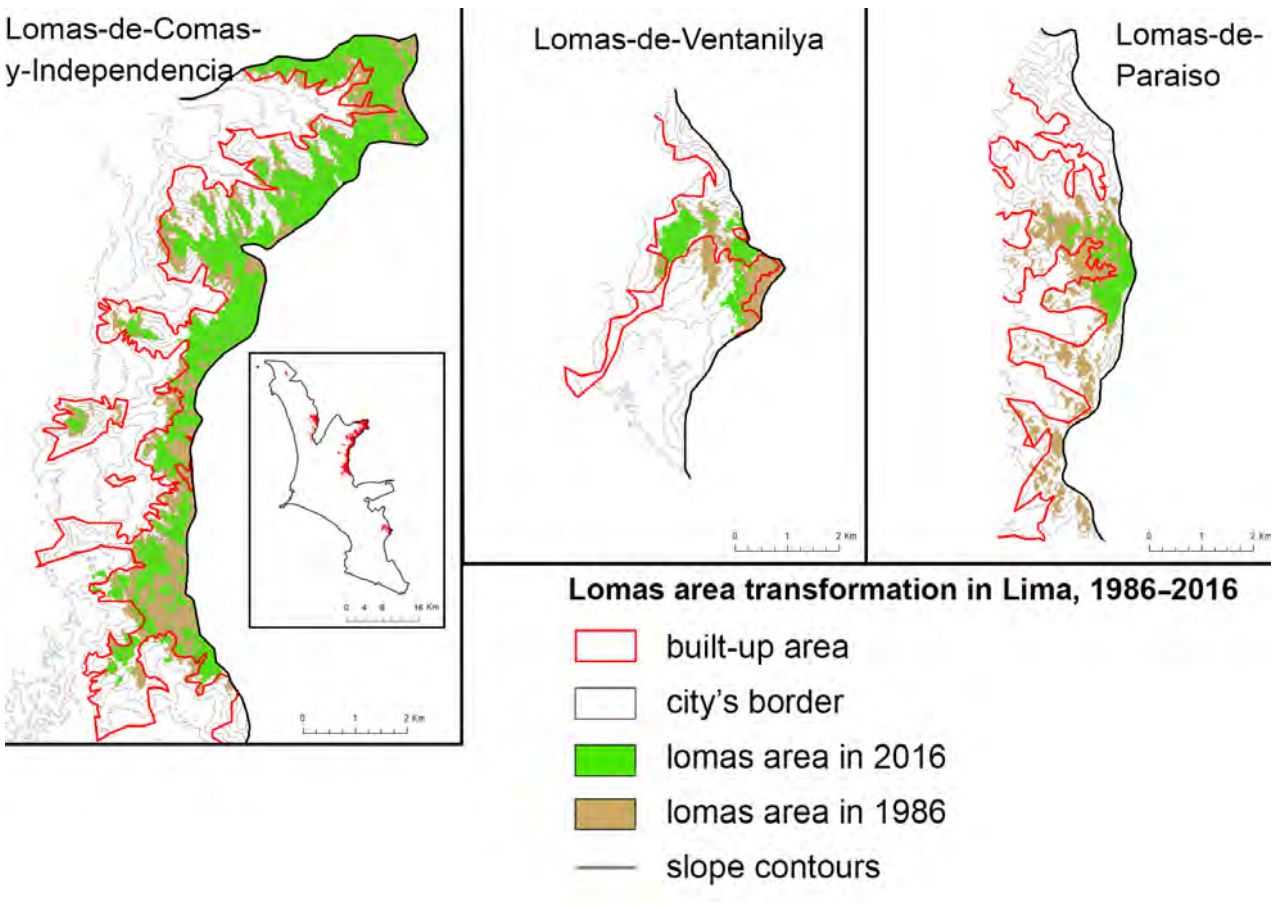


Fig. 2 – Transformation of lomas area during in Lima, 1986–2016.

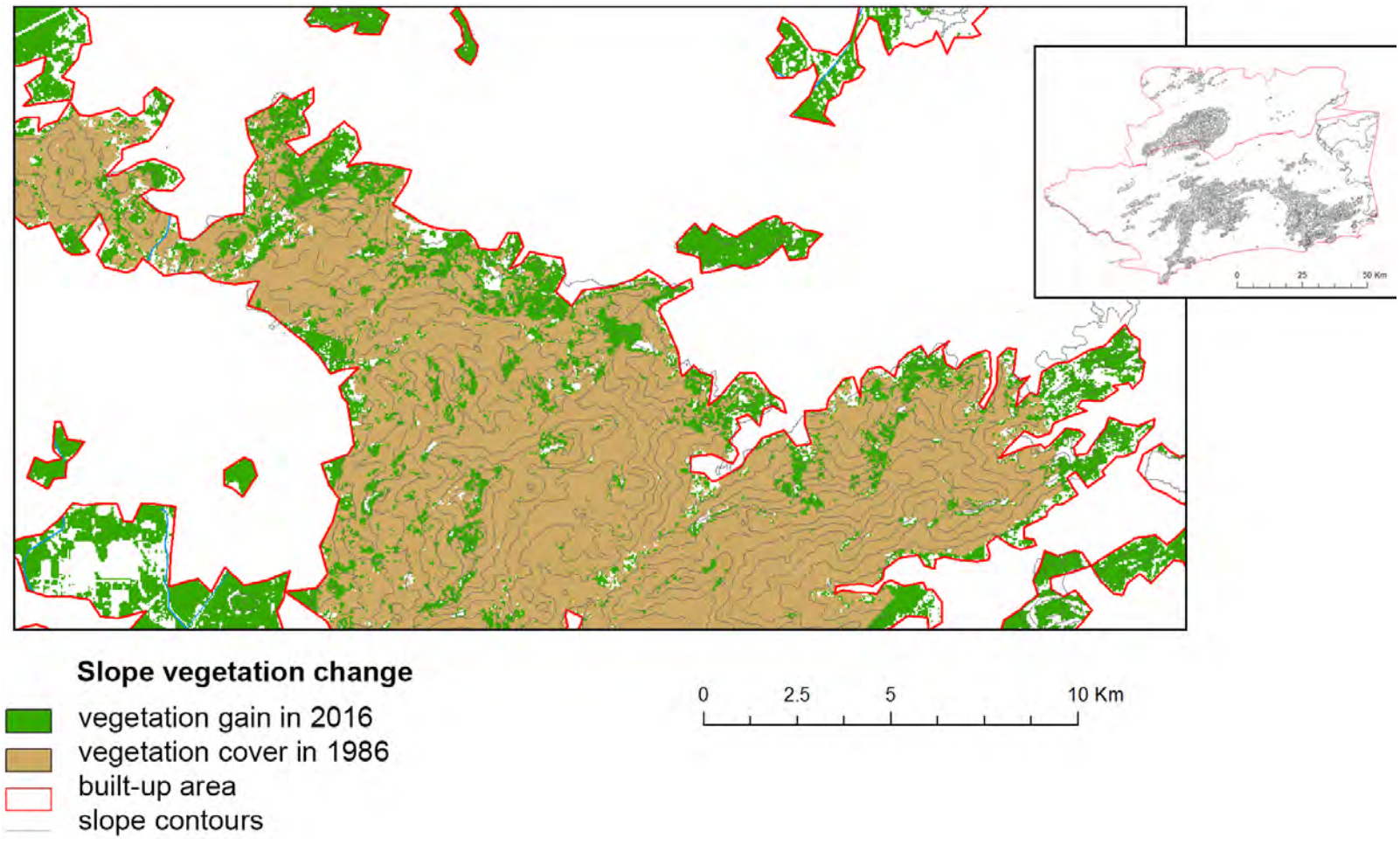


Fig. 3 – Slope vegetation change in Rio de Janeiro, 1986–2016.

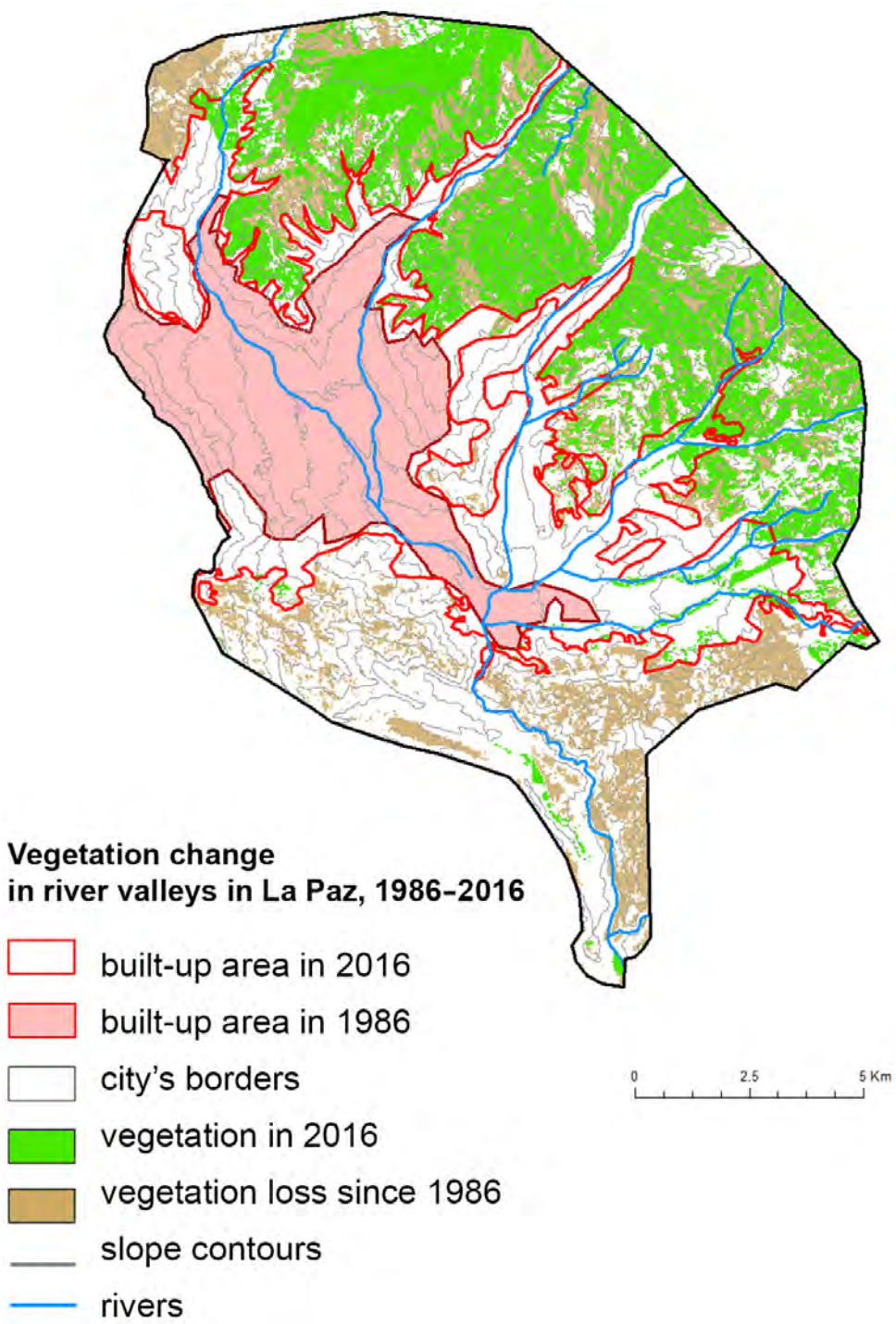


Fig. 4 – Change of valley vegetation in La Paz, 1986–2016.

