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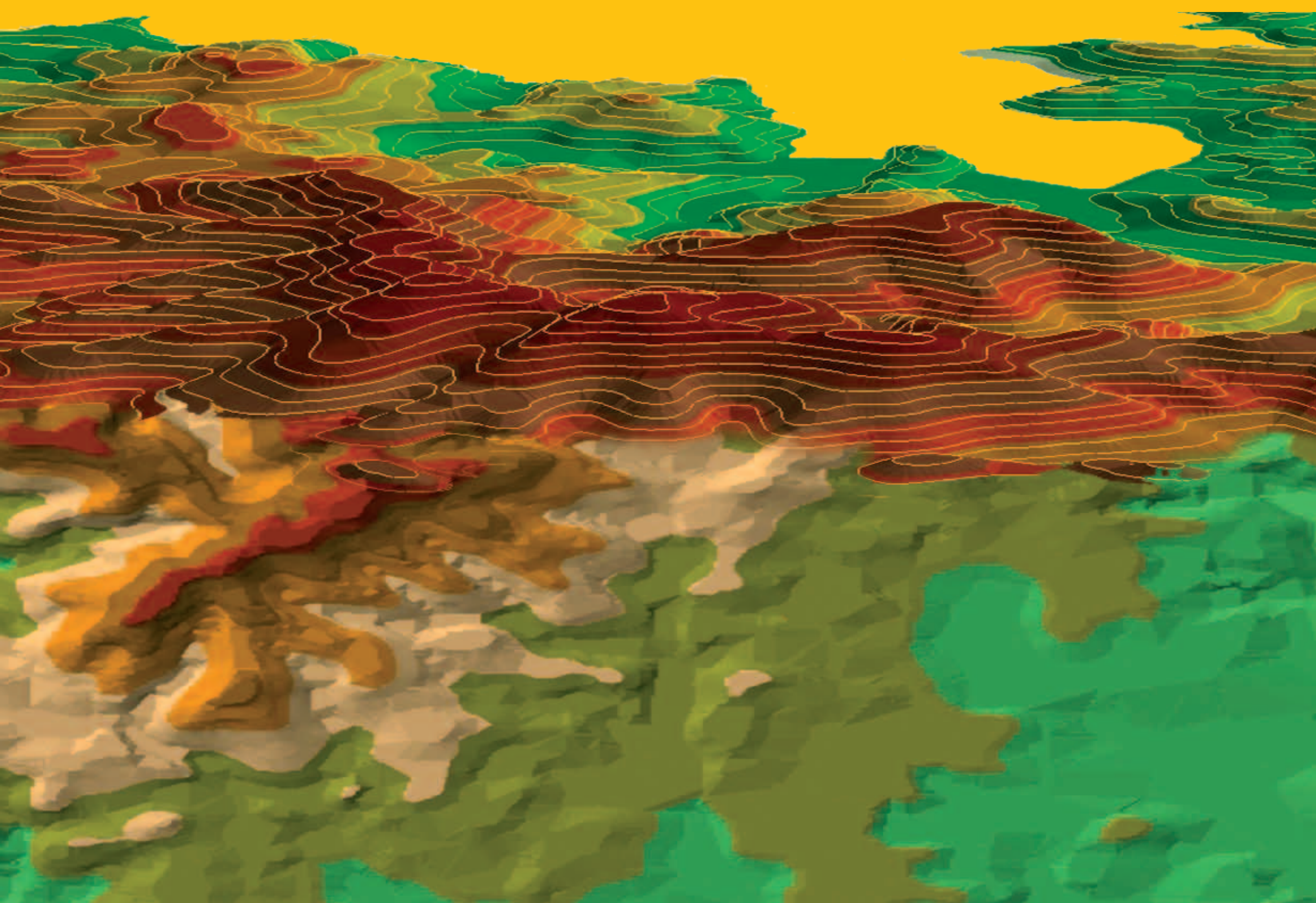

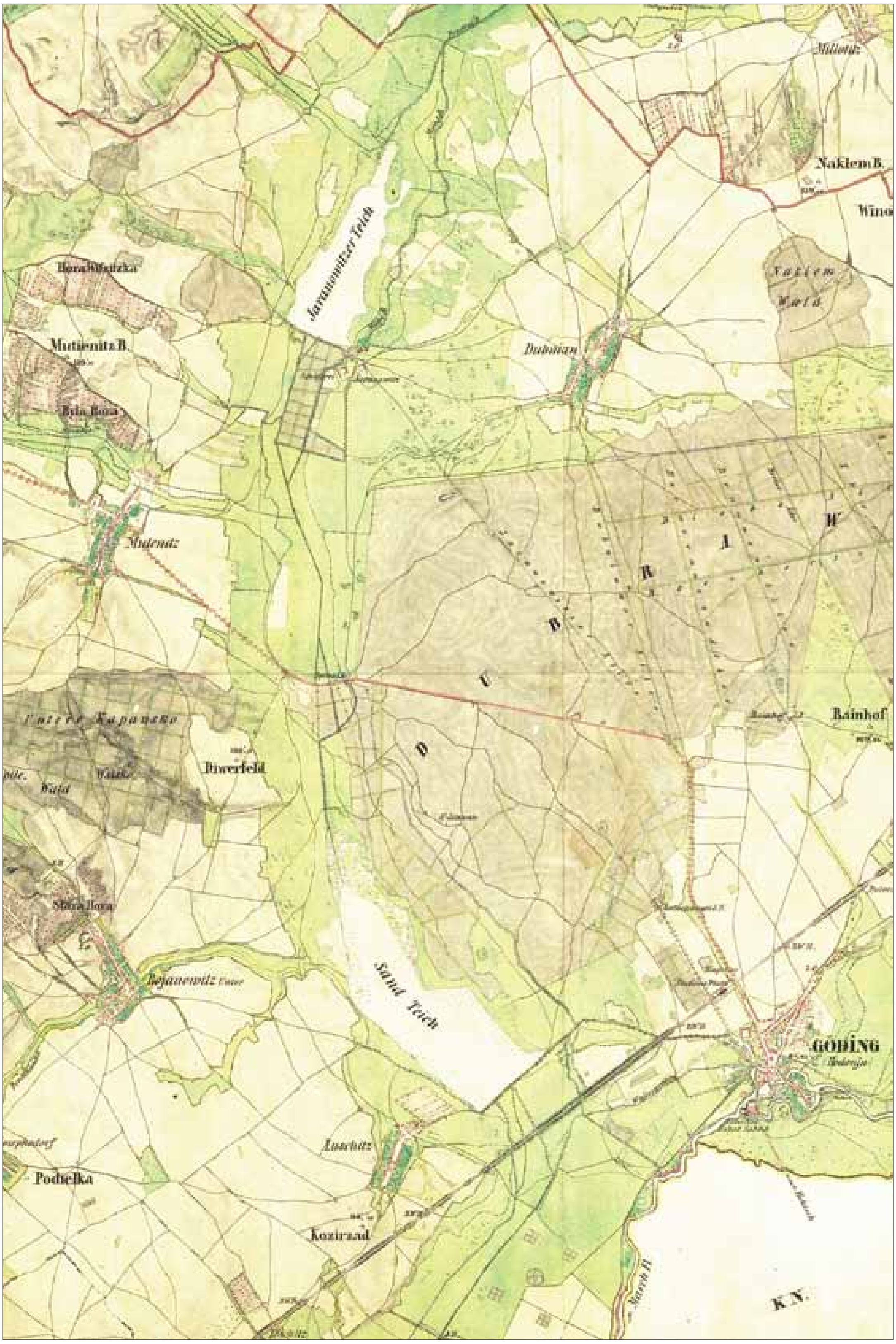

Fig. 5: Lower reaches of the Kyjovka River on the map from the 2nd Austrian Military Mapping 1838. Instead of the fishpond system, there are only two fishponds, i.e. the (Horní) Jarohněvický rybník (Jaranowitzer Teich on the map) and the Písečenský rybník (Sand Teich) on the left. The large Nesyt fishpond was drained too and the Kyjovka R. opened into the Dyje River
Source: Ministry of the Environment of the Czech Republic

Illustration related to the paper by J. Demek, P. Mackovčin and P. Slavík

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MGR, Institute of Geonics ASCR, v. v. i.
Department of Environmental Geography
Drobného 28, 602 00 Brno, Czech Republic
(fax) 420 545 422 710
(e-mail) mgr@geonika.cz
(home page) http://www.geonika.cz

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SPATIAL AND TEMPORAL TRENDS IN LAND-USE CHANGES OF CENTRAL EUROPEAN LANDSCAPES IN THE PAST 170 YEARS: A CASE STUDY FROM THE SOUTH-EASTERN PART OF THE CZECH REPUBLIC

Jaromír DEMEK, Peter MACKOVČIN, Petr SLAVÍK

Abstract

A quantitative evaluation of the dynamics and trends in changes of typical Central European landscapes in the Czech Republic is presented in this paper for the period 1836–2006. This study applied the technology of geographical information systems (GIS) to explore land-use changes using computer-aided analysis of historical and contemporary large-scale topographic maps. The area of study in the south-eastern part of the Czech Republic covers 4,187 sq. km. The analysis of a number of landscape changes from 1836 to 2006 showed that for 56% of the study area, the land-use did not change and thus the landscape remained stable. This quantitative approach, based on computer-aided interpretation of old and contemporary maps, provides valuable results relevant for planning processes and nature conservation for the changing cultural landscapes of Central Europe.

Shrnutí

Prostorové a časové trendy ve využívání krajiny ve Střední Evropě v posledních 170 letech: případová studie jihovýchodní části České republiky

Článek se zabývá kvantitativním vyhodnocením dynamiky a trendů změn v typických krajinách střední Evropy v období 1836–2006. V práci je použita metoda počítači podporovaného studia historických a současných topografických map v prostředí geografických informačních systémů (GIS). Studované území se nachází v jihovýchodní části České republiky a zaujímá plochu 4 187 km². Analýza prokázala, že využití krajiny se v období 1836–2006 nezměnilo na 56.0 % plochy a krajinu je tak možné považovat za stabilní. Tento kvantitativní výzkum, založený na počítači podporované analýze starých a současných map poskytuje cenné výsledky využitelné pro krajinné plánování a ochranu přírody v měnících se kulturních krajinách střední Evropy.

Key words: *spatial and temporal analysis of landscape patterns, trends of cultural landscape changes, landscape diversity, landscape stability, land-use, GIS based analysis of historical and contemporary topographic maps*

1. Introduction

Contemporary landscape ecology as an interdisciplinary science between biology and geography focuses on the analysis of spatial and temporal landscape patterns and their relationships to natural and socioeconomic processes. As a scientific discipline, landscape ecology has grown rapidly in recent years, supported by developments in geographical information systems (GIS) and spatial analysis techniques. A variety of ecological questions now requires large regions to be studied and spatial heterogeneity, disturbances, response, landscape changes and landscape stability to be understood (Turner, 1990). This study applied the technology of geographical information systems (GIS) to explore land-use changes using mainly the computer-aided analysis of old and contemporary large-scale topographic maps. Information derived from large scale topographic maps has an advantage in that they show land use spatial distribution together with the landscape micro-texture. Processing in the GIS-milieu enables also the quantitative evaluation of landscape metrics. On the other side, cartographers could over- or underestimate actual values of land-use categories. This type of errors is connected with the accuracy of map sources and their processing. The aim of this paper is to explore the relationships between land-use spatial patterns and landscape-forming processes of a typical Central European cultural landscape in the last 170 years.

Land use changes are ones of the far-reaching effects of human activities on modern landscapes. Among other things, many of European cultural landscapes have experienced a remarkable change since the early 19th century, particularly during the 20th century (Bender et al., 2005; Bičík et al., 2001; Boltižiar, 2007; Boltižiar, Brůna, Křováková, 2008; Cousins, 2001; Haase et al., 2007; Houghton, 1994; Lipský, 2007; Palang et al., 1998; Petit and Lambin, 2002; Stránská et al., 2008a, 2008b, 2008c; Vuorela et al., 2002).

All landscapes are historically contingent geosystems the structure and dynamics of which reflect continuous modification of pre-existing systems. Data about land-use can be used to discriminate between natural and cultural causes of environmental change. Environmental variability and trends have regional and local components. Land in the south-eastern part of the Czech Republic is used in many different ways, from high-density cities and sprawling suburbs to various types of agriculture and forestry. The changes of land-use reflect complex nature-society interactions and the development of natural environment and human society over time (Boltižiar, Brůna, Křováková, 2008; Žigrai, 2004).

2. Location

The studied area is situated in the south-eastern part of the Czech Republic near the border of Slovakia (map sheets of the Army of the Czech Republic on a scale 1:200 000 M-33-XXX Zlín and M-34-XXV Žilina) and covers an area of 4,187 sq. km (Fig. 1). The area of study is in the southeast and south limited by the border of Slovakia. The northern boundary of the region connects the town of Vyškov in the west, the town of Kroměříž in the middle and the town of Vsetín in the east. The western boundary runs from Vyškov in the north, the town of Bučovice in the middle and the village of Moravská Nová Ves in the south. The north-south axis of the studied area is formed by the middle reach of the Morava River.

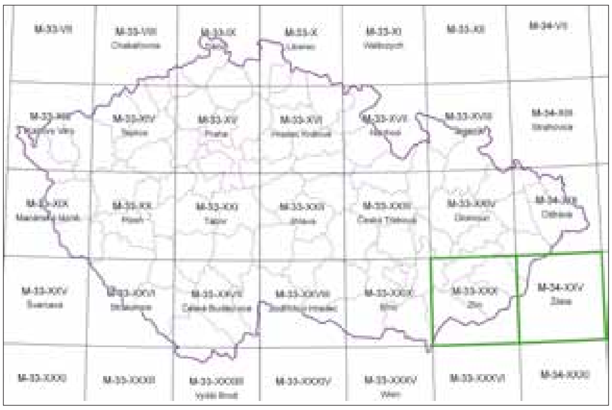


Fig. 1: Study area location (map sheets M-33-XXX Zlín and M-34-XXV Žilina) in the territory of the Czech Republic

In geological terms, the small north-western part of the studied area is formed by the Proterozoic Moravo-Silesian terrane and the southernmost part of the region between the towns of Hodonín and Napajedla is formed by Neogene deposits of the Vienna Basin. A predominant part of the region is composed of Mesozoic and Tertiary rocks of the Outer Western Carpathians with a typical nappe structure (Moravian-Silesian Flysch Carpathians: Stráník et al., 1993). Due to the direction of overthrusting and mostly nearly horizontal overthrust planes, the individual groups of nappes are arranged from the base to the top as follows: the older Magura group of nappes (Rača Unit, Bystrica Unit and White Carpathians Unit) on the top and the younger Outer group of nappes (Pouzdřany Unit, Ždánice Unit, Subsilesian Unit, Zdounky Unit and Silesian Unit) at the base (Chlupáč et al., 2002).

In the front of the Carpathians nappes developed a Neogene Carpathian Foredeep. The great ecological diversity of landscapes in the studied region results from combinations of the underlying patterns of topographic complexity, climatic variability, and environmental history. The great variety of relief types is typical for the studied area – from the plains and lowland hilly land of the Vienna Basin through the piedmont hilly land up to the flysch highlands and mountains on the Slovak border. According to the regional geomorphological division of the Czech Republic, the very small NW corner of the studied area belongs in the geomorphological subunit of Konická vrchovina Highland, classified in the subsystem of Brněnská vrchovina Highland, Province of Česká vysočina (Bohemian Highlands).

The larger part of the studied region is part of the geomorphological province of the Western Carpathians. Between the towns of Vyškov in the west and Holešov in the east, depressions developed in the geomorphological system of the Western Outer Carpathians Depression (Vyškovská brána Gate and the south-eastern part of the Hornomoravský úval Graben).The main part of the studied area belongs in the geomorphological system of the Outer Western Carpathians. The north-eastern part of the territory belongs in the subsystem of the Central Moravian Carpathians. The gentle rounded relief of the agricultural landscape of Litenčická pahorkatina Hilly land on the uplifted Neogene deposits of the Carpathian Foredeep rises above the depression of the Vyškovská brána Gate. Two forested flysch ridges of the highlands of Ždánický les Forest and Chřiby (Mt. Brdo 586.7 m a.s.l.) form the axis of the Central Moravian Carpathians. The extensive agricultural landscape of the Kyjovská pahorkatina piedmont hilly land with vineyards partially on flysch deposits and partially on Neogene deposits of the Vienna Basin lies more to the south. Forms of disastrous rill and gully soil erosion are common after heavy rains in this subregion (Stehlík, 1954).

The south-eastern part of the studied area belongs geomorphologically to manifold units of the subsystem of the Moravian-Slovak Carpathians, explicitly to the Vizovická vrchovina Highland on the rocks of the older Magura nappe. The highest part and the axis of the Vizovická vrchovina Highland is formed by the forested mountain ridge of the Komonecká hornatina Mts. (Fig. 9). The mountain relief of the Komonecká hornatina Mts. is surrounded by the lower Zlínská vrchovina Highland in the north and by the Luhačovická vrchovina Highland in the south. Transition to the lowlands of the Vienna Basin forms the piedmont of Hlucká pahorkatina Hilly land. On the border with Slovakia is the mountain ridge of the flysch White Carpathians (Mt. Velká Javořina 970.0 m a.s.l.) with typical protected herb-rich meadows (White Carpathians Protected Landscape Area). The Lyský průsmyk Pass divides the White Carpathians from the forested mountain ridges of the Javorníky Mts. (Mt. Malý Javorník 1019.2 m a.s.l.). A part of these flysch mountains is situated in the Protected Landscape area of Beskids. The Walachian type of landscape (fields on mountain slopes) with dispersed farm houses on clearings in fir-beech stands is typical of the Javorníky Mts. Forested ridges of the Hostýnsko-vsetínská hornatina Mts. (a part of the Western Beskids subsystem) rise in the north-east part of the studied region. Slopes of the flysch Carpathians are often deformed by landslides and mud flows (Krejčí, 1944; Záruba, 1938). Föhn-like winds from the White Carpathians cause aeolian soil erosion in the Hlucká pahorkatina Hilly land (Hrádek, Švehlík, 1995). This aeolian soil erosion is emphasised in spring on fields in the vicinity of the villages of Bystřice pod Lopeníkem and Bánov (Nekuda [ed.], 1992). The southern part of the studied region between the town of Napajedla in the north and Hodonín in the south forms a part of Vienna Basin called the South Moravian Basin. The axis of the Basin forms the Dyje-Morava Floodplain (Dyjsko-moravská niva). A part of the floodplain around the Lower Morava River is called the Lower Morava R. Floodplain (Dolnomoravská niva) and is up to 6 km wide (Fig. 10).

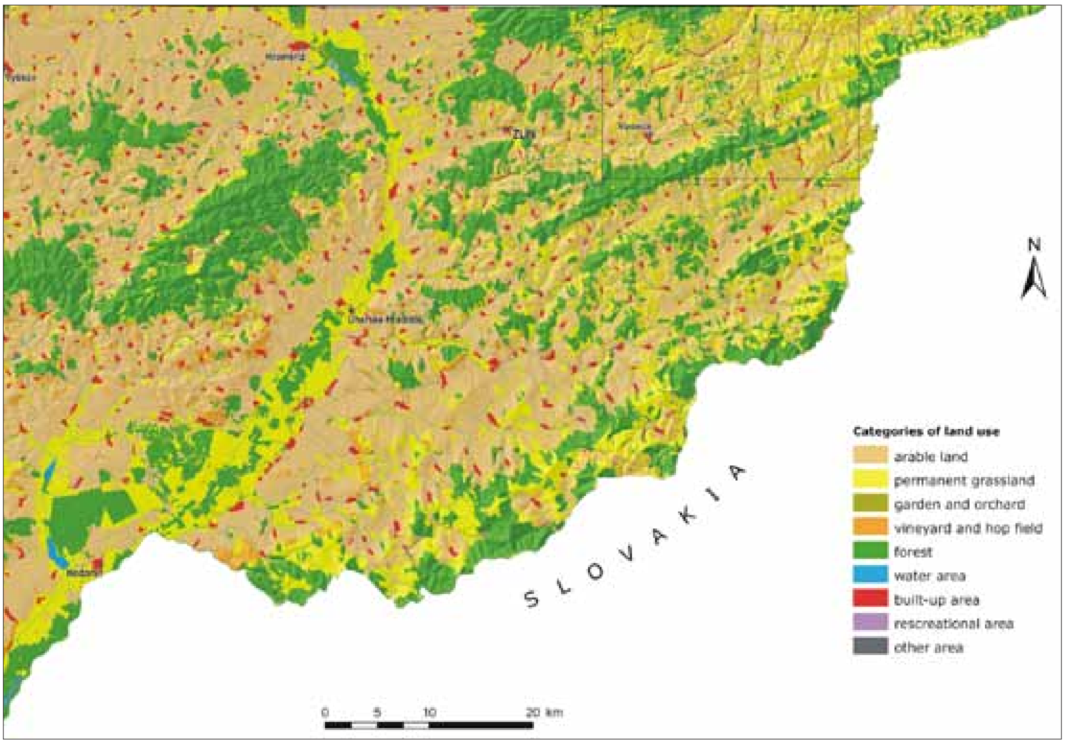


Fig. 2: Basic land-use map sheets M-33-XXX Zlín and M-34-XXV Žilina (1836), covering a part of the Moravian-Silesian Carpathians and the northern part of the Vienna Basin. This general legend is valid also for other basic land-use maps in this paper.
Source: Mackovčin et al., 2011

A typical feature of Southeast Moravia is climatic zoning. The climate is changing from very warm and dry Central European lowland type in the south, through warm climate of piedmont hilly lands up to mild warm climate of highlands and cold and wet climate of the Javorníky Mts. in the north-eastern part of the study region. The relief dissection and the active surface influence the atmospheric boundary layer and the ground layer of the atmosphere in the region.

The studied region drains into the Black Sea and mostly belongs in the Morava River catchment area. Only several watercourses on the Slovak border flow into the Váh River in Slovakia.

Vertical zones are obvious in the soils too. Typical soil types for warm plains and flat hilly lands in the south are black soils (chernozems). Brown soils and luvisols developed in piedmont hilly lands and highlands. Cambisols are soils of dissected highlands and mountains. Fluvisols are typical of floodplains. The whole Lower Morava Floodplain was flooded during the flood disaster in 1997.

The south-western part of the study region belongs to the old settlement areas. The Neanderthals had passed through the region 40,000 years ago. The settlements of Mikulčice and Staré Město u Uherského Hradiště were important centres of the Great Moravian Empire from the 8th to 10th century A.D. The Slavonic Empire collapsed in the early 10th century. Important trade routes followed the Morava River and the Olše River. Major villages were promoted to towns in medieval times, which launched the development of urbanized landscapes. The Slavonic village of Kroměříž in the southern part of the Hornomoravský úval Graben was granted town status in 1260, as well as the village of Holešov in 1272. In the Dolnomoravský úval Graben, the village of Hodonín was promoted to town in 1228, Uherské Hradiště in 1257, Strážnice in 1302, Uherský Ostroh in 1371 and Veselí nad Moravou in 1375. Colonization gradually spread from the core settlement area in the lowlands into the Carpathian highlands and mountains (Peřinka, 1905). In the Vizovická vrchovina Highland, the village of Uherský Brod was promoted to town status in 1272 and Zlín in 1397. At the foot of the Javorníky Mts., the village of Valašské Klobouky became a town in 1356 (Růžková, Škrabal et al., 2006). At the end of the 15th century and during a larger part of the 16th century, the forested frontier flysch mountains were colonized by Walachian pastoral tribes from Romania. Due to new methods of exploiting mountains, the pastoral tribes changed the natural, economic and cultural conditions of the mountain landscapes in the region. Although natural processes are still very much in play in the Flysch Mountains, human impacts connected with the Walachian colonization clearly show in this subregion (type of landscapes with fields on mountain slopes – so-called "kopanice"). Deforestation and grazing accelerated soil erosion and gravitational movements on steep flysch mountain slopes as well as accumulation in the valleys. Anthropogenic landscape changes in Central Europe occurred at several stages within the last 170 years. Characteristic features include acceleration in the sequence of changes, continual increase in the scope and complexity of ecological problems, growing destabilization of natural settlement and a rising proportion of irreversible changes. Great landscape changes took place in the 20th century.

3. Material and methods

3.1 Data acquisition and database

The long-term dynamics of land-use change are important for the evaluation of human impacts on the landscape. This authors' research is based on the computer-aided analysis of land-use changes on historical and contemporary large-scale topographic maps, namely on the

a) historical military maps created for the territory of the Czech Republic by the Austrian Military Geographical Institute in Vienna in 1836–1880 (2nd and 3rd Austrian Military Mapping);
b) post WWII military maps surveyed by the General Staff of the Czechoslovak People's Army and its successor organisation – the General Staff of the Army of the Czech Republic (military mappings 1952–1995); and
c) detailed civil maps 1:10 000 created by the Czech Office for Surveying, Mapping and Cadastre in Prague (Base Maps of the Czech Republic – digital version Zabaged 2002–2006).

Likewise, the continuity of the sources is of great importance. This means several time periods and corresponding landscape conditions must be represented by common attributes that were collected and recorded using a standard procedure. Topographic maps were geo-referenced. GIS processing and digital map creation were carried out using the ESRI ArcGIS 9.3 software.

3.2 Methods

Land-use categories (see Mackovčin, 2009) used in the study are as follows (Tab. 1). The categories are defined as follows:

1. Arable land – this category includes lands used mainly for agricultural production (principally fields with crops);
2. Permanent grassland – mainly meadows and pastures;

3. Garden and orchard – this category includes gardens, orchards, tree nurseries and ornamental gardens. Orchards are vectorized as a separate category outside of residential areas. Vegetable gardens distinguished on the maps from the 2nd Austrian military mapping are vectorized as parts of orchards;
4. Vineyard and hop field – include related objects outside of residential area (e.g. wine cellar, groups of wine cellars);
5. Forest – a large area of land that is densely covered with trees; in this category, the authors included also structures directly related to forestry (e.g. gamekeeper's lodge);
6. Water body – includes fishponds, lakes, water reservoirs, gravel pits filled with water, etc.;
7. Built-up area urban – artificial environment of dwellings as a part of town or city with multi-storey buildings and urban infrastructure;
8. Built-up area rural – connected with small settlements located in the countryside (outside a town or city);
9. Recreational area – land connected with leisure activities (incl. allotments and weekend homes), and
10. Other area – this category includes unused land, transport structures, mining sites, waste dumps, military objects (outside intravilan), etc.

In order to study the landscape changes, an interdisciplinary approach that integrates landscape ecology and history is vital (Bürgi, Russell, 2001).

Code	Name
1	Arable land
2	Permanent grassland
3	Garden and orchard
4	Vineyard and hop field
5	Forest
6	Water area
7	Built-up area urban
8	Built-up area rural
9	Recreational area
0	Other area

Tab. 1: Categories of land use
Note: For technical reasons, categories 7 and 8 are in the final basic land-use map 1:200 000 mapped together as built-up areas (Mackovčin, 2009). Category 9 –Recreational areas appears first in the post WWII land-use maps

Therefore, the authors studied the landscape changes in GIS milieu in four time periods 1836–1875, 1875–1955, 1950–1990 and 1990–2006.

4. Results

4.1 Landscape structure in the first half of the 19th century

Due to the fact that European landscapes achieved their greatest diversity in pre-industrial times (Antrop, 1997; Bender et al., 2005), it was very important to obtain data that originate from the first

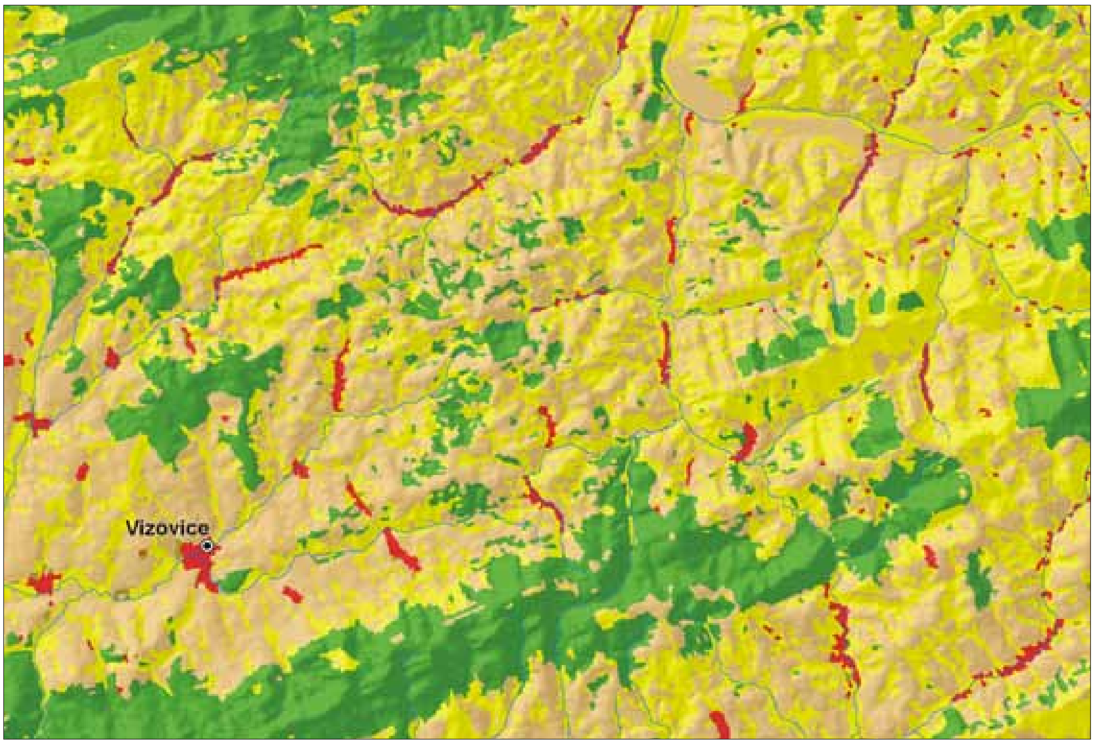


Fig. 3: Example of basic land-use in the Moravian-Silesian Carpathians nearby the town of Vizovice – the situation in 1836. For location of the territory and legend see Fig. 2
Source: Mackovčin et al., 2011

half of the 19th century. The landscape condition and structure in the first half of the 19th century is well represented on the map sheets from the 2nd Austrian Military Mapping. This survey was carried out in Moravia on a scale 1:28 000 in 1836–1841. Map sheets from this mapping already contain the triangulation net and therefore could be geo-referenced and processed in the GIS environment. As an example of the quantitative evaluation of land use based on these maps, the authors present results in Fig. 3 and Tabs. 2a and 2b.

The technical revolution during the 2nd Military Mapping resulted in the demolition of town walls and construction of factories, which resulted in the opening of towns. In about the middle of the 19th century, urbanized landscapes spread into surrounding rural landscapes. The town walls of Uherské Hradiště were already demolished and the newly obtained space was used to create town parks. The growing of sugar beet spread in the lowlands and on the bottoms of dried-out fishponds. Manufacturing in the Napajedla sugar refinery started in 1845 and in Kyjov in 1846. Iron ore (pelosiderite) mining from the flysch deposits began in 1838 and the first blast furnace was constructed in the town of Bojkovice in 1840. Large feudal estates still predominated in the agricultural landscapes. Nearly 70% of the land was devoted to agricultural production.

