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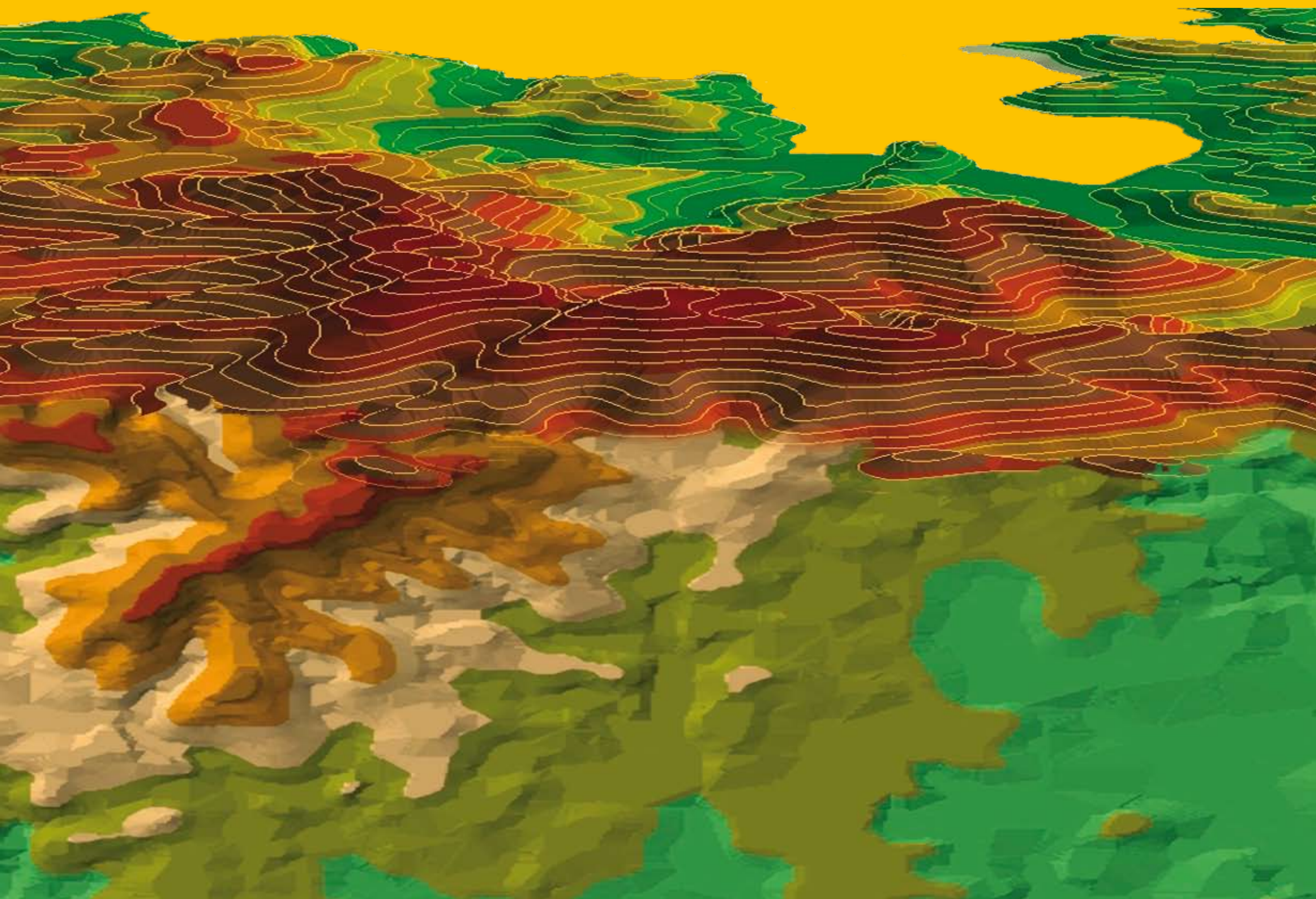

Fig. 5: Partly forested talus cone below the rock cliff. Notice the source zone in a ravine continuing to a debris flow in the upper part of the cone, and abundance of large woody debris on the cone (Photo P. Raška)

Fig. 6: Deceleration and accumulation of clasts below the rock cliff is frequently caused by the protective effect of ramified trees (Photo P. Raška)

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MGR, Institute of Geonics ASCR, v. v. i.
Drobného 28, 602 00 Brno, Czech Republic
(fax) 420 545 422 710
(e-mail) geonika@geonika.cz
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TRENDS IN SOIL DEGRADATION IN THE UPPER SVRATKA RIVER BASIN (CZECH REPUBLIC)

Miroslav DUMBROVSKÝ, Veronika HOŠKOVÁ, Jana PODHRÁZSKÁ, Kateřina VAŠINOVÁ

Abstract

The study area, the upper part of the Svratka River basin, was selected in order to evaluate trends in soil degradation primarily because it comprises natural conditions with a high potential for soil degradation. In order to collect relevant data on soil conservation, a questionnaire survey was designed and executed. Data on soil and farming practices were collected by a soil protection expert. In addition, farmers in the case study region were interviewed (semi-structured interviews) regarding policies concerning soil protection, as well as the farming practices they adopted. An expert for soil conservation conducted these interviews as well. The ownership structure implies insufficient motivations of land managers (both corporate farms and family farms) for long-term considerations related to soil protection.