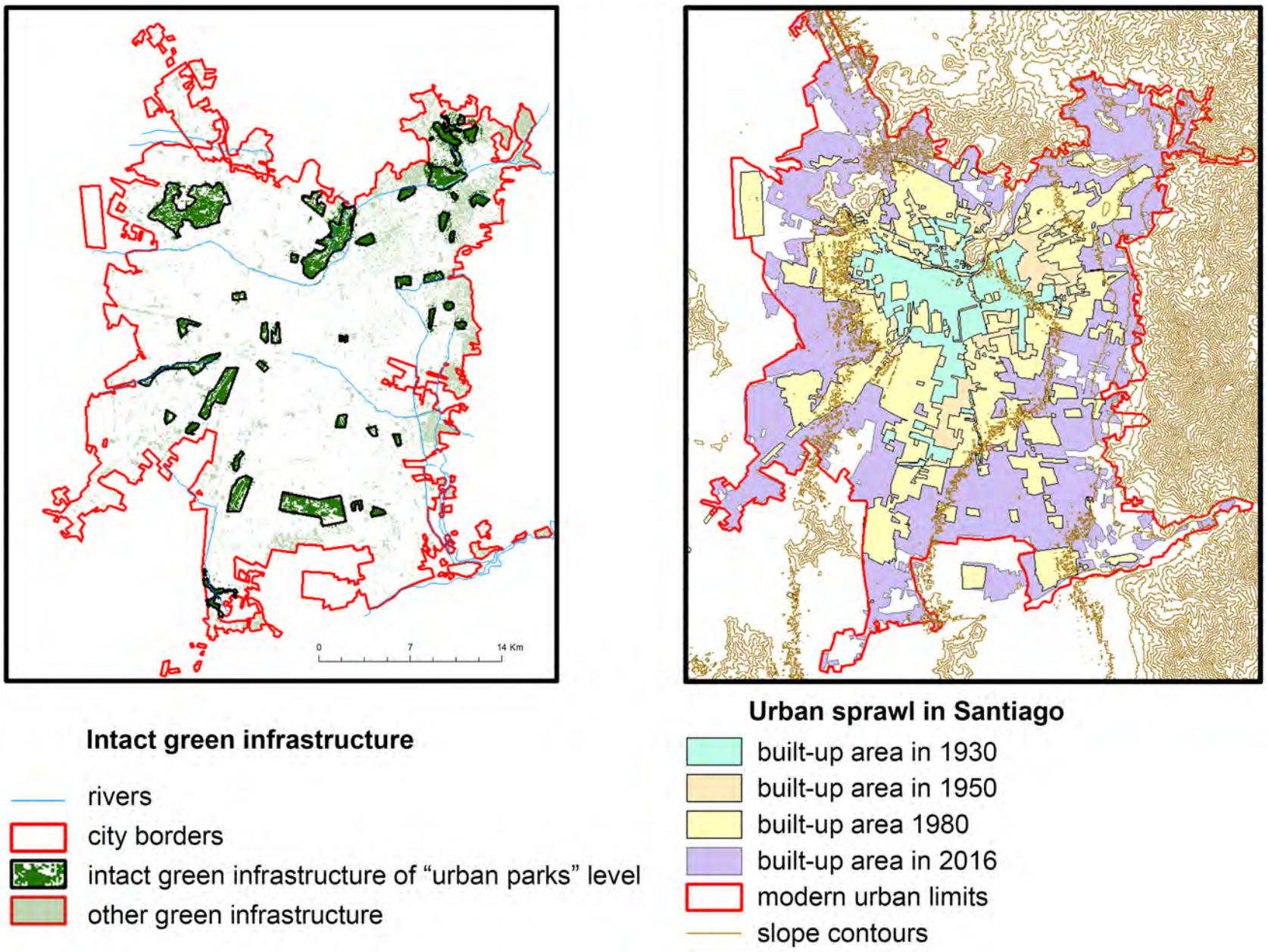


Fig. 5 – Urban sprawl and remaining vegetation of urban core in Santiago, 1930–2016.

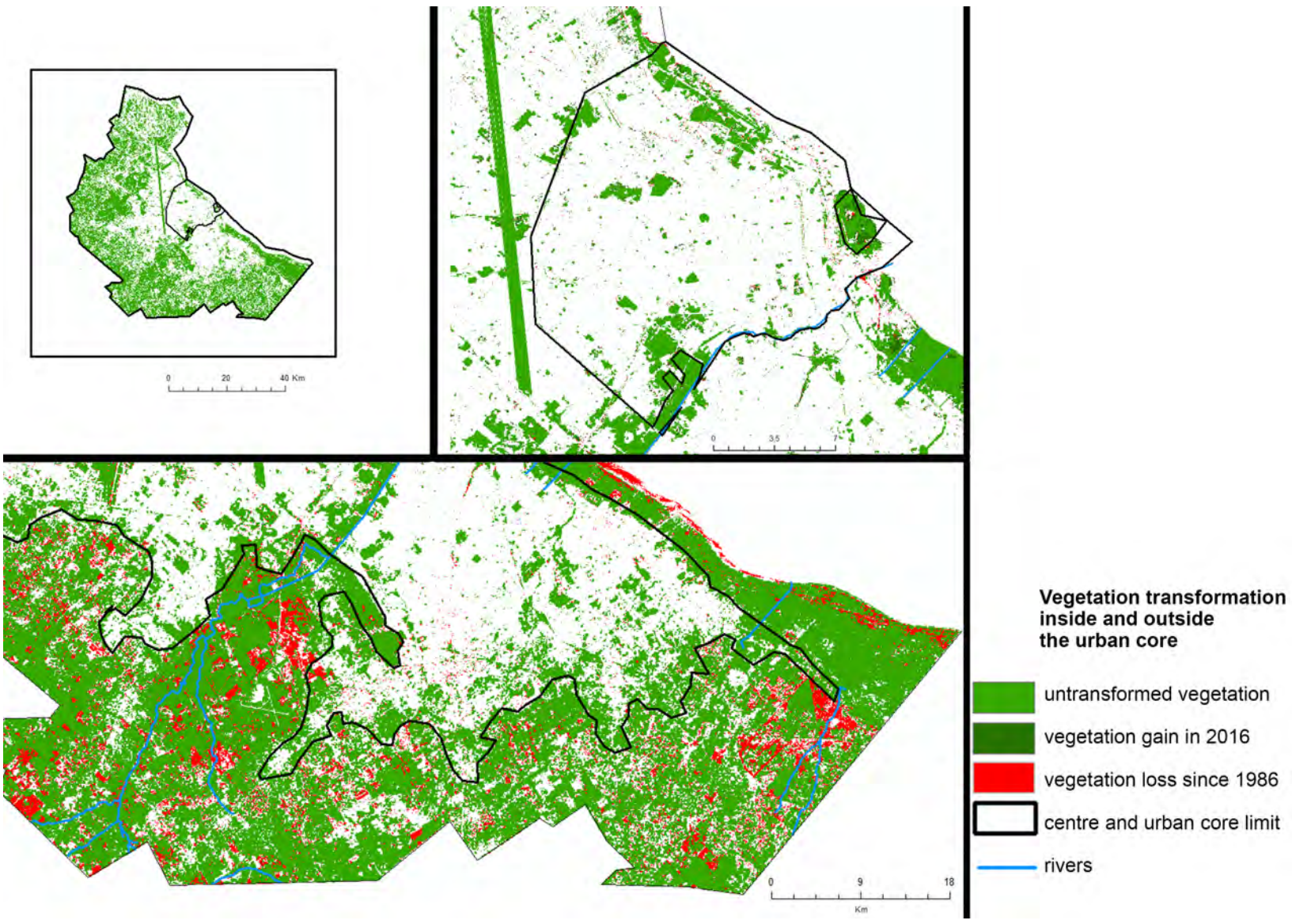


Fig. 6 – Change of vegetation on different green infrastructure levels in Buenos Aires, 1986–2016.

compact city, meaning that municipal borders almost coincide with actual urban core, vegetation that regulate the runoff is mostly situated outside the city and form the suburban level of urban green infrastructure. Population and agglomeration growth in Santiago was particularly intense. Since 1970, the growing city has occupied almost 72% of the surrounding vegetation within its modern limits (Fig. 5). It is much easier to develop flat surfaces, thus the urban expansion moves southwards, leaving northern slopes and valleys almost intact. Our results even show a small 5% increase on the level of urban forests that includes valleys vegetation.

A negative aspect of local restoration programs that can be noticed in a tremendous increase in vegetation of urban parks (up to 23%) is the composition of newly planted forests. It is eucalyptuses and *pinus radiate* for the most part, and these species are extremely vulnerable to wildfires that occur here in the hot and dry summer period quite often (Armesto 1998).

Among all studied cities, Santiago has shown the worst results of inner vegetation. Here green infrastructure occupies only 7% of area in the inner districts. Moreover, this is even less than in 1986. On the other hand, there is an increase in vegetation on the level of urban parks, possibly meaning that all improvement programs were aimed at the development of big green elements rather than small. The creation of new parks is connected with the general urban sprawl that took place during the studied period. These elements of a relatively big size appeared on the spots that were not suitable to build up.

4.5 Buenos Aires

Being the largest and the most populated city, green infrastructure in Buenos Aires plays a crucial role for comfortability of urban environment and public health. Thus, two types of green infrastructure – inner green elements and urban parks – are the focus of the study. In 1986, central parts of the city had only 3% of its area covered with vegetation. The period of 30 years showed an improvement by 12%, while the level of urban parks remained absolutely the same – 8% of the city's area. These results mean that while an amount of street vegetation and a number of private gardens increases, major parks for mass recreation are intact. On the one hand, it is a positive trend as these parks are not being occupied or destroyed for urban compression. But on the other hand, the population of the city continues to grow. It has increased by almost 5 million people since 1986 – by 30%. At the same time, the area of parks and public green space has not changed. Tree vegetation in Buenos Aires has also decreased (by 7%). The major decrease of green infrastructure here concerns the level of surrounding pampa and agricultural lands as these lands were also occupied (up to 21%) by new city districts (Fig. 6).

Natural vegetation of *pampa* mostly consists of grasses. In its natural conditions, trees usually grow along the river banks in delta (Walker 1999). Taking into account a small improvement in inner vegetation, we can say that the degradation of tree cover is, on the one hand, connected with the destruction of wetlands along the La Plata, and on the other hand, with grasses and shrubs usage in urban greening.

5. Discussion

A curious finding of this work is that in most studied cities a tremendous decrease in vegetation happened with suburban green infrastructure, but at the same time a significant increase in other parts allowed cities to remain relatively "green". For instance, Rio de Janeiro's suburban level has lost 29% during the chosen period, however, a total share of vegetation in the city has grown by 7%, mainly because of an intense restoration of urban forests (improvement by 7%) and streets' greening (from 5 to 27%). Not all cities are that successful. Santiago has still lost 19% of green infrastructure, but considering that suburban decrease was 25%, an improvement with urban parks and forests is impressive. A similar case can be found in La Paz, where in 30 years of urban expansion 21% of surrounding *puna* was built-up. Simultaneously, inner green infrastructure has increased by 18%, making life inside urban core more comfortable. As to Lima, it is an interesting example of a desert city to compare with Buenos Aires, situated in a humid and quite favorable climate. Considering, that natural vegetation of the arid zone is sparse and artificial one is vulnerable to harsh conditions, Lima manages to remain relatively green with its districts being vegetated much better than Buenos Aires. Though our results have shown an improvement of inner green infrastructure in both cities, the Peruvian capital is almost four times better vegetated than the Argentinian one.