The trend of drying out fishponds that started after the beginning of the 1st agrarian revolution continued. For instance, fishponds around the village Záhlinice in the Middle Morava River Floodplain were no longer plotted on the maps from the 2nd Military Mapping (Fig. 2). The same occurred with the fishpond in the village Bilany near the town of Kroměříž. Now, during the floods in Kroměříž, waters of the Morava River flooded the Middle Morava R. Floodplain in the section called Bilanské trávníky (Grasslands of

Code	Categories	1836	1876	1956	1990	2006
1	Arable land	1,907.5	2,215.9	2,291.9	1,889.8	1,727.1
2	Permanent grassland	1,010.2	640.3	292.0	373.4	477.0
3	Garden and orchard	19.7	24.5	37.3	68.0	68.0
4	Vineyard and hop field	53.7	41.3	27.7	54.5	38.1
5	Forest	1,089.5	1,153.2	1,317.7	1,430.1	1,475.1
6	Water area	5.3	0.6	6.7	19.3	20.9
7	Built-up area	101.2	111.1	209.8	331.1	354.9
8	Recreational area	–	–	2.1	17.5	22.4
0	Other area	0.2	0.4	2.1	3.6	3.8
	Total	**4,187.3**	**4,187.3**	**4,187.3**	**4,187.3**	**4,187.3**

Tab. 2a: Land-use changes in the study area in the period 1836–2006 (km²)
Source: VÚKOZ, v. v. i.

Code	Categories	1836	1876	1956	1990	2006
1	Arable land	45.6	52.9	54.7	45.1	41.3
2	Permanent grassland	24.1	15.3	7.0	8.9	11.4
3	Garden and orchard	0.5	0.6	0.9	1.6	1.6
4	Vineyard and hop field	1.3	1.0	0.7	1.3	0.9
5	Forest	26.0	27.5	31.5	34.2	35.2
6	Water area	0.1	0.0	0.2	0.5	0.5
7	Built-up area	2.4	2.7	5.0	7.9	8.5
8	Recreational area	–	–	0.0	0.4	0.5
0	Other area	0.0	0.0	0.0	0.1	0.1
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Tab. 2b: Land-use changes in the study area in the period 1836–2006 (%)
Source: VÚKOZ, v. v. i.

Bilany), covered the bottom of drained fishpond, the village green in Bilany and flowed into houses. Two fishponds were drained in the village of Mysločovice in the Tlumačovské vrchy Hills. Also, in the Lower Morava River Floodplain, several fishponds were drained and their beds used for meadow or arable land. On the map from the 2nd Military mapping, no more fishponds are plotted around the town of Strážnice. The Nesyt fishpond near Hodonín (earlier the second largest fishpond in Moravia) was drained too (Fig. 4).

The large unnamed fishpond on the junction of the Kyjovka River with the creeks Hruškovice and Zamazaná was also drained. The same happened to a smaller Mokronovský rybník Fishpond on the Kyjovka R. near the village of Svatobořice-Mistřín. Overleaf the map shows the (Horní) Jarohněvický rybník Fishpond (Jaranowitzer Teich with the area larger than today) and the Písečenský rybník Fishpond (Sand Teich – Fig. 5 – see cover p. 2). The millrace named Mühlbach still runs from the Kyjovka River bed to the mill on the dam of the Jarohněvický rybník Fishpond (Jaranowitzer Teich on the map – Fig. 5 – cover p. 2). However, the Nadýmák fishpond was already drained. Feudal estates were built in place of the former fishponds (Hlavinka and Noháč, 1926, p. 11).

The river pattern in the Lower Morava River Floodplain experienced a substantial change. The main river bed of the Olšava River no more led to the town of Uherské Hradiště, but from the town of Kunovice to the west and then parallel with the main Morava River bed to the south (contacts Yazoo). Thus, the Olšava R. opened into the Morava R. more to the south in the town of Uherský Ostroh. The Morava R. anastomosed to the south of Hodonín. Although its main channel continued freely to meander, the map showed a system of nicely anastomosing river fleets of the Morava River in the Lower Morava River Floodplain. The pattern of river fleets was a typical feature of the floodplain south of Lanžhot between the river beds of Dyje, Kyjovka and Morava. The overall patterns of the channel network included numerous smaller meandering or straight river fleets that diverted and again re-joined the main channels of the Morava and Dyje rivers and/or in some cases crossed the floodplain and connected the channels of the two main rivers. The higher flood activity on the Morava River is recorded in the decade of 1831–1840 (Brázdil et al., 2011).

The bed of the Kyjovka River led from the Písečenský rybník Fishpond towards the village of Mikulčice when the large Nesyt fishpond was drained and the fishpond bed was converted into arable land and meadows (Figs. 4 and 5). The Kyjovka River followed the western border of the floodplain to the south and fed into the Dyje River (Figs. 4 and 5). The degree of connectivity in the floodplains of south-eastern Moravia was still very high in this period.

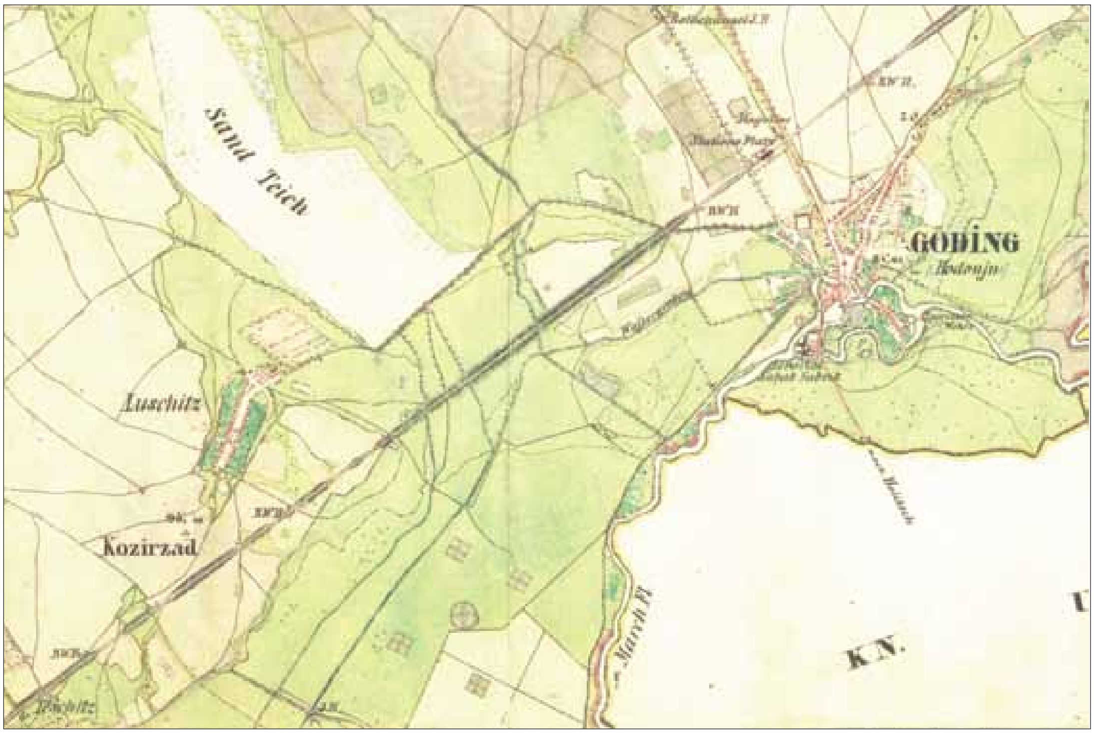


Fig. 4: The Lower Morava River Floodplain near the town of Hodonín on the map from the 2nd Austrian Military mapping in 1838. The large Nesyt fishpond was already drained, the Kyjovka River was flowing parallel with the Morava River and joined the Dyje River. Source: Ministry of the Environment of the Czech Republic

Fallow land farming in agricultural landscapes when farmers kept at least one-third of their arable land temporarily under relatively permanent grass was gradually abolished.

Maps of the 2nd Military Mapping show the beginning of reforestation of drift sands on the territory to the south of Bzenec (Dúbrava, Doubrava) that was launched in 1823 (Vitásek, 1942, p. 1).

The Northern Railway of the Austrian Emperor Ferdinand from Břeclav to Přerov was built in 1838–1841 (Figs. 4 and 5).

4.2 Landscape structure in the second half of the 19th century

During the second half of the 19th century, an entirely new industrial, demographic and transportation system came into existence. The authors used map sheets from the 3rd Austrian Military mapping for the evaluation of landscape development and landscape structure in the second half of the 19thcentury. The 3rd Military Mapping was carried out in the years 1875–1877 in Moravia on a scale 1:25 000. The period between the 2nd and 3rd Military Mapping was a phase of very rapid development of the cultural landscape, which experienced far-reaching changes. For instance, the number of plots showing a land-use change amounted to 22.53% in the Dolnomoravský úval Graben. The continuing agricultural revolution intensified agricultural production based on the increased share of arable land in the landscape (Bičík, Jeleček, Štěpánek, 2001). In this period, total abolition of fallow farming occurred. The share of arable land increased at the expense of permanent grassland (Tabs. 2a and 2b).

From the 1880s, feudal estates and private farmers in the studied area began to concentrate on intensive tillage of better soils, use of agricultural machinery, artificial fertilizers and the introduction of new systems of land management. In lowlands and flat hilly lands, plantations increased of sugar beet, which depleted arable land and gave rise to an increase of not only manuring, but also fertilization with the use of artificial fertilizers. The use of agricultural machinery was spreading. Also the number of sugar refineries was growing.

Agriculture in highlands and mountains, namely in "kopanice" areas (Fig. 6), remained slow. Landscape fragmentation increased due to the Austrian Law on free subdivision of fields from the year 1868.

The share of floodplain forest decreased in floodplains and arable land spread from hilly lands into floodplains. Cessation of natural avulsions, abandonment of many smaller channels and the concentration of discharge into one or two main channels were the main trends in the Morava River channel development in the Middle and Lower Morava River Floodplains in the second half of the 19th century (Grygar et al., 2011).

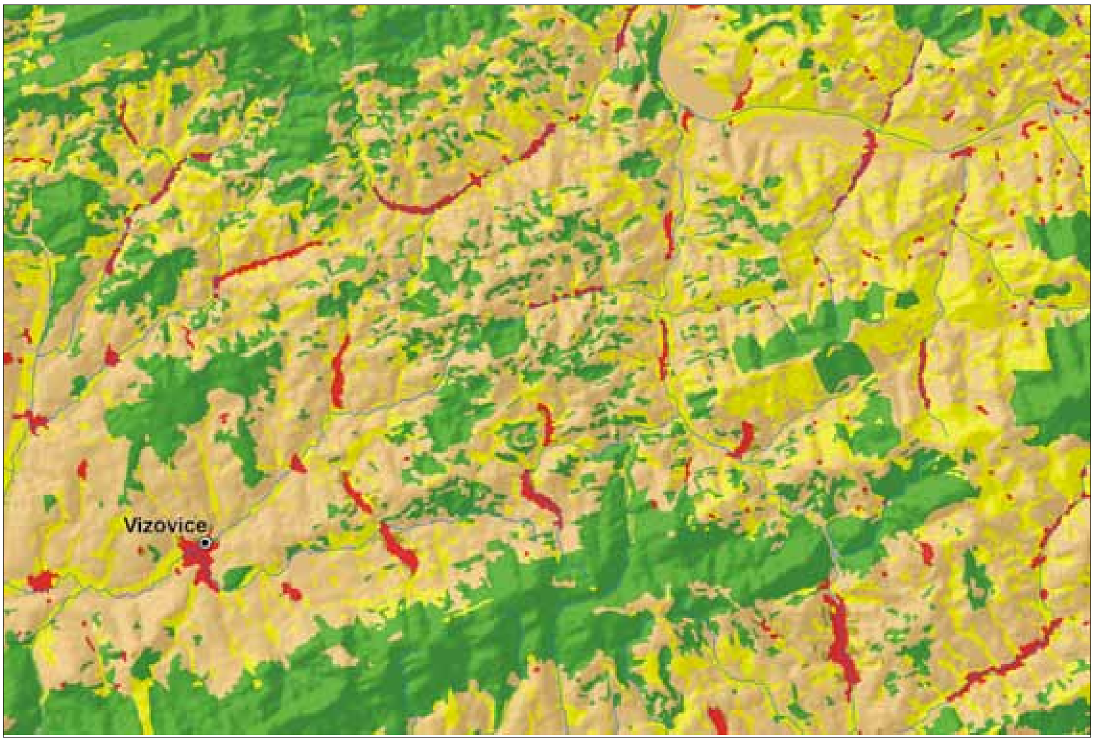


Fig. 6: An example of basic land-use in the Moravian-Silesian Carpathians with the "kopanice" areas nearby Vizovice – the situation in 1876. For location of the territory and legend see Fig. 2
Source: Mackovčin et al., 2011

The trend of draining fishponds further continued. For instance, the share of water areas decreased by about one half in the Dolnomoravský úval Graben (from 1.42% on map sheets from the 2nd Military Mapping to 0.74% on map sheets from the 3rd Military Mapping). The large fishponds (Horní) Jarohněvický rybník and Písečenský rybník were drained in the Kyjovka River valley. The Stonáč Creek channel near the village of Bilany was regulated in the Middle Morava River Floodplain in ca. 1880 (Peřinka, 1911, p. 281). A small fishpond in the village of Sobělice to the southwest of Kroměříž was drained, too.

A severe flood in 1877 caused dam wall breakage on the Bečva River and flooding of the entire Middle Morava River Floodplain. A great flood in the studied area is also reported from 1894 (Peřinka, 1912, p. 577) on the Morava R. in the decade 1891–1900 (Brázdil et al., 2011).

The trend of the spreading of built-up areas was increasing near large towns. The construction of the network of imperial and royal roads was finished in 1850 (Musil, 1987, p. 175) that – together with the growing network of railways – contributed to the fragmentation of landscapes. The above-mentioned Emperor Ferdinand Northern Railway was the main transportation line in the studied area in this period. The Vlára Railway from the city of Brno to the town of Trenčianská Teplá in Slovakia was also constructed in this period. The individual sections received operational status in the following way: 1 April 1883 Kunovice–Uherský Brod, 2 July 1884 Kyjov–Bzenec, 4 June 1887 Bzenec–Kunovice, 10 October 1887 Brno–Kyjov and 28 October 1888 Uherský Brod–Vlárský průsmyk Pass and Trenčianská Teplá in Slovakia. Nevertheless, wagoner services were still used for the local and long-distance transport of goods and mail. The imperial and royal roads were in a relatively good condition; other roads were dusty and not maintained (Nekuda, [ed.], 1992, p. 254). On 8 October 1899, the railway line Otrokovice–Zlín–Vizovice received operational status.

The maps from the 3rd Military Mapping show reforestation in the western part of the area of drift sand dunes (Dúbrava, Doubrava) to the south of the town of Bzenec. The construction of the transport network and the sprawling of settlements required a large amount of construction materials. Many gravel and sand pits were opened in the floodplains. Brick earth (loess, clay) was extracted in the surrounding hilly lands. Construction stones were extracted in many quarries in the flysch highlands and mountains.

4.3 Landscape structure in the first half of the 20th century

There is no coherent set of large-scale topographic maps for studying landscape development in the first half of the 20th century. Czechoslovak authorities mostly carried out the revision of maps from the 3rd Austrian Military Mapping only. In this relatively long period, the land-use of many plots changed (e.g. approximately one quarter of the plots in the Dolnomoravský úval Graben changed their use).

The first Czechoslovak agrarian reform after World War I restricted feudal estates and sold land to small farmers. Thus, a mosaic of small fields formed in rural landscapes. The average size of arable parcels was a few hectares in the first half of the 20th century.

Very high flood activity on the Morava River was reported in the period of 1911–1920 (Brázdil et al., 2011). This is why the Morava River channel regulation was launched in 1906 near the town of Otrokovice and on the lower reaches of its left tributary Dřevnice River in floodplain forests of the southern part of the Middle Morava River Floodplain. Draining of the other part of the Morava R. channel in the southern part of the Hornomoravský úval Graben between the town of Kojetín in the north and the village of Kvasice in the south was launched in 1911 (Peřinka, 1911, p. 5). Then there was stream channel regulation of the Morava River in the Dolnomoravský úval Graben between Napajedla and Lanžhot. The regulation measure shortened the Morava R. bed between these two towns from 82 km to 52 km (Kilianová, 2000, p. 30). The topographic map on a scale 1:75 000 revised in about 1930 shows the river bed regulation of the Morava River and cut-off free meanders between Napajedla and the village of Spytihněv. The river bed was also regulated around the town of Uherské Hradiště. The transformation of the anastomosing system into a single channel meandering system was completed in this period. The regulation considerably reduced the width of the regularly inundated area. Floodplain aggradation reflected the change and the area referred to as distal floodplain was much reduced.

Regulation was also the reason for a rectilinear bed of the Syrovinka River in the western part of the Lower Morava River Floodplain. The bed of the Kyjovka (Stupava) River is also of the artificial origin. This river runs parallel with the main bed of the Morava River. The Bata navigation and irrigation canal was constructed between the village of Sudoměřice and the town of Otrokovice in years 1935–1938.

The river bed of the Dřevnice River was regulated around the Bata Factories in the town of Zlín in the years 1919–1921. In the 1920s, the Olšava River (left tributary of the Morava River) was regulated too. The water reservoir on the Luhačovický potok

Brook situated about 3 km from the Luhačovice Spa was finished in 1930: The topographic map 1:25 000 produced in 1944 shows the beginning of restoration of the Mutěnické rybníky Fishponds.

The area of drift sands (Doubrava) to the south of Bzenec was already completely forested.

The intravilan of settlements was spreading in this period, especially the share of urbanized landscapes increased (see Tabs. 2a and 2b). The regulation of rivers was a trigger for the accelerated development of residential landscapes in the floodplains.

The local railway Kunovice–Staré Město connected the railway lines Břeclav–Přerov and the Vlára railway. The railway line from Veselí nad Moravou–Nové Město nad Váhom in Slovakia was constructed in the period from 1923 to 1928. This railway line connected the south-eastern Moravia with Slovakia. The railway section from the town of Vsetín to the village of Horní Lideč and further to Slovakia was finished in 1937.

4.4 Landscape structure in the second half of the 20th century

A typical feature for the second half of the 20th century is the impact of technological and scientific revolutions on the landscape. The cultural landscape in the studied territory experienced essential changes by changing agricultural practices, housing development and increasing landscape fragmentation. A rapid increase was recorded in the proportion of landscapes that had suffered irreversible change (Bastian, Bernhardt, 1993). After a long break of about 75 years, a new integrated set of large scale topographic maps was published by the Czechoslovak Army in 1952–1955 (S-52).

The second Czechoslovak agrarian reform passed after World War II. Industrialization and collectivization of agriculture was launched after 1955. The structure of agricultural land changed due to land consolidation. The matrix of individual fields disappeared completely. The mosaic of small fields of private farmers was gradually replaced by extensive fields of cooperative farms or state farms. The new single field size was approximately 50–100 hectares. Thus, the intensification and collectivization of agriculture generated a new type of simplified rural landscape, which is apparently less appealing than the traditional one. As a result of the intensification of agricultural production on the one hand, and the retreat of agriculture from unfavourable sites on the other hand, many of the extensively managed traditional land-use systems disappeared. Cropland expanded so much that natural ecosystems started to become rarer. The continued retreat of natural habitats and the growth of cooperative farms greatly simplified the landscape. The landscape simplification led to an increased abundance of crop pests and hence higher use of insecticides. The size of individual field plots grew further during the 1970s in the following wave of land consolidation. A larger part of the dispersed greenery (hedgerows, balks) disappeared from agricultural landscapes due to land consolidation. The removal of dispersed greenery caused consequently the disappearance of traditional medieval field patterns in rural landscapes (Sklenička et al., 2009). Agricultural production reached its peak in this period. The share of arable land decreased (Table 2a and 2b). The share of forested plots increased. Agrochemical inputs into the farmland markedly decreased after 1989.

Differences between the physical environment in towns and villages were largely reduced due to the 2nd Czechoslovak agrarian reform, following industrialization and collectivization of agriculture and the growth of urbanized landscapes sprawling from towns into villages in the second half of the 20th century.

Important features were trends in the restoration and construction of fishponds. The Pláňavský rybník Fishpond (44 hectares) on the left tributary of the Rusava River near the village of Záhlinice (Vlček et al., 1984, p. 217) and small fishponds in the village were restored. The Svárov fishpond (also called Nový rybník) on the Mojena and Rusava Rivers was constructed in 1964. Map S-52 from 1954–1955 shows the restoration of the large (Horní) Jarohněvický rybník Fishpond (150 ha) in the valley of Kyjovka (Stupava) River near the village of Jarohněvice. Downstream on the bed of the former large (Dolní) Jarohněvický (also Brodský) rybník Fishpond, the Mutěnice system of small fish hatchery fishponds was constructed (from the north: Bažantnice, Mlynářka, Srálkovský 11 ha, U křížku, Šilhánek, Hejdovský, Josef, Zbrodský 14 ha, Výtažník, U vrby, Za vrbou). On the bottom of the former large Písečenský rybník Fishpond between the village of Dolní Bojanovice and the town of Hodonín, the Hodonín fishpond system was constructed (from the north: Výtopa 11 ha, Bojanovický 20 ha, Novodvorský 21 ha, Dvorský 28 ha, Komárovský 19 ha, Nad sádkami 9 ha, Lužický 28 ha and the new Písečenský rybník Fishpond 32 ha). The consolidated Czechoslovak military map surveyed in 1991 shows that between the Mutěnice fishpond system and the Hodonín system, large sedimentation basins of the Hodonín power station were situated. This map also shows a new small fishpond situated on the right bank of the right tributary of the Prušánka River downstream of Dolní Bojanovice.

Construction of the Bojkovice water reservoir on the Kolelač Creek was finished in 1966, and the Ludkovice water reservoir on the Ludkovický potok Brook in 1968. The construction of other water reservoirs was finished as follows: Buchlovice (10 ha) on the Dlouhá řeka River in 1969, Ordějov (14.9 ha) on the Bystřička R. near Bánov in 1971, and Slušovice (77.7 ha) on the Dřevnice R. in the Hostýnské vrchy Hills in 1975.

The regulation of watercourses continued, especially in the floodplains of Morava and Dyje rivers (Dyjsko-moravská niva), in response to higher flood activity in the period 1961–1970 (Brázdil et al., 2011). The regulation resulted in disturbed connectivity. Nevertheless, the regulation of the Morava River and its tributaries was not able to protect the Lower Morava River Floodplain from complete inundation during the disastrous flood in 1997 (Demek et al., 2012).

Catastrophic landslides destroyed 12 houses (of 33) on flysch slopes in the village of Maršov near the town of Uherský Brod in 1967 (Nekuda [ed.], 1992, p. 570). The geohazard in this village continues. Extremely high precipitation in 1997 that caused the above-mentioned catastrophic flood caused also the rejuvenation of landslides on slopes of the Moravian-Silesian Carpathians as well as the development of new landslides and mudflows (Krejčí et al., 2002, Demek et al., 2012 b).

The areas of gravel pits flooded with groundwater increased in the Middle Morava and Lower Morava River Floodplain. Large gravel pits developed in the Middle Morava R. Floodplain to the south of the town of Hulín, between Tlumačov and Kvasice and near the town of Otrokovice (Bahňák). Gravel pits flooded with groundwater are situated in the Lower Morava R. Floodplain near Babice, Ostrožská Nová Ves and Moravská Nová Ves (Basic Water Management Map).

In that period, the built-up area began to grow rapidly (Tabs. 2a and 2b). Unfortunately, the residential landscapes in the floodplains were sprawling too. Consolidated Czechoslovak military maps produced in 1990–1992 provide documentary evidence about the rapid growth of urbanized and suburbanized landscapes in the studied area including the growth of this type of landscapes in the floodplains. Urban landscapes became more fragmented during the process of urban development. The growth of recreation landscapes growth can be documented too. The maps also show the growing degree of landscape fragmentation. Deficiency of the set of these maps lies in the underestimated area of permanent grasslands.

Toward the end of the 20th century, the regulation of the Morava River was accomplished (Kirchner, Nováček, 1999), which began to resemble a sewer, namely downstream of the town of Hodonín. Floodplain forests were maintained in the Lower Morava biosphere reserve at the junction of rivers Morava, Dyje and Kyjovka on the border with Slovakia and Austria.

The loss of arable land through rain-wash was increasing in the Dyjsko-moravská pahorkatina Hilly land between the town of Břeclav in the west and the town of Hodonín in the east (Fig. 2).

4.5 Landscape structures at the beginning of the 21st century

The present landscape structure is shown on the raster Base Maps of the Czech Republic 1:10 000 as well as on aerial and satellite photographs. The detailed maps reveal that in the recent decades, urban built-up activities have greatly increased impervious surfaces and resulted in remarkable urban sprawling in the study area. Built-up areas have reached their historical maximum (Tabs. 2a, 2b and Fig. 8).

Agricultural landscapes in lowlands and hilly lands represent a typical mosaic of large blocks of arable land and vineyards presenting the landscape of the study area as a special landscape type in the territory of the Czech Republic. Large blocks of fields of fertile soils from the socialist times still predominate in lowland agricultural landscapes. Another peculiar landscape type represents mountain landscapes with the Walachian type of settlements that extend in the mountainous parts of the White Carpathians and the Javorníky Mts. up to the summits of watershed ridges. The accession of the Czech Republic to the EU in 2004 supports trends to a more intensive use of fertile land in lowlands and to a gradual conversion of less fertile soils in highlands and mountains into permanent grasslands or forests.

A new type of landscape element is represented by large shopping malls with extensive "hardscapes" on the periphery of towns or on important road/highway crossings.

5. Quantitative evaluation of landscape changes

Construction of the sheets of digital land-use maps M-33-XXX Zlín and M-34-XXV Žilina (Czech part) by the public research institute VÚKOZ for the periods 1836–1875, 1875–1955, 1950–1990 enabled quantitative evaluation of landscape changes in the period 1836–2006. GIS enabled the development of digital maps of landscape changes, which were constructed by successively overlaying the four basic temporal layers according to categories of changes, beginning with the oldest layer from 1836.

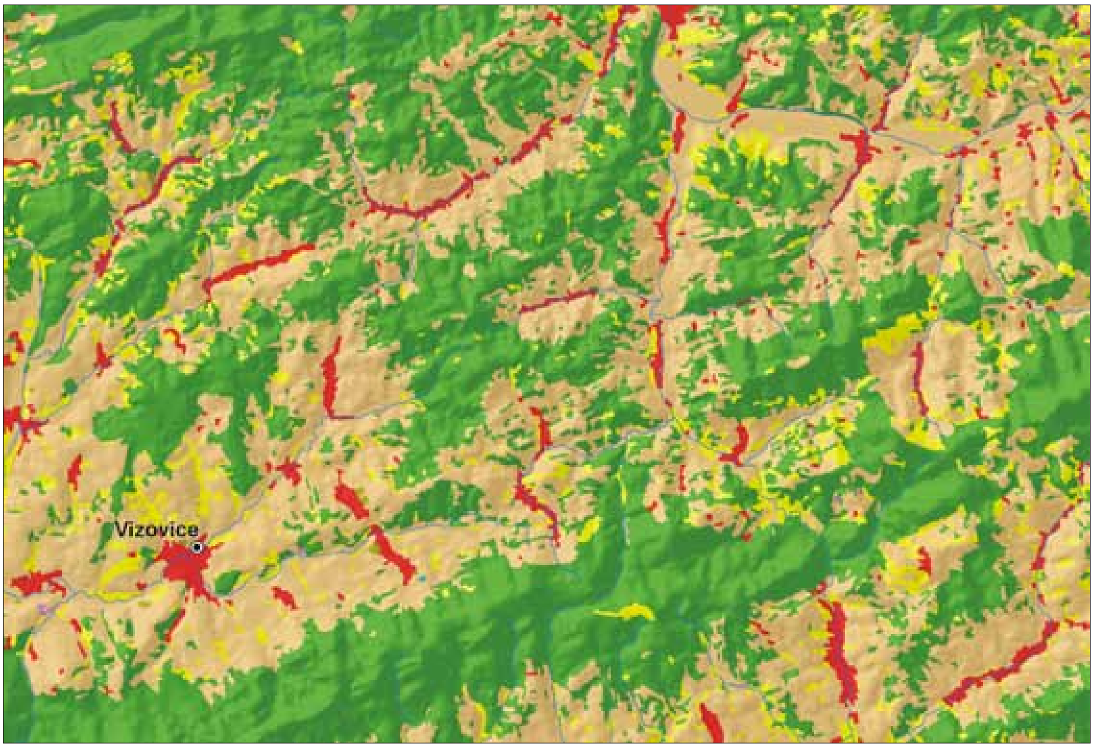


Fig. 7: An example of basic land-use in the Moravian-Silesian Carpathians nearby the town of Vizovice – the situation in 1955 before the collectivisation of agriculture. For location of the territory and legend see Fig. 2
Source: Mackovčin et al., 2011

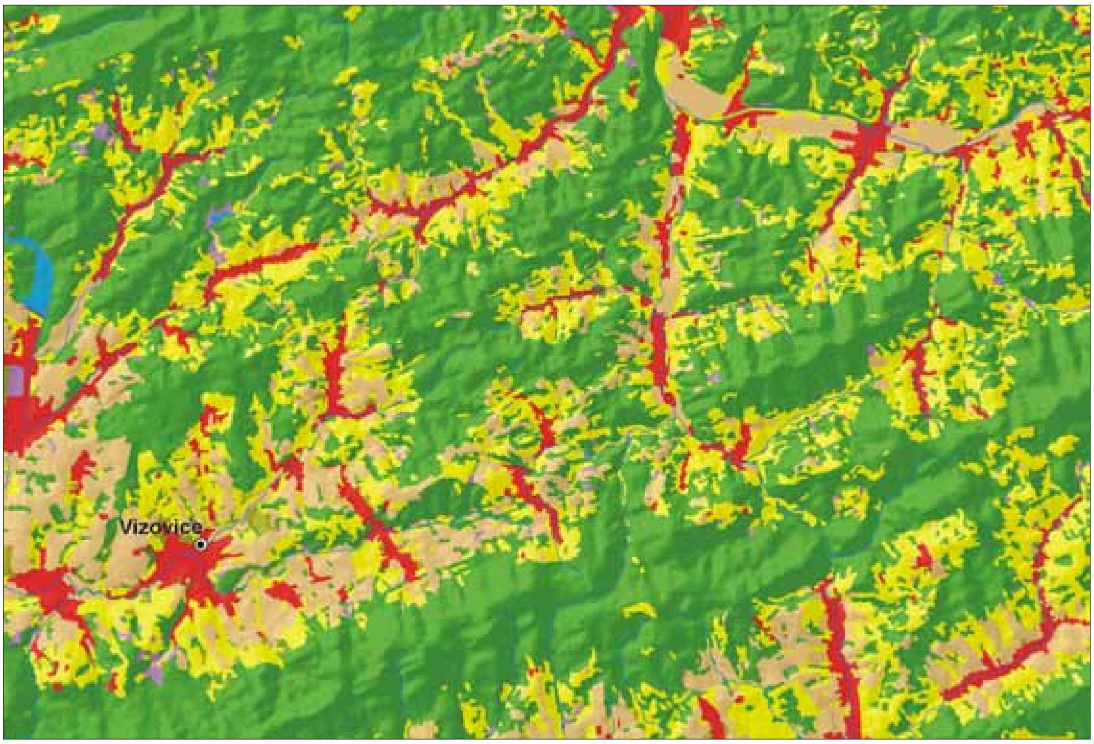


Fig. 8: An example of basic land-use in the Moravian-Silesian Carpathians nearby the town of Vizovice – the situation in 2006. Built-up plots (red) reached their historical maximum. For location of the territory and legend see Fig. 2
Source: Mackovčin et al., 2011

5.1 Landscape metrics

The digital database and the maps enabled a detailed evaluation of the landscape metrics. The following tables show the number of polygons, total area of individual land-use categories in hectares, average area of plots in the respective land-use categories in hectares and the share of the respective land-use categories in percent in four temporal layers.