Shrnutí

Trendy degradace půdy v povodí Svratky (Česká republika)

Řešené území bylo vybráno pro případovou studii vyhodnocení trendů půdní degradace zejména kvůli přírodním podmínkám, náchylným k intenzivní degradaci půdy. Na základě speciálně sestavených dotazníků, experti na ochranu půdy prováděli průzkum a jednání na vybraných farmách s uživateli půdy. Průzkum se zaměřoval na odhad stávajícího stavu intenzity erozních procesů a jejich trendy a byla zjišťována stanoviska uživatelů vzhledem k jejich názoru na intenzitu degradace půd na jejich farmě. Názory expertů a uživatelů půdy byly následně porovnávány a vyhodnocovány. Většina půdy není užívána vlastníky pozemků, ale je v nájmu zemědělských společností, pro které není motivující fakt, že po realizaci opatření nastává obnova a zvýšení půdní úrodnosti až po delším časovém období.

Key words: *soil erosion, soil degradation, land consolidation, Upper Svratka River basin, Czech Republic*

1. Introduction

Soil degradation is one of global problems today, which has a high economic and environmental impact (Lal, 1998). Soil erosion in particular is a serious environmental, social and economic problem and an important factor in assessing landscape stability, health and function. Soil erosion is an interactive process influenced by both natural and cultural factors, such as precipitation, relief, soil properties, vegetation cover and land use. A direct connection exists between soil erosion and intensive agricultural production (Reicosky et al., 2005). The assessment of soil degradation (especially of soil erosion) is essential for land management aimed at soil and water protection. Soil degradation due to erosion is one of the main causes of soil fertility decline and hence of reduced crop yields in many parts of the world (Greenland and Szabolcs, 1994). Land degradation can be caused by natural processes as well as by human management and involves a simultaneous degradation of soil, hydrological properties and/or vegetation (Cammeraat and Imeson, 1998). The on-site and off-site costs of land degradation can be very material, as reported in a range of studies (Lal and Stewart, 1990; Pimentel et al., 1995). In addition, local land users will normally base their decisions on analyzing local costs and benefits only, considering less the off-site costs of land degradation (Paterson et al., 1993; Lutz et al., 1994). Due to their high dependency on land as a base of food production and income generation, farmers are much aware of changes in the soil quality. In recent years, participatory approaches showed that farmers can reliably identify different soil units in their fields and assign certain soil properties to erosion-affected areas (Oudwater and Martin, 2003).

The upper part of the Svratka R. Basin (subcatchment of the Morava River basin-up to the confluence with the Svitava River) was chosen as a case study for many reasons but mainly because of its natural conditions with a high potential for soil degradation (Fig. 1).

Relief, geomorphology, present state of the complex system of soil properties, agricultural farming practices and land use are contributing to accelerated soil erosion with all its negative impacts on the environment. A significant part of the river basin area is suitable for the accumulation of water and serves as a protection zone of drinking water reservoir. The general issue is highly fragmented land ownership but concentrated management (large farms). There is a dynamic process of land consolidation.

Fig. 1: Case study area – The upper part of the Svratka River basin

2. Material and methods

The case study includes an agri-environmental approach. The analytical framework provides a foundation for defining research and refers to the development