We would also like to notice that the most intact level of green infrastructure is urban parks. Probably being places with high historic value and touristic attraction, these elements must be more or less well-maintained and protected by law. This result also proves that while old recreational green space is conserved, new areas of this type do not appear. It may be challenging in densely built-up cities like Buenos Aires or Rio de Janeiro to create new parks amidst urban infrastructure. Judging by the classified images, there are areas in other cities though, clear of buildings and roads, but lacking vegetation as well.

It is also obvious now that the most transformed level of green infrastructure is suburban, as new outskirt districts were built in 30 years. The intensity and size of its destruction, though, directly depends on the surrounding landscape, as flat surfaces are much easier to develop. This observation also concerns the preserved vegetation inside the urban core that belongs to the level of urban forests. The cases of Rio de Janeiro and Santiago have shown that the majority of urban forests are situated on local hills (*serros* and *morros*), which are difficult, inconvenient and dangerous to develop. Excluding slums (some of which were removed in Santiago during the studied period), these places are not built-up and remain intact solely for their economic disadvantage and not because of special urban planning that leaves huge green areas for ecosystem services.

6. Conclusion

Our work has investigated the structure and dynamics of green infrastructure in representative Latin American cities to define main features of its transformation and development. While all cities are not heterogeneously vegetated and mostly lose their green infrastructure, there is still improvement on the level of street vegetation, meaning that for the government recreational functions are clearer and easier to provide. Other services that bigger green elements can perform are either neglected or treated by residual principle, when their development does not require any additional measures or these green areas cannot be effectively used in any other way. We see, though, that in some cases natural disasters, triggered by deforestation, pose a serious threat and then green infrastructure's merit is acknowledged. Still, in most cases unstoppable urban expansion devours more surrounding lands and prevails over the concept of a "compact

city" that implies a densely populated, but also well-planned settlement with a limited urban sprawl.

The methods in this research enable us to study the structure and distribution of urban greening. However, more accurate results may be achieved by investigating more classes of land-use to define all ecosystem services the lands can perform. Distinguishing wetlands, agriculture, roof-vegetation and others can give a more detailed picture of the real situation with green infrastructure in Latin America.

References

AHERN, J. (2013): Urban landscape sustainability and resilience: The Promise and Challenges of Integrating Ecology with Urban Planning and Design. Landscape Ecology, 28, 6, 1203–1212.

ALBERTI, M. (2008): Advances in Urban Ecology. Integrating Humans and Ecological Processes in Urban Ecosystems. Springer, New York, 93–131.

AMORIM, H.B., SALAMENE, S. (2012): Estimate of the area occupied by reforestation programs in Rio de Janeiro state. Cerne, Lavras, 18, 1, 23–34.

ARANA, C., SALINAS, L. (2007): Fragilidad de los ecosistemas de Lomas costeras del Perú central. Dilloniana, 5, 1, 32–35.

ARMESTO, J.J., ROZZI, R., SMITH-RAMÍREZ, C., ARROYO, M.K.T. (1998): Conservation targets in South American temperate forests. Science, 279, 1271–1272.

ARTMANN, M. (2014): Assessment of soil sealing management responses, strategies, and targets toward ecologically sustainable urban land use management. Ambio, 43(4), 530–541.

Atlas Ambiental de Buenos Aires – Available online: http://www.atlasdebuenosaires.gov.ar/aaba/

FERNANDES, N.F., TUPINAMBA, M. (2010): Rio de Janeiro: A metropolis between granite-gneiss massifs (Geomorphological landscapes of the world). New York: Springer Science & Business Media, 89–100.

KARAKOUZIAN, M. (1997): Geology of Lima. Environmental & Engineering Geoscience, 3, 55–58.

MAZA, C.L., HERNANDEZ, J., BOWN, H., ESCOBEDO, F. (2002): Vegetation diversity in the Santiago de Chile urban ecosystem. Arboricultural Journal, 26, 4, 347–357.

MORRÁS, H.J.M. (2010): Ambiente físico del Área Metropolitana. Dinámica de una ciudad Buenos Aires, 1810–2010. Dirección General de Estadística y Censos Gobierno de la Ciudad Autónoma de Buenos Aires, 27–62.

NAUMANN, S. (2011): Design, Implementation and Cost Elements of Green Infrastructure Projects. Final report, European Commission, 138.

O'HARE, G., RIVAS, S. (2005): The landslide hazard and human vulnerability in La Paz city, Bolivia. The Geographical Journal, 171, 239–258.

PRB. Population Reference Bureau (2019). https://www.prb.org/international/geography/south-america/ (30. 11. 2019).

SARA, L.M., TAKANO, G., ESCALANTE, C. (2014): City Report Metropolitan Lima and Callao. KwaZulu-Natal: University of KwaZulu-Natal.

SEMENZATO, R. (1996): Fog: A water resource for the development of arid regions. Working paper 96-4 Fifth Joint Conference on Agriculture, Food, and the Environment, Abano Terme, Padova, Italy. Center for International Food and Agricultural Policy, University of Minnesota, 8–12.

SEPÚLVEDA, S.A. et al. (2006): Landslide hazards in Santiago, Chile: an overview. Proceedings of the 10th Congress of the International Association of Engineering Geology and the Environment, paper, 105, 1–8.

VEBLEN, T.T., YOUNG, K.R., ORME, A.R. (ed.) (2015): The physical geography of South America. Oxford University Press.

WALKER, L.R. (1999): Ecosystems of Disturbed Ground. Elsevier Science B.V., Amsterdam.

WWF. World Wildlife Fond (2019). http://wwf.panda.org/knowledge_hub/where_we_work/atlantic_forests/ (30. 11. 2019).

Agricultural Landscape Changes based on LPIS Data in the Districts Pezinok and Senec, Slovakia

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1. Introduction

Image records obtained by the remote sensing methods, aerial and satellite images became, thanks to the reiterated imaging of Earth surface, irreplaceable information source for the analysis of landscape changes such as urbanisation, forestation or deforestation. Another important monitoring object is also the loss of farmland which is normally resulting of land withdrawal in favour of constructions. A specific example of farmland loss is abandonment often associated with disappearance of permanent grassland (Kuemmerle et al. 2008; Prishchepov et al. 2013; Alcantara et al. 2013; Pazúr et al. 2014).

Operative acquisition of data about the dynamically changing land cover (especially concerning the occurrence of changes and their scope or size) requires the use of the new progressive approaches to the collection and processing of data about landscape not only for the monitoring of dynamism of farmland but also from the point of view of implementation of supporting mechanism for agricultural entities in the EU. The main administrative tool for the management of subsidies in agriculture is the Integrated Administration and Control System (IACS). This system provides for the submission of applications for subsidy, administrative controls, in situ checks, payments and sanctions of farmers (Sagris, Devos 2009). The key component of the IACS system from the point of view of agricultural land is the Land Parcel Identification System (LPIS), legislatively defined in the EU Regulation of the European Parliament and the Council No. 1306/2013. The LPIS provides for the identification and localisation of declared parcels and facilitates the control of duplicate declarations or over declarations. Primarily it serves as a reference database for verification of the data quoted in applications for subsidy provided for the farmed land.

The LPIS is also a valuable information source about the dynamism of landscape on the local level. As Levin (2017) reports, data of the LPIS register collected in some European countries already at the beginning of the 1990s (EEC 1992) make possible the analyses of changes in agricultural landscape for almost two decades now. High Nature Value farmland (Lomba et al. 2017) has been analysed on the basis of the LPIS; other example is the assessment of conversion and abandonment of permanent grassland (Nitsch et al. 2012) or the analysis of the dynamism of the temporary grassland (Zimmermann et al. 2016). Barbottin et al. (2018) assessed applying the LPIS the dynamism of the area of farms identifying six basic types of dynamism regarding the enlargement or diminution of agricultural area and reconfiguration of landscape structure. Kopecká et al. (2019) presented, again based in the LPIS, the monetary evaluation of the farmland losses in favour of construction and abandonment of farmland in selected localities.

Tomlinson et al. (2018) used the LPIS data aggregated into selected classes (arable land, permanent cultures, forest, permanent grassland, temporary grassland, and other) for making maps of land use and identification of its changes in the years 2005–2013 in Great Britain. Losses of farmland were also analyzed in the territory of Denmark and Flanders (Kerselaers, Levin 2018) for selected five-year intervals by means of the LPIS. Several authors point to the fact that the LPIS is an alternative information source about land use as related to the statistical data derived of cadastral data. In difference from the cadastre, the LPIS is based on physical blocks delimited by natural borders and on user relationships (not owner relationships). It is one of the main reasons of rather distinct differences in the scope of landscape changes when comparing the data of these central databases (Vachuda 2016; Dimopoulou 2012).

The LPIS system operates in the Slovak Republic since 2004 and its regular updating makes it possible to track the land cover changes including those in the area of the farmed land. It identifies and quantifies agricultural land by the following types of parcels: arable land, hop fields, vineyards, gardens, orchards, and permanent grassland. Other farmland in this system includes the one without a known user who did not apply for subsidy (the land has not been verified at a particular date). The LPIS has been built based on digital orthophotos not older than five years. A referential parcel, subject to the entire administration and the control of applications, is a parcel of the production block. Information contained in the database of reference parcels (inclusion into the LFA, Natura 2000 and other) must be always up to date and reflect the truest possible reality of the reference parcel including its area and borders. As far as the subsidy is concerned, it is defined as a minimum area of 0.3 ha in a reference parcel.

Differences in the dynamism of farmland withdrawal for building and the overgrowing of various cultures of agricultural parcels by shrub and tree vegetation using the LPIS database were not analysed in Slovakia so far. It is the reason why is this study focused on the aspects of the assessment of changes of agricultural landscape and the aim is the identification, classification, and assessment of changes in the use of farmland in the years 2004–2018 in two districts situated in the hinterland of the capital of the Slovak Republic. As character of the territory of these districts is quite different, first of all in terms of geomorphology, emphasis has been laid on the determination of the rate of abandoned land and land withdrawal for the construction in the frame of farmland losses and for the assessment of the quality of withdrawn land.