5.1.1 Landscape structure in 1836

Table 3 shows the largest extent of permanent grasslands and the largest plots of permanent grasslands (24.9 ha) in the studied period 1836–2006.

5.1.2 Landscape structure in 1875

Tab. 4 documents the growing size of arable land as a result of the industrial revolution and the growing number of inhabitants resulting in the growing demand for food.

5.1.3 Landscape structure in 1955

Tab. 5 contains some surprising data. The first is a smaller number of the polygons of arable land despite the fact that the area of arable land was still growing and reached its maximum in the studied period (total area 54.7%) and despite the fact that the topographic maps depict the landscape before the socialist collectivization of agriculture. Also, the number of the polygons of permanent grassland is smaller. These differences could have resulted from the changed topographic map key. The growing number of water bodies is the result of the reconstruction of former drained fishponds and construction of new water reservoirs.

5.1.4 Landscape structure in 1990

The area of arable land is slightly decreasing to 45.1% and the number of polygons is increasing again despite the processes of collectivization of agriculture and formation of large parcels of arable land. The extent of permanent grasslands is slightly increasing.

5.1.5 Landscape structure in 2006

The area of arable land is further decreasing to 41.3% as well as the number of polygons. The area of permanent grassland is again slightly increasing. The area of forested land and built-up areas reached their maximum in the studied period.

5.2 Number of landscape changes in 1836–2006

The computer-aided analysis of the number of landscape changes in the period 1836–2006 showed that land use did not change for 56% of the studied territory (Tab. 8). The analysis showed that some landscapes are more vulnerable to change than the others. Stable areas are forested mountain landscapes around the state border in the White Carpathians and in the Javorníky Mts. (Fig. 13 – see cover p. 4). Some changes of land use were registered in the areas of specific Walachian colonization around the village of Starý Hrozenkov in mountain landscapes with alternating meadows and forests. Land use changes are also apparent in landscapes with alternating meadows and forests occurring in piedmont highlands of the White Carpathians (e.g. in the Suchovská vrchovina Highland and Komeňská vrchovina Highland). The forested ridges of the Komonecká hornatina Mts. in the Vizovická vrchovina Highland (Fig. 11), beech stands in the highlands of Ždánický les Forest and in Chřiby are also stable

In the agricultural landscapes of the Vyškovská brána Gate, Hornomoravský úval Graben, Litenčická pahorkatina Hilly land, Hlucká pahorkatina Hilly land and lowlands of the Hornomoravský úval Graben, there are stable plots of arable land sloping up to 5 degrees. Large flats of arable land with agrocoenoses of monocultures dominate on these plots. On the other side, frequent changes of land-use occurred on steeper inclined slopes over time. Indigenous, ecologically stable formations (e.g. fragments of forests, permanent grassland, bush, possibly orchards and vineyards) have been replaced by arable land. More frequent are changes in the landscape of the Mutěnická pahorkatina Hilly land with fields and forests at the foot of the Chřiby Highland. Changes of land-use in the more vulnerable Middle Morava River Floodplain (Fig. 14 – see cover p. 4) and Lower Morava River Floodplain landscapes were very common (up to 4 changes during the above mentioned period – Fig. 10).

5.3 Stable areas in the period 1836–2006

The authors classified the plots that retained the same land-use during the period of 170 years as stable plots. On these plots, the natural conditions were in balance with demands of the human society in the last 170 years.

Categories of land use	Number of polygons	Area (ha)	Average area (ha)	Share on total area (%)
arable land	2,665	190,745.6	71.6	45.6
permanent grassland	4,054	101,016.0	24.9	24.1
garden and orchard	499	1,972.6	4.0	0.5
vineyard and hop field	331	5,374.0	16.2	1.3
forest	1,126	108,954.6	96.8	26.0
water area	59	527.5	8.9	0.1
built-up area	828	10,120.3	12.0	2.4
recreational area	–	–	–	–
other area	13	21.0	1.6	0.0

Tab. 3: Landscape structure of the studied area in 1836

Categories of land use	Number of polygons	Area (ha)	Average area (ha)	Share on total area (%)
arable land	1,736	221,593.7	127.6	52.9
permanent grassland	4,055	64,030.1	15.8	15.3
garden and orchard	575	2,453.1	4.3	0.6
vineyard and hop field	356	4,127.7	11.6	1.0
forest	1,289	115,318.3	89.5	27.5
water area	17	60.0	3.5	0.0
built-up area	901	11,110.3	12.3	2.7
recreational area	–	–	–	–
other area	18	38.4	2.1	0.0

Tab. 4 : Landscape structure of the studied area in 1875

Categories of land use	Number of polygons	Area (ha)	Average area (ha)	Share on total area (%)
arable land	813	229,186.9	281.9	54.7
permanent grassland	2,512	29,196.1	11.6	7.0
garden and orchard	613	3,734.2	6.1	0.9
vineyard and hop field	226	2,772.0	12.3	0.7
forest	1,481	131,769.6	89.0	31.5
water area	76	664.4	8.7	0.2
built-up area	1,137	20,982.0	18.5	5.0
recreational area	68	212.2	3.1	0.0
other area	46	214.2	4.7	0.0

Tab. 5: Landscape structure in 1955

Categories of land use	Number of polygons	Area (ha)	Average area (ha)	Share on total area (%)
arable land	1,364	188,979.0	138.5	45.1
permanent grassland	3,639	37,337.8	10.3	8.9
garden and orchard	1,184	6,799.9	5.7	1.6
vineyard and hop field	191	5,449.2	28.5	1.3
forest	1,966	143,006.9	72.7	34.2
water area	177	1,933.1	10.9	0.5
built-up area	1,076	33,115.6	30.8	7.9
recreational area	466	1,748.4	3.8	0.4
other area	72	361.7	5.0	0.1

Tab. 6: Landscape structure in 1990

Categories of land use	Number of polygons	Area (ha)	Average area (ha)	Share on total area (%)
arable land	1,275	172,712.7	135.5	41.3
permanent grassland	3,704	47,694.4	12.9	11.4
garden and orchard	1,513	6,797.7	4.5	1.6
vineyard and hop field	249	3,811.0	15.3	0.9
forest	2,277	147,511.0	64.8	35.2
water area	191	2,087.7	10.9	0.5
built-up area	1,074	35,492.6	33.0	8.5
recreational area	568	2,244.0	4.0	0.5
other area	73	380.5	5.2	0.1

Tab: 7: Landscape structure in 2006

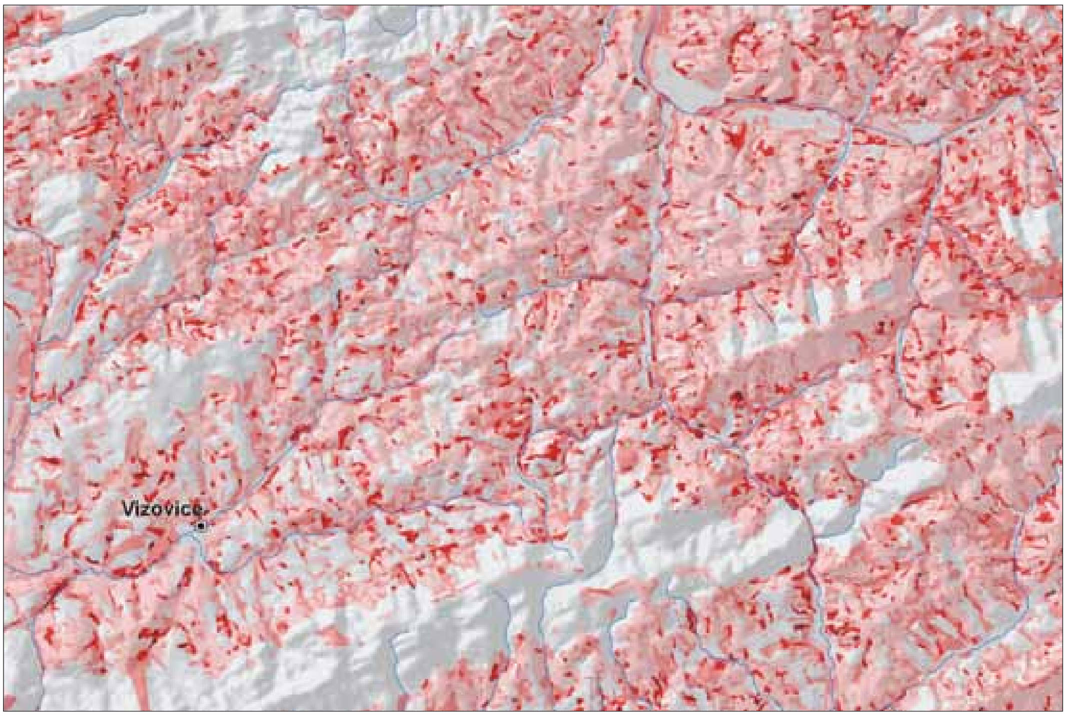
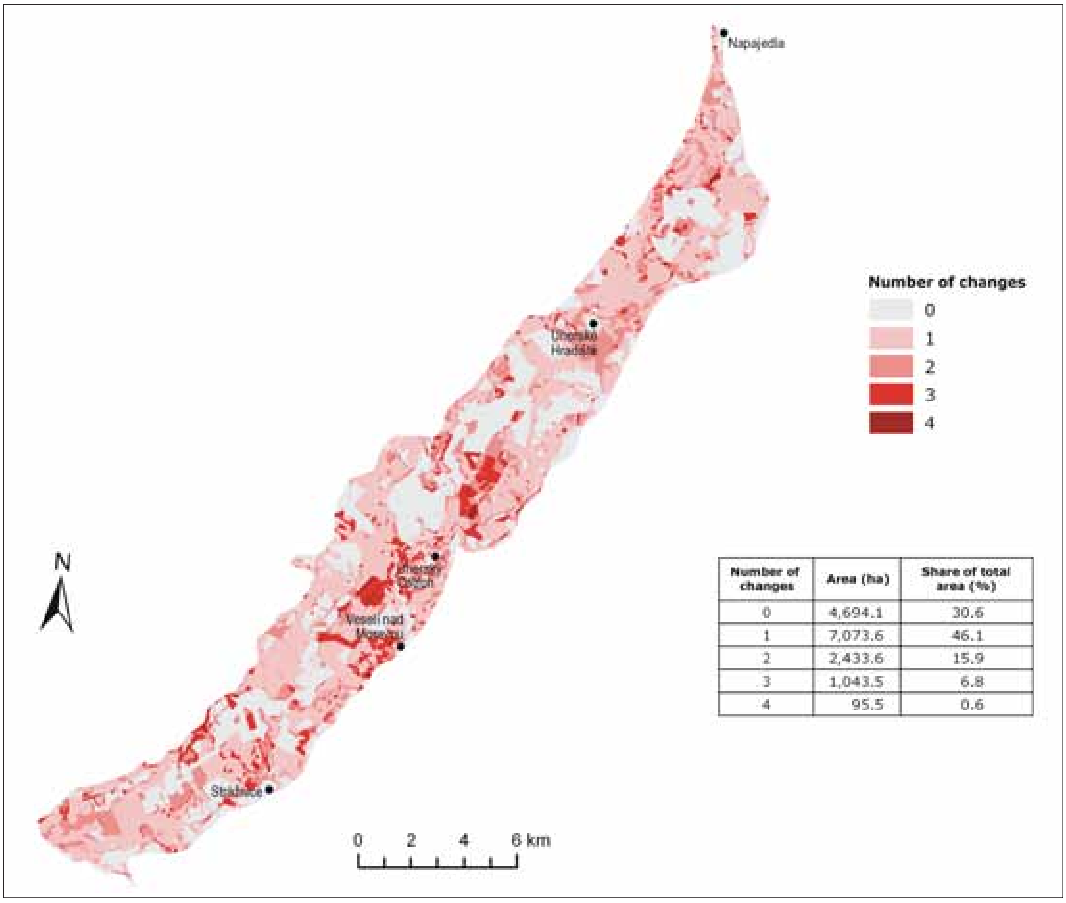


Fig. 9: An example of the number of land-use changes in the Moravian-Silesian Carpathians nearby the town of Vizovice in the period 1836–2006. The map shows the stability of the flysch ridge of Komonecká hornatina Mts. in the Vizovická vrchovina Highland. For the legend see Fig. 10
Source: Mackovčin et al., 2011.



Number of changes	Area (ha)	Share of total area (%)
0	4,694.1	30.6
1	7,073.6	46.1
2	2,433.6	15.9
3	1,043.5	6.8
4	95.5	0.6

Fig. 10: The number of land-use changes in the Lower Morava River Floodplain (Dolnomoravská niva) in the period 1836–2006. Floodplains were highly dynamic geosystems in this period
Source: Mackovčin et al, 2011

Number of changes	Number of polygons	Area (ha)	Share of total area (%)
0	2,650	234,585.2	56.0
1	6,977	116,417.8	27.8
2	10,499	52,409.2	12.5
3	5,849	13,805.8	3.3
4	1,044	1,513.6	0.4

Tab. 8: The number of landscape changes 1836–2006

Area in stable usage	Number of polygons	Area (ha)	Average area (ha)	Share on total area (%)
arable land	1,595	123,884.6	77.7	29.6
permanent grassland	867	5,990.1	6.9	1.4
garden and orchard	23	72.7	3.2	0.0
vineyard and hop field	81	718.5	8.9	0.2
forest	851	94,498.0	111.0	22.6
water area	2	7.1	3.5	0.0
built-up area	692	9,414.2	13.6	2.2
recreational area	–	–	–	–
other area	–	–	–	–
In total	**4,111**	**234,585.2**	**–**	**56.0**
Area in unstable usage	**2,284**	**184,146.4**	**80.6**	**44.0**

Tab. 9: Stable and unstable plots in the study area according to land-use type in the period 1836–2006

Fig. 11: Stable plots. The forested Klášťovský hřbet Ridge and the rock pediment in the depression of the Pozlovická brázda Furrow. Photo J. Demek

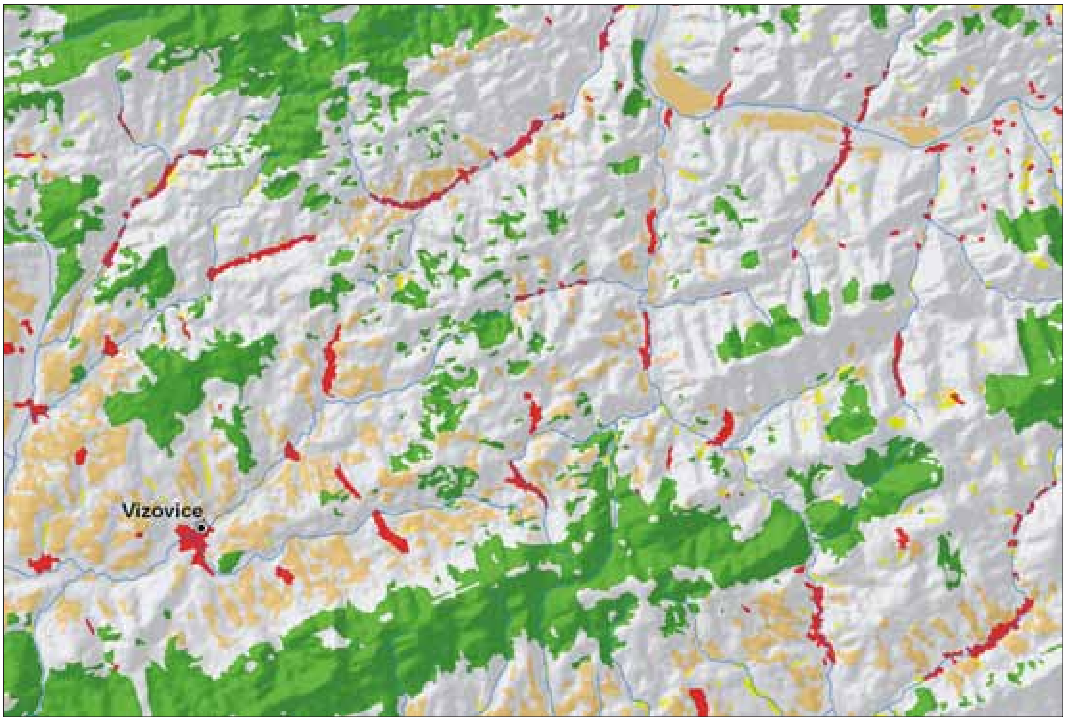


Fig. 12: An example of the map of stable and unstable plots in the Moravian-Silesian Carpathians nearby the town of Vizovice in the period 1836–2006. Legend see Fig. 2. Grey flats are unstable plots
Source: Mackovčin et al., 2011

These stable plots occupy 56% of the studied area (Tab. 9). Plots of arable land in lowlands and flat hilly lands (29.6% of the studied area) showed the stable land use. Stable large blocks of arable land occurred namely in the Vyškovská brána Gate, in the Hornomoravský úval Graben (with the exception of the Middle Morava River Floodplain), in lower parts of the Litenčická pahorkatina Hilly land, in the Mutěnická pahorkatina Hilly land (with the exception of floodplains) and in lower parts of the Vizovická vrchovina Highland (especially in the Hlucká pahorkatina Hilly land). Stable were also forest stands on the ridges of Ždánický les Forest, Chřiby, Hostýnské vrchy Hills and Klášťovský hřbet (Fig. 11). It is interesting that for the whole period forests also covered the highest parts of the flysch Litenčická pahorkatina Hilly land and Mladcovská pahorkatina Hilly land as well as some lower ridges of the Vizovická vrchovina Highland.

6. Conclusions

The development of new analytic and computing technologies and the higher demand for scientific guidance in decision making concerning future landscape transformation and restoration have propelled research on landscape changes in the Czech Republic over the past decade. The manual and computer-aided evaluation of historical and contemporary large-scale topographic maps allowed the authors to define some trends in land-use changes and transformation of Moravian landscapes in the last 240 years.

The first trend in the studied period was the drainage of a large number of fishponds shown on maps from the 1st Austrian Military Mapping connected with the agrarian revolution in 1764–1836. Fish farming was no more profitable in the 19th century and the growing population required a higher production of food. The beds of former fishponds changed into pastures, meadows, arable land or even in some places foundations for Feudal estates.

The second trend was increase in the area of water bodies, especially the restoration of fishponds drained in the past, mainly in the first half of the 19th century. This trend is especially apparent on the Czechoslovak Military maps S-52 produced in 1952–1955.

A third trend was an increasing share of arable land especially in the lowlands and hilly lands of the study area due to the agrarian revolution in the second half of the 19th century, progress in land cultivation and demand for food for the increasing number of inhabitants. The extension of arable land mostly proceeded at the expense of permanent grassland (compare Tab. 2a and 2b). Unfortunately, the data are deformed due to the change of the map key during the fourth consolidation of military maps of the Czechoslovak People's Army produced in the years 1988–1995 that underestimated the category of permanent grassland. The third trend is obvious until the year 1990. With the re-introduction of the capitalist economy after 1990, the area of arable land started to decrease.

The fourth trend is the gradually increasing area of forests. This trend results from the industrialization of agriculture. The agricultural use of steep slopes became uneconomical. Besides, the fields on these steep slopes were endangered by accelerated soil erosion. Industrialized agriculture guaranteed enough food for inhabitants and this is why the plots less favourable for mechanized agriculture or devastated were reforested. Balks (often constructed of stone blocks) between the former abandoned fields are still common in the contemporary cultural forests.

The fifth trend is the increasing area of urbanized plots, especially in the 20th century, and the decreasing differences between various environments in towns (urbanized landscapes) as well as in villages. Unfortunately, urbanized landscapes sprawl also into endangered areas, e.g. into regularly inundated floodplains or into landslide areas.

Finally, a sixth trend is the increasing area of recreation plots in the second half of the 20th century.

In order to predict the future of landscapes, an historical perspective is particularly important. Quantitative studies of historical and contemporary large-scale topographic maps in a GIS environment make it possible to elucidate the driving forces (natural and socioeconomic) in the landscape development in the last 170 years, the years of principal changes in the cultural landscapes of Central Europe. The exact knowledge of historical landscape conditions and landscape change over time and the related databases in GIS milieu facilitate and improve predictions about the future state of Czech landscapes.

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Authors´ addresses:

Prof. RNDr. Jaromír DEMEK, DrSc., e-mail: *demekj@seznam.cz*
Peter MACKOVČIN, e-mail: *peter.mackovcin@vukoz.cz*
Petr SLAVÍK, e-mail: *petr.slavik@vukoz.cz*
The Silva Tarouca Research Institute for Landscape and Ornamental Gardening, v. v. i.
Department of Landscape Ecology and Department of GIS Applications
Lidická 25/27, 602 00 Brno, Czech Republic

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THE CZECH-POLISH AND AUSTRIAN-SLOVENIAN BORDERLANDS – SIMILARITIES AND DIFFERENCES IN THE DEVELOPMENT AND TYPOLOGY OF REGIONS

Petr KLADIVO, Pavel PTÁČEK, Pavel ROUBÍNEK, Karen ZIENER

Abstract

Cross-border relations and borderland issues are presented in this paper using two borderlands in Central Europe: Austrian-Slovenian and Czech-Polish. In the theoretical part, various types of cross-border links are described, mostly depending on previous political circumstances. Subsequently, the most important historical milestones in the development of the two borderlands are identified. This comparison of borderlands dwells on the statistical analysis of demographic and other socioeconomic characteristics, including the accessibility and types of settlement systems in the four countries. Finally, a cluster analysis and the development of five relatively homogeneous groups of territorial units presents a new viewpoint in the study of border areas, and enables a typology of both borderlands based on socioeconomic characteristics.

Shrnutí

Česko-polské a rakousko-slovenské pohraničí – podobnosti a rozdíly ve vývoji a typologie regionů

Článek se zabývá otázkami vývoje rakousko-slovinského a česko-polského pohraniční. První část je zaměřena na teoretické přístupy k vývoji přeshraničních vazeb a popisuje také historické mezníky ve vývoji obou zkoumaných pohraničí. Dále byla popsána metodologie výzkumu, který byl založen na porovnání a statistické analýze dynamických i okamžikových charakteristik územních jednotek v obou pohraničích (demografické, socioekonomické charakteristiky, dostupnost). Shluková analýza byla potom použita pro komplexní typologii územních jednotek v obou pohraničích. Bylo vytvořeno pět typů územních jednotek a byly diskutovány otázky jejich výskytu ve zkoumaných územích.

Keywords: *cross-border collaboration, regional disparities, Austria, Czech Republic, Poland, Slovenia*

1. Introduction

In this paper we focus on some aspects of the geography of border areas. The paper tries to introduce a more comprehensive and synthetic view on the processes and determinants of the current stages of development on the example of Czech-Polish and Austrian-Slovenian borderlands. The main aim is to bring a new viewpoint to the discussion about the border areas. As mentioned by Bufon (2007), "the literature written up till now on geography of border landscapes mainly comprises of works dealing with border areas as part of individual countries only, while rarely extending over the political borders to define and discover a so-called cross-border region". In this article, we would like to break this rule and analyze border areas (borderlands) as non-divided spaces. The aim of the common project between the Geographical Institutes of the Palacký University in Olomouc and University of Klagenfurt (founded by the Programme "Aktion Österreich-Tschechische Republik") was to compare the two borderlands with a different history and development of the border situation and different conditions for cross-border interaction and collaboration. In this process, perceptions and valuations of local and regional stakeholder groups were gathered and analyzed. The paper presents a basic regional analysis of the borderlands including the development of the borders and border regimes as well as conclusions for cross-border collaboration and integration. The analysis of selected characteristics should describe the current stage of the development in both border areas where similar cross-border links are expected. In particular, we would like to answer the question whether there are more similarities between adjoining areas on both sides of the border or between areas along the border. In other words, is the political border the main dividing factor of the spatial structure or not? What does it mean for functional relations and for the development of an integrated border region?

2. Theoretical basics

Related to the European integration and enlargement in politics, society and science, the perspective has changed from border regions and their problems to cross-border interaction and development, from a national state point of view to an interregional or European point of view. National borders have lost a larger part of their function as a barrier meaning that cross-border interaction and collaboration have become increasingly important (Jeřábek, 2002). In the border research of the last decades, different approaches and fields such as Border area view (Ratti, 1993) and Transnational Regionalism View (Schmidt-Egner, 2005) have been developed.

The different types of borderlands interaction by Martinez provide a basis for the borderland analysis in our study. Using the example of the border between the USA and Mexico, he distinguishes four stages of borderland interaction: (1) Alienated borderlands, (2) Coexistent borderlands, (3) Interdependent borderlands and (4) Integrated borderlands (Fig. 1). In the "alienated borderlands", the routine cross-border interactions are practically non-existent. The permeability of the border is very low. The border is functionally closed and the residents of the neighbouring countries act as strangers to each other. In the case of the "coexistent borderlands", the border is slightly open, so that international relations are possible but only a limited cross-border interaction develops. The borderland interdependence exists if regions on both sides of the border are symbiotically linked with each other. Economic complementarities generate cross-border interaction and collaboration, which stimulate the development of markets, capital and labour. Moreover, the "interdependent borderlands" are characterized by social relationships across the border. On the other hand, some factors such as over immigration, trade competition and ethnic nationalism influence the cross-border relations and the border regime negatively. In the "integrated borderlands", no barriers exist to trade and human movement across the common border. The neighbouring regions merge economically, with capital, product, and labour flowing. The major political differences between the neighbouring countries are eliminated and the locals perceive themselves as members of one social system (Martinez, 1994, p. 1–5). In the sense of Martinez, the widely-used term "trans-border region" (or "cross-border region") is equal to the "integrated borderlands". That means that functional relations

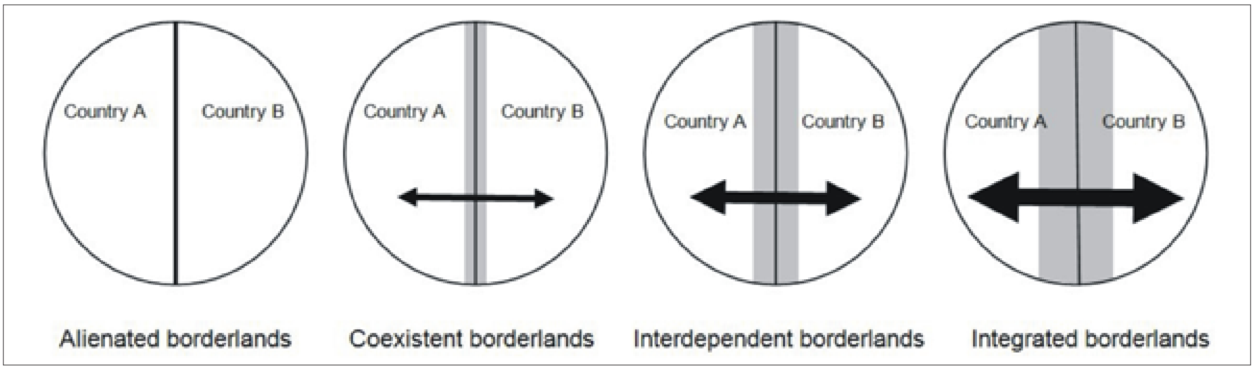

Fig. 1: Types of borderland interaction (by Martinez). Source: Martinez, 1994, p. 3

and interactions across the border exist and common cross-border regional identity has developed. Whereas the Austrian-Slovenian border was part of the Iron Curtain, there is a long tradition of cross-border interacting and cooperation. In the Czech-Polish borderland, the traditional cross-border cooperations were discontinued in the context of the two world wars. Interactions started developing again in the 1990s after the accession of the two countries in the EU. However, the development of integrated borderlands is not only based on the regional structures, it requires durable functional relations in particular.

When we look at the differences between border regions and cross-border regions in Europe, Bufon distinguishes three basic groups: West European, Central European and East European (Bufon, 1998, cit. in Bufon, 2007). The Central and East European ones are typical for our case study region. In the Central European type, historical regions often do not match the actual spatial regionalization. Numerous delimitation processes have occurred there namely following the two world wars in the last century and divided the originally homogeneous historic regions into several units. Cross-border regions do not fit the administrative spaces and rather match the existing cultural or historic regions. Aside from the interstate cooperation and openness, they also display "a remarkably high level of social integration, which usually leads to the formation of special cross-border spatial systems that could be defined as "regions within regions" (Bufon, 2007, p. 6).

On the other hand, the East European regions are characterized, according to Bufon, by a combination of old and new borders in the traditionally less developed and sparsely populated space. During the communist regime, this unfavourable situation was magnified by causing or encouraging the emigration of autochthonous population and hindering the social and economic development in the border areas. Because of their low potential, such borderlands have even in the new circumstances only very limited possibilities for advanced forms of cross-border cooperation. This is why Bufon (2007) calls them "regions under reconstruction". It is obvious that institutional and political aspects, such as the border-crossing regime or institutionalization of cooperation on different levels, play still a very important role today and even for our studied border areas, which lag behind the West European type.

Until 1990, interaction and economic cooperation across the border between Austria and the former Yugoslavia were easier than in other parts of the Iron Curtain and were already institutionalized in the late 1970s in the form of the Alps-Adria working community, which was based on the former cooperation between Carinthia, Slovenia and the Friuli-Venzia Giulia region in Italy (Wastl-Walter and Kofler, 1999). Nevertheless, inequalities between Carinthia and Slovenia, resulting from conflicts at the end of the First World War (Carinthian struggle of resistance, Carinthian Plebiscite), were still strong (Valentin, 2005; Moritsch, 2001). In this sense, the border between Austria and Slovenia can be rather classified as that of the Central European type although it does not meet all criteria. The Czech-Polish relations regarding the border regime development are even more complicated. In spite of the fact that the two countries were members of the so-called "socialist camp" and faced similar problems of transition after 1990, the base to start collaboration was much lower and we can clearly name them as East European border regions although the potentials are higher than in other border areas of this type. To understand the current stage of cross-border relations and their development, it is necessary to look at the fundamental historical evolution of the study areas.

3. Historic milestones in the development of borderlands

The development of the state border between the Czech Republic and Poland is a result of a complicated long-term historic trajectory. Important political events especially in the 18th and 20th centuries determined the development of the current Czech-Polish border. One of the crucial milestones was in 1742 when a substantial part of Silesia and the Kłodzko region (almost 37,000 km^2) were lost by the Habsburg monarchy and became part of Prussia. The new border between Prussia and Austria often did not respect natural phenomena such as rivers or mountain chains and divided many settlements (e.g. in the Javorník region). These territorial changes (the loss of Silesia) lasted until World War I. Between the two wars, Czechoslovakia had its new borders for the first time also with the newly established Poland. The three border point between these countries and Germany was located on the Odra (Oder) River near Gliwice and Bohumín. As a result of World War II, the shift of this three border point to the west, to Lusatian Neisse, led to an enormous enlargement of the Czech-Polish border.