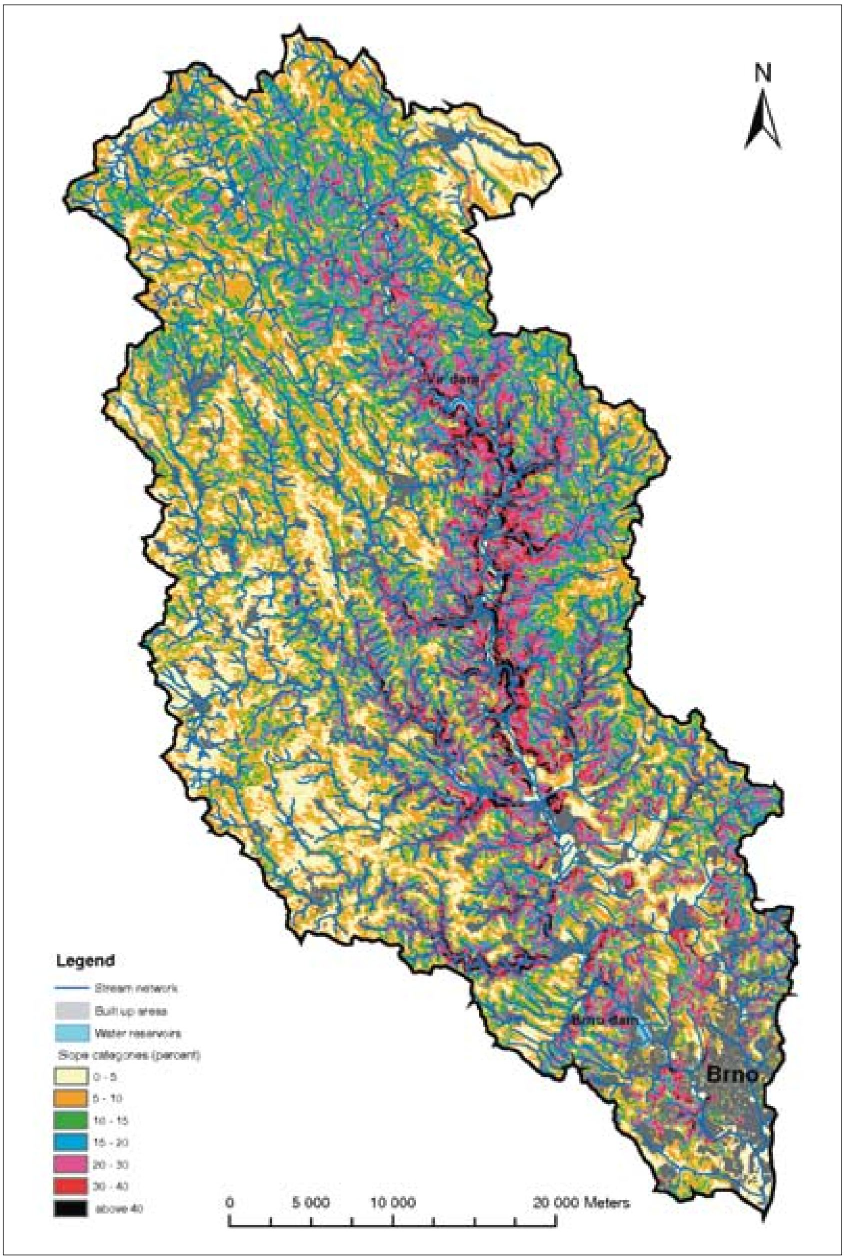

Fig. 2: Slope categories in the upper part of the Svratka River basin

of a common concept for the analysis of agri-environmental conditions in the case study, comprising a specification of the environmental conditions (soil and climate) land use and agricultural activities of soil conservation and land management practices. The research also requires the development of an adequate methodological approach (selection of data sources, data gathering including fieldwork, and data processing methods). This procedure will require a detailed review of the relationships between farming practices and soil conditions and will provide information on both the effectiveness and the economic performance of soil conservation measures. A Consequential Concept for institutional and policy analysis was described in the Final report on the project 'Sustainable Agriculture and Soil Conservation (SoCo)', a JRC Scientific and Technical Report (EUR 23820 EN – 2009). This means that the development of a common concept for the institutional and policy analysis of case studies takes into account different types of actors, transactions, policies, instruments and institutions, governance structures and property rights, assessment of policy instruments' quality, institutions and governance, and implementation structures.

In the upper part of the Svratka River basin, 53% (71,010 ha) of the total area is used for agriculture, of which 50,170 ha is arable land, 20,540 ha