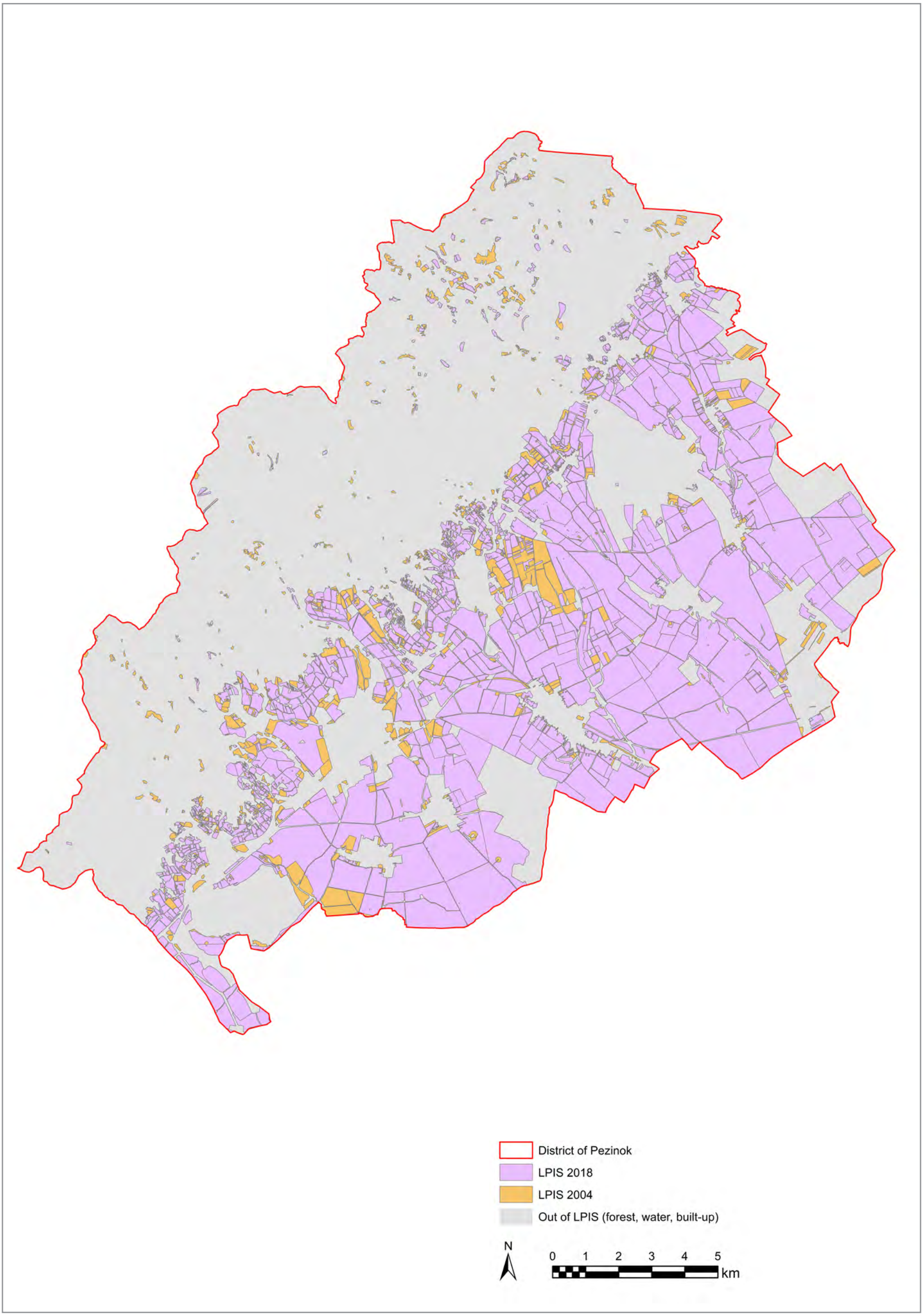

Fig. 1a – Superposition of LPIS layers from the years 2004 and 2018 in the territory of district Pezinok.

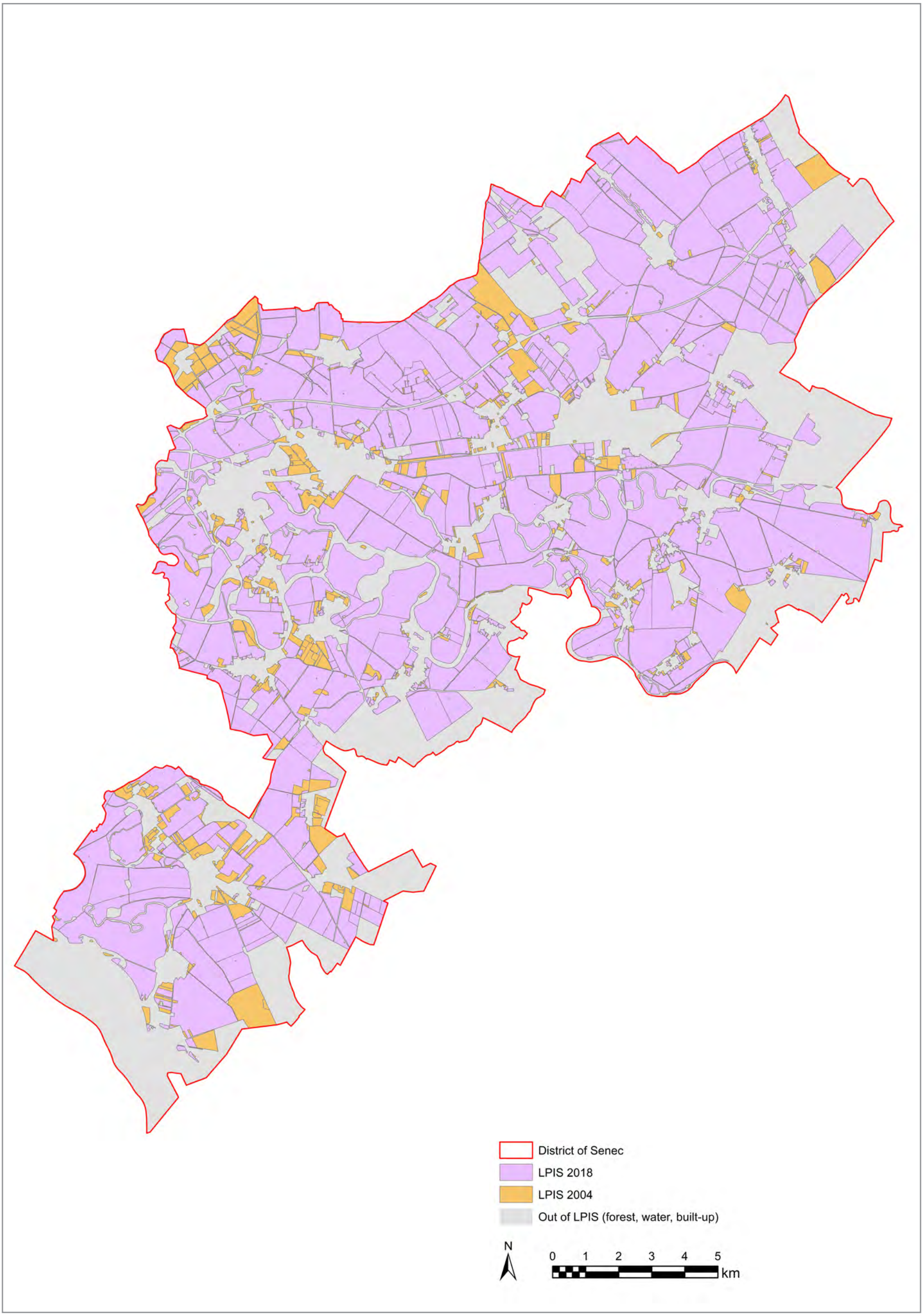

Fig. 1b – Superposition of LPIS layers from the years 2004 and 2018 in the territory of district Senec.

2. Methodology

The basic methodical procedure for the identification of changes of the agricultural landscape in selected model areas is the bitemporal analysis of the LPIS data layers combined with orthophotos and the PEU (pedological-ecological units) database in ArcGIS 10.5.

LPIS layers from the years 2004 and 2018 authored by the National Agricultural and Food Centre and the Soil Science and Conservation Research Institute, orthophotos of the years 2003–2017, borders of districts from the ZBGIS® database and the PEU map related to 2018 were used as the input data.

The first step consisted in superposition of the district borders and land blocks filed in the LPIS layers and the actively farmed agricultural land in the districts of Pezinok and Senec in the years 2004 and 2018 (Fig. 1) was identified. Subsequently, a layer of changes in the frame of the LPIS in time horizon of 2004–2018 was created from the difference between these two layers which was submitted to a more detailed analysis. Polygons smaller than 0.3 ha were excluded from the database of changes.

The remaining identified changes (in total 1,330 polygons) were classified into the following classes:

1. Built-up: this class was originally that of agricultural areas changed by intensive anthropogenic activity. The following subclasses were identified in the areas of construction:
   1.1. Construction of residential areas with family houses: areas with maximum two storied single family houses and the contiguous gardens, local communications including areas under construction.
   1.2. Construction of production, service and transport infrastructure: areas with the industrial or agricultural production including family farms, logistic centres, motorways, roads, railway tracks, solar panels, etc.
   1.3. Construction of sport sites: football stadiums, golf courses, horse riding areas, dog training areas, a water park, etc.
   1.4. Construction of dump sites: deposits of communal and industrial waste.
2. Abandonment of farmland: originally agricultural land (arable land, orchards, vineyards, permanent grassland) overgrown by woody vegetation (shrubs or trees) not showing any traces of cultivation.
3. Gravel mining: originally agricultural areas with ongoing sand and gravel mining; part of the mining area is flooded in the majority of cases.
4. Methodical and technical changes: changes in the database due to the changed methodology of mapping (e.g., exclusion of landscape elements from the original blocks, exclusion of field roads) or technical changes associated with updating of the database (e.g., changes of the numeric codes of the reference parcels because of their division or merging). As these changes in the database were not real changes in land they were not subject to further analysis.

Pedological-ecological units (PEU), soils with the determined quality, are the basic mapping and evaluating units which are relatively homogeneous areas with properties of similar or affinitive pedological-ecological forms. They were classified based on the assessment of homogeneity or affinity of climatic conditions (T), genetic property of soils (P), soil-forming substrate (G), granularity (Z), gravel content (K), soil depth (H), inclination (S), and exposition of the area (E) by certain criteria (Fig. 2).

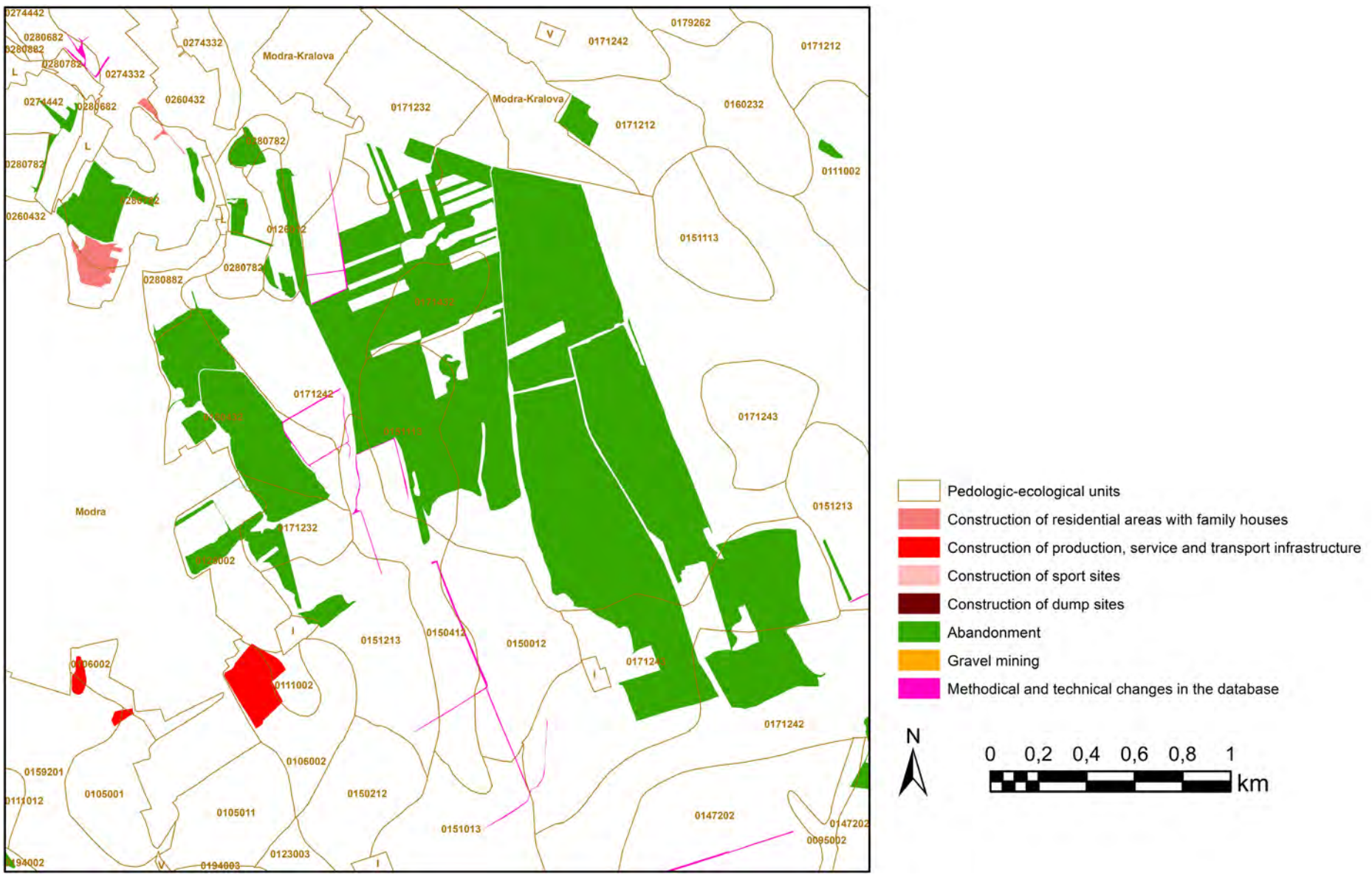

Fig. 2 – Map fragment of changes of agricultural land and the PEU map.