As mentioned above, the Czech-Polish borderland is composed of two specific and different parts. The original Sudetenland part is characterized by almost complete population exchange. On both sides of the border, the German population was transfered and the new Czech and Polish population was resettled. Consequently, the centuries-long continuity was interrupted in all aspects. Only the current 3rd generation of the new population established roots here more deeply. On the other hand, the shorter eastern part of the Czech-Polish borderland did not experience so many changes in terms of population exchange and the Polish population is here present on both sides of the border (Hannan, 1996). But if an observer were to assume that there are substantial differences in cross-border relations, their quality and intensity, it is not the case (Siwek, 2011). The originally very sharp divide between these two parts of the Czech-Polish borderland has been smoothed. One of reasons is that normal cross-border contacts along the whole border have developed only in the last twenty years. An illustrative example is a so-called Těšín/Czieszyn problem which has been solved at an international level. As late as 1958 the agreement between Czechoslovakia and Poland about the final delimitation of the state border was signed. But even today we can observe some tensions and examples of national intolerance on both sides (Blažek et al., 2006). Larger numbers of the Czech citizens of Polish nationality (in the sense of ethnicity) live only in the Czech part of the Těšín/Cieszyn Silesia. On the Polish side of the border, the Czech minority practically does not exist. This imbalance to a certain extent determines relations in this part of the Czech-Polish border.

Following the political changes in Czechoslovakia and Poland at the end of the 1980s, cross-border collaboration has changed. Until the end of the 1980s, boundaries in this region and generally in the whole of Eastern Europe had the function of spatial barriers and their permeability was low. Border zones were peripheries of particular national, highly autarkic, economic systems (Stryjakiewicz, 1998; Turnock, 2002). Since the middle of the 1990s, cross-border projects between Czech and Polish partners have been supported by the EU, at first by Phare CBC Programmes and since the accession of the Czech Republic and Poland (2004) to the EU within the scope of INTERREG Programmes. As an institutional framework for the integration process of border areas and organisation of cross-border collaboration, six Euroregions were established along the whole Czech-Polish border: Neisse-Nisa-Nysa (1991, trilateral with Germany), Glacensis (1996), Praděd-Pradziad (1997), Silesia (1998), Těšínské Slezsko-Śląsk Cieszyński (1998) and Beskydy-Beskidy (2000, trilateral with Slovakia) (see INTERREG III A Programme Czech Republic–Poland, 2004). However, the integration beyond borders means not only the establishment of physical and institutional preconditions but also a dense network of contacts and interactions (Ladysz, 2006).

A crucial milestone for the present border between Austria and Slovenia was the end of World War I. Previously, Carinthia, Styria and Krain were provinces of the Habsburg Monarchy which were settled by the German- and Slovenian-speaking populations in different proportions. Due to the disintegration of the Habsburg monarchy and the emergence of new national states, the Republic of German Austria (as it called itself) and the Kingdom of Serbs, Croats, and Slovenes (later Yugoslavia), a national state border was established. This process was connected with different territorial demands, border conflicts and armed clashes (Carinthian struggle of resistance). The final delimitation of the border was determined on an international level by the Treaty of St. Germain (1919) and the Carinthian Plebiscite (1920). The most eastern area of the current Austrian-Slovenian borderland was transferred from Hungary (Treaty of Trianon, 1920) to Austria (Burgenland) and Slovenia (Prekmurje). Following these completely new boundaries, different ethnic minorities, e.g. Carinthian Slovenes and the German-speaking minority in Štajerska (former Lower Styria), lived in new national states (see Bufon, 1993; Klemencic, Bufon, 1994; Bufon and Minghi, 2000; Moritsch, 2001; Moll, 2007).

In Carinthia, the conflicts with Carinthian Slovenes and their organisations, and tensions between Carinthia and Slovenia exist up to the present day, although activities focused on solving the conflicts have been enhanced recently. On the other hand, the cooperation between Carinthia, Slovenia and Friuli Venezia Giulia in areas such as spatial development, culture, tourism, transport and water management, already operating in the 1960s, is an early example of transnational cooperation. In general, contacts and co-operation between Austria and the former Yugoslavia were easier than in other parts of the Iron Curtain. Nevertheless, some of the reservations against Slovenes or Slovenia result from this period (Valentin, 2005).

Since the mid-1990s, cross-border projects between Slovenia and Austria are supported by the EU Regional Policy, 1995–2003 by INTERREG and PHARE CBC Programmes, and by the INTERREG Programme since the accession of Slovenia to the European Union. Between Styria and Slovenia, the Euroregion Styria-North East Slovenia was established (2001). In the Carinthian-Slovenian borderland, the Work Group – Cross-border Regional Partnership Karavanke (2002), founded from the initiative of regional development agencies in Carinthia and the northwest part of Slovenia, is responsible for cross-border projects (OP SI-AT 2007–2003, 2007).

4. Methodology of regional analysis

In recent times, geographical research on border regions has been focused mostly on cross-border collaboration, related to the stronger role of the institutional regional policy of the EU. The geographical structure of borderlands (natural environment, population, settlements, economy, transportation, etc.) and the day-to-day contacts of people across the border remain a rather marginal topic of research. In this paper, we would like to compare the regional structure of the Austrian-Slovenian and Czech-Polish borderlands using socio-demographic and socio-economic indicators in a more complex way, to understand better similarities and differences in the two types of European border areas. However, this kind of analysis is usually faced with many methodological problems, especially the comparability of statistical data and borderland delimitation. The selection of characteristics to be investigated was limited due to their availability, comparability and consistency from four different resources. Of course, for the analysis we tried to find more relevant characteristics such as the level of entrepreneurship, unemployment level or similar indicators, but our effort failed due to their inaccessibility and/or incomparability.

The delimitation of both borderlands is based on the pragmatic need of using administrative units for statistical and other analyses in the area. We wanted to select those kinds of units that would enable a detailed enough insight into the territorial structures and that would be of a relatively similar size in terms of their population and area. The number of these units should be in every country large enough to be representative. Therefore, we used the district level: Bezirke in Austria, malé okresy (or správní obvody obcí s rozšířenou působností) in Czechia, powiaty in Poland and upravne enote in Slovenia. We selected for the analysis districts bordering with the neighbouring country.

Data covering the population are available and they indicate regional structures and development. Comparable data of other sectors like economy or transport are rare on the level of small-scale units. Moreover, at least a medium-term development should be considered. Therefore, the following regional analysis dwells primarily on four indicators: (1) population density; (2) medium-term population development; (3) age structure; and, (4) employment structure. This includes typologies and references to different types of area as well as basic functional relations and processes which could not be measured by quantitative data within this study but could be qualitatively described instead (e.g. main traffic routes, agglomeration and suburbanisation process). Data were visualised through cartographic methods using ArcGIS.

In Austria, Czech Republic and Poland, statistical data at the district level are available; in Slovenia, data about the upravne enote had to be aggregated from the communities. Further problems of data harmonization concerned different years for the population census in the national states (Austria and Czech Republic 2001, Poland and Slovenia 2002), availability of indicators in all four countries, different modes of statistical elicitation (beginning of the year, end of the year, different classifications). Therefore, for example, data about the population of Czech and Polish districts originate from 31 December 2010 and about the population of Austrian and Slovenian districts from 1 January 2011. In this context, the medium-term population development can be only calculated as a difference between the population of one year and the second year (only quantitative). The basic processes of natural population dynamics and migration could not be analyzed within this study. The basic year for population development also differs because of the administrative reform in Poland in 1995. Therefore, population development is calculated as an index 1991/2011 in the Austrian-Slovenian borderland and as an index 1995/2010 in the Czech-Polish case. The age structure is analyzed simply according to the share of inhabitants in the main age groups (0–14, 15–64, 65+). The employment structure is shown as a share of employed people in the main sectors of economy: primary sector, secondary sector and tertiary sector based on the census data 2001 or 2002. In Austria, the data for the three sectors are calculated from 17 sections of the Austrian statistical classification of economic activities (ÖNACE).

The employment structure will be analyzed by means of the Ossan triangle which combines the shares of the three sectors (each sector has a share from 0% to 100% while the sum of all sectors is 100%). In this triangle graph, each district is represented by one point. Based on this triangle graph, a typology of districts showing the different relations between the sectors will be created. Additionally, as an indicator of urbanisation, the percentage of people living in municipalities with more than 5,000 inhabitants is used. The problem of this indicator relates to the strong dependence on administrative structures in the respective countries.

To get a more complex view of the socio-demographic and socio-economic situation in the two borderlands, a typology of all districts was created using the cluster analysis (k-average method). Fundamental rules of cluster analysis were respected. This method is to some extent subjective, concretely in delimitating the optimal number of clusters. The delimitation of five types was selected as the most relevant. The cluster analysis was calculated using the Statistica software programme and a matrix was constructed having 84 rows (districts) and 8 columns (statistical variables):

1. population development 1991–2011/1995–2010,
2. percentage of young population (0–14) 2010/2011,
3. percentage of working age population (15–64) 2010/2011,
4. percentage of older population (65+) 2010/2011,
5. percentage of primary sector 2001/2002,
6. percentage of secondary sector 2001/2002,
7. percentage of tertiary sector 2001/2002 and
8. percentage of people living in municipalities with more than 5,000 inhabitants 2010/2011.

5. Characteristics of the Austrian-Slovenian and Czech-Polish border areas

The two study areas along the Czech-Polish and Austrian-Slovenian borders vary significantly as to their size and total population (see Tab. 1). The border between the Czech Republic and Poland is more than twice as long as the border between Austria and Slovenia. Accordingly the Czech-Polish borderland is nearly twice as big as the Austrian-Slovenian borderland. On the Austrian side, the borderland consists of parts of the Federal States of Carinthia, Styria and Burgenland. In Slovenia, regions in the sense of planning or development units do not exist until recently and this is why the defined statistical regions are normally used

	Czech-Polish Borderland	Austrian-Slovenian Borderland
Defined borderland (project)	790 km border 22,468 km^2 , 4.1 Mio people 33 Malé okresy (CZ), 23 Powiaty (PL)	330 km border 12,283 km^2, 1.2 Mio people 11 Bezirke (A), 17 Upravne Enote (SI)
Administrative units on the regional level (NUTS 2 or 3)	CZ (Kraj): Liberec, Hradec Králové, Pardubice, Olomouc, Moravian-Silesian PL (woivodeship): Lower Silesian, Opole, Silesian	A (Bundesland): Carinthia, Styria, Burgenland SI (statistical regions): Gorenjska, Koroška, Savinjska, Podravska, Pomurska
Landscape	Mountain regions of the Sudeten Mts. and Western Beskids Mts. (above 1200 m, Sněžka/ Śnieżka about 1600 m) Upper Silesian basin with coal deposits, hilly areas and lowlands of Silesia	Mountain regions of the Karavanke Alps and the Kamnik-Savinja Alps (above 2000 m/2500 m), Lavanttal Alps (above 2000 m), Klagenfurt Basin (on average 450 m), hilly areas and lowlands of Southern Styria, Podravje and Pomurje regions
Spatial structure	rural areas, urban or/and traditional industrial areas Agglomerations of Upper Silesia and Ostrava Biggest towns (population as at 31 Dec.2010): Ostrava (303,609), Bielsko-Biała (174,729), Rybnik (141,757), Wałbrzych (120,197), Liberec (101,865), Jelenia Góra (83,963), Havířov (82,022), Karviná (60,679), Opava (58,274), Frýdek-Místek (58,200)	rural areas, in Slovenia partly older industrial areas, urban area of Klagenfurt and Villach (Carinthian central region) Biggest towns (population as at 1 Jan. 2011): Maribor (111,730), Klagenfurt (94,303), Villach (59,285), Kranj (55,029)
Main traffic routes	Brno–Olomouc–Ostrava–Katowice–Kraków (rail, road), Ostrava–Český Těšín/Cieszyn–Bielsko-Biała (road) Hradec Králové – Wrocław (rail, road), (Prague)–Liberec–Zittau, Turnov–Harrachov–Jelenia Góra (road)	Wien–Graz–Maribor–Ljubljana (road,rail), Wien–Graz–Klagenfurt–Villach–Italy (road, rail not via Graz), Salzburg–Villach–Kranj–Ljubljana (road, rail)

Tab. 1: Basic characteristics of the Czech-Polish and Austrian-Slovenian borderlands (CZ – Czech Republic, PL – Poland, A – Austria, SI – Slovenia / road – motorway, rail – main railway route)
Source: authors' compilation based on INTERREG III A Programmes Austria–Slovenia (2005) and Czech Republic–Poland (2004), Statistical Offices of Austria, Slovenia, Poland, Czech Republic

for regional analysis. The Czech-Polish borderland is situated in three Polish and five Czech administrative units on the regional level (Tab. 1). The mean size of the districts in Austria and Poland is larger than in the Czech and Slovenian border regions.

The western part of the Austrian-Slovenian border is formed by an alpine mountain range which complicates the economic development as well as the cross-border road and railway traffic. Besides the motorway and railway, Karavanke tunnels and some mountain passes provide for the cross-border road traffic. In the hilly areas and lowlands, natural conditions for border crossing are better but the infrastructure is less developed. The railway connection from Carinthia to Maribor along the Drau/Drava River is only a branch line. In the Czech-Polish borderland, mountain ranges are not as high as the Alps but their impact on the cross-border transport are similar.

5.1 Population density and different area types

According to Seger (2007), peripheries in border areas (twin) often adjoin each other. However, the number and intensity of cross-border functional relations and interactions is higher between the agglomeration and the central regions. By contrast, only little cross-border collaboration exists between the peripheral rural areas close to the border. The indicator of population density gives a first impression of the spatial structure and area types in the two analyzed borderlands (Fig. 2). In the Czech-Polish borderland, the population density is much higher than in the Austrian-Slovenian borderland (185 compared to 100 persons per km^2). The highest population density in the Polish border region is more than twice as high as the lowest population density in the Austrian border region.

The Austrian part of the borderland is mainly a rural area of low or very low population density (Lower

Carinthia 52 persons/km^2). In the Styrian and Southern Burgenland, borderland towns over 10,000 inhabitants are absent. Only the Carinthian Central Region with two larger towns of Klagenfurt and Villach can be characterized as an urban area because of suburbanisation processes in the surroundings of the towns (six other municipalities with more than 5,000 inhabitants). This suburbanisation area reaches near the Slovenian border. The same is true for Maribor. Even though the larger cities of Graz and Ljubljana are situated outside of the borderland, their urban agglomerations affect the borderland. In the Slovenian part of the borderland, moreover, rural areas alternate with early industrialized urban areas (e.g. in Koroška and in the Upper Sava R. valley) with a higher population density and a partly higher percentage of population in towns. The Austrian-Slovenian borderland is peripheral only partially. Klagenfurt, the capital of Carinthia, Villach, Kranj and Maribor function as high-order centres with different functions. Ljubljana, the capital of Slovenia, and Graz, the capital of Styria, are not very far apart. The main railway routes and motorways cross the borderland between Graz and Maribor, within Carinthia and Gorenjska. Following this, peripheral areas can be found especially in the high mountain regions closer to state the border or between Carinthia and Styria, as well as in the north-eastern Slovenian region of Pomurska.

In the Czech-Polish borderland the population density differs to a much greater extent (Fig. 2). There are areas of low population density such as the rural mountain area of Jeseníky in Moravia and the Kłodzko region in Poland (99 persons/km^2) on the one hand, and the urban and industrial agglomerations of Upper Silesia and Ostrava with a high population density on the other hand. It can be seen that the population density of lowland areas is higher than that in the neighbouring mountain areas (e.g. the Nysa district and the Jeseníky Mts.). In the Upper Silesian basin, on both sides of the border, important industrial agglomerations developed based on coal deposits and mining. Ostrava, the largest town of the borderland, is the third largest city in the Czech Republic. On the Polish side, only the south-western part of the Upper Silesian agglomeration and the area of Bielsko-Biała belong to the borderland. Katowice, the capital of the voivodeship and the centre of the agglomeration, is situated outside the border region. The divided town Český Těšín/Cieszyn (25,445/34,408 inhabitants), located east of Ostrava, constitutes a special border situation. In the western part of the Czech-Polish borderland, the population density is very heterogeneous corresponding to the alternation of larger towns (e.g. Liberec, Wałbrzych, Jelenia Góra) or urban-industrial areas with more rural areas.

In the eastern part of the Czech-Polish borderland, the only cross-border motorway between Poland and the Czech Republic runs from Ostrava to Katowice and Kraków and via Český Těšín/Cieszyn to Bielsko-Biała, but it is partly under construction. Additionally the main railway connection between the Czech Republic and Poland goes via Ostrava and Katowice. In the middle and western regions, the capitals of voivodeships and townships mostly lie further away from the border. Only the town of Liberec is situated within the borderland. Consequently the west-east motorways are running also outside of the borderland via Wrocław, Opole and Katowice in Poland and between Liberec and Olomouc in the Czech Republic (planned). This is why some parts of the borderland, especially in the low mountain ranges, can be characterized as peripheral areas.

5.2 Population development as an indicator of regional development dynamics

The medium-term population development from the early 1990s to the present day provides first insights into the regional development. The comparison of the two borderlands shows a slightly positive dynamics of the Austrian-Slovenian borderland where the population growth and population decline districts balance out (index 1991–2011 in the Austrian part 1.03 and in the Slovenian part 1.01). In the Czech-Polish borderland, both sides of the border are characterized by the population loss (index 1995–2010 on the Polish side 0.95 and on the Czech side 0.98).

The Polish part of the borderland recorded the highest depopulation. The population grew only in the area around Bielsko-Biała and Rybnik. This could have resulted from suburbanization processes because of population decline in these two cities. All other districts lost the population, some of them more than 10% (e.g. Wałbrzych and Kłodzko). The depopulation processes in the border regions probably overlapped with the massive out-migration from Poland. On the Czech side, the situation is different. In the more peripheral mountain regions of Krkonoše and Jeseniky and partly in the Ostrava agglomeration, the population development was more or less negative. The area of Liberec and Jizerské hory Mts., the Orlické hory Mts. and some districts around Ostrava recorded a slight population growth (Fig. 3).

In the Austrian-Slovenian borderland, a substantial population growth is visible in the areas of Klagenfurt, Villach, Maribor and Kranj. This reflects the dynamic development in Klagenfurt and the Carinthian central region, in the Maribor region as well as in the agglomerations of Ljubljana and Graz, including suburbanization processes. The municipality of

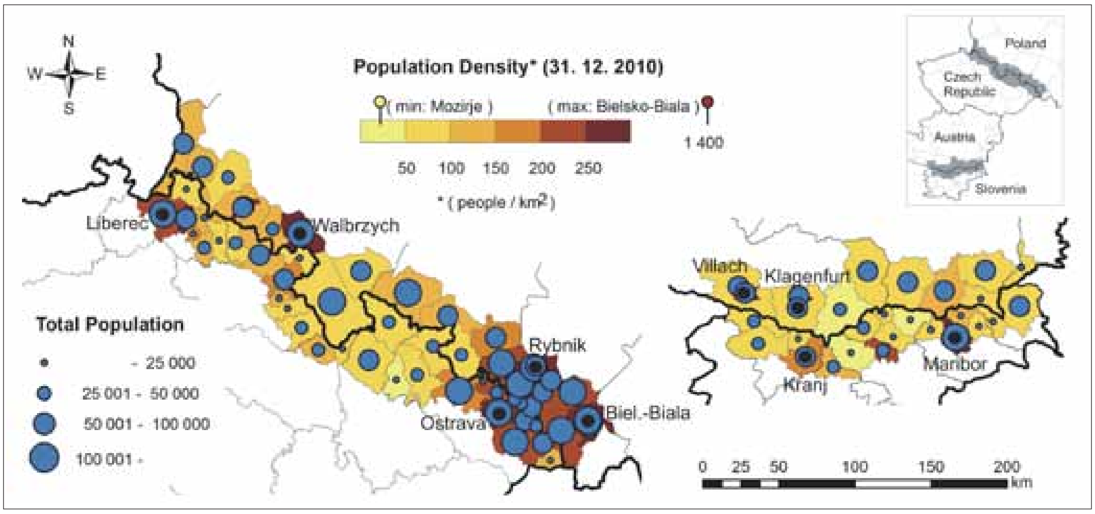

Fig. 2: Population density in the Czech-Polish and Austrian-Slovenian borderlands 2010/2011
Source: Czech Statistical Office, Central Statistical Office of Poland, Statistik Austria, Statistical Office of the Republic of Slovenia

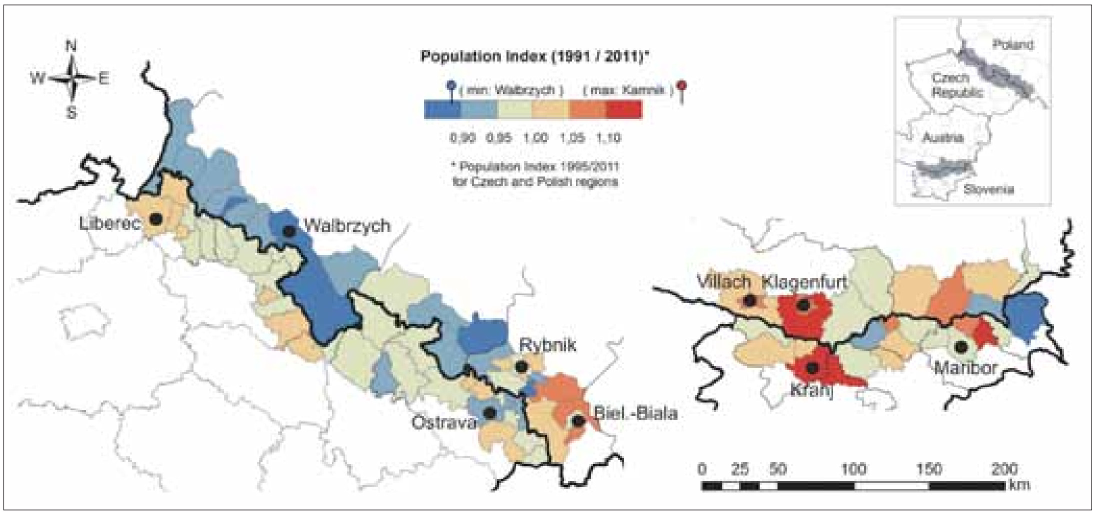

Fig. 3: Population development in the Czech-Polish and Austrian-Slovenian borderlands 1995–2010/1991–2011
Source: Czech Statistical Office, Central Statistical Office of Poland, Statistik Austria, Statistical Office of the Republic of Slovenia

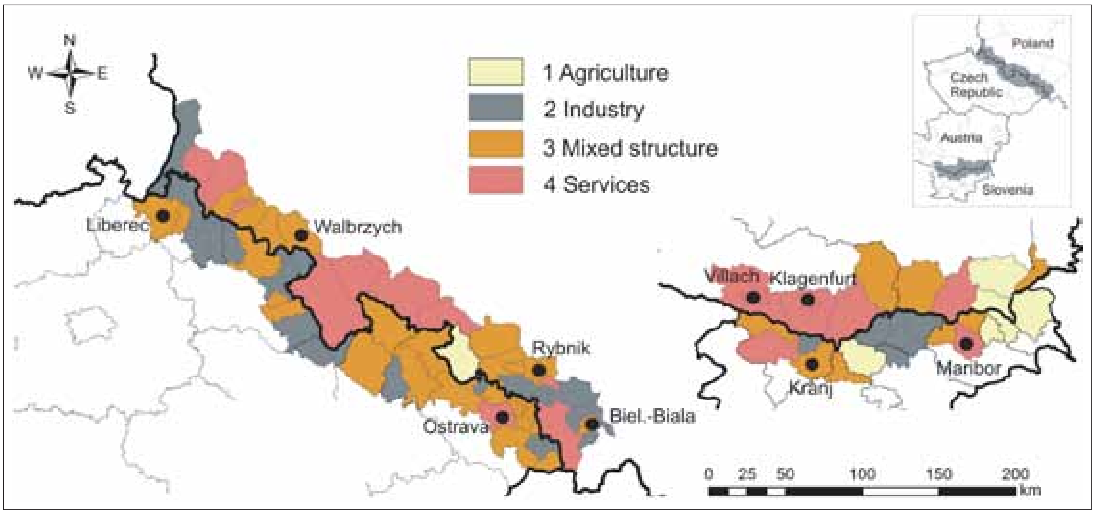

Fig. 4: Types of employment in three economy sectors in the Czech-Polish and Austrian-Slovenian borderlands 2001/2002
Source: authors' calculation based on Statistical Offices of Czech Republic, Poland, Austria and Slovenia

Maribor continually lost population and is currently characterized by a stable situation, while the populations of Klagenfurt and Villach continued to grow. On the other hand, the peripheral areas on both sides of the border have shown a population loss. The highest depopulation is observed in the most eastern area of Murska Sobota and in the neighbouring district of Radkersburg (Fig. 3).

5.3 Age structure – the main age groups

The shares of the main age groups show further characteristics of the borderlands and indicate potentials or problems. Due to the selective migration processes, the depopulation areas are mainly characterized by a high percentage of older people (65+) and the suburbanization areas by a higher percentage of working age population and families with children. However, the age structure is influenced by the natural population dynamics (e.g. higher/lower birth rate), too. Therefore, the shares of the main age groups varied from district to district and the triangle shows a considerable dispersal of statistical units. Some tendencies are visible though. Nearly the whole Austrian border region is characterized by high shares of older people (above 18%) and low shares of people at working age (up to 68%). In the Polish border region, the middle part has a higher percentage of older people (from above 17% to more than 19%) and a lower percentage of young people (below 14%). In the Czech border region, the share of older people is much lower (below 16%), especially in the central and eastern part. In the Slovenian border region, the situation is also more heterogeneous but the potential of people at working age shows an increasing trend in the eastern part.

5.4 Employment structure

Looking at the employment structure in the study areas, we can observe the trends of the European development. The share of employment in the primary sector is low but it shows also big differences. In more than 90% of all districts, the share of agriculture lies below 10% and in 15% of districts even below 1%. These are mostly industrial areas or highly urbanised areas (e.g. urban districts) in particular in the eastern part of the Czech-Polish borderland. More than 10% employees in the primary sector can be found in the north-eastern part of Slovenia (Murska Sobota, Gornja Radgona, Lenart) and the Slovenian district of Mozirje, in South-East Styria (Feldbach, Radkersburg) and the district of Głubczyce in Poland. These regions are characterized by a low level of urbanisation and industrialisation and good conditions for agriculture (e.g. Głubczyce). Podravje and Prekmurje as well as South-East Styria are important wine-growing areas.

The second trend shows a growing share of the tertiary sector. In the Austrian border region, all districts have a share of more than 50% of employees, except for Wolfsberg. The highest share is recorded in the high-order centres of Klagenfurt and Villach (above 70%) and their surrounding districts (between 60% and 70%). In the Slovenian, Czech and Polish border regions, the share of the tertiary sector in some districts is rather high (60% or more) due to their functioning as central places and/or tourism, for example Żory, Jelenia Góra, Kłodzko, Cieszyn, Lwówek Śląski in Poland, Ostrava in the Czech Republic and Maribor in Slovenia. Districts with a higher importance of industry and more than 50% employees in the secondary sector concentrate more or less in the traditional industrial areas such as the western part of the Slovenian border region (e.g. Dravograd, Tržič, Velenje, Ravne na Koroškem, Radlje ob Dravi), in the eastern districts of the Polish border region (e.g. Pszczyna, Wodzisław Śląski, Bielsko-Biała) and in various parts of the Czech border region (e.g. Železný Brod, Kravaře,Tanvald, Frýdlant).

A more complex view of the employment structure is displayed in Fig. 4. The typology consists of four types of districts: Type 1 represents all districts with a high share of agriculture. Type 2 is characterized by high numbers of employees in industry and by industry dominance. Type 3 and Type 4 are dominated by services which however differ in the percentage of industrial employees. The high share of industry employees in Type 3 leads to a mixed structure of services and industry. In contrast, Type 4 is clearly dominated by services (Tab. 2).

Type	Number of districts	Employees in economy sectors (%)		
		I.	II.	III.
1. agriculture	7	> 10		
2. industry	25	< 10	> 40, > III.	
3. mixed structure	34	< 10	> 40, < III.	
4. services	18	< 10	< 40	> 50

Tab. 2: Criteria of employment types. Source: authors' calculation

This typology of districts shows some interesting differences between the borderlands. The Austrian part of the borderland is most typical for domination of service function caused by high level services of urban areas and/or tourism especially around the Carinthian lakes. In the eastern part services also dominate, Type 3 (Deutschlandsberg, Jennersdorf) tends to Type 4 and Type 1 (Radkersburg, Feldbach) shows also more than 50 % employees in services including tourism. The mixed structure in the district of Wolfsberg results from a higher percentage of industry as well as agriculture (e.g. fruit-growing). The Slovenian side of the border is much more differentiated; all four types can be found. Up to the present day, the industry dominated areas include the Koroška region (Dravograd, Slovenj Gradec, Ravne na Koroškem, Radlje ob Dravi) and the neighbouring Velenje area. In the Gorenjska region, only Tržič belongs to the industry type while in Kranj and Jesenice industry is dominated by services (Type 3). Kranjska Gora and Radovljica are characterized by Type 4. In the easternmost part of the Slovenian-Austrian borderland, the very high proportion of workers in agriculture (> 12%) results from a more rural structure and wine-growing.

On the Czech side of the borderland, mainly two types of districts can be found: industry dominated employment structure (Type 2) and mixed structure of services and industry (Type 3). This closely relates to their long tradition of industrialisation and relatively high urbanisation levels. In the area of larger towns such as Opava, Liberec and Český Těšín, a combination of services and industry prevails, but only in Ostrava do the services dominate clearly. Moreover, in several parts of the mountain regions, the mixed employment structure results from tourism (e.g. Krkonoše Mts., Jeseníky Mts.). Industry plays an important role in the area of Třinec.