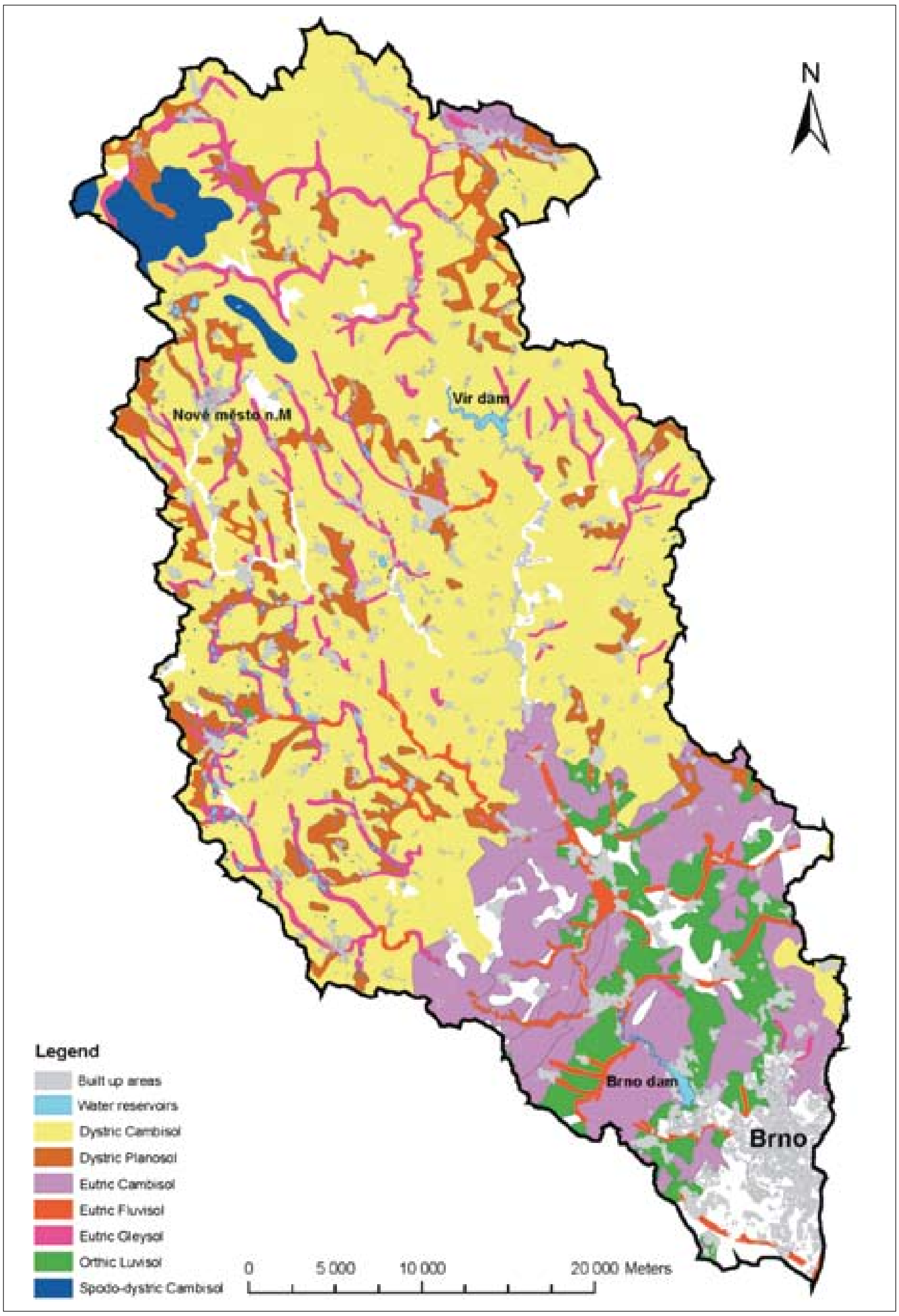

Fig. 3: Main soil types in the upper part of the Svratka River basin

grassland and 297 ha orchards. About 42% of the land is designated as a protected area. A part of the area is designated as a Protected Landscape Area (Ždárské vrchy Hills); a part of the area is designated as a drinking water protected zone (Vír reservoir dam).

Soils in the case study area are heterogeneous. Three main soil types were found in the catchments (Source: Soil map of the Czech Republic, characterization according to FAO Soil Classification). The first one, which covers about 54% can be mostly found on slopes of the catchment area and is classified as Dystric Cambisol with sandy loam and loamy sand topsoil (Fig. 3). The bedrock is weathered and fractured.

The second and the third soil types are classified as Eutric Cambisol and Dystric Planosol and cover approximately 13% and 8% of the case study area, respectively. The prevailing parent rock consists of weathered paragneiss and erosion products, phyllites, shales, greywackes, granites and their erosion products.

Main threats to soil in the case study area are represented by soil erosion caused by water, soil compaction, loss of organic matter and to a limited extent also by diffuse soil contamination.

Data on soil and farming practices were collected from the questionnaires by a soil protection expert and tabulated as output. Farmers in the case study region were interviewed (semi-structured interviews) as to adopted policies and farming practices. Interviews were conducted also by soil conservation expert. Farms were visited and all interviews were performed face-to-face.

In the following, the outline of the questionnaire and the questions contained are described. The survey consisted of the following parts:

- General part (contact information),
- Related soil characteristics and farming practices,
- Assessment of soil conservation measures and farming practices in dependence on crop products,
- Effects of soil conservation measures on the soil threats.

3. Results and discussion

The main soil degradation problem (Tab. 1) in the case study area is water soil erosion due to large plots predominantly used as arable land, hilly landscape or steep slopes in highlands; intensive farming practices, and frequent extreme hydrological events. Most of the soil lost by erosion comes from the cropland.

Soil compaction occurs due to intensive conventional farming on arable land (using heavy machinery) especially in the lower part of the case study area (around Brno City – farms 7 and 8). The loss of soil organic matter results from the continual soil erosion process. Main causes of the loss of organic matter are conventional farming practices without applying manure and other organic matter. It is also linked with the decreasing water retention capacity of soils, which in turn is caused by compaction and land conversion. The loss of organic matter leads to the decreasing natural crop productivity of soils and to decreases yields.