3. Areas of Interest

Districts Pezinok and Senec are in the Administrative Region of Bratislava in western Slovakia (Fig. 3). The overall area of district Pezinok is 375.40 km². Parts of three landforms extend to the territory of the district: the Little Carpathian Mts. Podunajská nížina lowland and Podunajská pahorkatina hill land, especially its part Podmalokarpatská pahorkatina hill land. Beech and oak woods prevail in the area of the Little Carpathians. Apart from the Protected Landscape Area Malé Karpaty there are also several nature reserves in the district and the most important of them is the wetland Šúr in the municipality of Svätý Jur with rare flora and fauna thriving in what is the remnant of the original boggy-fen alder wood and a peat bog. The rest of the territory is agricultural landscape, mostly arable land, and the prevailing permanent culture is vineyards. The cadastre data reveal that out of the 16,813 ha of farmland there are 11,437 ha of arable land, 3,166 ha of vineyards, 1,437 ha of permanent grassland, 727 ha of gardens and 47 ha of orchards. The area of forest plots (16,123 ha) is comparable to that of agricultural land; built-up areas cover 2,408 ha, 456 ha correspond to water bodies and other areas cover 1,754 ha (Geodesy, Cartography and Cadastre Authority of the SR, 2018). There are three towns in the district: Pezinok, Modra, and Svätý Jur and 14 communes. In 2004, the population of the district was 55,043 and it increased before 2017 to 62,459. It means that the district population increase during the study period was more than 13% (Source: datacube.statistics.sk).

The area of district Senec is 359.75 km²; it is situated prevailingly in the Podunajská rovina plain, and marginally in the Trnavská tabuľa plain. The relief is flat. The territory of the district Senec is plain with thermophilic Pannonian vegetation covered by heavily exploited Chernozems, Fluvisols and Chernitsas. Farmland (total 26,911 ha) consists of arable land which, with an area of 25,191 ha, distinctly prevails. Gardens account for 1,042 ha, vineyards for 388 ha, orchards for 128 ha, and grassland covers 163 ha. In terms of size of the share in the land pool, built-up areas are the second largest (3,288 ha), followed by the remaining areas (2,917 ha), water bodies (1,531 ha) and forest plots (1,342 ha) (Geodesy, Cartography and Cadastre Authority of the SR 2018).

The territory is situated in the river basin of the Malý Dunaj with a rich deposit of gravel and sand. Apart from the town Senec there are 28 communes which experienced intensive constructions in recent years. Population of the district amounted to 81,412 in 2017 which compared with the year 2004 (53,763) represents an increase by more than 51%.

Regarding the fact that the two districts are situated in hinterland of the capital they were subject to an accelerated suburbanisation process. Axes of the development are the motorway corridor D1 and the road II/502 running through the sub Little Carpathian communes where the changes of land cover are most conspicuous (Šveda 2011).

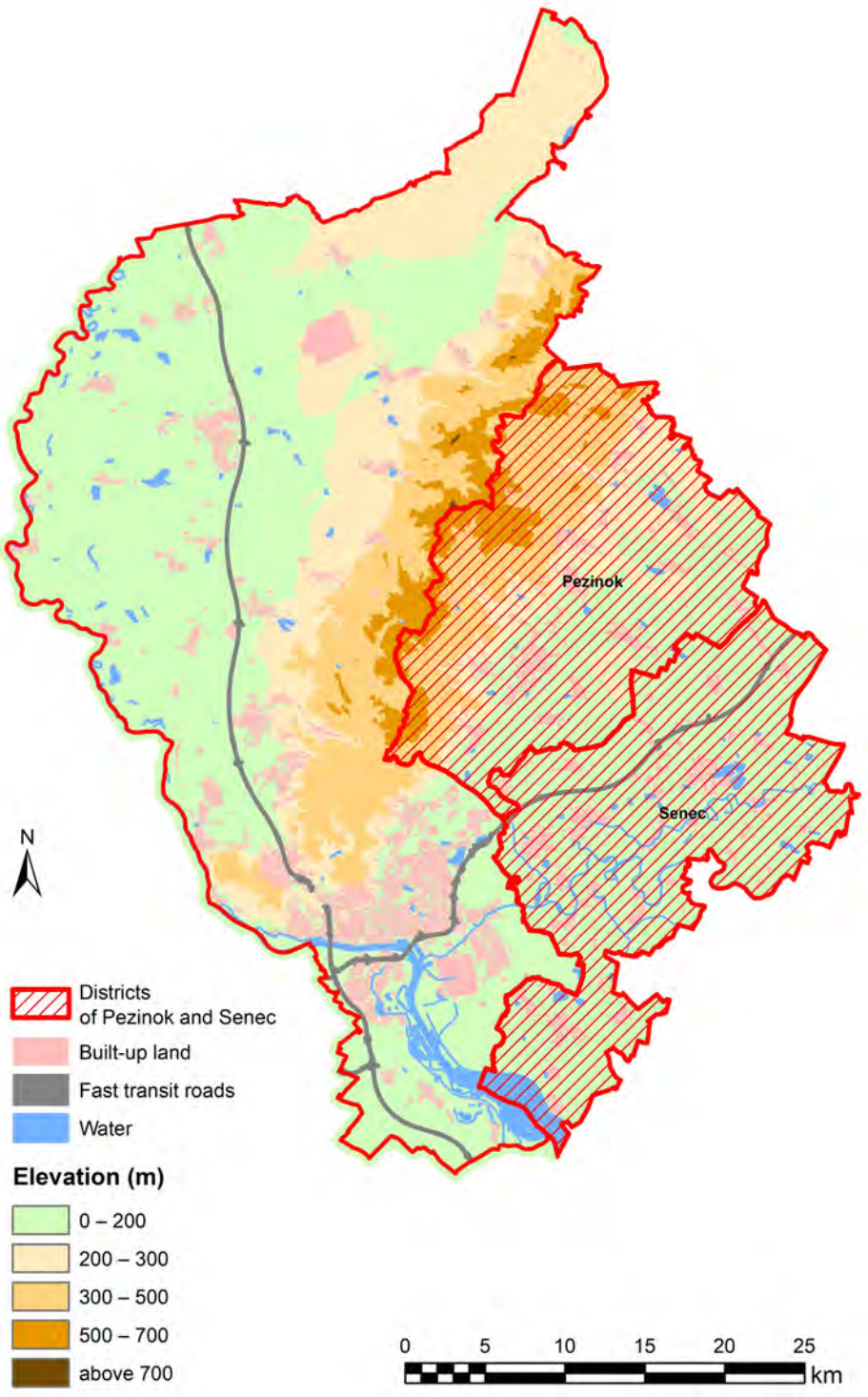

Fig. 3 – Situation of districts Pezinok and Senec in the Administrative Region of Bratislava.

4. Results

In 2004, the area of agricultural land recorded in the LPIS database for Pezinok was 163.19 km², that is, 43.5% of total district area. Before 2018, this recorded area dropped to 147.16 km² (39.2%). Comparison of these two LPIS data layers made it possible to identify 3,898 areas with an overall surface area of 16.03 km², including 724 ones with an area of 15.25 km² which met the defined size criterion of the minimum area of more than 0.3 ha.

The diminishment of agricultural land in district Senec filed in the LPIS database was even more pronounced. Out of its original area of 276.77 km², that is, 76.9% of district area in 2004, the share of agricultural land dropped to 71.3% (256.42 km²). The total of 1,823 polygons included 606 with an area exceeding 0.3 ha.

Classification of recorded changes in district Pezinok reveals a distinct dominance of abandoned areas also in terms of the polygon number and the area of changes (Tab. 1). Most of the abandoned land was identified in Modra (315 ha) followed by Pezinok (190 ha) and Svätý Jur (128 ha). Abandoned land appeared first of all in the localities of former vineyards which were transferred from the cooperative husbandry to private owners (Fig. 4). Extensive losses of agricultural land were in favour of construction (almost 30%) while the construction of single family homes prevailed. But the share of construction of production and service sites, and transport infrastructure was also substantial. The greatest withdrawals took place in Pezinok (132 ha), Slovenský Grob (100 ha), and Limbach (55 ha) (Figs. 5 and 7). Other types of the tracked changes were only marginally represented.

Losses of agricultural land in district Pezinok were identified in total of 116 various PEUs. The greatest losses in district Pezinok are owed to the construction on trenched Cultisols (PEU

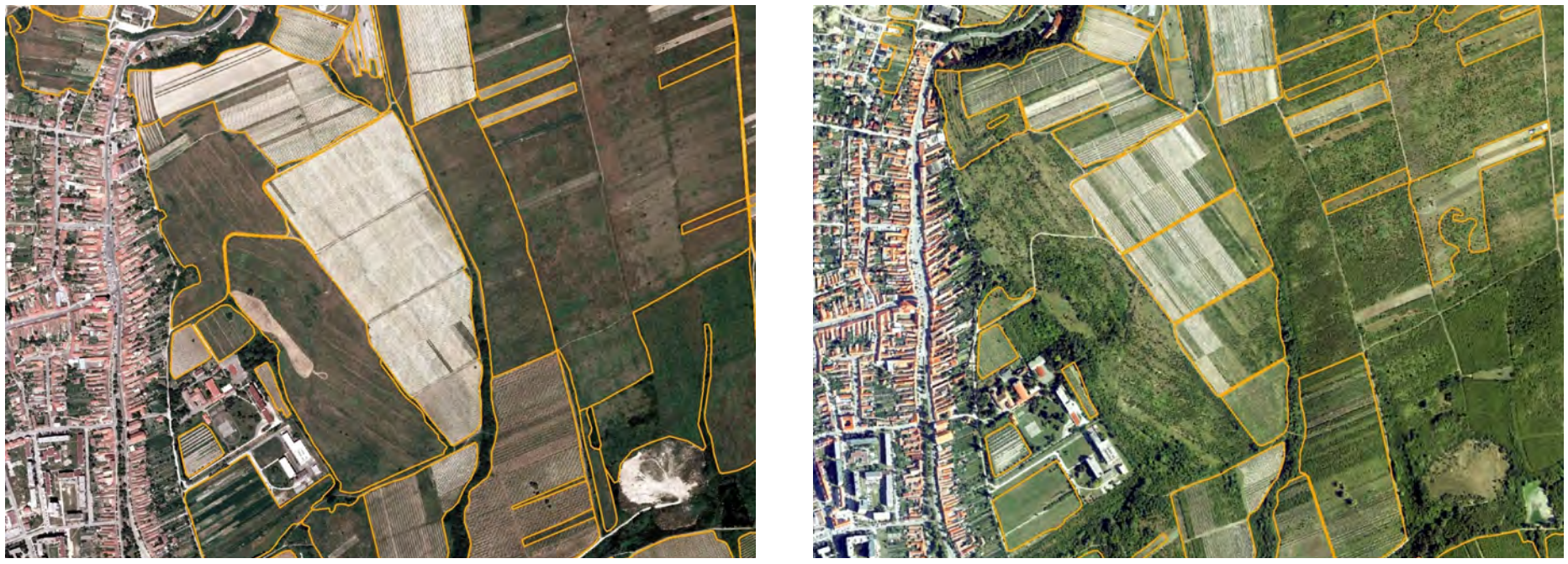

Fig. 4 – Example of the change of filed blocks of reference parcels in the LPIS database due to the abandonment in the municipality of Modra: year 2004 (left), year 2018 (right). Orthophoto © GKÚ, NLC.