Nevertheless, also districts with the lower population density are industrialised (e.g. Broumov, Králíky, Rýmařov). The main difference between the more industrialised districts is the structure of industry. In the Ostrava region, heavy industry with negative impacts on the environment still predominates; in other regions it is rather mechanical engineering (Liberec, Vrchlabí), glass industry (Jablonec nad Nisou, Železný Brod), textile industry (Ústí nad Orlicí) and similar branches. On the Polish side of the border, services play a more important role while the share of industrial employment is a little bit lower. It is a result of deeper decline of industry (mining, textile industry) in this part of Poland accompanied by current high unemployment numbers and out-migration. The following Type 4 is the most frequent type, which characterizes the mountain areas or foot hills of Karkonosze (Lubań, Lwówek Śląski), Orlické hory Mts., Jeseníky Mts. (Kłodzko, Nysa) and Beskids (Cieszyn). In the basin of Upper Silesia and in the area of Bielsko-Biała, heavy industry has dominated until now, partly as Type 2 with the domination of

Type	Generalized characteristics	Number	Typical districts
I.	(more) urban areas with a high share of tertiary sector and trend of population growth, but with a very low share of working age population and high share of older population	8	Klagenfurt Stadt and Land, Villach Stadt and Land (Austria)
II.	(more industrialised) urban areas with a mixed structure of tertiary and secondary sector, high share of working age population and slight population loss	24	Bohumín, Havířov, Karviná, Třinec (Czech Republic)
III.	urban or rural areas with a higher share of tertiary sector, high share of older population and depopulation	10	Nysa, Ząbkowice Śląskie, Kłodzko (Poland)
IV.	traditional industrial areas without larger towns with a low proportion of population in tertiary sector, high share of young population and working age population	29	Šumperk, Vrchlabí (Czech Republic), Dravograd, Velenje (Slovenia)
V.	rural areas with a very high share of primary sector and high share of older population	13	Völkermarkt (Austria), Murska Sobota, Lenart (Slovenia), Prudnik (Poland)

Tab. 3: Clusters description and examples
Source: authors' compilation

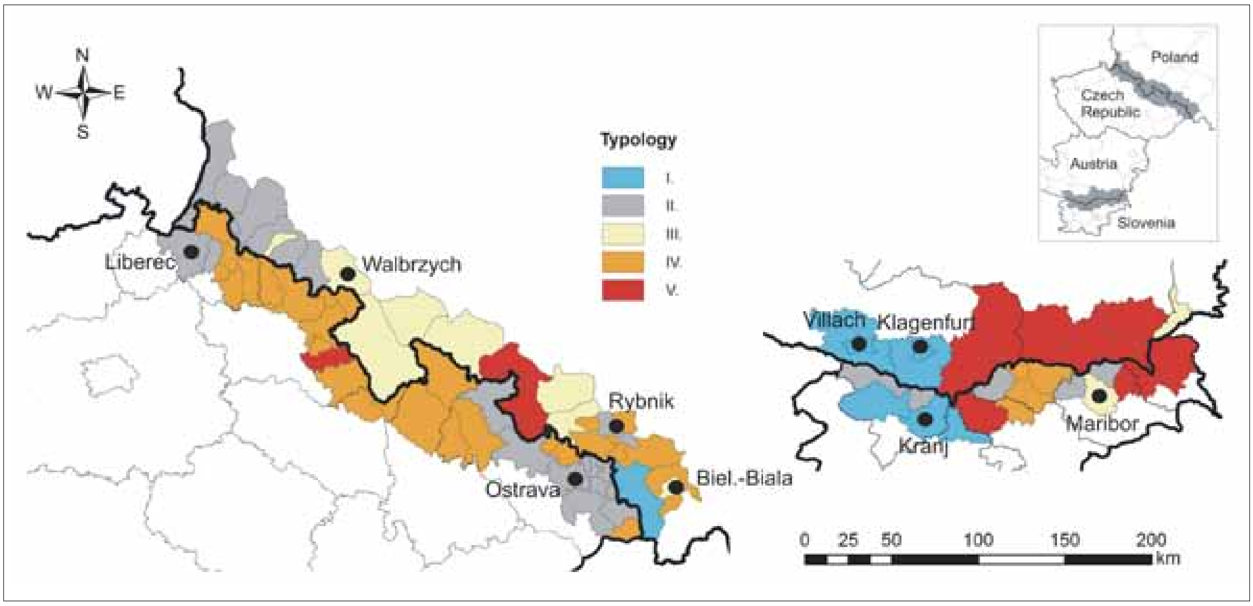

Fig. 5: Complex typology of districts in the Czech-Polish and Austrian-Slovenian borderlands by means of cluster analysis
Source: authors' calculation based on Statistical Offices of Czech Republic, Poland, Austria and Slovenia

industrial employment (e.g. Jastrzębie-Zdrój, Powiat bielski, Powiat wodzisławski) or as Type 3 with the mixed structure of services and industries (e.g. Rybnik area, Powiat raciborski). Głubczyce is the only district with a higher percentage of agriculture.

6. Complex types of socio-demographic and socio-economic variables based on cluster analysis

As indicated at the outset, our main intention was to look at the two borderlands as at a "united space without borders". For this reason we tried to elaborate a complex typology of all 84 units based on all variables, using the cluster analysis described above. The result of the cluster analysis is five types of districts. Table 3 contains the cluster description and typical examples for each type. It is very interesting that these typical examples are mostly concentrated in only one (Types 1–3) or two (Type 4) countries. Fig. 5 shows the location of the types in the borderlands.

The roots of these clusters are based on the long term social and economic path dependent development. If we would have made this analysis for statistical data 100 years ago, the picture would have been quiet similar. For example, one might examine the maps of social and economic structure from the Atlas of the Austro-Hungarian Monarchy based on the 1910 census (Rumpler and Seger, 2010). A surprising picture can be observed especially in the Austrian-Slovene borderland. Here we can find more similarities in the characteristics on the two sides of the border, which rather respect the historic boundaries between Styria and Carinthia than the current political borders. The long ago established inertia of settlement systems and also the inertia of economic structure are still more important than the political borders. The urban areas of Klagenfurt, Villach, Kranj and Kamnik are characterized by the tertiary sector and in spite of their unfavourable age structure show positive population development (Type I). Rural areas with more agriculture and a higher share of older population (Type V) are shown in the eastern part of the borderland in Austria and partly in Slovenia, where they are interwoven with more industrialized areas with a higher share of working age population.

The same type of inertia can be seen also in the Czech-Polish borderland. Characteristics of regions in the Czech-Polish borderland exhibit markedly greater differences than those in the Austrian-Slovene borderland. The inherited residential and economic structures also participate in the resulting typology of regions and their classification in the respective clusters. Most typical is a long strip of Czech districts along the Polish border characterized as traditional industrial areas without the domination of big towns or cities and currently a favourable population age structure (Type IV). Despite the population exchange, geographical systems remained relatively unchanged. The process of deindustrialisation shows more on the Polish side as well as in Czech Silesia. These regions are also characterized by above-state-average unemployment and strong out-migration. Most of the jobs in industries were cancelled in the 1990s. A good example is the Ostrava conurbation, or more rural but originally industrialized regions of the southwestern corner of Poland.

7. Conclusion

Due to the availability of data, the regional analysis on this small-scale level could only dwell on demographic data, which can only partially reflect regional structure and development. In particular, the structure of employment in the three economic sectors cannot indicate the real economic structure of the borderlands. Nevertheless, the indicators employed show the level of urbanization or tertiarization. It is necessary to take into account that the actual administrative units affected the results of the analysis, too. To be understood properly, long-term demographic processes require the use of at least medium-term time series of population development (in the case of the Czech-Polish borderland unfortunately without the first half of the 1990s). Therefore, statistical analysis provides a first overview of the borderland situation and a starting point for detailed studies.

Regarding the original question, the analysis shows a heterogeneous situation in both borderlands. Partially, adjoining areas on both sides of the border have similar characteristics, for example, a couple of mountain areas with more or less low population density, the urban agglomerations of Upper Silesia and Ostrava, or the rural areas with higher importance of agriculture in Southeast Styria and Prekmurje. In these parts of the borderland, the state border divides areas of principally similar regional structures. Similar structures also result from comparable development processes, for example, early industrialization of foothills and mountain areas in Czech, Polish and Slovenian border regions. The long-term inertia of settlement structures and in part, socio-economic structures, influences current regional development. However, for a certain time, most of the traditional cross-border links and functional relations were disrupted by more or less closed state borders and border areas orientated to national centres. However, not all parts of the two borderlands are actually peripheral areas of their countries. The changes of the last decades considerably differentiated the borderlands along the border. For example, the middle-term population development was more negative on the Polish side of the border (except the most eastern part) than on the Czech side. In the Austrian part of the borderland, the level of tertiarization is higher than in Slovenia. The process of European integration results in a rapidly changing character of state borders, which are no longer physical barriers to be crossed only with difficulties and ever more become an administrative limit of a certain psychological and cultural significance (Vaishar et al., 2007).

In this sense, a couple of similarities between the two borderlands were found. Differences between the Czech-Polish and Austrian-Slovenian borderlands are related to processes the classification of which Bufon (2007) used for his typology of the European border regions. In the Austrian-Slovenian borderland, the dynamic urban areas and the southern part of Styria exhibit a substantial population growth, partly influenced by the agglomerations of Ljubljana and Graz. In contrast, some districts recorded a considerable population loss. In the other areas, the population development is relatively stable. This reflects the heterogeneous structure of the borderland with dynamic urban areas (central places) on the one hand, and traditional industrial or rural areas with diverse problems on the other hand. The whole borderland shows a mild population growth, which is somewhat higher in the Austrian part. Austria is the only one of the four countries that was developing without greater changes over the last decades. Despite the problems during the transition process, Slovenia belongs to successful new EU member states although the Gross Domestic Product (GDP) per capita is still below the EU-27 average: 2008: 91% and 2010: 85% (Lorber, 2008; Eurostat, 2012).

The Czech-Polish borderland is characterized by two fundamental transformation processes: by the population exchange on both sides of the border after World War II and by the Perestroika of the post-socialist states and economies after 1989. Today, GDP per capita (2010) is much higher in the Czech Republic (80%) than in Poland (63% – Eurostat, 2012). Bufon (2007) calls the border regions in Central-Eastern and Eastern Europe transition countries as the "regions under reconstruction". The negative middle-term population development reflects this situation. Except for the easternmost part, nearly the whole Polish border region is characterized by a substantial population loss. On the Czech side of the border, the population decrease is lower and in three areas the population is stable or slightly growing. A positive change is shown in the areas of Bielsko-Biała and Liberec. However, these areas lack the dynamic centres such as those existing in the Austrian-Slovenian borderland. As to the population development and employment structure, the situation is heterogeneous particularly in the agglomerations of Ostrava and Upper Silesia.

Cross-border cooperations are often based on similar potentials, problems or interests, for example, in nature conservation, management of resources and environment, regional or rural development and different economy sectors. On the other hand, interactions across the border for working, shopping or recreation are rather due to different structures such as complementary offers in the neighbouring country that are within easy reach. The Jeseniky Mts. on the Czech side of the border and two lakes near the Nysa R. on the Polish side provide such complementary offers that are frequently used for recreation by people living on both sides of the border. For a better understanding of how to use the various potentials for improving cross border relations and collaboration, we have to employ a wider range of analyses including network analysis, surveys and qualitative interviews, which give us a more complex view of the border regions.

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Authors´ addresses:

Mgr. Petr KLADIVO, Ph.D., e-mail: *petr-petr@email.cz*
RNDr. Pavel PTÁČEK, Ph.D., e-mail: *pavel.ptacek@upol.cz*
Department of Geography, Faculty of Science, Palacký University
17. listopadu 12, 771 46, Olomouc, Czech Republic

Mgr. Pavel ROUBÍNEK, e-mail: *pavel.roubinek@seznam.cz*
Department of Social Geography and Regional Development, Faculty of Science, University of Ostrava
Kranichova 8, 710 00 Ostrava - Slezská Ostrava, Czech Republic

Dr. hab. Karen ZIENER, Ph.D., e-mail: *karen.ziener@uni-klu.ac.at*
Department of Geography and Regional Studies
Faculty of Management and Economics, Alpen-Adria-Universität Klagenfurt
Universitätsstraße 65-67, 9020 Klagenfurt, Austria

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A TRANSPORT CLASSIFICATION OF SETTLEMENT CENTRES IN THE CZECH REPUBLIC USING CLUSTER ANALYSIS

Stanislav KRAFT

Abstract

An application of cluster analysis to road transport in studying the transport classification of the main settlement centres in the Czech Republic is presented in this paper. The aim of the applied cluster analysis is primarily to reveal those factors that co-determine the transport importance and the size of particular settlements. The principal role under these factors has the complex importance of the centre as measured by its population size and its location within the transport network. Based on the application of the cluster analysis, five typological groups of settlement centres were defined according to the inter-variability of all monitored components, which can be aptly used primarily in transport planning practice.

Shrnutí

Dopravní klasifikace středisek osídlení České republiky: využití metod shlukové analýzy

Příspěvek se zabývá aplikací shlukové analýzy při studiu dopravní klasifikace hlavních středisek osídlení České republiky na příkladě silniční dopravy. Smyslem aplikace shlukové analýzy je především hledání podmiňujících faktorů spoluutvářejících dopravní význam a velikost jednotlivých středisek, mezi nimiž zaujímají stěžejní úlohu především populační význam střediska a jeho poloha v dopravní síti. Na základě aplikace shlukové analýzy bylo vymezeno pět typologických skupin středisek podle vzájemné variability všech sledovaných komponent, které mohou být vhodně využívány především v dopravně-plánovací praxi.

Key words: *transport hierarchy, road transport, settlement centres, cluster analysis, Czech Republic*

1. Introduction

The assessment of the relationship between transport and the spatial organisation of society ranks among the fundamental research phenomena in current transport-geographical research. In this context, Marada et al. (2010) mention that the research of links between the resulting forms of geo-societal (complex) and transport (partial) systems should be focused on when seeking the relationship between transport and the spatial organisation of society. Both the current foreign (e.g. Derudder and Witlox, 2009) and Czech (Marada, 2008 or Kraft and Vančura, 2009a) studies demonstrated many times that there are very strong connections in the organisation of transport systems and complex systems. Hence, there is a reciprocal relationship between transport and the spatial organisation of society. However, the study by Rodrigue et al. (2006) points to the fact that the mutual reciprocity may be perceived in two ways. First, it is the reciprocity given by the location, which forms the separate transport system. This is because the transport interactions are strongly related to the deployment of transport nodes and transport links that form and determine the current shape and intensity of transport system interactions on the various hierarchical levels. The reciprocity driven by mobility is another manifestation, as the deployment of socioeconomic activities in the area is always linked to transport.

Thus, the above discussions may be summarized by concluding that there is a certain interdependence between transport and the spatial organisation of society as transport is affected by the settlement system, which is, in return, affected by transport and its spatial arrangement. Despite relatively satisfactory results of investigation into this matter, however, some serious objections may be presented, in a strictly critical perspective, to the essence and nature of the transport – society duality study. According to Keeling (2007), there are a number of issues still to be addressed in the current study of the relationship between transport and society, often without any adequate conceptualization (a similar position is also shared in the study by MacKinnon et al., 2008).

The main goal of this contribution is a transport classification of settlement centres in the Czech Republic using methods of cluster analysis based on road transport. This contribution follows up on previously published studies (Hůrský, 1978; Marada, 2008) in which the identical statistical characteristics were empirically proven between the transport system organisation and the societal system organisation. The study by Kraft and Vančura (2009b) has proven the existence of the correlation between the hierarchical organisation of the settlement and transport systems on the basis of studying the changes in the settlement centre transport hierarchy in the Czech Republic between 1990 and 2005. Methodically, there are, however, some questions determining the size-related important characteristics of individual settlement centres that have not been resolved yet. One can point especially to two essential problems that determine the transport importance of individual centres – identification of the transit transport impact and the influence of the transport infrastructure endowment of settlement centres on their final transport size. For instance, Viturka (1981) argues that the importance of individual settlement centres as to the transport is, in many cases, affected by especially two phenomena – a complex importance of the centre, usually expressed by its population number, as well, as the settlement centre location within the transport network. The "real" importance and tasks of these centres in the Czech Republic transport system can be identified after analysing the differentiation of the above components, which help to create the importance of individual settlement centres in the transport systems. Individual settlement centres can also be classified into relevant typological groups based on the similarity of all monitored components that determine their transport hierarchy. As a suitable tool for this process, a cluster analysis method can be used, as it enables us to grasp the variability of all affected components (transport importance, transport location, population) of the monitored centres. This article thus aims to answer especially the following questions: In what way does the transport hierarchy of settlement centres develop in the Czech Republic in the present period? How does the phenomenon of transport location and complex/population size of settlement centres affect the transport importance of the settlement centres? Which centres benefit from their appropriate location and, on the other hand, which centres are limited by their transport location? Which settlement centres show a high traffic level and are undersized in terms of their infrastructure? The above questions represent significant drivers for geographical research from the transport viewpoint, especially for strengthening the role of this research in transport planning. They may also contain some implications for the regional and transport policy of the Czech Republic, and, as a result, they are highly relevant and important for society.

2. Theoretical embedding – transport and settlement hierarchy

This paper is based on the methods of studying the transport hierarchy, which are further developed and brought closer to applied research. Transport hierarchies are among the fundamental geographical methods from the transport viewpoint, describing the differences in importance of transport nodes and their transport links. Theoretically, the transport hierarchy issue may be considered as a study of the correlations between the transport system organisation and the settlement system organisation. In this context, the methods and the procedures taken from settlement geography are frequently used in studying this correlation. According to Marada (2003), it is, however, necessary to distinguish between the hierarchical position of individual roads and that of the transport nodes. Transport hierarchy of settlement centres, as one of the basic structural and morphological features of transport networks, is very closely related to the transport node accessibility. The transport hierarchy issue is, however, of a relatively complex nature and it is studied using a variety of methods and procedures (for details see Ullman, 1980 or Mirvald, 1988). Of the currently determined study approaches to the transport hierarchy of transport nodes, three basic types of criteria used for the settlement centre hierarchy can be defined:

- *Hierarchization of transport centres by the road accessibility of their nodes* – a traditional transport-geographical method, originally based on graph theory (e.g. Ullman, 1980). It consists in the intentional transformation of the existing transport network and nodes into a graph where the availability of individual transport nodes is monitored upon the existence of direct links to the other network nodes. As this is a purely mathematized approach to studying the given issue, graph theory was frequently employed in the 1960s, in the period known as the quantitative revolution in geography. Garrison (1960) applied this theory to analyze highway system connectivity in the United States in 1957. Similarly, this mathematically modelled approach was employed by Yerra, Levison (2005) in studying the dynamics of transport network development. In the Czech environment, graph theory was used especially in connection with the application of quantitative approaches in transport geography in the 1970s and 1980s (e.g. Korec, 1981). However, graph theory and the transport hierarchy analyzed thereby are of a rather descriptive nature and are frequently used to illustrate the historical development of individual transport networks (Rodrigue et al., 2006).

- *Hierarchization of transport centres by the degree of their infrastructure endowment* is based on a simple assumption that the transport importance of the centre is not primarily determined by its road accessibility, but also it is, in particular, based on the level of the centre endowment with various road types. Using the Czech Republic as an example, the study by Marada et al. (2010), however, indicates various groups of relatively important settlements lying in an inconvenient transport location and, on the other hand, of relatively less important centres located in an exposed transport location. This system was applied, for instance, in the study by Hůrský (1978) dealing with the attractiveness of centres in the former Czechoslovakia as to their location, in which the author applied a simple rating method (see below). A similar procedure was also used to evaluate the differentiation of regional towns by their level of transport infrastructure endowment in the study by Kraft (2009) or to assess the transport location and the traffic services of municipalities in the NUTS2 – South-East region, addressed in the study by Toušek et al. (2006).
- *Hierarchization of the transport centres by their size-relevant features* is currently the most frequently used approach to the transport hierarchy study. It is primarily based on distinguishing the monitored set of centres as to their importance on the basis of the intensity of transport relations between the centres themselves and between the centres and their transport hinterlands. Globally, attention is also given especially to the hierarchical position of the cities categorized as "world cities" as to the number of serviced passengers in international air passenger transport or the number of air flights with other international metropolises (e.g. Grubesic et al., 2009; and in the later study by Seidenglanz, 2008 or Grenčíková et al., 2011). An interesting view of the centre hierarchization by gateway functions within metropolitan areas in Germany is provided in the study by Jurczek (2008).

Another important question relating to the study of the transport hierarchization of centres is its relationship to the settlement hierarchy issue. It is beyond dispute that transport contributed to deepen the settlement hierarchy, as it had a significant impact on the concentration of industrial activities and inhabitants in towns especially during the industrialization era. This relation, however, can also be applied the other way round, as in the cases where the importance of the centres in their settlement system was also the main development factor of their importance in the transport perspective. The relationship between the settlement (complex) and transport (partial) hierarchies can be thus labelled as reciprocal, since the transport and transport connections determine the development of the settlement hierarchy, while the transport hierarchy development is influenced by the settlement centres and their interrelations (see similar comments by Nuhn, Hesse, 2006).

This issue of the transport hierarchy study has a relatively long tradition in the Czech and Slovak environments. Many pieces of work dealing with the transport hierarchy of transport links or their nodes were published by Hůrský (e.g. 1974, 1978). These traditional studies were primarily focused on analyzing the differentiation of transport hierarchization and their links upon the public transport or the transport infrastructure endowment of such centres, and were thus of a rather descriptive nature. In his studies, he arrived at a notable conclusion – that being preceded by service functions, transport plays the second most important role in the evaluation of town centrality and, therefore, it is necessary to primarily focus on the study of the settlement centre transport hierarchization in relation to the complex hierarchization. Newer studies addressing the issue of the settlement centre transport hierarchization in the Czech Republic were published by Marada (2008) who often applies methods that are close to settlement centre geography. His works are concerned with studying the features of the settlement and transport hierarchy, primarily focused on public transport, arriving at the conclusion that there is a relatively high association between the transport and settlement/complex hierarchies in the Czech Republic. Among other authors dealing with this issue, Viturka (1981) may be mentioned, since his works are directly addressing the relationship between the settlement structure and road transport.

Based on the above discussion of empirical studies relating to the fundamentals of transport hierarchy, a few essential and generally applicable conclusions that form the needed "basis of inspiration" for further research may be formulated:

1. Despite some intermodal differences, we can point to the fact that the transport hierarchization of centres is relatively strongly related to the settlement hierarchy as transport has played and still continues to play an important role in distinguishing the importance of centres in the settlement system. This fact is also noted in the study by Marada (2006) that proves, from the vertical and horizontal transport location of settlement centres that *a)* there is a considerably

high degree of mutual association between the transport infrastructure endowment of settlement centres and the intensity of public transport and individual vehicle transport, and that *b)* all these indicators simultaneously go hand in hand with the importance of centres according to their complex significance value.

2. As to size-relevant features, the transport hierarchization of centres is particularly influenced, in line with Hůrský (1978), by their transport infrastructure endowment, transport location (similarly noted by Korec, 1996) and, to a certain degree, by other elements determining their settlement/regional importance such as population size, working size and the complex size. It is, however, necessary to note certain types of centres where a predominant occurrence of one of these features may unduly inflate their real transport importance (especially their transport location). As far as the overall differentiation of the transport centre hierarchization is concerned, the resulting transport hierarchy, determined by the size-relevant features, primarily depends on the cumulation of the above characteristics.

3. Research methods

As discussed above, current trends in the development of the settlement centre transport hierarchization in the Czech Republic (in relation to a previous evaluation – Kraft, Vančura, 2009b) are monitored in the first part of this work. The following second part classifies the settlement centres on the basis of their transport and complex characteristics using cluster analysis. Settlement centres were congruently defined on the basis of their complex size value ascertained by the latest available population census taken in 2001. The study thus evaluates 144 settlement centres of at least a micro-regional importance, i.e. centres that make up a framework of the current settlement system of the Czech Republic. The definition of the centres was adopted from the study by Hampl (2005).

In order to ascertain the transport size of individual centres, values of the annual average intensity of road vehicles driving through the census station located closest to residential areas of the monitored centres in 24 hours were allocated to each centre on the basis of data from the Road Transport Census. For each centre, real values were included from all census stations on motorways, expressways, and 1st and 2nd class roads leading through the residential area of the centres. Given this methodology for expressing the transport importance of individual centres, those centres with a certain exposure of their location were given an advantage, as also the high traffic intensity values from the motorways and expressways not always leading through the residential area of individual centres were included in the values of these centres. However, the nature of the data fails to enable separation of the transit transport that is in charge of traffic connections between individual centres from the "local" transport operating between the given centre and its transport facility. The transport importance of individual transport centres in the road transport system is evaluated using a relative transport size indicator, which is defined as a share of all road transport intensity values (incoming and outgoing vehicles) of the given centre in the road transport intensity of all centres (all centres = 10,000). These characteristics make it possible to monitor qualitative changes in the transport importance of the centres, especially changes in the transport importance of various hierarchical levels of settlement centres in the Czech Republic.

At the second stage of the research, all centres were, using cluster analysis, classified into individual typological groups upon the mutual differentiation and similarity of three main factors monitored – transport importance of the centres, transport location of the centres in the road network and population of the centres. The purpose of applying cluster analysis was to find those groups of centres that show an identical or very similar proportional structure of individual components being monitored. The cluster analysis method (hierarchical division clustering method) was used for classifying the centres (similar to Kladivo, 2011). This methodological procedure represents an important tool for studying the spatial homogeneity of data files, and, because of this, it can be aptly applied to the research of transport hierarchization of centres and their determining factors (McGrew and Monroe, 1999). It is evident that this procedure envisages the observed fact to be generalized to a certain degree. It is, however, relatively reliable in revealing certain regularities in the size and structural differentiation of the monitored centres. The transport importance of the centres as of 2010, expressed by an absolute total of all motor vehicles driving through the centre, was selected as a dependent variable for the centres. On the other hand, the population numbers of the centres and the qualitatively evaluated transport location were determined as independent variables. The qualitatively evaluated transport location is inspired by the approach of Hůrský (1978) to the transport classification of centres in the then Czechoslovakia. Based on the differentiation in the transport infrastructure endowment of individual centres, the qualitatively evaluated transport position of the centres was calculated as a sum of 10 × the number of motorways and expressways leading through the centre, 3 × the number of 1st class roads and 1 × the number of 2nd class roads. This graduation is based on the proportionality of average values of the transport intensity as per individual road types based on the 2010 Road Transport Census.

Despite efforts to include more independent variables in the research that would be relevant for the explanation of the differentiation of centres according to the share of freight transport, the author did not succeed in obtaining them. In this case, a criterion of the industrial production of individual centres could be used, but this is not statistically recorded in the Czech Republic.

4. Transport hierarchy of settlement centres in the Czech Republic – development and current trends

The previous evaluation demonstrated many times that there was a relative decrease in the transport importance of centres at medium and lower hierarchical levels between 1990 and 2005, while the largest centres were characterized by a definite increase in their importance (in absolute and relative values). This fact is basically affected by two factors. The first factor is that the largest transport centres are, as a general rule, the largest complex centres, too. Thus, their transport growth based on their size is caused by the general emphasizing of integration processes in the settlement system and strengthening of their importance within the regional systems. This can be exemplified by the increasing attractiveness of the largest towns from the viewpoint of commuting to work (more details can be found in Toušek et al., 2005, for example), resulting in an increased transport intensity, or the incoming suburbanization processes that require higher demands for car transport (as discussed in the studies by Urbánková and Ouředníček, 2006). Another important aspect is the fact that the largest transport centres also include centres of lower complex importance, the transport importance of which is especially given by their appropriate location within the transport network (for more details, see Kraft and Vančura, 2009b).

The results of the 2010 transport hierarchy analysis clearly demonstrate that the transport hierarchy has been further deepening, i.e. showing a growing asymmetry in the size relevant characteristics of the monitored set of centres (Tab. 1). The average transport intensity in the monitored centres already exceeded 44 thousand vehicles per 24 hour period in 2010 which represents a significant increase of this

Rank	Centre	Relative transport size	Rank	Centre	Relative transport size
1.	Praha	721.9	125.	Rumburk	24.1
2.	Brno	362.3	126.	Frýdlant	23.0
3.	Ostrava	245.0	127.	Blatná	22.4
4.	Olomouc	224.1	128.	Tanvald	22.2
5.	Plzeň	197.1	129.	Milevsko	21.7
6.	Jihlava	185.6	130.	Vimperk	21.4
7.	Frýdek-Místek	163.4	131.	Hořovice	21.4
8.	Hradec Králové	163.2	132.	Dvůr Králové n. Labem	20.7
9.	Beroun	157.8	133.	Semily	20.5
10.	Prostějov	151.0	134.	Nový Bydžov	20.1
11.	Velké Meziříčí	148.9	135.	Valašské Klobouky	20.1
12.	Brandýs n. Labem	146.5	136.	Sušice	19.9
13.	Humpolec	145.5	137.	Hlinsko	19.5
14.	Vyškov	133.8	138.	Dačice	19.3
15.	České Budějovice	133.6	139.	Podbořany	18.2
16.	Pardubice	132.8	140.	Tachov	16.3
17.	Kralupy n. Vltavou	127.3	141.	Bystřice n. Pernštejnem	16.1
18.	Poděbrady	121.7	142.	Chotěboř	16.1
19.	Ústí n. Labem	119.9	143.	Prachatice	16.0
20.	Mladá Boleslav	115.4	144.	Broumov	11.4

Tab. 1: The largest and smallest centres according to their relative transport size (2010)
Source: Road transport survey 2010, author's calculations
Note: Relative Transport Size = all transport volumes entering or departing the centre; all centres = 10,000

indicator in comparison to 1990 (21,997 vehicles). The maximum number of incoming and outgoing vehicles within 24 hours was registered in Prague (464,230 vehicles) and the minimum again in the Broumov centre (7,315 vehicles). The proportionality of the traffic flows continued to change as well. In 2010, the share of trucks in the centres was merely 18.8% of the total transport flow, while 80.5% was attributed to passenger cars and motorcycles accounted for the remaining percentage (0.7%). The last listed means of transport represented only a rather marginal part of the transport flow, though there was a tiny increase in the motorcycle transport in absolute and relative figures as compared with 2005. In comparison with 1990, there was also a further reduction of the freight transport by almost 9 percentage points in the centres, contrary to an increase of passenger transport by almost 10 percentage points. This trend again reflects the generally changing structure of the transport flows in the Czech road and motorway network during the monitored years.

The hierarchization level of the set of centres proved that the dominance of large transport centres is continuously growing at the expense of smaller and medium-sized centres. This can be documented also by the data in Table 1, in which twenty largest and smallest centres are compared according to relative transport importance in 2010. Primarily, it is necessary to highlight the growing dominance of Prague, which increased its relative transport importance from 527.3 in 1990 to 721.9 in 2010. The relative increase can also be seen in the remaining transport centres at the highest hierarchy levels (primarily Brno, Ostrava, Olomouc, Plzeň, Jihlava), which demonstrates the trends listed above showing the strengthening of the principal transport centres and therefore also a higher concentration of traffic flows in a smaller number of centres. As a result, we found most Czech regional capitals among the most significant transport centres in 2010. Karlovy Vary (31st position), Liberec (26th position) and newly also Zlín (25th position), the transport importance of which is weakened primarily by the lack of superordinate roads, can be seen as an exception. The opposite case with an increased importance would be for example the area of Ústí nad Labem, the transport importance of which was raised by the construction of the D8 motorway, which resulted in certain traffic redirection from the main flow Prague–Dresden. In this case, too, the centres of lower complex importance are to be found among the top 20 of most significant centres. However, their transport location is very exposed, adding value to their overall transport importance. What is meant by that is primarily the effect of the D1 motorway (Velké Meziříčí, Vyškov), R10 expressway (Brandýs n. Labem, partially Mladá Boleslav) or D5 motorway (Beroun) etc. Again, we can thus document the correlation between the transport importance of the centres themselves, which is determined by their complex importance in the settlement and regional system of the Czech Republic and their transport location. At the opposite end of the monitored set, we can again find centres the low transport importance of which is given by the joint influence of their low complex transport importance and the peripheral transport location in the road network (as analogously described in the study by Zapletalová, 1998).