Farmers' perception of the severity of soil degradation problems in their area is presented in Tab. 1. There was no difference between the opinion of farmers about the

Soil degradation problem	Severity on the farms							
	farm 1	farm 2	farm 3	farm 4	farm 5	farm 6	farm 7	farm 8
Soil erosion (water)	3	3	2	3	3	2	4	4
Soil erosion (wind)	0	0	0	0	0	0	0	0
Loss of organic matter	1	1	1	1	2	3	3	3
Carbon balance	1	1	1	1	2	3	3	3
Diffuse contamination	1	1	0	1	1	1	3	3
Compaction	3	1	0	0	0	0	3	3
Acidification	2	1	0	2	2	1	2	2
Retention capacity	3	1	1	1	1	1	4	4
Off-site damages	2	1	1	1	2	1	4	4

Tab. 1: Estimation of the severity of soil degradation problems on various farms
Source: own assessment, interviews
Note: The numbers indicate the severity of soil degradation problems at farms examined by means of questionnaire 2 with the classification ranging from 5 (severe) to 0 (no problem). The rating was made through interviewing different farms.

severity of soil degradation on the farm and off-farm in the surrounding area a possible reason being rather high acreages of the farms.

Farmers operating farms in the upper part of the case study area perceived the risk of soil erosion by water (ranking 2–3) as moderate. Three farmers from the lower part of the study area perceived the risk as moderate to severe (ranking 3–4). The results confirm that the most serious problem in the case study area is soil erosion caused by water.

Soil erosion caused by wind is not a problem in this area due to climatic conditions and land use, despite unfavourable soil conditions.

Farmers operating farms in the upper part of the case study area (farms 2, 3 and 4) and farm 1 from the lower part of the case study area perceived the loss of organic matter as low because their farms have a high production of available farmyard manure and the farmers add organic matter back to the soil. Farmers on farms 5, 6, 7 and 8 considered the loss of organic matter as moderate (ranking 2–3). Their perception was influenced by the fact that they have a low production of manure (farms 4, 5 and 6) and conventional arable farming (just cereals, maize and rapeseed production – especially on farms 7 and 8). The same evaluation applies to the problem of carbon balance. Regarding the diffuse soil contamination, no problem was reported by farms 1 through to 6 thanks to a good management of fertilizers and special management practice in the protected zones of water resources. The contamination was considered moderate by farmers in the lower part of the case study area, who adopted conventional intensive arable farming (mostly cereals, corn and rapeseed production).

Soil compaction is considered a moderate problem on farms 1, 7 and 8 with soils susceptible to compaction due to intensive (heavy machinery) conventional arable farming. This is not a problem on farms featuring light soils with a low content of clay particles in the topsoil and subsoil. According to the farmers' perceptions, acidification is only a minor problem. Farmers believe that it is necessary to apply lime, but their economic situation does not allow them to buy lime or lime-containing fertilizers.

The decreasing retention capacity of soils with on-site damages is most visible on farms 7 and 8 with a high rate of soil erosion and compaction. Soil degradation on these farms is caused by intensive conventional growing of row crops (e.g. cereals such as corn and sunflower) without conservation measures and appropriate crop rotation.

Soil degradation is less severe on farms 1 through to 6 because these farmers had changed their land management practices in order to reduce soil degradation as recommended by the Morava River Board, State Enterprise. The opinions of farmers about soil degradation trends differ from expert opinions in the case of the study area. Expert assessments concerning soil degradation problems and damages are more critical.

Water erosion, soil compaction and loss of organic matter result from inappropriate farming practices and lead to the degradation of the soil structure and cause severe damages both on and off-site. On-site damages have accelerated due to the severe impact of soil erosion on complex soil properties with negative consequences on the soil productivity. Soil erosion removes topsoil layers and during ploughing and tillage operations, the topsoil blends with the subsoil.

The subsoil usually has less desirable physical properties because it contains coarser and clay material and is of worse structure. Degradation of the surface structure is a second factor induced by erosion. This less favourable structure along with soil compaction creates higher bulk density, which is limiting for the emergence of seedlings and for root penetration. A third factor is the loss of nutrients. Nutrients such as nitrogen, phosphorus, and potassium can be solubilized in the surface runoff or attached to soil particles that are removed during the process of erosion. The results of soil degradation mentioned above are often characterized as "pseudo-drought", a consequence of the loss of moisture and water-holding capacity.

Nutrients attached to soil particles in sediments are lost during the erosion process proportionally to their concentration in the sediment at the point of detachment. The loss of these nutrients is associated with the removal of fine, inorganic and organic, colloidal material where the nutrients are adsorbed. With a reduction of the soil clay colloidal content over time, the productive capacity of the soil is reduced.