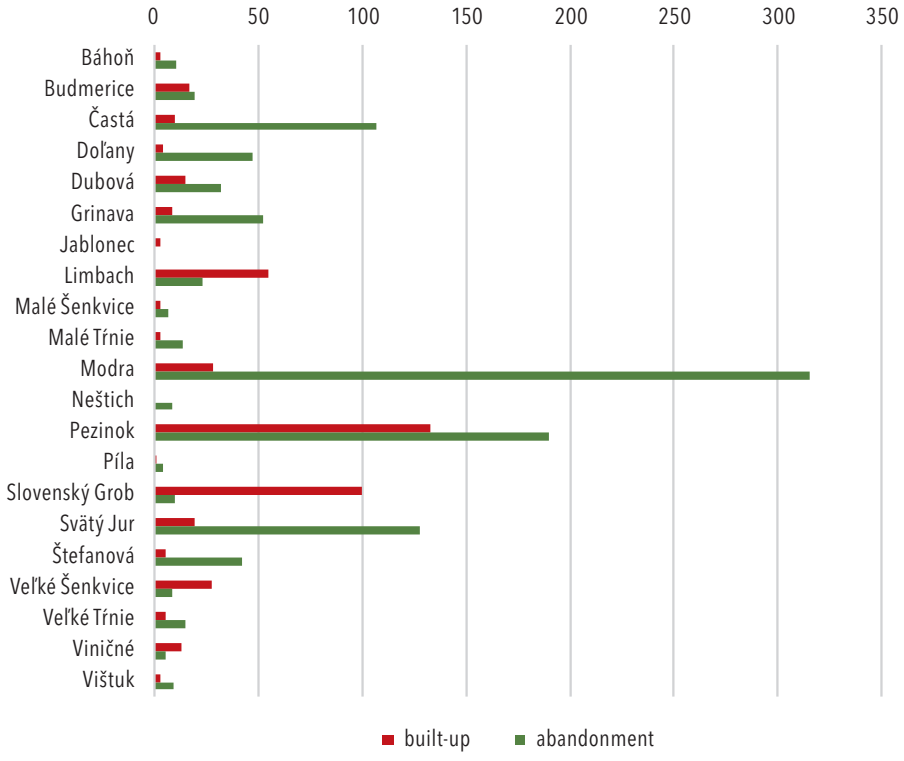

Fig. 5 – Loss of agricultural land in the years 2004–2018 due to construction and abandonment in the municipalities of the district Pezinok.

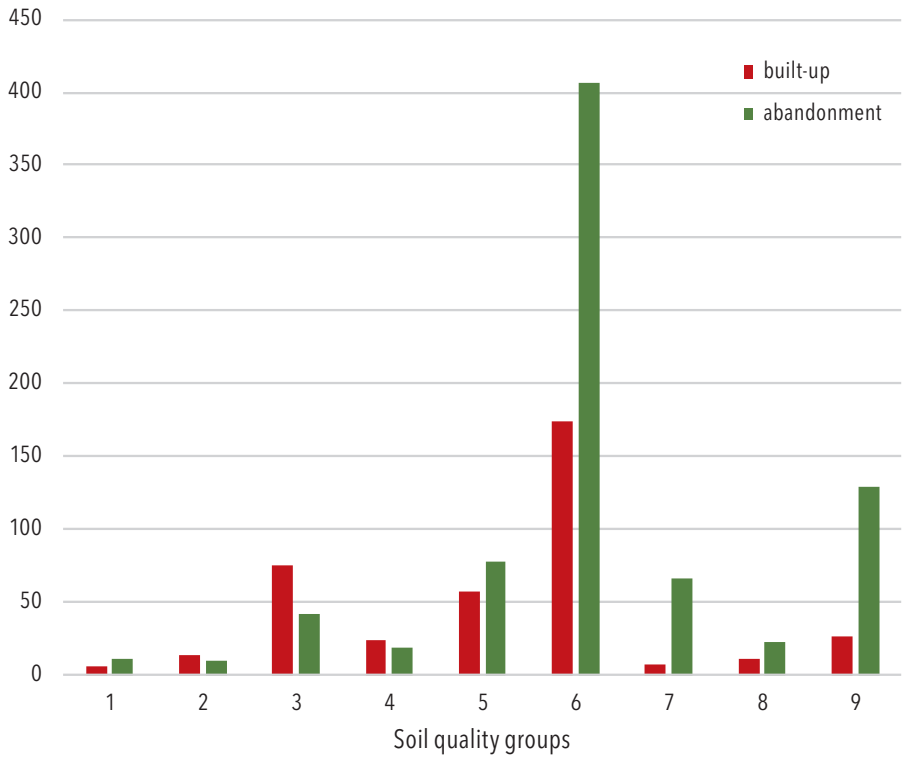

Fig. 6 – Diagram with losses of agricultural land by PEU groups in the district Pezinok.

Tab. 1 – Classification of agricultural land losses in the 2004–2018, district Pezinok

	km²	%	No. of polygons
District of Pezinok	375.40	100	
LPIS 2004	163.19	43.5	2,045
LPIS 2017	147.16	39.2	1,390
Change 2004–2017	16.03	4.3	3,898
Changes over 0.3 ha	15.25	4.1	724
Class	**km²**	**%**	**No. of polygons**
1. Built-up	4.52	29.6	182
1.1 Construction of residential areas with family houses	3.34	21.9	123
1.2 Construction of production, service and transport infrastructure	1.07	7.0	51
1.3 Construction of sport sites	0.04	0.3	5
1.4 Construction of dump sites	0.07	0.5	3
2. Abandonment	10.43	68.4	501
3. Gravel mining	0.06	0.4	2
4. Methodical and technical changes in the database	0.24	1.6	39
Sum	15.25	100	724

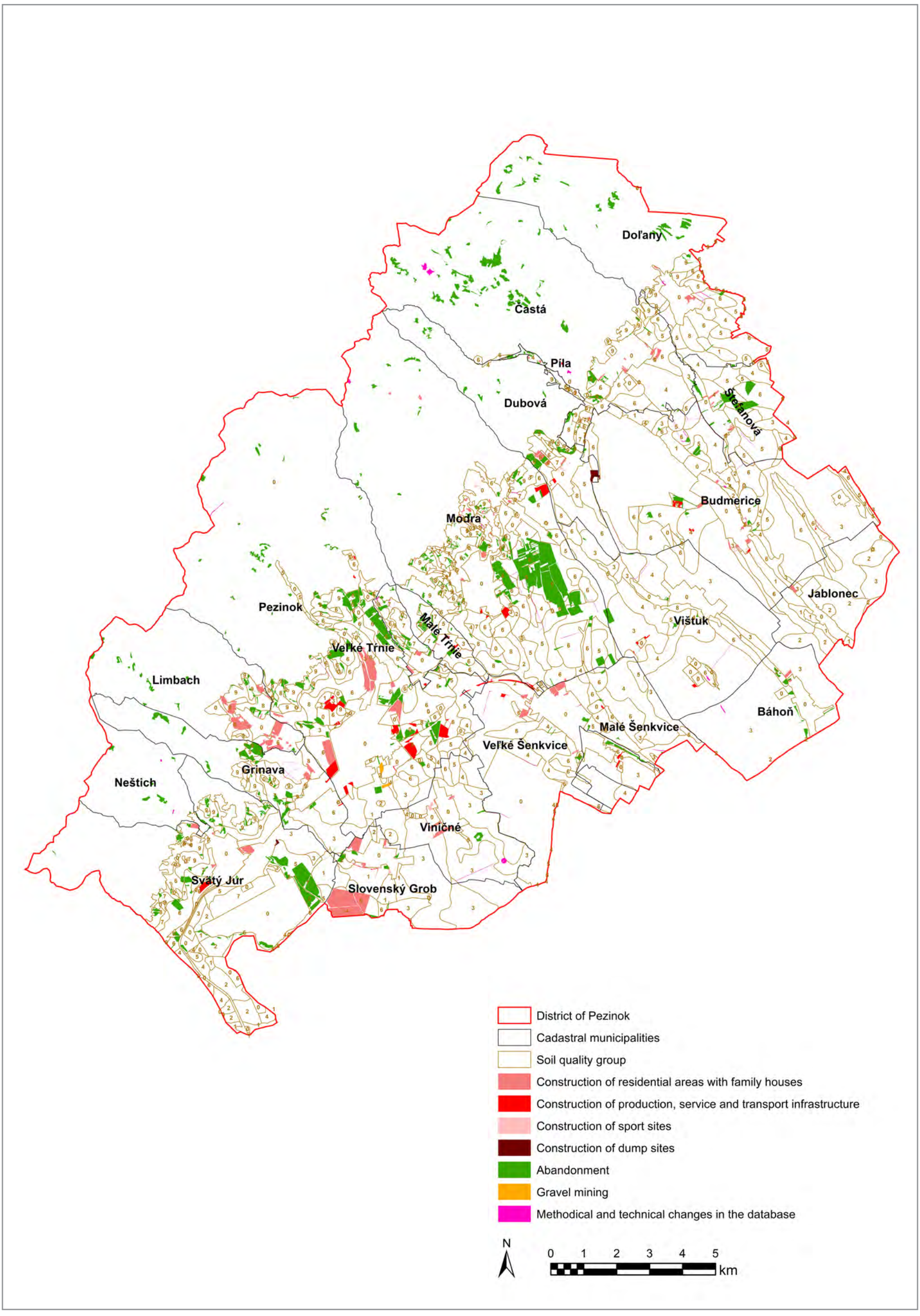

Fig. 7 – Classification of changes of LPIS 2004–2018 in district Pezinok.