The concentration of these centres is again remarkable in the less populated areas of the Czech Republic with low industrialization. From the viewpoint of size-relevant characteristics, it is nevertheless necessary to highlight the continuous weakening of the importance of these centres (e.g. the relative transport size of Broumov decreased from 15.7 to 11.4 during the monitored period). Considering the weakening importance of small centres and the increasing importance of large centres, we can prove the growing asymmetry in the spatial distribution of traffic flows and the gradually deepening hierarchization of the set of centres as per transport indicators. In 2010, we could also define clear lines of centres with higher transport importance and higher share of freight road transport in the Czech road and motorway network: Praha (Prague) – Beroun – Rokycany – Plzeň; Praha – Benešov – Tábor – České Budějovice; Cheb – Karlovy Vary – Most – Teplice – Ústí n. Labem – Děčín; Praha – Roudnice – Lovosice – Teplice; Praha – Mladá Boleslav – Turnov – Jičín/Liberec; Praha – Poděbrady/Kolín – Hradec Králové/Pardubice; Hradec Králové – Litomyšl – Svitavy – Brno/Olomouc; Brno – Vyškov – Prostějov – Olomouc – Hranice – Ostrava; Hodonín – Uherské Hradiště – Zlín/Kroměříž – Přerov. These highly exposed axes can be deemed the main international/supraregional transport lines created by automobile transport. The overview of all centres, structured by their relative transport size, is shown in Fig. 1.

5. Transport classification of settlement centres – using cluster analysis

It was clearly stated in the above analysis of the hierarchy of transport centres that the transport hierarchization, or more precisely the transport importance, of individual centres is influenced primarily by two key factors – a centre's transport location within the road network and its complex importance expressed by its population size. Based on this finding, attention is paid to this phenomenon, namely to the influence of these key determinants on the transport size of

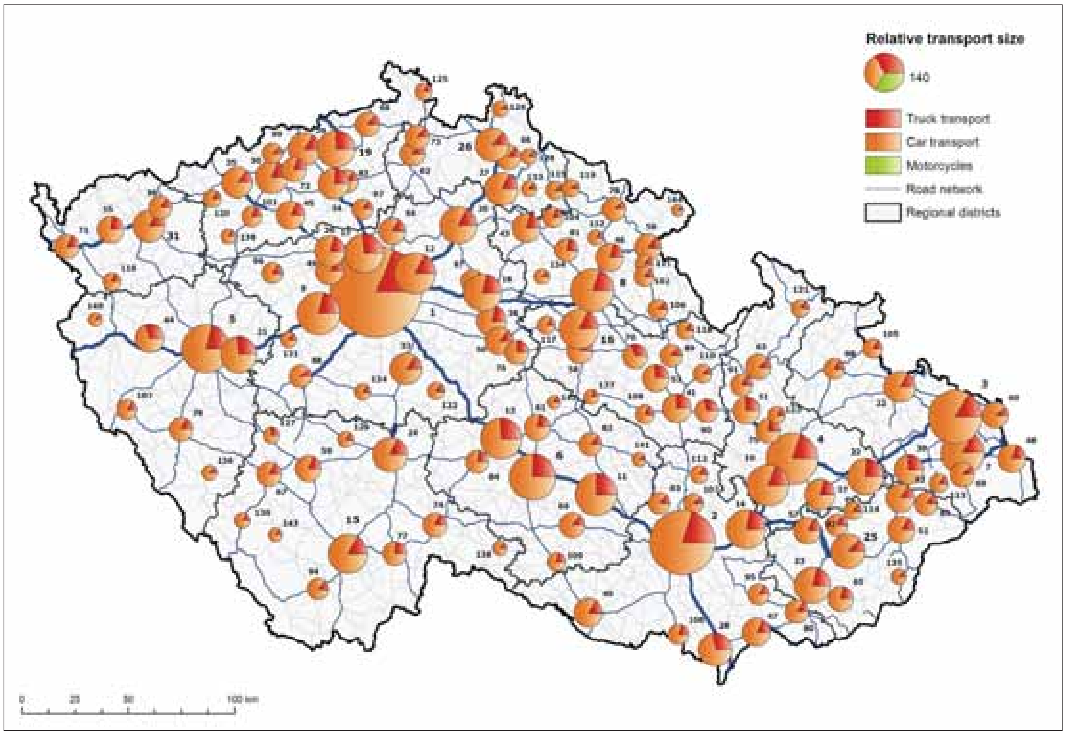

Fig. 1: Transport hierarchy of Czech settlement centres by relative transport size (2010)
Source: Hampl 2005, Road transport survey 2010, author's calculations

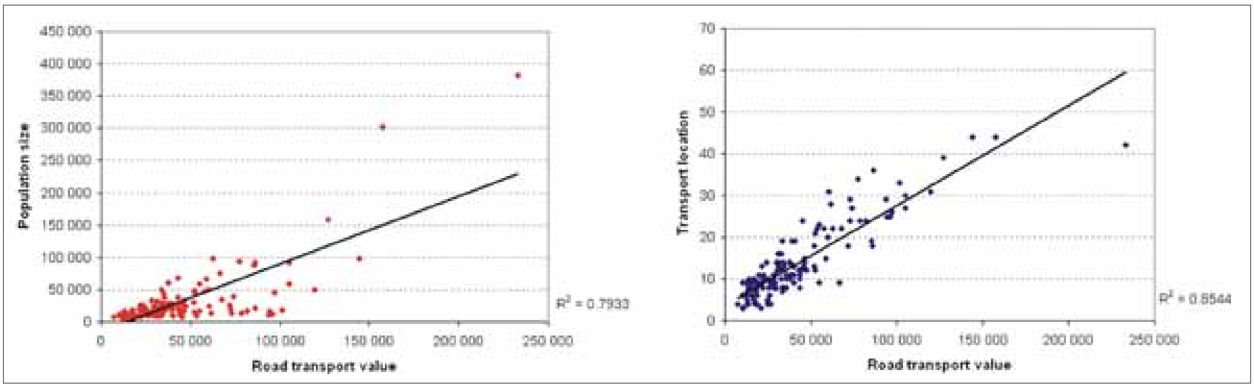

Fig. 2: Relation of the population number (a) and the qualitatively evaluated transport location (b) to the overall transport importance of centres (2010)
Source: Road transport survey 2010, author's calculations

the centres. Therefore, we monitored the transport hierarchization of settlement centres in the Czech Republic in 2010 in relation to both determining factors as stated above. Generally, it can be confirmed that there is a linear relation between the growing population sizes of individual centres and their relative transport importance. Put in a simple way, if the population number in a centre increases, its transport importance grows as well. Even though there are certain outliers in this simple relation that are caused by the exposed/peripheral transport location of the centres (the exposed position of centres such as Velké Meziříčí, Humpolec, Stříbro or, the other way round, the peripheral position of Tachov or Jeseník can be taken as examples), it can be stated that the population size of individual centres is one of the key factors in the differentiation of this transport importance. As demonstrated earlier (Kraft, Vančura, 2009b), the population size of individual centres correlates more with the importance of the centre according to passenger car transport rather than according to freight road transport importance. The freight road transport is, however, in the closest relation with the transport location phenomenon, as it can be confirmed that the highest share of freight transport is documented to occur in centres with the most exposed location. Also in the case of qualitatively evaluated transport location, we can highlight a remarkable linear relation between the quality of transport location and the overall transport importance of the centre (highest coefficient of determination R2). Nevertheless, the centres in a relatively worse transport location the high transport size of which is determined primarily through their complex importance (for example Zlín or České Budějovice) or their – though exposed – transport position, however, without a quality transport infrastructure (Benešov) occur even there. The high linear interdependence between the transport importance of centres and their population size or their transport location is documented also in Fig. 2.

Therefore, attention will be now given to searching for the main factors determining the importance and the hierarchical position of individual centres according to automobile transport. It will be primarily the search for centres, the transport importance of which is given rather by their population number and centres with the transport importance primarily determined by their exposed transport location. The overall transport importance of these centres is certainly often caused by an interaction of the two (possibly more) factors. The result of the identification of the determining factors of the transport importance of individual centres is the typology of individual centres exactly according to the weight and share of each of the stated factors in the overall importance of the centre in the transport system. The purpose was to look for such types (clusters) of the centres whose transport importance would most correspond with the transport location of top quality and with their complex importance, expressed in this case through the mere population size by the method of hierarchical clustering (based on the maximum possible similarity within a cluster and the maximum differentiation of this cluster from other clusters). Based on the k-diameter method, five typological groups of centres were determined which have the most similar components of transport importance, transport location and population number, i.e. which showed the highest correlation. Tab. 2 shows the essential structural characteristics of the individual cluster groups of centres indicating their mutual differentiation.

The first group of centres (Cluster 1) largely consists of large transport centres with high values of transport location but with low values of complex importance. Therefore, it includes significant and medium significant centres whose transport importance is primarily determined by the exposure of their location within the transport network. The statement is proven also by the list of centres with the lower complex importance in this category situated on the main routes in the Czech Republic (Rokycany, Stříbro, Beroun, Slaný, Humpolec, Vyškov, Velké Meziříčí, Hranice, etc.). The second fundamental feature of this category of centres is represented by the presence of centres lying outside the reach of expressways, which however

	Number of centres	Average transport importance	Average complex importance	Average transport location	Average truck transport share (%)	Average car transport share (%)	Basic features of cluster
Cluster 1	32	46,725.9	13,092.8	18.4	21.6	69.2	Mainly transport and transport-location exposed centres with lower complex size
Cluster 2	20	26,140.1	11,325.8	9.6	16.6	70.1	Centres with lower complex and transport size with peripheral transport location
Cluster 3	35	72,379.0	83,931.3	20.7	17.4	70.9	Centres with highest complex and transport size with exposed transport location
Cluster 4	27	34,268.3	28,132.9	11.5	16.3	70.4	Centres with average value of transport and complex size with lower transport location
Cluster 5	30	41,236.0	28,630.6	7.7	14.8	72.5	Larger transport and complex centres with peripheral transport location

Tab. 2: Basic structural characteristics of cluster groups of the centres (2010)
Source: Road transport survey 2010, Czech Statistical Office 2010, author's calculations

have clearly the character of supraregional or regional transport nodes (Blatná, Milevsko, Čáslav, Jaroměř, Moravské Budějovice, Svitavy, Mohelnice, Litovel, etc.). It can be justly stated that this category includes important centres with a high share of transit/freight transport. It is exactly the remarkably above average share of freight transport in these centres that proves their transport importance being strongly influenced by their location exposure.

By contrast, the second group of centres (Cluster 2) includes centres of low transport importance, low complex importance and rather low value of transport location, i.e. less significant transport centres the low transport importance of which results from the combined effect of a rather peripheral transport location and low population size. In this group of centres we can find centres lying as a rule on less important roads that do not have any major transit role in the transport system of the Czech Republic (Dačice, Hlinsko, Podbořany, Dobruška, Žamberk, Jeseník, Valašské Klobouky etc.). Conspicuous is a relatively low share of freight transport, as demonstrated by their rather marginal importance as to the generation of supra-regional traffic flows.

Fully developed centres of high transport and complex importance and favourable transport location form the basis of the third group (Cluster 3). In this category, we can find most regional and former district towns of the Czech Republic, which proves their relatively complex character. In the case of these centres we can observe the accumulation of all variables mentioned above, hence it is not possible to ascertain whether the transport importance of the respective towns is determined by their complex importance as opposed to their transport location. Centres belonging in this cluster group include both the important transport centres in which the high share of freight transport is influenced by the high individual automobilization of their hinterlands (Praha, Plzeň, Ústí nad Labem, Brno, Olomouc etc.) and the centres situated on more important supra-regional flows from where a part of the freight transport is taken away by the near motorways (Havlíčkův Brod, Žďár nad Sázavou, Nový Bydžov, Tábor, Kroměříž etc.). The high share of passenger car transport in this group can be attributed to the existence of large and strongly automobilized settlement centres.

In the fourth group of centres (Cluster 4), the complex importance of centres combined with rather average values of transport location starts to play a more pronounced role. The transport importance of these centres is thus influenced by their population size rather than by their transport location. This group therefore includes mainly smaller transport centres in less favourable transport locations as to the main transport flows of the Czech Republic (Domažlice, Sušice, Vlašim, Mariánské Lázně, Kyjov etc.). This fact is also reflected in a relatively low share of freight transport in these centres, which again indicates their lower transport importance as based on the generation of more significant transport intensities. Certain exceptions in this category can be considered the towns Pardubice, Znojmo, Teplice or Liberec, which on the contrary play a relatively important part in the distribution of supra-regional traffic flows but are affected by their not entirely favourable position within the road network.

Finally, the fifth group of centres (Cluster 5) is characterized by the high transport importance and to a certain extent also by their complex importance – however, with an unfavourable transport location. It includes primarily large centres situated on important routes, yet with a relatively peripheral transport location caused usually by the absence of higher road infrastructure (Zlín, České Budějovice, Benešov, Chomutov, Příbram, Šumperk, Hodonín, Vsetín etc.) and smaller centres with an unfavourable transport location (Tachov, Prachatice, Český Krumlov, Boskovice etc.). It is the high complex importance and the low transport location that are the determining characteristics for this group of centres. The set of all centres including their classification in the individual typological groups and brief characteristics of the cluster groups is provided in Fig. 3.

6. Conclusions

From the viewpoint of the vertical organization of the transport system in the Czech Republic, it was clearly demonstrated that the two monitored systems (transport and residential/complex) are strongly interlinked. Similarities and interconnections of their hierarchical organization are to a certain extent logical since the system of settlements is one of basic determinants forming transport links in the territory (as discussed in Řehák, 1982). Thus, we can corroborate the trivially formulated hypothesis about the high association of transport and complex centre hierarchization (similarly for public transport – see Marada et al., 2010). The fact was also confirmed that the centres are far less hierarchically developed according to transport indicators than according to complex indicators. Nevertheless, some essential changes that have resulted in the deepening of hierarchization tendencies in the vertical organization of the transport system occurred in the period 1990–2010 also in the transport characteristics. This deepening was caused by the weakening significance of smaller transport centres and by the progressive growth of the size-

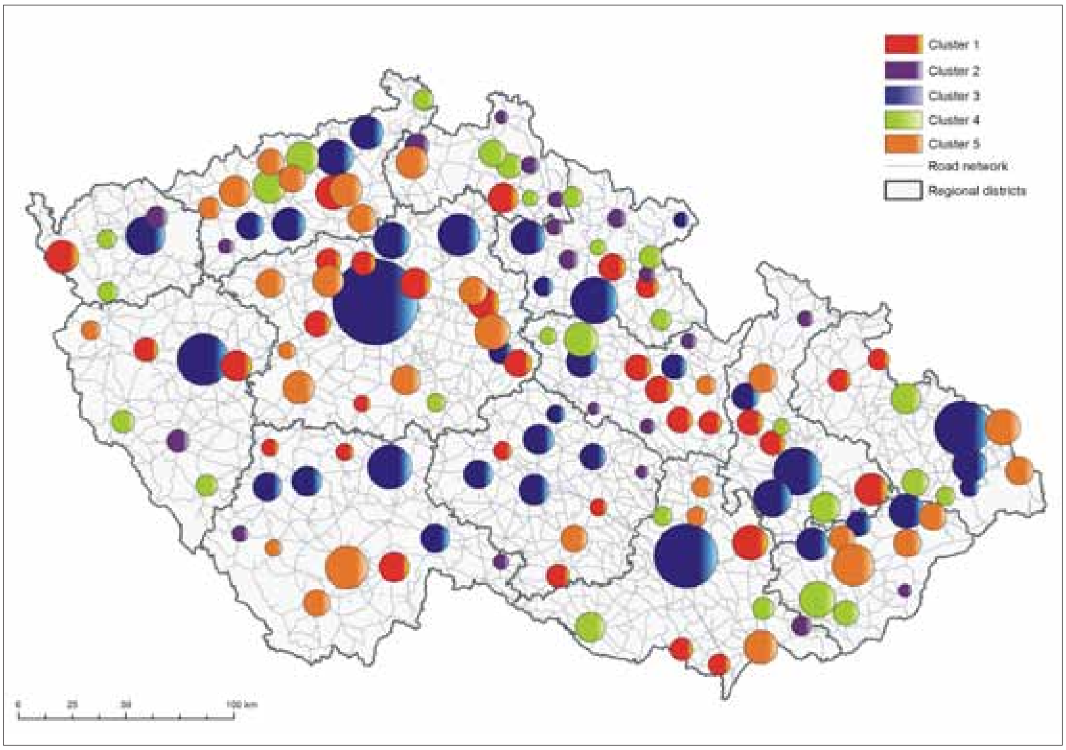

Fig. 3: Cluster groups of settlement centres according to their relative transport size (2010)
Source: Hampl 2005, Road transport survey 2010, author's calculations
Note – the size of the circles corresponds to relative transport size of centres in 2010

relevant characteristics of the largest centres. However, a conspicuous sign of the transport hierarchization of centres is the fact that the deepening of hierarchization tendencies is influenced to various extents by different road transport modes. Currently, we can therefore consider freight transport to be primarily the most hierarchically developed transport mode. As to road transport development in the Czech territory, we can consider as positive namely the fact that the intensity of freight road transport in urban areas of Czech towns shows in general a relative (in some cases even absolute) decrease. Freight road transport has been moved gradually to bypass/motorway communications and its the unfavourable consequences following out from the operation of this transport mode represents a relatively lower impact on Czech towns.

The principal outcome of our study into the transport hierarchy of settlement centres can be considered results of analysis generalizing some broader relations of the transport hierarchy of settlement centres including setting the issue into a broader context. Following from this are some facts that had been formulated already several times but not verified so far (e.g. Viturka, 1981; Marada, 2003), namely that the transport importance of centres always results from the interaction of the vulnerability/peripheral character of the transport location and more complex indicators, particularly the centre's population size or attractiveness for commuting to work. It is also important to note that some centers (e.g. Český Těšín or Břeclav) are severely affected by freight transport. Their importance in the transport system of the Czech Republic is primarily supported by the proximity of the state border. These examples are therefore part of the cross-border urban complexes and their position cannot be definitely perceived as purely peripheral (similarly for Slovakia in Horňák, 2006).

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Author's address:

RNDr. Stanislav KRAFT, Ph.D.
Department of Geography, Pedagogical Faculty, University of South Bohemia in České Budějovice
Jeronýmova 10, 371 15 České Budějovice, Czech Republic
e-mail: *kraft@pf.jcu.cz*

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THE LOCATION OF TOURIST ACCOMMODATION FACILITIES: A CASE STUDY OF THE ŠUMAVA MTS. AND SOUTH BOHEMIA TOURIST REGIONS (CZECH REPUBLIC)

Josef NAVRÁTIL, Roman ŠVEC, Kamil PÍCHA, Hana DOLEŽALOVÁ

Abstract

The impact of various characteristics of geographic space on the location of tourist accommodation facilities is assessed in this paper. Spatial indicators, nearest-neighbour analysis, kernel estimation of the probability density of occurrence, analyses of distances and location in selected environments were used. Hotels create spatial clusters situated mainly in urbanized areas. The predominant occurrence of guesthouses moves from urban areas to colder higher altitudes and to countryside pond areas. Hostels are strictly related to towns, and camps and resorts are situated primarily near water surfaces in warmer areas.

Shrnutí

Lokalizace ubytovacích zařízení cestovního ruchu: Případová studie Šumavy a Jihočeského turistického regionu, Česká republika

Cílem příspěvku je identifikace vlivů různých charakteristik míst a prostředí na lokalizaci ubytovacích zařízení. Bylo využito prostorových indikátorů, analýzy nejbližšího souseda, jádrového odhadu pravděpodobnostní hustoty výskytu a analýzy vzdáleností a polohy ve vybraných prostředích. Hotely se vylišují především svou lokalizací do urbanizovaných prostorů. Převaha výskytu penzionů je posunuta z městského prostředí do chladnějších vyšších nadmořských výšek a do venkovských rybničních oblastí. Turistické ubytovny jsou lokalizovány výhradně do měst. Kempy a rekreační střediska jsou lokalizovány především do blízkosti vod v teplejších oblastech.

Keywords: *lodging, tourism, locate, model, Šumava Mts. and South Bohemia tourist regions, Czech Republic*

1. Introduction

The spatial organisation of tourism has been a core topic in both Slovak and Czech geographical scientific studies for several decades (Vystoupil and Kunc, 2009). These studies have been focused primarily on problems related to the distribution of 'attractiveness', regardless of whether this was in terms of preconditions or potential. Much less attention has been paid to problems directly related to the geography of the material-technical base location. From the viewpoint of the tourism business, it is primarily a matter of accommodation facilities – except for large hotels (Bučeková, 2007), second housing (largely staying beyond the market supply: Fialová and Vágner, 2005) and more recently, modern forms of accommodation (Kadlecová and Fialová, 2010). Taking into account the fact that problems of second housing attract high levels of attention in both Czech and Slovak literature (summarized by Vystoupil et al., 2010), we will focus entirely on the free capacity of accommodation.

Accommodation facilities are basic elements of the material-technical base of tourism (Mariot, 1983), since they facilitate the visitors' stay in a destination and constitute a basis for the further development of the destination (Goeldner and Ritchie, 2009). This is the reason why they are considered to be a core source for the sustainable competitiveness of a destination (Ritchie and Crouch, 2003) and their lack "acts as a constraint on overnight visitor numbers" (Ritchie and Crouch, 2003, p. 246). Building up the accommodation capacities is one of the essential parts of the process of planning tourism development in destinations (Goeldner, Ritchie, 2009), as the location of hotels constitutes a part of the development of the regions (Bégin, 2000). The location of hotels also influences the activities of tourists (Shoval et al., 2011).

Patterns in the distribution of accommodation facilities reflect an immensely complex spectrum of factors and conditions that have an impact on this part of the tourism sector (for literature reviews, please see Urtasun and Gutiérrez, 2006, and Aliagaoglu and Ugur, 2008). The basis of these factors and conditions is represented by constraints and opportunities resulting from both the environment of a location and from the enterprise itself (Chung and Kalnins, 2001), the space-time diversity of which brings various competitive advantages (Kalnins and Chung, 2004). As the basis of the location of accommodation facilities, the presence of a tourist attraction is stated as being something towards which the visitors are pulled by an attractive force (Ritchie and Crouch, 2003). In the location of accommodation, the distance decay function manifests itself – with regard to the attraction's location (Prideaux, 2002) – as the typical tourist wanting to be within walking distance of tourist attractions (Arbel and Pizam, 1977).

Besides these two properly geographic problems, another important element of location is the benefit from the agglomeration of economic activity (discussed for example by Head et al., 1995 or Johansson and Quigley, 2004), that predestine entrepreneurial entities for creating spatial clusters (Porter, 2000). To a certain measure, a principle of differentiation stands in opposition to the last cited very strong driver, the basis of which is the aim of an accommodation facility to become different from their competitor. This holds true for the location of accommodation facilities, too. Regarding the agglomeration and differentiation forces, the location of an accommodation facility is given by the following rule: "by conforming, businesses obtain positive externalities and, by differentiating, they avoid the negative impact of direct competition associated with high levels of absolute conformity and possibly achieved competitive advantage" (Urtasun and Gutiérrez, 2006, p. 398).

Previous analyses of spatial links of accommodation facilities' location were focused mainly on hotels and hotel chains. From the perspective of geographic characteristics of locations (testifying the absolute position of the hotel), a wide range of models were created concerning the hotels' location in urban structures (Bučeková, 2001). Among basic models, we have to cite locations given by socio-economic gravitation and transportation accessibility. The first group comprises locations in the historical centre, in the area between the historical centre and the central business district and in an attractive location. The second group includes locations near the main railway station, along the main road connecting the town with other centres of the urban system in the area or along the road connecting the town centre with the airport (simplified, according to Bégin, 2000; Aliagaoglu and Ugur, 2008). In the Central European milieu, we can also complete the above-mentioned examples by including hotels situated in large housing estates (Bučeková, 2001).

The relative position of hotels was studied based on their geographic distance, supply price, size and services offered (Urtasun and Gutiérrez, 2006). A general trend towards clustering was discovered (Kalnins and Chung, 2004) and many "studies point to the tendency of accommodation to concentrate in the city centre, which is usually the location of the historical core and of most attractions" (Shoval and Cohen-Hattab, 2001, p. 911). In any case, a shift in the location of large hotels was confirmed rather towards the economic centre of the town than towards the historical one: this is documented for example by quickly developing tourism in the Chinese Xiamen (Bégin, 2000). This phenomenon could be related also to the process of de-concentration in the location of hotel facilities (Bučeková, 2007) and to their move towards town peripheries with better accessibility (Shoval and Cohen-Hattab, 2001) and to spatial changes within urban areas (Klusáček et al., 2009) and other economic and social changes in post-communist countries (Stiperskia and Lončar, 2011). A connection was also confirmed between the distance of the hotel's location from the town centre and the type of visitors: "hotels close to the centre unquestionably host a significantly higher percentage of individual tourists than they do tourists belonging to tour groups" (Shoval, 2006, p. 70).

However, these general trends have more actual variants since an influence of the accommodation facility's size and concrete environment on the location was found. A crucial variable in creating spatial clusters is the size of accommodation facilities and their pertinence to hotel chains, as found in results from the analysis of rules in the distribution of Texas hotels (Chung and Kalnins, 2001). Models explaining the processes of the clustering of large and small service providers within one area bring quite often opposing results (compare the results of Chung and Kalnins, 2001; Kalnins and Chung, 2004; Urtasun and Gutiérrez, 2006). One of the reasons could be different costs for building up a facility – hotels "are permanent structures, which grace the landscapes for a long time" (Goeldner and Ritchie, 2009, p. 461), whereas a significant attribute of small accommodation facilities is their relatively high dispersion in a given space, weak promotion in the locality and rapid coming to existence and end (Bégin, 2000).

Accommodation facilities are not located exclusively in large towns, but also close to core resources and attractions situated outside of urban structures (Correia Loureiro and Kastenholz, 2011), where the main attraction is related to nature and landscape (Walford, 2001) and that go through a phase of economic restructuring (Nevěděl et al., 2011). Similar to towns, a high number of types of accommodation facilities visited by different visitors' segments exist also in rural areas (Albaladejo Pina and Díaz Delfa, 2005). Although accommodation "can be an important source of income in towns and villages, especially if it goes beyond simply providing beds for the night" (Albacete-Sáez et al., 2007, p. 46), research in rural areas on the location of these accommodation facilities has attracted unquestionably a lower interest than hotels in towns and cities. When looking up the official statistics of visit rates in accommodation facilities recorded by the Czech Statistical Office, it is obvious that there are other important accommodation capacities besides the hotels in big towns and cities as a component of destinations' tourism sources.

With regard to the differences found in the location of particular accommodation facilities in various environments, it was decided to opt for the evaluation of differences in the location of particular types of accommodation facilities as the aim of this article. The intention was to answer the following research questions:

- Are there differences in the spatial characteristics of the particular types of accommodation facilities?
- Do the above described location criteria have a different effect upon the location of the different types of accommodation facilities?

The neighbouring tourist regions of the Šumava Mts. and South Bohemia were selected as a study area (Fig. 1). These regions belong amongst the most important destinations for domestic tourism and also, because of their proximity to the state border, as destinations for many foreign tourists.

Fig. 1: Study areas within the borders of the Czech Republic, a = Šumava Tourist Region, b = South Bohemia Tourist Region; abbreviations of countries are given in brackets.

2. Methods

2.1 Data set

To be able to assess the location of accommodation facilities in the observed areas, it was first necessary to create a territorially localized database of accommodation facilities. Individual accommodation facilities were identified using the Internet network within a three-phase process. The first phase was recording of accommodation facilities registered by tourist information centres in the observed areas. In the second phase, this database was checked and completed with details of accommodation facilities mentioned on the websites of individual municipalities. In the third phase, the database was extended by adding accommodation facilities registered on the following servers: *http://www.penziony.cz/, http://www.nadovcu.cz, http://ubytovani.nettravel.cz/, http://www.ubytovani.net/, http://www.hotel-ubytovani.com/, http://kamsi.cz/, http://www.ubytovani.cz/, http://www.levneubytovani.net, http://www.prespat.cz/, http://www.ubytovanivcr.cz/, http://ubytovani.turistik.cz/, http://www.e-ubytovani.eu/, http://www.ubytovani-cechy.cz/ and http://www.tourism.cz/.*

The accommodation facilities were localized over WMS map layers of Cenia (CENIA, 2010–11) in the JANITOR J/2 (Pala, 2008) and Quantum GIS (Athan et al., 2011) environments with the information on the number of beds and accommodation type. To be able to further model the number of visitors, it was necessary to use the typology in accordance with the categories of the Czech Statistical Office – hotel, guesthouse, camp, cottage settlement, tourist hostel and resort. To assign the type of accommodation facility, the marking attributed to the particular facility in the source was used. The number of beds, which was not detectable from available sources, was determined as a whole-number value of the average number of beds in the respective type of accommodation facility contained in our database.

The importance of an accommodation facility was measured using a model number of visitors for the given accommodation facility. The number of visitors was simulated, based on the information from the public database operated by the Czech Statistical Office. Based on the number of beds (Capacities of mass accommodation facilities according to the category in tourist regions (CRU6170PU_TR)) and the number of overnight stays (Visit rate of mass accommodation facilities according to the category in tourist regions (CRU9010PU_TR)) comprised in this database, we calculated the average occupancy of the individual types of facilities in different categories in 2010. With regard to the fact that most of the necessary data at lower geographic levels is registered as 'confidential,' the calculation was made separately for the tourist regions of South Bohemia and Šumava Mts. (the lower geographic level could not be used). The potential number of clients (C) of a given facility was then expressed as:

C = (beds × days × occupancy) / overnights

where *beds* = number of beds in the respective accommodation facility, *days* = number of days in the year, *occupancy* = occupancy, and *overnights* = average number of overnight stays in the tourist region. From the perspective of the model of visit rate, the most important type of accommodation in both tourist regions is the hotel, even though guesthouses are comparable in terms of their visit rate (Tab. 1). The category 'cottage settlements' was excluded from subsequent analyses as the number of identified facilities within this category was low.

Type of accommodation	Number of facilities	Number of beds	Potential number of clients (2010)
Hotel	302	19,174	555,630
Guesthouse	1,700	27,593	361,367
Camp	95	8,347	38,598
Hostel	104	6,432	50,976
Resort	58	4,729	61,201

Tab. 1: Numbers of facilities, beds and potential number of clients

2.2 Data analysis

The location of the accommodation facilities was analyzed with the use of a variety of approaches. To answer the first research question, the basic geographical approach to the assessment of the spatial pattern of a point distribution (Robinson, 1998) was used. First, the spatial indices were investigated. The Lorenz Curve, as a simple graphical way of comparing spatial patterns, and the Gini coefficient were used. The problem for both these indicators consists in their relation to the lower territorial units of the observed area. Unfortunately, we did not have at our disposal any official breakdown classification of the two tourist regions into smaller areas or any specified areas that would create these regions (Vágner and Perlín, 2010). The proposal for the new zoning of tourism (Vystoupil et al., 2007) did not solve the problem, as the applied approach is of the typological character. For this reason, we used the version of the tourism zoning from 1981, which although being 30 years old, is the most recent real geographical tourism regionalization on the territory of the present-day Czech Republic. Afterwards, a point pattern analysis was simulated with the application of the nearest-neighbour analysis (Aplin, 1983). The values of R-statistics and z scores were calculated using the Quantum GIS (Athan et al., 2011). In the third step, spatial clusters were modelled (Robinson, 1998) as density maps (Bornmann, Waltman, 2011). High-density areas were identified as areas with kernel estimation values greater than the mean plus two standard deviations (Shi, 2010). The case-side method of kernel estimation was performed by Spatial Analyst 1.0 of ArcView 3.1.