Dissolved nutrients are also lost in the run-off and deposited with sediments in various water reservoirs in the case study area. For example, in the Brno dam the amount of deposits containing sediments with a high content of nutrients, pesticides mixed with sediments from municipal waste is 3.8 mil m^3 (Source: Study for the Regional office of South Moravia region for the project „Clean Svratka“, 2006).

From an environmental point of view, this sediment is classified as hazardous toxic material. This sediment material is an important source of water eutrophication with a great negative effect on water quality, aquatic life and recreational conditions.

4. Trends in soil degradation and consequences

The perceived trends in soil degradation over the last ten years in the case study area are presented in Tab. 2. Over the last ten years, the general perception among farmers is that the soil degradation problems have shown a slight to moderate increase (except for water erosion on farm 3 and retention capacity and off-site damages on farms 7 and 8), i.e. that soil degradation has become worse.

The best situation is found on farms, which were provided technical assistance and support by the Morava River Board, State Enterprise. Soil degradation problems on the farms were mitigated over the last ten years especially in the upper part of the case study area (part of the area is designated as drinking water protection zone – Vír Reservoir Dam). The application of conservation measures (mostly soil erosion control) helps to decrease the soil degradation. Main reasons for the more favourable situation are as follows: conversion of arable land to grassland, use of intercrops and undersown crops, and suitable agricultural techniques causing less soil degradation. The situation on the lower part of the case study area is rather different (Fig. 4).