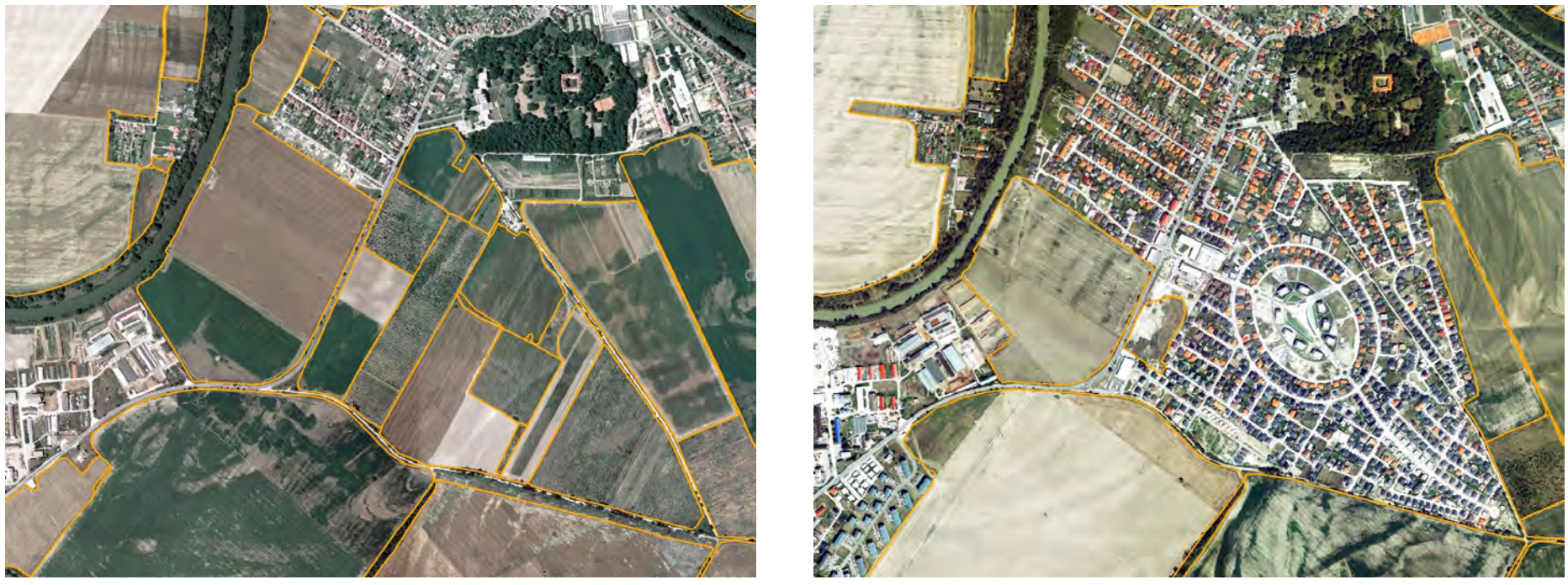

Fig. 8 – Examples of changes in reference parcel blocks filed in the LPIS database due to construction in the municipality of Malinovo: year 2004 (left), year 2018 (right). Orthophoto © GKÚ, NLC.

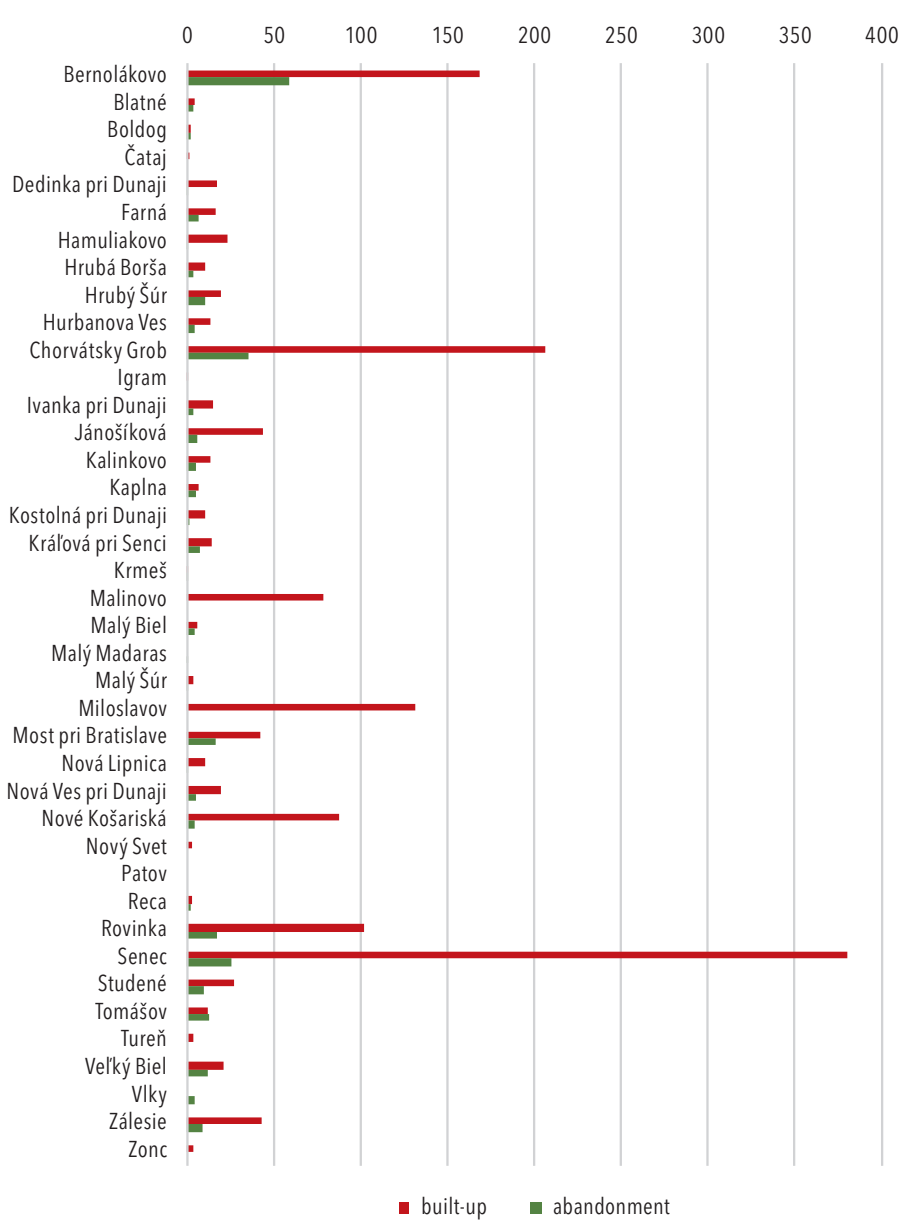

Fig. 9 – Losses of agricultural land in the years 2004–2018 due to construction and abandonment in the municipalities of the district Senec.

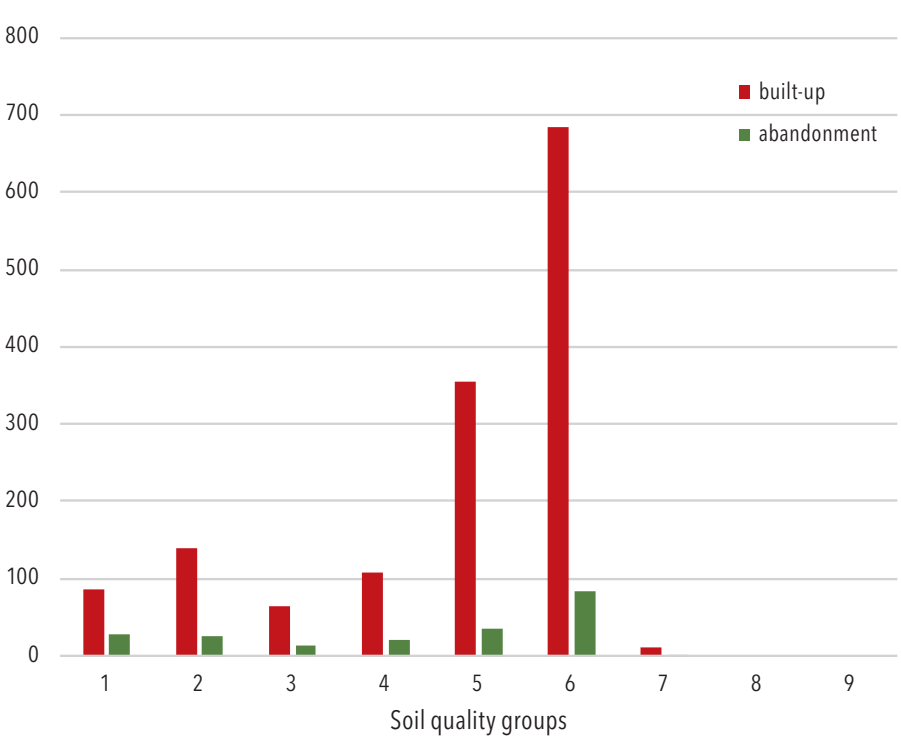

Fig. 10 – Diagram with losses of agricultural land by PEU groups in the district Senec.

Tab. 2 – Classification of agricultural land losses in district Senec

	km²	%	No. of polygons
District of Senec	359.75	100	
LPIS 2004	276.77	76.9	1,075
LPIS 2017	256.42	71.3	722
Change 2004–2017	20.35	5.6	1,823
Changes over 0.3 ha	20.01	5.6	606
Class	**km²**	**%**	**No. of polygons**
1. Built-up	15.70	78.5	408
1.1 Construction of residential areas with family houses	11.06	55.3	298
1.2 Construction of production, service and transport infrastructure	3.87	19.3	87
1.3 Construction of sport sites	0.66	3.3	19
1.4 Construction of dump sites	0.11	0.5	4
2. Abandonment	2.81	14.0	147
3. Gravel mining	1.16	5.8	14
4. Methodical and technical changes in the database	0.34	1.7	37
Sum	20.01	100	606

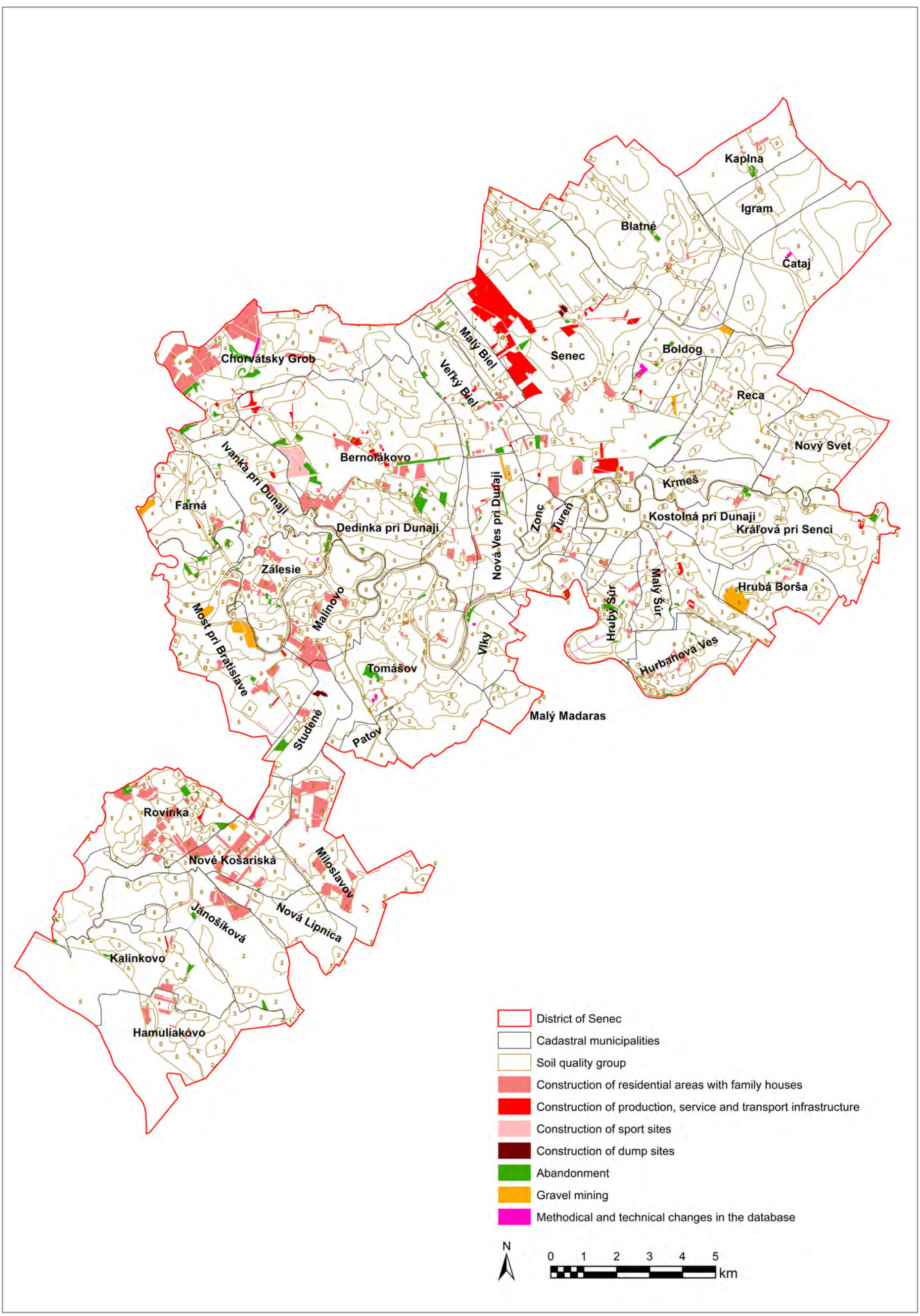

Fig. 11 – Classification of LPIS changes in 2004–2018 district Senec.