Regarding the second research question, the impact of location criteria was assessed equally by three approaches. First was the assessment of the absolute geographical distance from the nearest element that can make a location more attractive for building up an accommodation facility (having at the same time a point or linear character). Such elements comprise cultural-historical attractions, historical centres, railway stations, important roads (second and higher class) and recreational water areas. The historical centre was identified as a town square or village square over WMS map layers of Cenia, as were the railway stations and stops. To assess the proximity of an important road, it was decided to use the layer 'road' of the product ArcČR 500 (ARCDATA PRAHA, s.r.o.). Furthermore, we used the layer of monuments considered by visitors in tourist regions to be 'important' (Navrátil et al., 2010, p. 56) to assess the proximity of cultural and historic attractions. Finally, to assess the proximity of recreational water areas (Navrátil et al., 2009) that are part of basic tourist elements in the observed areas (Navrátil et al., 2011), we have considered water areas cited in the Atlas of Tourism (Vystoupil et al., 2006) – especially the stretches that are most used for water tourism and the recreational water areas cited in the atlas.

Within the Quantum GIS environment, each accommodation facility was assigned the proximity of the nearest element from each group of the above-mentioned location elements. Differences in average distances among the types of accommodation were investigated by One-way ANOVA with the Tukey unequal N HSD post-hoc tests (Quinn and Keough, 2002).

However, attractions gain the character of polygons, i.e. their location is not influenced by the proximity of a 'certain' point or line, but they are located in a 'certain' environment instead. Due to this finding, the location of the accommodation facility in attractive environments was further assessed. The types were selected according to preconditions for the location of tourist facilities (Mariot, 1983). Climatic types were determined according to Quitt (1971). Because of the low number of accommodation facilities, the climatic areas were united according to a key similar to the key used in the school atlas of the Czech Republic (Basařová et al., 2001): all cold areas were comprised into the cold temperate area, MT3, MT4 and MT5 into the colder moderately warm area (MW), MT7 and MT9 into the middle MW area and MT10 and MT11 into the warmer MW area.

The types of relief were determined according to framework relief types (Löw and Novák, 2008) united into two groups: *a)* ordinary relief (landscapes of hilly areas and highlands of Hercynian, landscapes of plains, landscapes of wide river floodplains and landscapes without differentiated reliefs = towns and cities), and *b)* contrasting relief (landscapes of highlands, landscapes of highly situated plateaus, karst landscapes, landscapes of distinct slopes and rocky mountain ridges, landscapes of kettles, landscapes of carved valleys and landscapes of piles and cones). Land use types were set according to the framework of landscape types and according to area exploitation (Löw and Novák, 2008) – agricultural, agro-forestry, forestry, pond, urbanized. Also, an assessment was made of the accommodation facility location within nature conservation and landscape protection areas, namely with regard to the fact that nature conservation acts as a decelerating element in the development of tourism (Vepřek, 2002) and, at the same time, as a basic natural and landscape attraction (Mariot, 1983). The observed categories were national parks, protected landscape areas and natural parks. Conformity of the model number of visitors in the respective categories of the four above-mentioned types with the expected number of visitors in these categories (which is given by the share of the given category in the total area of the studied territory and by the share of the model number of visitors of this category in the total model number of visitors in the studied territory) was tested by the chi-square goodness-of-fit test (Meloun and Militký, 2006). ANOVA and chi-square test were calculated using the STATISTICA 10 software package (StatSoft, 2011).

Considering the fact that the factors of environment used in the analysis are not supposed to be understood as independent variables (Griffith, 2009), it was necessary to evaluate the most important analyzed factors by means of multidimensional exploratory approaches. To determine the importance of respective variables in the context of all evaluated variables, principal component analysis (PCA) was used applying the programme CANOCO 4.5 (ter Braak and Šmilauer, 2002). The data were not transformed before the proper analysis. Connections between the accommodation facility type and environment factors were assessed by using redundancy analysis (RDA), applying the programme CANOCO 4.5 (ter Braak and Šmilauer, 2002) as well.

3. Results and Discussion

3.1 Impact of space on the location

The curves of location (= Lorenz curves) of the individual categories (hotel, guesthouse, camp and tourist hotels) are quite close to the diagonal and their Gini coefficients are relatively low too (Fig. 2). Both indicators depend on the size of spatial units used and it is true that the curve of location is, with the increasing spatial unit, closer to the even distribution represented by the diagonal in the graph and the Gini coefficients are lower as well. Despite that, the result testifies a relatively regular distribution of these types of accommodation facilities in the respective tourist zones or their parts, including some areas of the observed tourist regions South Bohemia and Šumava – in contrast to the observed distribution of hotels in urban structures (Bučeková, 2001; Bučeková, 2007). The expected regularity of distribution is impaired particularly in the case of resorts as shown by the course of the location curve as well as by the Gini coefficient value.

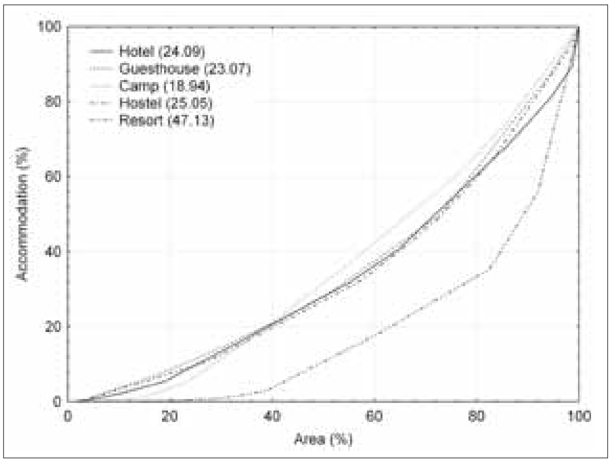

Fig. 2: Lorenz curves of accommodation facility types, Gini coefficients are presented in the upper left

	R-statistics	z scores
Hotel	0.347	– 21.721
Guesthouse	0.370	– 49.759
Camp	0.581	– 7.815
Hostel	0.477	– 10.203
Resort	0.638	– 5.272

Tab. 2: Results of the nearest-neighbour analysis with the values of R-statistics and z scores. All cases are significant at $p < 0.05$

Cluster structures in the distribution of all types of accommodation facilities (Tab. 2) were indentified through nearest-neighbour analysis of the first level. The most significant tendency to clustering was observed in hotels and guesthouses. These indications could show the stronger effect of agglomeration forces influencing these types of accommodation facilities (Kalnins and Chung, 2004). The weakest but still significant effect of these forces was proven in the case of resorts. Under the regime of the Czechoslovak Socialist Republic, these facilities were built up namely in the hinterlands of industrial agglomerations and under specific circumstances (Havrlant M., 1973; Havrlant J., 2003). This result was also proved by the analysis of spatial clustering. We succeeded in identifying an important number of 'hot spots' with a concentration of visitors. These specific locations are different for each of the types of accommodation facilities (Fig. 3). Points of the concentration of hotel visitors are above all in large towns of the region (České Budějovice, Tábor, Písek and Klatovy), in areas with unique cultural and historic monuments (Český Krumlov, Hluboká) and at places with a high spatial accumulation of tourism attractions (Třeboň – history and landscape, area of Železná Ruda/Markt Eisenstein – winter sports, area of Kvilda and Kašperk – winter sports and nature). A completely different structure is evinced, however, by the distribution of the second most important type

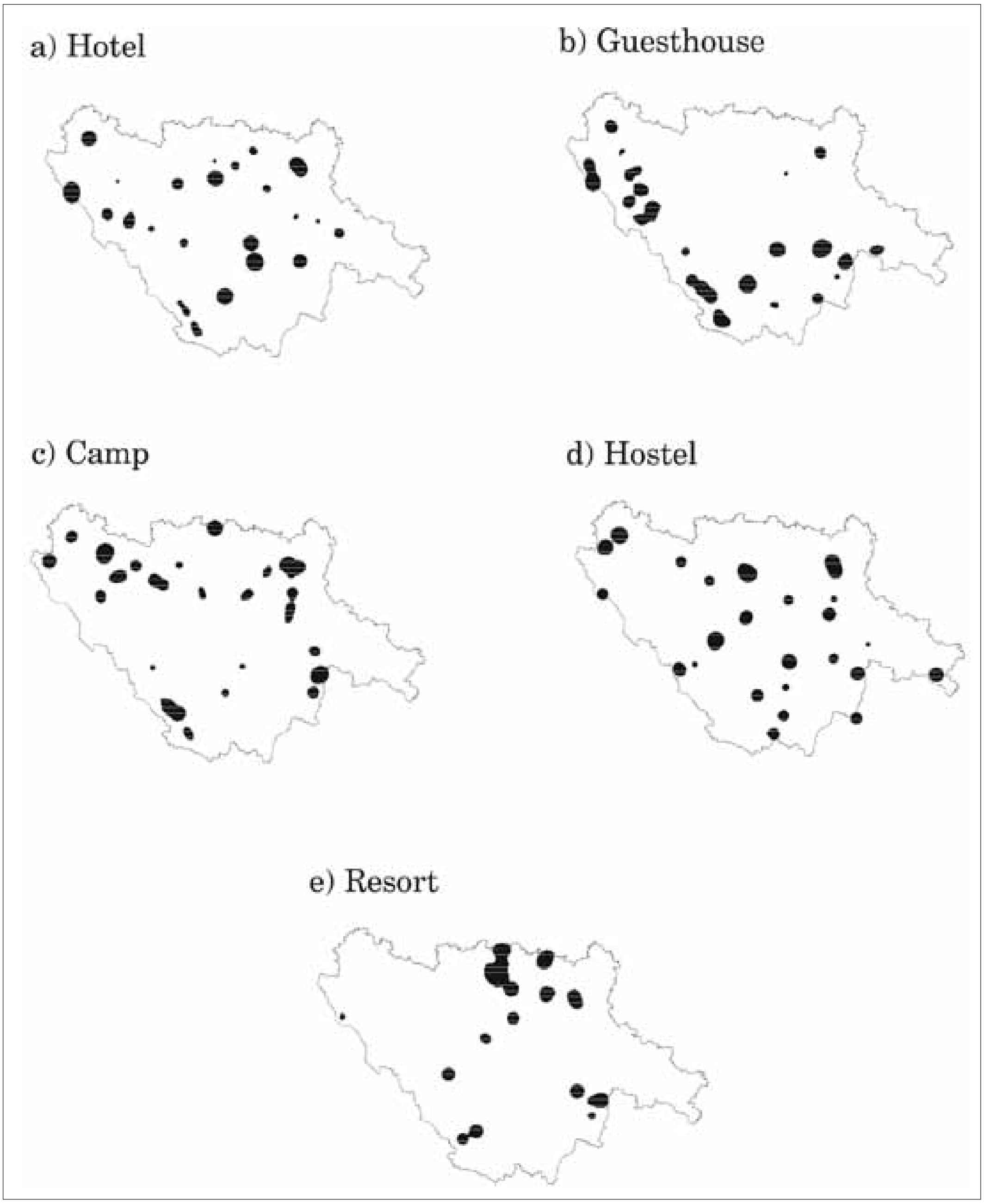

Fig. 3: High-density areas (> mean + 2 standard deviations) of each type of accommodation facility as identified by the case-side method of kernel estimation

of accommodation facilities – guesthouses. Points of their concentration are moved more significantly towards the areas of 'suitable' natural conditions (apart from České Budějovice and Český Krumlov). The centres are situated in two areas: Třeboň area plus the bordering Czech Canada and in the Lipno area plus all the western Šumava. The location of camps substantially differs from both previous location models. The camps are particularly linked to the presence of water surfaces in the landscape. Here we include namely the Lužnice and Otava Rivers used for water sports, water reservoirs such as Lipno, Orlík and the ponds Staňkovský and Hejtman in the Třeboň area. In the case of tourist hostels, the spatial links of their occurrence could not be identified due to the relatively low number of these facilities. We identified a lower number of resorts as well. Despite this fact, we can determine three basic areas of their presence in the observed area – it is particularly the Orlík water reservoir area. A higher concentration of resorts is also noticeable in the Třeboň area and on the lower reach of the Lužnice River.

3.2 Impact of the place on the location

The analysis of spatial clusters obviously shows that the location of individual types of accommodation facilities differs and that it is necessary to study them separately. In the majority of the potential factors of location of accommodation facilities, differences were found in the impact of these factors on the location of particular types of accommodation facilities.

Depending most on proximity to a cultural-historical attraction are hotels, then tourist hostels and guesthouses. On the other hand, statistically significantly different and less dependent on proximity to a cultural-historical attraction are camps and resorts (Fig. 4a). This fact could result from the diverse bid-rent functions (Aitchison et al., 2000) of the two types because resorts and camps need for their entrepreneurial activities substantially larger space and larger area surface than hotels (even the larger ones) and their clientele is usually one with lower expenditures during travelling. Therefore, these facilities provide usually lower standards of services. Considering the fact that the presence of an important monument increases the unit price of land in its surroundings, the camps and resorts are not able to outbid hotels. From this point of view, we can also see an interesting fact that hotels are significantly closer to particular attractions than are guesthouses. This fact could be influenced by the general character of attractiveness of the respective areas, where the accommodation facilities are situated as well as by

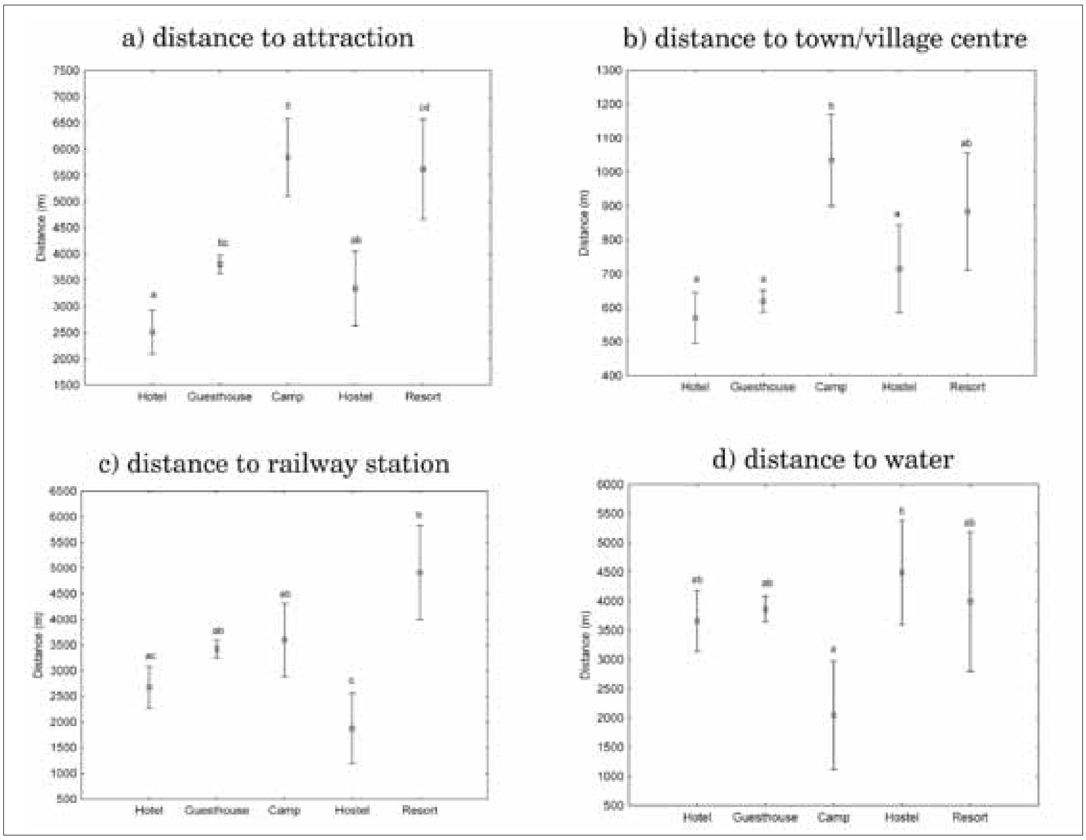

Fig. 4: Distances to selected factors of location for each accommodation type; plotted are mean values (vertical bars denote 0.95 confidence intervals); results of One-way ANOVA; means with the same letter do not differ significantly (Tukey HSD for unequal N test, p > 0.05, N = 2,259)

other localization factors that are important for guesthouses, but not for hotels (compare images ‚a' and ‚b' in Fig. 3). Similar, also, is the case of distance between the accommodation facilities and the centre of a town or village (Fig. 4b). As for the distance to cultural and historic attractions, guesthouses and hotels differ only in distance from the town centre.

The distance from the railway station was confirmed as a factor of location as well, but, moreover, as a factor that significantly differentiates the location of particular types of accommodation facilities (Fig. 4c). The closest average distance from the railway station was found in the case of tourist hostels; their location is significantly closer than that of guesthouses, camps and resorts. On the contrary, the highest distance was found in the case of resorts (significantly further than the cited hostels and even hotels). On the other hand, there were no differences identified in the proximity of the respective types of accommodation facilities to important roads.

With regard to the specific importance of water surfaces for tourism in the Czech Republic and especially for tourism in the studied regions, we also assessed the significance of the location distance from water (Fig. 4d) and identified the highest weight for camps, the distance of which differs significantly from more distant tourist hostels. This result could confirm the location of hostels in the urban area whereas the typical location of camps is in the rural environment, especially in proximity to water (compare Fig. 3c).

By means of the goodness-of-fit test we identified different models in location for all types of accommodation facilities based on a comparison of the model number of visitors and their expected number in different environments.

Climate belongs to the most important factors for the location of tourist activities (Mariot, 1983) and affects also the location of the individual types of accommodation facilities (Tab. 3). Hotels are importantly concentrated, compared to the even distribution, particularly in towns and cities (Goeldner and Ritchie, 2009) and furthermore, even in the coldest areas – mountain resorts. Guesthouses are, on the contrary, concentrated significantly only in colder areas. On the other hand, warm areas are characterized by a higher presence of hostels, resorts and also camps.

Other main preconditions for a tourist location are relief and rock environment (Miklós, 1978). This was found to be true as it was successfully confirmed for all observed types of accommodation facilities with the exception of tourist hostels (Tab. 4). All other types of accommodation facilities show a higher visit rate in landscapes of contrasting relief types than was expected. This is especially true for resorts whose attendance was twice as high as expected. In absolute numbers, the most important part of visit rate move towards the landscapes of contrasting relief types is generated by hotels (over 60 thousand), which is a very interesting finding with regard to the fact that hotels are primarily pulled into the urban structures (see above).

In the sense of the spatial pattern of land use, the landscape is considered a tourist attraction as well. Land use attractiveness as a self-standing category of attractiveness was demonstrated (as could have been expected based on above-mentioned results) namely in hotels located in towns, in which the number of guests was 10 times higher than expected by the model (Tab. 5). The importance of urbanization cores for the location of hotels was thus repeatedly confirmed (Bučeková, 2007), this time when comparing them

		Cold	**Colder MW**	**Middle MW**	**Warmer MW**	**Chi-Square**	**d.f.**	**p**
Hotel	observed	185,858.0	118,492.0	117,367.0	133,913.0	88,280.1	3	< 0.001
	expected	107,718.0	143,217.8	186,058.2	118,636.0			
Guest house	observed	68,963.0	54,232.0	132,987.0	105,185.0	27,640.5	3	< 0.001
	expected	70,056.9	93,145.1	121,007.3	77,157.7			
Camp	observed	8,007.0	12,583.0	13,720.0	4,288.0	18,96.4	3	< 0.001
	expected	7,482.9	9,948.9	12,924.9	8,241.3			
Hostel	observed	15,656.0	17,318.0	13,753.0	4,249.0	9,391.2	3	< 0.001
	expected	9,882.5	13,139.5	17,069.8	10,884.2			
Resort	observed	31,946.0	9,078.0	10,741.0	9,436.0	42,480.9	3	< 0.001
	expected	11,864.8	15,775.0	20,493.8	13,067.4			

Tab. 3: Measured and expected values of the model number of visitors in the respective types of accommodation facilities in the respective types of climate

		Ordinary	Contrasting	Chi-Square	d.f.	p
Hotel	observed	398,029.0	157,601.0	57,215.0	2	< 0.001
	expected	464,151.8	91,478.2			
Guest house	observed	263,028.0	98,339.0	30,359.4	2	< 0.001
	expected	301,872.0	59,495.0			
Camp	observed	31,738.0	6,860.0	48.1	2	< 0.001
	expected	32,243.3	6,354.7			
Hostel	observed	46,107.0	4,869.0	1,771.0	2	< 0.001
	expected	42,583.4	8,392.6			
Resort	observed	36,794.0	24,407.0	24,399.7	2	< 0.001
	expected	51,125.0	10,076.0			

Tab. 4: Measured and expected values of the model number of visitors in the respective types of accommodation facilities in respective types of relief

		Agricultural	Agro-forestry	Forestry	Urbanized	Pond	Chi-Square	d.f.	p
Hotel	observed	15,307.0	289,767.0	46,640.0	161,306.0	42,610.0	1,341,762.0	4	< 0.001
	expected	25,108.2	347,970.8	123,019.2	16,395.6	43,136.2			
Guest house	observed	10,662.0	228,015.0	31,001.0	30,320.0	61,369.0	107,793.9	4	< 0.001
	expected	16,329.7	226,11.0	80,008.4	10,663.3	28,054.6			
Camp	observed	3,283.0	19,661.0	4,523.0	1,920.0	9,211.0	17,516.8	4	< 0.001
	expected	1,744.2	24,172.5	8,545.8	1,139.0	2,996.6			
Hostel	observed	5,870.0	24,108.0	1,764.0	15,832.0	3,402.0	152,022.0	4	< 0.001
	expected	2,303.5	31,924.4	11,286.3	1,504.2	3,957.5			

Tab. 5: Measured and expected values of the model number of visitors in the respective types of accommodation facilities in the respective types of land use

with other types of accommodation, which is also the case of tourist hostels (ten times more clients than expected were accommodated in town hotels.). Likewise, the number of clients of guesthouses in towns is higher than expected (compared to hotels, however, significantly lower, only less than three times as much as expected). Compared to hotels, more than double the number of visitors than expected was discovered in pond landscapes. However, even more important is the pond landscape for camps – they have three times more clients than expected. Apart from the pond landscape and in contrast to the previous types of accommodation facilities, for camps it is also the rural landscape that plays a significant role since the amount of clients accommodated in the agricultural-forest landscape was almost twice than expected. Resorts primarily represent an out-of-the town type of accommodation as none of them was localized in an urban type of landscape, which among other things rendered invalid the implementation of the goodness-of-fit test and hence the assessment of the importance of landscape types for their location.

From the comparison of paradigmatic and expected visit rates in the individual types of accommodation facilities according to the type of conservation, we can see that natural parks do not belong to areas where accommodation facilities are located (Tab. 6). We found too that National parks represent areas, where the visit rate of all accommodation facilities is lower than it should be as related to their surface area (with the exception of guesthouses). This fact is due to restricted construction resulting from requirements for nature conservation and landscape protection.

Guesthouses usually do not have special requirements for their construction and are quite often indistinguishable from the residential function of a village or town (Bégin, 2000). Therefore, it is necessary to understand the existence of a national park as a decelerating factor of the development of tourism (Vepřek, 2002). On the other hand, visitors are significantly attracted by the protected landscape areas in which their attendance is higher than it should be compared to their size (with the exception of

		Without protection	National Park	Protecte Landscape Area	Natural Park	Chi-Square	d.f.	p
Hotel	observed	382,054.0	19,189.0	136,564.0	17,823.0	57,032.3	3	< 0.001
	expected	380,382.6	31,735.9	88,140.8	55,370.7			
Guest house	observed	170,828.0	25,763.0	130,539.0	34,237.0	118,563.0	3	< 0.001
	expected	247,390.8	20,640.2	57,324.4	36,011.6			
Camp	observed	25,218.0	598.0	10,923.0	1,859.0	6,015.8	3	< 0.001
	expected	26,424.0	2,204.6	6,122.9	3,846.4			
Hostel	observed	43,338.0	1,609.0	4,810.0	1,219.0	6,885.9	3	< 0.001
	expected	34,898.0	2,911.6	8,086.4	5,080.0			
Resort	observed	42,179.0	970.0	13,924.0	4,128.0	4,294.0	3	< 0.001
	expected	41,898.0	3,495.6	9,708.4	6,098.9			

Tab. 6: Measured and expected values of the model number of visitors in the respective types of accommodation facilities in large protected areas

tourist hostels) The number of accommodated clients is significantly higher than it corresponds to the surface of the protected landscape areas. That number seems to be fundamental for guesthouses (more than double) but also for hotels, camps and resorts, where it is by 50% higher than it should be. Tourist hostels are situated out of protected areas, which only confirms their location in the town centres.

The PCA results confirm interrelations of the observed factors of environment and the individual types of accommodation facilities. The first component axis separated locations distributed along the gradient of urban – natural environment (Fig. 5), i.e. locations situated in the national park with a cold climate, characterized by higher density of forests, presence of irregular relief types and difficult accessibility, from those locations situated in warm climate and in urban areas. The second component axis separated rural localities along the gradient of water – agricultural environment. This was differentiated namely by facilities situated in landscapes with water bodies, localized particularly in protected landscape areas. Based on the PCA we can conclude that in the observed area, there are three basic and diametrically different types of places with the location of accommodation facilities, i.e., towns, nature, and water. Based on the passively fitted types of accommodation facilities in the graph, we can hypothetically confirm the results of the density graphs of the spatial distribution of individual accommodation facilities – by their location, hotels and hostels gravitate to the urban environment, guesthouses and resorts incline to the natural environment, and camps to the water environment. This hypothesis was successfully confirmed by the direct ordination of RDA, as its both first and second axes are significant (F = 17.540, $p < 0.01$; resp. F = 7.815, $p < 0.01$). The explained variability is, however, not too

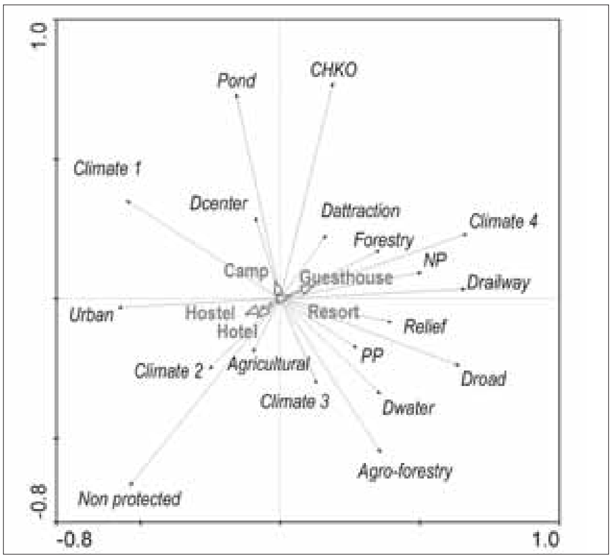

Fig. 5: 1st and 2nd axes of the PCA of the data of environment factors with passively projected types of accommodation facility (length of their arrows is independent on different numbers of types of accommodation facility in the database)
Dcenter = distance to city/town/village centre
Dattraction = distance to cultural/historic attraction
Droad = distance to road
Drailway = distance to railway station
Dwater = distance to water bodies in recreational use
Relief = contrasting relief
Urban = urbanized type of landscape
Pond = pond type of landscape
Agricultural = agricultural type of landscape
Agro-forestry = agro-forestry type of landscape
Forestry = forest type of landscape
NP = location within National Park
CHKO = location within Protected Landscape Area
PP = location within Natural Park
Non-protected = location out of any protected area
Climate1 = warmer MW
Climate2 = middle MW
Climate3 = colder MW
Climate4 = cold

high (1.1%), although this is not surprising. All types of accommodation facilities are localized in almost all types of the studied variables of the environment. We have after all succeeded in demonstrating statistically significantly different models of location factors for the individual types of accommodation facilities (relative in relation to other types of accommodation facilities). For the hotels, the most important criterion of location is the urban area. For the guesthouses, it is the natural environment of cold climate with a dynamic relief and location within a national park. For the camps and for the resorts, too, it is a long distance from the centres of towns and villages, as well as from cultural and historic attractions, and for the hostels, it is the location in areas outside the protected areas (Fig. 6).

4. Conclusions

We tried to assess the impact of a broad number of geographic factors in the location of accommodation facilities in two tourist regions of the Czech Republic: South Bohemia and Šumava Mts. The information on location, size and type of accommodation facility was obtained from documents published on the Internet. The data source basis created in this way allowed us to geocode the location of 2,259 accommodation facilities and to enlarge our knowledge of the spatial organization of accommodation capacities of the material-technical basis of tourism, the analysis of which normally uses the visit rate statistics of mass accommodation facilities in municipalities or in higher territorially administrative units from the database of the Czech Statistical Office or from the 'census of people, houses and flats'. Regarding the fact that our database is geocoded to addresses according to the descriptive number and comprises even individual holiday homes, this database allowed us to assess the spatial structure of tourist facilities in a way that is impossible using conventional and generally accessible sources of information.

Based on our analysis, we conclude that the impact of the majority of geographical location factors for accommodation facilities cited in the research literature was confirmed. However, the location of the individual types of accommodation facilities significantly differs and each type of accommodation facility can be characterized by the following average effects of location:

- hotels participate most importantly in the number of accommodated people in the observed regions; they show an important tendency to create spatial clusters and these clusters are situated mainly in urbanized areas. Besides the large towns and cities, hotels are typically located in the proximity of unique cultural and historic attractions, as well as mountain resorts for winter sports;

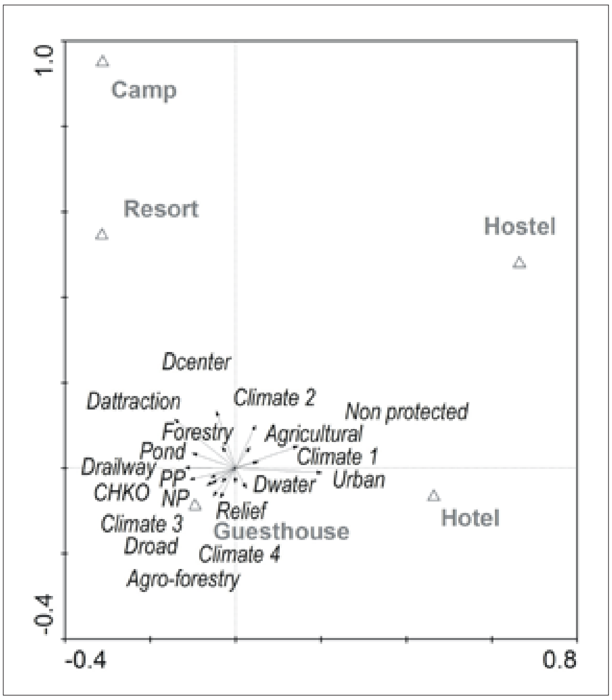

Fig. 6: 1st and 2nd canonical axes of redundancy analysis
For legend see Fig. 5

- guesthouses constitute the second most important part in the total number of accommodated clients and are concentrated in urban areas, too, but not as strictly as hotels, as the core of their occurrence moves towards special rural structures – to colder higher altitudes and to pond areas. They are also the only accommodation type more expanded (than expected) directly in the Šumava National park;
- camps have found the focal point of their presence decidedly out of urban areas; they are situated namely near water courses and water surfaces, especially in warmer areas;
- tourist hostels are strictly related to towns and an important location factor for them is the accessibility of public transport; and
- resorts are localized particularly in several specific areas in the observed regions and strictly out of the urban environment, namely near water in warmer areas.