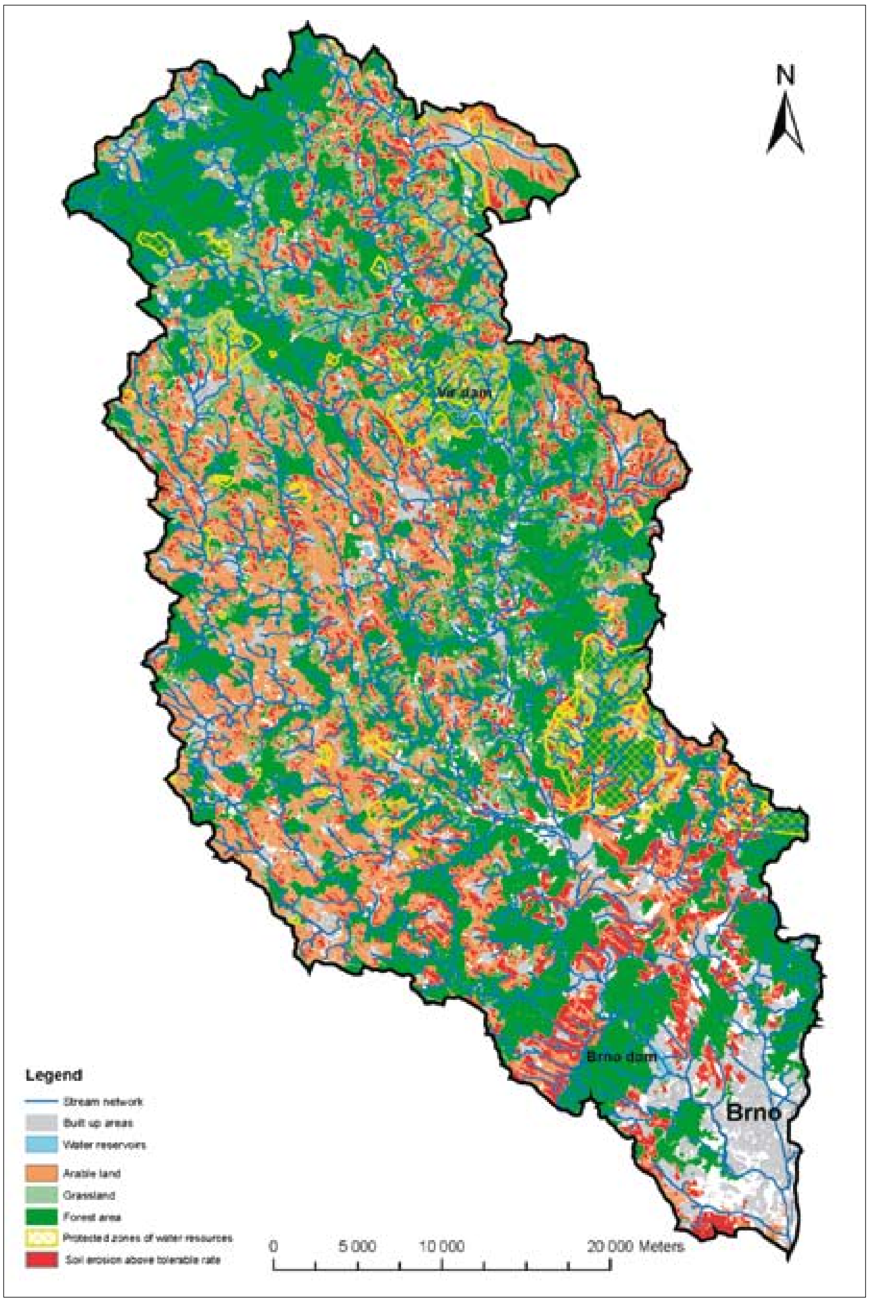

Fig. 4: Hot spots of the case study area – the Svratka River basin

Soil degradation problem	Trend							
	farm 1	farm 2	farm 3	farm 4	farm 5	farm 6	farm 7	farm 8
Soil erosion (water)	2	3	4	1	3	2	3	3
Soil erosion (wind)	0	0	0	0	0	0	0	0
Loss of organic matter	1	1	1	1	2	3	3	3
Carbon balance	1	1	1	1	2	3	3	3
Diffuse contamination	1	1	0	1	1	1	3	3
Compaction	3	1	0	0	0	0	3	3
Acidification	2	1	0	2	2	1	2	2
Retention capacity	3	1	1	1	1	1	3	4
Off-site damages	2	1	1	1	2	1	4	4

Tab. 2: Trends in soil degradation on various farms over the last ten years
Note: The numbers indicate the trend of soil degradation problems of farms, with the classification ranging from 5 (great change) to 1 (small change). All ratings are positive indicating that soil degradation is perceived to have become more severe. The rating was made through interviewing different farms (Questionnaire)

Soil degradation increases due to accelerated soil erosion and because of the lack of land users willingness to apply soil conservation measures during the last ten years, associated with a weak legislation and lack of economic motivation. Further, land users are aware of degradation problems in the case study area to some extent but there is a lack of information and educational programmes targeted on the environmental problems and on the consequences of soil degradation processes.

The negative trends in soil degradation due to water erosion continue in spite of material impacts on the production capacity of soils. Reason is that current and recent effects of erosion on productivity have been masked by improved and increased fertilization, improved cultivars, selective pesticides, technology and management. However, it is evident that this compensatory process cannot be maintained indefinitely.

5. Conclusions

As mentioned above, the best situation is on the farms where soil degradation problems have been already improved (mostly due to a high activity of Morava River Board, State Enterprise) during the last ten years and especially in the upper part of the case study area (a part of the area is designated as drinking water protected zone – Vír Reservoir Dam).

The improvement has been achieved mainly because farmers have adopted a system of agro-technical and organizational measures such as conversion of arable land to grassland and growing of intercrops and undersown crops and suitable agricultural techniques causing less soil degradation

Nevertheless, when introducing a soil erosion control in a certain watershed, agro-technical soil management and organizational practices themselves are usually not enough to curb the surface runoff substantially. This is why it is necessary to apply a whole complex system of soil conservation measures including technical measures (Janeček et al., 2007).

Biotechnical and technical soil conservation measures cannot be applied without respecting property rights. Therefore, it was found suitable to develop a system of soil and water conservation in the process of land consolidation in the Czech Republic.

Recently, the process of complex land consolidation in the Czech Republic has provided a unique opportunity for improving the quality of the environment and sustainability of crop production through better soil and water conservation.

Acknowledgement

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Authors' addresses:

Assoc. Prof. Ing. Miroslav DUMBROVSKÝ, CSc., e-mail: *dumbrovsky.m@fce.vutbr.cz*
Ing. Veronika HOŠKOVÁ, e-mail: *hoskova.v@fce.vutbr.cz*
Ing. Kateřina VAŠINOVÁ. e-mail: *kvasinova@seznam.cz*
Brno University of Technology, Faculty of Civil Engineering
Institute for Landscape Water Management
Žižkova 17, 602 00 Brno, Czech Republic

Ing. Jana PODHRÁZSKÁ, e-mail: *podhrazska.jana@vumop.cz*
Research Institute for Soil and Water Conservation,
Dept. For Land Use Planning Brno
Lidická 25/27, 602 00 Brno, Czech Republic

LAND USE DEVELOPMENT IN THE CENTRAL PART OF THE SPIŠ REGION (SLOVAKIA) SINCE THE 18TH CENTURY

Radoslav KANDRÍK, Branislav OLAH

Abstract

Land use developments and changes in the central part of the Spiš region since the 18th century are discussed in this paper. Using the ArcGIS 9.x software, available aerial photographs and historical maps were processed and land use categories were identified for five points in time. The areas with stable land use, as well as those with various intensities of land use change, were assessed. The main trends in land use and their locations were identified. The analysis revealed several similarities with comparable neighbouring regions, but also some regional specification.