code 0174231; 65 ha), Chernitsas (0027003; 36 ha and 0126002, 33 ha) and Chernozems (0032065; 30 ha); abandonment prevailed in the PEU areas without code (forest plots), 216 ha, on trenched Cultisols recreated by terracing (0171242; 181 ha) and on Cambisols on pronounced slopes (0280882; 47 ha and 028088; 30 ha). In terms of the Regulation of the Government of the SR No. 38/2013 about levies for seizure and unauthorized withdrawal of agricultural land, all agricultural lands are classified into 9 groups of soil quality according to the appurtenance to the PEU. The top quality soils are in the 1st group and the worst quality ones are in group 9. Pursuant the Law about protection and use of agricultural land No. 220/2004 the best quality soils in each municipality are legally protected albeit they can be used for other than farming purposes temporarily or permanently only in indispensable cases where there is no other option. Fig. 6 brings a survey of agricultural land losses by individual PEU groups in district Pezinok. It is obvious from the diagram, that the losses due to abandonment and constructions took place first of all in land of inferior quality.

Regarding the flat territory and the good accessibility of the capital, withdrawals in favour of construction prevailed in losses of farmland in district Senec (Tab. 2). Like in district Pezinok, construction of single family houses prevailed (55.3%), and as rule it was carried out next to the existing built-up area in individual communes. Important share (almost 20%) corresponds to the production, service and transport infrastructure with the dominating superregional logistic centres next to the D1 motorway not far away from the town Senec.

The greatest withdrawals motivated by construction took place in the municipalities of Senec (380 ha), Chorvátsky Grob (207 ha), Bernolákovo (168 ha), Miloslavov (131 ha), Rovinka (102 ha), and Nové Košariská (commune Dunajská Lužná 87 ha). Šveda (2011) reports that these localities stand out for a highly dynamic increase of construction of the new residential zones with traits of the Western European suburbs (small plots and blind alley network) (Fig. 8). Accelerated construction is also associated with an increased extraction of gravel and sand which accounts for the loss of 116 ha of farmland during the tracked period. Abandonment of farmland was observed in about 280 ha, but in difference from the district of Pezinok in this case it is not abandoned vineyards but arable land which is destined for future construction. Most of the abandoned land was identified in Bernolákovo (59 ha), Chorvátsky Grob (36 ha), and Senec (26 ha) (Figs. 9 and 11).

As the spatial heterogeneity of the territory is lesser, losses of agricultural land in district Senec were identified in 62 different PEUs, i.e. considerable less than in district Pezinok. The greatest losses in favour of construction were on Chernozems (PEU code 0032062; 239 ha) and Fluvisols in plains (PEU codes 0015005; 125 ha and 0001001; 110 ha); abandonment prevailed in areas without PEU codes (forest plots) 29 ha, on Fluvisols (0001001; 23 ha), Chernozems (0032062; 19 ha) and Chernitsa/Chernozems (0017002; 18 ha). Survey of the losses of agricultural land by individual groups of farmland quality in district Senec is in Fig. 10. Construction took place especially in the soil quality groups 6 and 5, but relatively big withdrawals were also recorded in the categories of top quality soils.

5. Conclusion

The LPIS primarily serves as a reference base for verification of data quoted in applications for support provided for worked agricultural land. Data from the LPIS database are also valuable information about the real use of farmland; they made it possible to identify its changes on local level and combined with the information about PEU establish the losses of farmland pursuant the existing legislation. Marked losses of farmland in two districts in the hinterland of Bratislava, i.e. Pezinok and Senec were analyzed in this study. In the years 2004–2018 about 20 km² of agricultural land was permanently withdrawn for construction. Consequences of the abandonment and degradation of farmland are a considerable economic loss. Results of this study demonstrate the abandonment of more than 13 km² of farmland. Its effects are negative both from the economic point of view and the overall appearance of landscape. Losses of farmland were prevailingly observed in land of inferior quality but also in case of high quality soils which should be subject to increased protection. The presented analysis applying combination of the LPIS and PEU data may contribute to better understanding of processes in cultural landscape along with their environmental and economic effects.

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References

ALCANTARA, C., KUEMMERLE, T., BAUMANN, M., BRAGINA, E.V., GRIFFITHS, P., HOSTERT, P., KNORN, J., MÜLLER, D., PRISHCHEPOV, A.V., SCHIERHORN, F. (2013): Mapping the extent of abandoned farmland in Central and Eastern Europe using MODIS time series satellite data. Environmental Research Letters, 8, 3, doi:10.1088/1748-9326/8/3/035035. Available at: http://iopscience.iop.org/article/10.1088/1748-9326/8/3/035035/pdf.

BARBOTTIN, A., BOUTY, C., MARTIN, P. (2018): Using the French LPIS database to highlight farm area dynamics: The case study of the Niort Plain. Land Use Policy, 73, 281–289, doi: 10.1016/j.landusepol.2018.02.012, https://prodinra.inra.fr/record/429657.

DIMOPOULOU, E. (2012): Towards an Integrated Cadastral System Fulfilling LPIS Requirements. In Knowing to manage the territory, protect the environment, evaluate the cultural heritage. FIG Working Week Rome, Italy May 6–10, 2012. Available at: https://www.oicrf.org/documents/40950/43224/Towards+an+integrated+cadastral+system+fulfilling+LPIS+requirements.pdf/d7f5c4d2-60d4-d713-ef3d-88c41d74767c.

EEC (1992): Council Regulation (EEC) No 3508/92 of 27 November 1992 establishing an integrated administration and control system for certain community aid schemes.

KERSELAERS, E., LEVIN, G. (2018): Applying LPIS data to assess loss of agricultural land – experiences from Flanders and Denmark. Geografisk Tidsskrift-Danish Journal of Geography, doi: 10.1080/00167223.2018.1537797.

KOPECKÁ, M., SZATMÁRI, D., SVIČEK, M. (2019): Hodnotenie zmien vo využívaní poľnohospodárskej pôdy v okresoch Pezinok a Senec v rokoch 2004–2018. Geografický časopis, 71, 2, 121–140. doi:https://doi.org/10.31577/geogrcas.2019.71.2.07.

KUEMMERLE, T., HOSTERT, P., RADELOFF, V.C., LINDEN, S., PERZANOWSKI, K., KRUHLOV, I. (2008): Cross-border comparison of post-socialist farmland abandonment in the Carpathians. Ecosystems, 11, 614–628, doi: https://doi.org/10.1007/s10021-008-9146-z.

LEVIN, G. (2017): Agricultural registers for the assessment of landscape changes: Options and challenges for the application of IACS and LPIS data. IALE 2017 European Landscape Ecology Congress: From pattern and process to people and action, Ghent, 12–15 September 2017. Available at: https://iale-europe.eu/iale2017/agricultural-registers-assessment-landscape-changes-options-and-challenges-application-iacs.

LOMBA, A., STROHBACH, M., JERRENTRUP, J.S., DAUBER, J., KLIMEK, S., MCCRACKEN, D.I. (2017): Making the best of both worlds: Can high-resolution agricultural administrative data support the assessment

of High Nature Value farmlands across Europe? Ecological Indicators, 72, 118–130, https://doi.org/10.1016/j.ecolind.2016.08.008.

NITSCH, H., OSTERBURG, B., ROGGENDORF, W., LAGGNER, B. (2012): Cross compliance and the protection of grassland – Illustrative analyses of land use transitions between permanent grassland and arable land in German regions. Land Use Policy, 29, 440–448, https://doi.org/10.1016/j.landusepol.2011.09.001.

PAZÚR, R., LIESKOVSKÝ, J., FERANEC, J., OŤAHEĽ, J. (2014): Spatial determinants of abandonment of large-scale arable lands and managed grasslands in Slovakia during the periods of post-socialist transition and European Union accession. Applied Geography, 54, 118–128, doi: 10.1016/j.apgeog.2014.07.014.

PRISHCHEPOV, A.V., MÜLLER, D., DUBININ, M., BAUMANN, M., RADELOFF, V.C. (2013): Determinants of agricultural land abandonment in post-Soviet European Russia. Land Use Policy, 30, 873–884, https://doi.org/10.1016/j.landusepol.2012.06.011.

SAGRIS, V., DEVOS, W. (2009): Core conceptual model for Land Parcel Identification System (LCM), GeoCAP version 1.1. JRC Scientific and Technical Reports, 53. Available at: http://ies-webarchive-ext.jrc.it/mars/mars/content/download/1676/9118/file/10272pubsy.pdf.

Štatistický úrad SR (2018): Stav a pohyb obyvateľstva. Available at: www.datacube.statistics.sk (2. 8. 2019).

ŠVEDA, M. (2011): Suburbanizácia v zázemí Bratislavy z hľadiska analýzy zmien krajinnej pokrývky. Geografický časopis, 63, 2, 155–173.

TOMLINSON, S.J., DRAGOSITS, U., LEVY, P.E., THOMSON, A.M., MOXLEY, J. (2018): Quantifying gross vs. net agricultural land use change in Great Britain using the Integrated Administration and Control System. Science of the Total Environment, Volumes 628–629, 1 July 2018, 1234–1248, https://doi.org/10.1016/j.scitotenv.2018.02.067.

Úrad geodézie, kartografie a katastra SR (2018): Štatistická ročenka o pôdnom fonde v Slovenskej republike podľa údajov katastra nehnuteľností k 1. januáru 2018. Bratislava. Available at http://www.skgeodesy.sk/files/slovensky/ugkk/kataster-nehnutelnosti/sumarne-udaje-katastra-podnom-fonde/statisticka-rocenka-2017.pdf.

VACHUDA, J. (2016): Agricultural land use changes according LPIS in Brno Metropolitan Area. Human Geographies – Journal of Studies and Research in Human Geography, 10, 2, 129–146, doi:10.5719/hgeo.2016.102.3.

ZIMMERMANN, J., GONZÁLEZ, A., JONES, M.B., O'BRIEN, P., STOUT, J.C., GREEN, S. (2016): Assessing land-use history for reporting on cropland dynamics – A comparison between the Land-Parcel Identification System and traditional inter-annual approaches. Land Use Policy, 52, 30–40, https://doi.org/10.1016/j.landusepol.2015.11.027.