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Authors´ addresses:

RNDr. Josef NAVRÁTIL, Ph.D., e-mail: *josefnav@gmail.com*
Ing. Roman ŠVEC, e-mail: *rsvec@ef.jcu.cz*
Ing. Kamil PÍCHA, Ph.D., e-mail: *kpicha@ef.jcu.cz*
Ing. Hana DOLEŽALOVÁ, Ph.D., e-mail: *dolezal@ef.jcu.cz*
Department of Trade and Tourism, Faculty of Economics,
University of South Bohemia in České Budějovice
Studentská 13, 370 05 České Budějovice, Czech Republic

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PROBLEMS OF THE REGIONAL NOMENCLATURE OF THE POLISH-CZECH BORDERLAND

Agnieszka ROZENKIEWICZ, Janusz ŁACH

Abstract

Similarities and dissimilarities in the number and origin of regional names in the physical-geographical division of the Polish-Czech borderlands are discussed in this contribution. The main aim is to introduce a new regional nomenclature created with the recognition of equality and sovereignty, as well as border changes concerning trans-boundary regionalization at the level of macro-regions and meso-regions. The final results are maps that show the cross-border solutions for the problems discussed, including the English nomenclature that should facilitate international research into this field of research. The subject matter of the study refers to the regional research of the Polish-Slovak borderland carried out by Jarosław Balon and Miłosz Jodłowski from the Jagiellonian University in Kraków.

Shrnutí

Problémy regionální nomenklatury v polsko-českém pohraničí

Článek se zabývá současnými podobnostmi a rozdíly v počtu a původu regionálních názvů fyzicko-geografického členění v polsko-českém pohraničí. Cílem je představit novou regionální nomenklaturu vytvořenou s vědomím rovnosti a svrchovanosti zemí i změn hranic týkajících se přeshraniční regionalizace na úrovni makro- a mezo-regionů. Výsledkem jsou mapy, které představují návrh nové nomenklatury včetně návrhu jeho překladu do angličtiny, což by usnadnilo mezinárodní výzkum v tomto oboru. Tato práce vychází z obdobného regionálního výzkumu v polsko-slovenském pohraničí, kterou zpracovali Jarosław Balon a Miłosz Jodłowski z Jagellonské university v Krakově.

Key words: *regional names, physical-geographical division, Polish-Czech borderland*

1. Introduction

The place names (toponyms) co-create the physical and cultural landscape. They express the morphological and cultural forms that exist in the description of the landscape. Language is a basic tool that describes the history of a place that determines its identity (Chylińska, Kosmala, 2010). This paper addresses the issues of the diverse toponymy of the Polish-Czech borderland. The Polish-Czech border within the Lower Silesian Province is about 500 kilometers long and its overall route from the north-west to the south-east was determined by varied historic and natural factors. The historic factors were decisive in terms of dividing the homogeneous morphological regions into separate parts differently named, e.g. Pogórze Izerskie and Frýdlantská pahorkatina Hilly Land. The accession of Poland and the Czech Republic to the Schengen zone on 21 December 2007 had a significant impact on the transboundary co-operation. The new reality poses numerous questions that are concerned with the directions of the borderland's development and its function. It also requires research into the environmental, social and economic phenomena that started to occur in the borderland. One of problems in the Polish-Czech relations is the necessity of reaching an agreement concerning the borderland regionalization and its nomenclature. This research presents similarities and discrepancies in the quantity and origin of the physical-geographical nomenclature of the Polish-Czech borderland at the level of macro- and meso-regions. It attempts to introduce new toponyms in accordance with the rules of cohesion, equality and territorial sovereignty. The authors present a proposal for synthetic maps of regional nomenclature.

2. Historical conditions that influenced the existing regional nomenclature of the borderland

The southern geographical and historical border of Silesia, including Lower Silesia, dates back to the 10th century, when the Bishopric of Wrocław was established in the year 1000. The south-western border of Silesia was a line along the massif of the Jizerské hory Mts. (Polish: Góry Izerskie) and the Krkonoše Mts. (Polish: Karkonosze), going through the massif of the Kamienne Mts. (Polish: Góry Kamienne) to the edge of the Sudetic Marginal Fault in the area of the Sowie Mts. (Polish: Góry Sowie). On the line of the Sudetic Marginal Fault, the border went along the edge of the Sowie Mountains, Bardzkie Mountains (Polish: Góry Bardzkie), Złote Mountains (Polish: Góry Złote), Rychlebskie Mountains (Polish: Góry Rychlebskie) to the Jeseník Massif (Czech: Hrubý Jeseník) in the south-eastern direction (Fig. 1)

As far as the north-western part of Silesia is concerned, the Jizerské hory Mts. and the Krkonoše Mts. have constituted a stable border zone since the 10th century. However, the borderland from Lubawka to Prudnik, including the area of Kłodzko Land had undergone numerous political changes up to the 15th century (Staffa, 2005). At the end of the 10th century, the Kłodzko Land was the property of the Polish house of Slavnikids (Polish: Sławnikowice). In 995, it came into the ownership of the Czech Přemyslid dynasty (Czech: Přemyslovci) and was included into the Bohemian Crown. Due to the efforts of Casimir I the Restorer at the beginning of the 11th century, the Kłodzko Land came back to the Polish possession. In the year 1093, Břetislav II rejoined the Kłodzko Land to the Czech state and finally under the terms of the Treaty of Kłodzko from 1137 it belonged to the Diocese of Prague (Praha), thereby to the Kingdom of Bohemia. In the period of the Czech rule in Lower Silesia and the Kłodzko Land, other regulations of the borders took place. In 1477, Náchod and Homole were acquired to the County of Kłodzko, which was reduced by the lands near Bronów in 1491. For five subsequent centuries the Polish-Czech borderland was owned in turn by the Bohemian Crown from 1335 to 1526, the Austrian house of Habsburg from 1526 to 1740, and then from 1740 to 1918 it was ruled by Prussia and Germany (Czapliński et al., 2002).

Fig. 1: Prehistoric and early Piast period to the year 1138 (Authors´ elaboration based on the historical map from Atlas Dolny Śląsk, Śląsk Opolski, Eko-graf, Wrocław 2008)

The problem of the ethnic identity of inhabitants living in the Polish-Czech borderland was not apparent until the 13th century. Apart from the Jewish nation, the population of Silesia was homogeneous in terms of language-wise and it was constituted mainly by the autochthonous Poles (Wójcik, 2006). This situation has been changing since the 1220s when the Walloons, Germans and Flemish started to settle down in the area on the Magdeburg Rights. During the rules of Henry I the Bearded (1165–1238), a new settlement law related to both the Polish and German population, eliminating the previous divisions that mainly consisted in isolating the Polish nation. Since the times of Bolesław II the Rogatka (1220–1278), the immigrated German knighthood dominated the manors where the German culture, customs and language were introduced. The turn of the 13th and 14th centuries was a period of dominating German language in urban administration, trade, crafts, judiciary and trade guilds (Wójcik, 2006). The period between the 14th and 16th centuries was characterized by the occurrence of two national groups in Silesia. The area to the west of the Oder River (today's area of Sudeten Mts. and Sudeten Foreland) was inhabited by the German population with a minority of the Polish people. In the area to the east of the river, Polish nationals outnumbered the Germans (Goliński, 2006; Mrozowicz, 2006).

The existence of the politically and ethnically homogeneous formation of today's Polish Sudeten came to end after World War I and II. Since the end of World War II, almost the whole area of historic Silesia, including Lower Silesia, Opole Silesia and Upper Silesia has belonged to Poland. The border delimitation however aggravated a conflict between Poland and Czechoslovakia, already existing after World War I, which became especially apparent in the 1940s and 1950s. This problem concerned the area of Zaolzie, Kłodzko Land (near Kudowa Zdrój and Międzylesie), and the regions of Głubczyce, Racibórz, Wałbrzych, Jelenia Góra and the areas of Żytawa, Głuchołazy and Koźle. Under pressure from the Union of Soviet Socialist Republics, Poland and Czechoslovakia signed a treaty of friendship and solution of the border conflict on the 10 March 1947 in Warsaw. Nevertheless, it was not until the 13 April 1958 when the agreement concerning the border delimitation was signed, which definitely ended the arrangements relating to the borderline in the Lower Silesia section. This situation gave rise to new conditions which were decisive in the development of the settlement in the area, and which determined its current shape, including the place names. The process of Polonization was multidimensional and among other things comprised the changes of the regional nomenclature. As early as in 1945, Aleksander Zawadzki banned usage of the German language with a simultaneous order to remove traces of the German culture (Czapliński et al., 2002). The expansion of the Polish borders by regained territories in 1945 led to another interesting phenomenon, namely Repolonization. Ideological politics of the People's Republic of Poland aimed at demonstrating the justice of history, which was to be expressed by the fact that the Piast lands were Polish again. The politics of Repolonization led to the struggle against the presence of the German language on monuments, printed matters, place names, geographical objects and to the ban on using the German language. The urgent need of this period was to introduce the new Polish nomenclature of places, topographic points and geographical elements. Most existing names did not have any equivalents in either Polish of Slavic meaning. New names started to appear spontaneously thanks to the creativity of the first settlers or authorities of the Polish Army (Kamiński et al., 2006).

The phenomenon of resettling the Sudeten region after World War II did not concern its Czech part largely. After the displacement of the Sudeten Germans, the area remained to be inhabited by Czech settlers, whose lineage dates back to the 9th century when the Slavic-Czech tribes were united by the Přemyslid dynasty. Until the beginning of the 16th century, the political and ethnic stability of the Bohemian Kingdom guaranteed giving and evolving the Czech names. The stability was destroyed, however, when the Habsburg dynasty ascended the Czech throne. A religious and political conflict began, which led to the Germanization of the Czech lands that became part of the Austrian Empire and part of Austria-Hungary in 1867. After the fall of the Austro-Hungarian Monarchy in 1918, an independent state – Czechoslovakia was established. This entailed the revival of the Czech language in toponyms. Czech names of sites and orographical units were officially proclaimed after 1918. Austrian names in the German language were either translated or adjusted to the requirements of the Czech language and among others comprise the following examples: Spindelmuhle – Špindlerův Mlýn, Karlsbrunn – Karlova Studánka, Hohes Rad – Vysoké Kolo, Altvater – Praděd, Friedland – Frýdlant, Braunau – Broumov, Adersbach – Adršpach. All of the above-mentioned factors of the complex history of Silesia resulted in a situation where the neighbouring geographical objects on both sides of the border frequently have completely divergent names (Potocki, 2008; Rozenkiewicz, Łach, 2010).

3. The existing and proposed regional division and nomenclature of the Polish-Czech borderland

The commonly used physical-geographical divisions of the borderland at the level of macro- and meso-regions by Kondracki (1998) and Demek et al. (1987), for Polish and Czech regionalization respectively, are not coherent and show significant differences relating to borders, nomenclature and ranks of the regions (Fig. 2).

The research has shown numerous problems with the physical-geographical interpretation of regions considering their ranks, the spelling of their names in Polish and Czech and their origin. Problems of incoherent regional names in the borderland area of the Sudeten were discussed by Walczak (1968) and Kondracki (1994). The issues pertaining to the nomenclature, particularly in the area of the Central Sudeten, were also addressed by Potocki (2000, 2008). Similar problems of inconsistence in the regional nomenclature regarding the Polish-Slovak borderland were argued by Balon and Jodłowski (2004). The subject of our paper relates to the regional research undertaken by the above-mentioned authors from the Jagiellonian University in Kraków.

Fig. 2: Meso-regions of the Polish-Czech borderland (according to Kondracki, 1998; Demek et al., 1987); Symbols at the names of regions refer to symbols used in Tab. 1. (Adapted after Łach et al., 2010)

The Polish-Czech borderland zone in the border section of the Lower Silesian Province is located in the province of the Bohemian Massif (Czech: Česká vysočina), and the sub-province of the Sudeten with the Sudeten Foreland (Czech: Krkonošsko-jesenická soustava). There are substantial differences in the nomenclature of the same regional unit even at the level of sub-provinces. According to Potocki (2000), the Czechs stopped using the name Sudeten because of its negative political connotation in the 1980s. They replaced it with an artificially created name Krkonošsko-jesenická soustava, which consists of the names of two highest mountain ranges of the Sudeten – the Krkonoše Mountains (the Giant Mts.) and Hrubý Jeseník (Mts.). In a further regional division of the same area Demek et al. (1987) distinguished four macro-regions (Czech: soustava), three of which are transboundary and are characterized by different nomenclatures on both sides of the border. The concerned macro-regions comprise the Western Sudeten (Czech: Krkonošská soustava), the Central Sudeten (Czech: Orlická soustava), the Eastern Sudeten (Czech: Jesenická soustava) and one region located entirely on the Polish side of the border – the Western Sudeten Foreland. For these macro-regions, the Czech names are similar to the Polish ones and stem from the highest mountain range within each unit.

On the taxonomic level of macro-regions, the borders of regions on the territory of Poland and the Czech Republic are convergent and coherent. Taking into consideration the common macro-regional nomenclature, the authors suggest that the Czech Sudeten should be given similar names to their Polish equivalents – the Western Sudeten (Polish: Sudety Zachodnie, Czech: Západní Sudety), the Central Sudeten (Polish: Sudety Środkowe, Czech: Střední Sudety) and the Eastern Sudeten (Polish: Sudety Wschodnie, Czech: Východní Sudety).

The situation is different on the level of meso-regions where complications stem from a different number and different origin of the names. Within the Polish-Czech borderland, in the Lower Silesian Province there are 14 Polish meso-regions distinguished by Kondracki (1998) and 11 Czech meso-regions in the classification by Demek et al. (1987) – see Tab. 1.

In the research on the nomenclature, the number of existing regional names was reduced respecting the principles of equality and sovereignty. With this end in view, the following rules of creating the new names of the regions were used (adapted after Balon and Jodłowski, 2004):

- If the region has two different physical-geographical names on both sides of the border, then only one, common, compound name should be accepted. In accordance with the rule of sovereignty, the newly created compound name should consist of the names used in Poland and in the Czech Republic, e.g. Frydlandzko-Izerskie Foothills/ Jizersko-frýdlantská Foothills (Polish: Pogórze Frydlandzko-Izerskie, Czech: Jizersko-frýdlantská pahorkatina). Frequently, the compound names comprise names of local towns, rivers and cultural regions what might exclude creating a homogeneous name in terms of the origin;
- If the border regions have similar physical-geographical names, then the local names should be left unchanged. However, while describing the region we should refer to it as to a whole, including both cross-border parts. For instance, Karkonosze and Krkonoše (the Giant Mountains) should be used for Polish and Czech publications respectively but with reference to the area as a whole. The same solution is proposed for example for the Izerskie Mountains/Jizerske Mountains and the Orlickie Mountains/Orlicke Mountains;
- If the region has two similar names but one of them represents the physical-geographical features of the region better, it should be left as the valid one, e.g. Masyw Śnieżnika + Králický Sněžnik = Masyw Śnieżnika (English: the Snieznik Massif); and
- If the region has a name only on one side of the border and it does not exist on the other, the existing name should be left unchanged, e.g. Lubawska Gate (Polish: Brama Lubawska) or the Bystrzyckie Mountains (Polish: Góry Bystrzyckie).

As a result of applying the above-mentioned rules, a new map of the physical-geographical division of the Sudeten was made. It includes the following newly-created or reduced regional names in the Polish and Czech language (Fig. 3):

- Polish: Pogórze Frydlandzko-Izerskie, Czech: Jizersko-frýdlantská pahorkatina;
- Polish: Góry Stołowo-Broumowskie, Czech: Stolové a Broumovské hory;
- Polish: Góry Kamienno-Jaworowe, Czech: Kamenné a Javoří hory;
- Polish: Obniżenie Ścinawsko-Broumowskie, Czech: Scinavská a Broumovská pánev;
- Polish: Góry Rychlebsko-Złote, Czech: Rychlebské a Zlaté hory; and
- Polish: Masyw Śnieżnika, Czech: Masiv Snežníku.

Another new element was the introduction of the name of the Polish meso-region which was reduced from Obniżenie Żytawsko-Zgorzeleckie to Obniżenie Żytawskie (English: Zytawska Basin).

The reduction and unification of the nomenclature of the physical-geographical regions is not an easy process as both countries have distinct orthography and spelling rules. It is recommended that in the further research the names are consulted with the Czech and German experts in this field. The simplification of the Polish-Czech borderland's nomenclature would facilitate the process of academic research not only for regional but also for European significance. Furthermore, the implementation of the proposed changes would also allow the usage of the unambiguous English nomenclature, where the overall number of the regions was reduced from 25 to 16 (Fig. 4).

<table>
<tr><th>Macro-regions Poland</th><th>Meso-regions Poland</th><th>Macro-regions The Czech Republic (podsoustava/oblast)</th><th>Meso-regions The Czech Republic (celek)</th></tr>
<tr><td rowspan="2">A – Pogórze Zachodniosudeckie (332.2)</td><td>1. Obniżenie Żytawsko-Zgorzeleckie (332.25)</td><td rowspan="4">E – Krkonošská (IVA)</td><td>I – Žitavská pánev (IVA-4)</td></tr>
<tr><td>2. Pogórze Izerskie (332.26)</td><td>II – Frýdlantská pahorkatina (IVA-5)</td></tr>
<tr><td rowspan="2">B – Sudety Zachodnie (332.3)</td><td>3. Góry Izerskie (332.34)</td><td>III – Jizerské hory (IVA-6)</td></tr>
<tr><td>4. Karkonosze (332.37)</td><td>IV – Krkonoše (IVA-7)</td></tr>
<tr><td rowspan="8">C – Sudety Środkowe (332.4-5)</td><td>5. Brama Lubawska (332.41)</td><td rowspan="8">F – Orlická (IVB)</td><td rowspan="4">V – Broumovská vrchovina (IVB-1)</td></tr>
<tr><td>6. Góry Kamienne (332.43)</td></tr>
<tr><td>7. Obniżenie Ścinawki (332.47)</td></tr>
<tr><td>8. Góry Stołowe (332.48)</td></tr>
<tr><td>9. Pogórze Orlickie (332.51)</td><td>VI – Podorlická pahorkatina (IVB-3)</td></tr>
<tr><td>10. Góry Orlickie (332.52)</td><td rowspan="2">VII – Orlické hory (IVB-2)</td></tr>
<tr><td>11. Góry Bystrzyckie (332.53)</td></tr>
<tr><td>12. Kotlina Kłodzka (332.54)</td><td>VIII – Kladská kotlina (IVB- 4)</td></tr>
<tr><td rowspan="3">D – Sudety Wschodnie (332.6)</td><td>13. Masyw Śnieżnika (332.62)</td><td rowspan="3">G – Jesenická (IVC)</td><td>IX – Králický Sněžnik (IVC-4)</td></tr>
<tr><td>14. Góry Złote (332.61)</td><td>X – Rychlebské hory (IVC-5)</td></tr>
<tr><td></td><td>XI – Hanušovická vrchovina (IVC-3)</td></tr>
<tr><td>Code 332.x in division by J. Kondracki 1998</td><td>Code 332.xy x in division by J. Kondracki 1998</td><td>Code IVx in division by J. Demek et al. 1987</td><td>Code IVx-y in division by J. Demek et al. 1987</td></tr>
</table>

Tab. 1: The division and nomenclature of the macro-regions and meso-regions of the Polish-Czech borderland (Adapted after Łach et al., 2010)

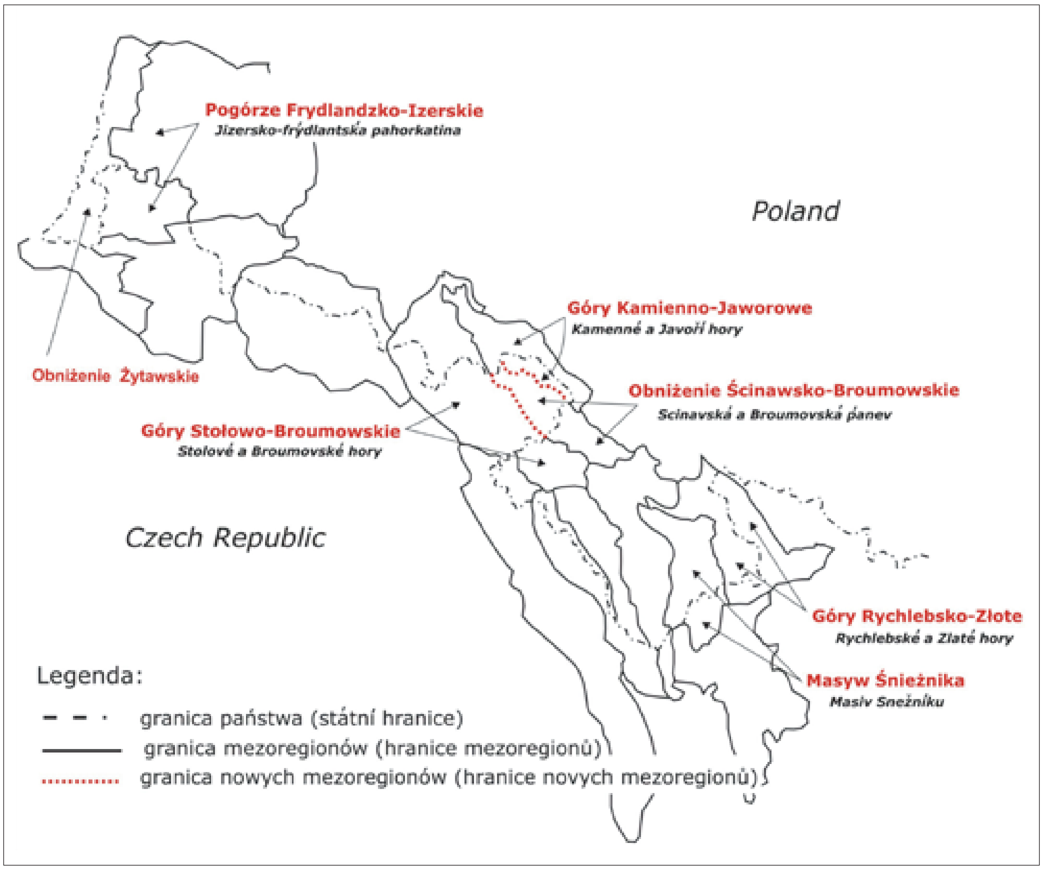

Fig. 3: Proposal for the new nomenclature of the physical-geographical division of the Sudeten (Adapted after Łach et al., 2010)

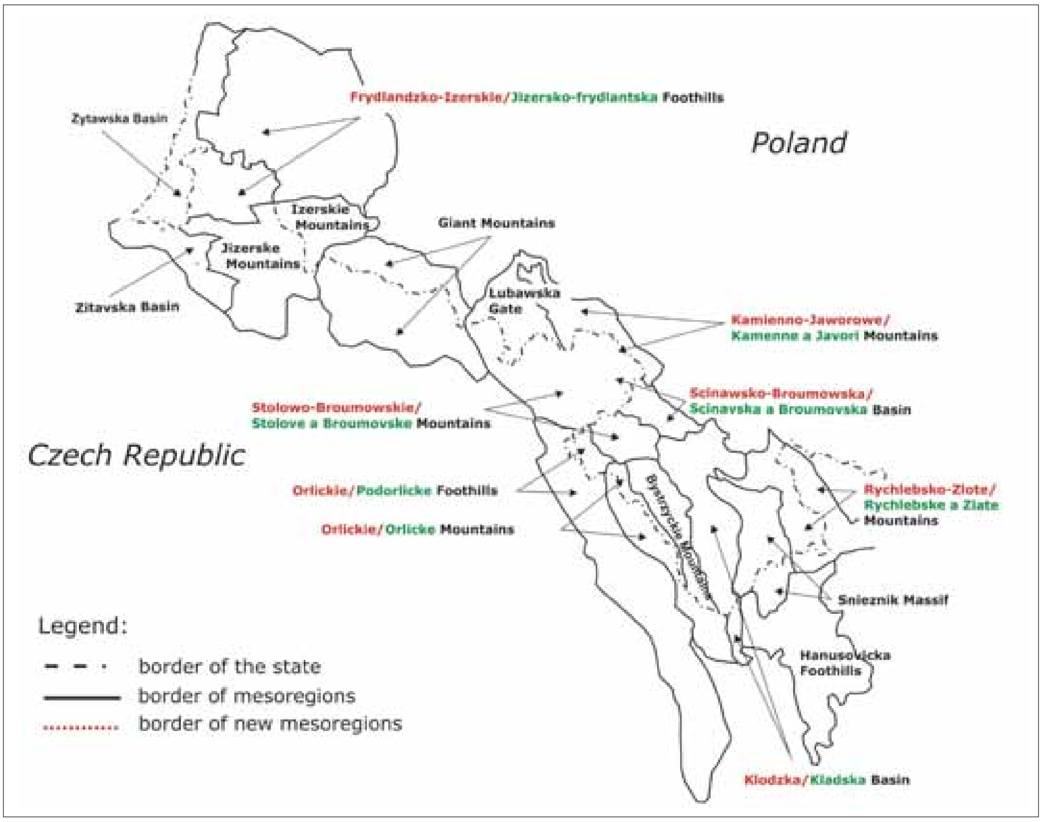

Fig. 4: Proposal for the English nomenclature of the physical-geographical regions of the Sudeten within the Polish-Czech borderland (Adapted after Łach et al., 2010)Summary

Summary

The political and ethnic changes of many centuries determined the current picture of the Polish-Czech borderland, which still remains the area of numerous social and economic actions that facilitate the co-existence and co-operation of its peoples. The historical-political changes of the 20th century resulted in the border issues for the Czech Republic and Poland again in this area. Resulting from the complex history, the regional division of the borderland is far from being geographically or linguistically homogeneous. In case of both Polish and Czech borderlands, the recovered physical-geographical areas were given new names. However, the German nomenclature had a significantly greater impact on creating the Czech toponyms, which were either directly translated from the German language or their semantic form resembles the previous one. The existence of two names of different meaning in one morphologically homogeneous region brings numerous problems in the interpretation of its geographical environment. By the virtue of the fact that the number of the physical-geographical regions of the Sudeten borderland is unequal on both sides of the border, the number of toponyms also differs. However, all the place names consistently refer to morphological terrain forms. This demonstrable proposal for the physical-geographical nomenclature of the Polish-Czech borderland, despite all efforts, still might cause controversy from the content-related or methodological perspective and requires linguistic expertise. Nevertheless, it has to be emphasized that an important element of this research was the rule of sovereignty of local names. The new regional names, where applicable, correspond to elements of the local, national and international languages. Maps of the new physical-geographical division presented in this paper can be used as a basis for further regional agreements in trans-boundary co-operation.

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Authors´ addresses:

Mgr. Agnieszka ROZENKIEWICZ, e-mail: *agnieszkarozenkiewicz@wp.pl*
Dr Janusz ŁACH, e-mail: *lach@geogr.uni.wroc.pl*
Institute of Geography and Regional Development, Department of Regional and Tourism Geography, University of Wrocław
Pl. Uniwersytecki 1, 50-137 Wrocław, Poland

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MORAVIAN GEOGRAPHICAL REPORTS

Aims and Scope of the Journal

Moravian Geographical Reports [MGR] is an international peer-reviewed journal, which has been published in English continuously since 1993 by the Institute of Geonics, Academy of Sciences of the Czech Republic, through its Department of Environmental Geography. It receives and evaluates articles contributed by geographers and by other researchers who specialize in related disciplines, including the geosciences and geo-ecology, with a distinct regional orientation, broadly for countries in Europe. The title of the journal celebrates its origins in the historic land of Moravia in the eastern half of the Czech Republic. The emphasis at MGR is on the role of 'regions' and 'localities' in a globalized society, given the geographic scale at which they are evaluated. Several inter-related questions are stressed: problems of regional economies and society; society in an urban or rural context; regional perspectives on the influence of human activities on landscapes and environments; the relationships between localities and macro-economic structures in rapidly changing socio-political and environmental conditions; environmental impacts of technical processes on bio-physical landscapes; and physical-geographic processes in landscape evolution, including the evaluation of hazards. Theoretical questions in geography are also addressed, especially the relations between physical and human geography in their regional dimensions,

Instructions for authors

The journal, Moravian Geographical Reports, publishes the following types of papers:

(1) **Original scientific papers** are the backbone of individual journal issues. These contributions from geography and regionally-oriented results of empirical research in various disciplines normally have theoretical and methodological sections and must be anchored in the international literature. We recommend following the classical structure of a research paper: introduction, including objectives (and possibly the title of the general research project); theoretical and methodological bases for the work; empirical elaboration of the project; evaluation of results and discussion; conclusions and references. Major scientific papers also include an Abstract (up to 500 characters) and 3 to 8 keywords (of these, a maximum of 5 and 3 of a general and regional nature, respectively). With the exception of purely theoretical papers, each contribution should contain colour graphic enclosures such as photographs, diagrams, maps, etc., some of which may be placed on the second, third or fourth cover pages. For papers on regional issues, a simple map indicating the geographical location of the study region should be provided. Any grant(s) received to support the research work must be acknowledged. All scientific papers are subject to the peer-review process by at least two reviewers appointed by the Editorial Board. The maximum text size is 40 thousand characters + a maximum of 3 pages of enclosures. The number of graphic enclosures can be increased by one page provided that the text is shortened by 4 thousand characters.

(2) **Scientific communications** are published to inform the public of continuing research projects, scientific hypotheses or findings. This section is also used for scientific discussions that confront or refine scientific opinions. Some contributions may be reviewed at the discretion of the Editorial Board. Maximum text length for these scientific communications is 12 thousand characters.

(3) **Scientific announcements** present information about scientific conferences, events and international co-operation, about journals with geographical and related issues, and about the activities of geographical and related scientific workplaces. The scientific announcements are preferably published with colour photographs. Contributions to jubilees or obituaries on prominent scientific personalities are supplied exclusively on request from the Editorial Board. The maximum text length of the scientific announcements is 5 thousand characters.

(4) Moravian Geographical Reports also publishes **reviews** of major monographs from geography and other related disciplines published as books or atlases. The review must contain a complete citation of the reviewed work and its maximum text is 3.5 thousand characters. Graphics are not expected for the reviews section.

Fig. 13: Forested Javorníky Mts. on the boudary to Slovakia in the area of Walachian colonization ("kopanice"). In the backfround the Highland Vizovická vrchovina. Photo J. Demek

Fig.14: The floodplain forest around the Morava River in the Middle Morava Floodplain (Středomoravská niva) near the village Dub nad Moravou. Photo J. Demek

Illustration related to the paper by J. Demek, P. Mackovčin and P. Slavík