Shrnutí

Vývoj využívaní krajiny ve vybrané části středního Spiše (Slovensko) od 18. století

Práce hodnotí vývoj využívání krajiny centrální části středního Spiše od 18. století a její změny. Pomocí programu ArcGis 9.x, dostupných leteckých snímků a historických map byly identifikovány formy využívání krajiny vybraného území v pěti časových horizontech. Byly lokalizovány plochy se stálým využitím a zhodnocena intenzita změn využití krajiny. Byly identifikovány hlavní trendy ve využívání krajiny včetně jejich geografické lokalizace. Srovnání získaných výsledků s přilehlými regiony potvrdilo některé podobnosti v charakteru trendů, ale zároveň poukázalo na určitá regionální specifika.

Key words: *land use development, changes, intensity, Spiš region, Slovakia*

1. Introduction

The Spiš region is well known for its natural beauties and rich history. It is surrounded by three national parks (Tatra National Park, Pieniny National Park and Slovak Paradise National Park). The value and richness of its historical monuments were acknowledged by UNESCO and the most valuable sites were enlisted in the World Natural and Cultural Heritage List (Levoča, Spišský hrad Castle, Spišská Kapitula, Spišské Podhradie, Žehra).

The lower part of the Spiš region was more important during the medieval period than the upper part where the High Tatras' mountain and spa tourism resorts are located. The crucial role for the regional development played Via Magna, the trade road connecting the Hungarian lowlands with the Polish Kingdom. Another phenomenon affecting the development of the region was the „Spišský záloh", deposit of 13 Spiš towns and the Ľubovniansko-podolínský castle lordship to the Polish Kingdom for almost 360 years (Michálek et al., 1989).

The present landscape is a result of both natural processes and human impact. Identification of man activities and their impact on the landscape in time enables us to understand the present landscape structure and its possible further development. Land use represents an intersection between natural conditions and their human utilization according to cultural preferences, economic demands, legal and technical possibilities of local inhabitants. The study of land use or land cover change belongs to the most frequented topics of both geography and landscape ecology. It has rich tradition in the Slovak and Czech cultural landscape-oriented research (Žigrai, Miklós et al., 1980; Žigrai, 1983; Ivanička, 1987; Kolejka, 1987; Žigrai, 1995; Žigrai and Drgoňa, 1995; Feranec, et al., 1996; Lipský, 2000; Brůna et al., 2002; Olah, 2000, 2003c; Olah and Žigrai, 2004; Olah et al., 2010; Boltižiar, 2004, 2007; Chrastina, 2005a, b; Kunca et al., 2005; Petrovič, 2005; Chrastina, Boltižiar, 2006). Identification of previous land use is usually based on an analysis of historical cartographic sources (from 18th to 20th century) and aerial photographs (since the 1950s) or satellite images (since the 1970s). Although these information sources vary in scale, accuracy and information value, they represent the only base for long term land use development study.

The main hypothesis for the central Spiš region land use study is: "Was the land use development of the study area different (due to its natural and social conditions) from the other neighbouring regions?"

2. Study area

The study area is situated in the Spiš region (NE Slovakia) and lays mainly in the Hornadska kotlina Basin (Fig. 1). The rectangular study area (558 km^2) was designed in order to cover the Central Spiš cultural landscape with four main urban centres (Spišská Nová Ves, Levoča, Spišské Podhradie and Spišské Vlachy) and its mountain border (Levočské vrchy Hills from the north, Mt. Branisko from the east, Volovské vrchy Hills and Slovak Paradise Mts. from the south). The major part of the territory bedrock is composed of sandstone, claystone, limestone, travertine and breccia (paleogene sediments of the Podtatranska skupina Group, flysh sediments and travertine (Gross, 1999; Ložek, 1973). The land is formed with basin-heights relief and a network of dellen valley, dellen basin and furrows go through the whole basin. In the vicinity of the Hornád River (Novoveská kotlina Basin and Vlašská kotlina Basin), there are numerous high and middle river terraces (Michaeli, 2001). The climate of the territory is mild warm, mild wet, with cold winter and average temperatures ranging from 6 to 7 °C. Mean annual precipitation amount is 600–700 mm (Lapin et al, 2002). The prevailing soil type is Cambisol. The present wood composition is dominated by Norway spruce (*Picea abies, L.*), Scots pine (*Pinus sylvestris, L.*) and black pine (*Pinus nigra, L.*), large stretches of mixed forests are situated in the south (Miklós, 2002).

Despite the fact that the area is geographically rather isolated (a mountain surrounded basin), it played an important role throughout the history. People inhabited the Spiš region in the prehistoric times (Neanderthal skull found in Gánovce near Poprad) and the territory was continuously inhabited in historical times by the Celts and by Teutonic tribes. In the times of the Great Moravia Empire, the territory of Spišská Nová Ves and its vicinity was already an important regional centre. The colonization was discontinued in middle of the 13th century because of the Tartar invasion. After this period, only a part of the original population had returned and rebuilt their homes in the old settlements. In order to compensate for the population loss, new colonists from Czech

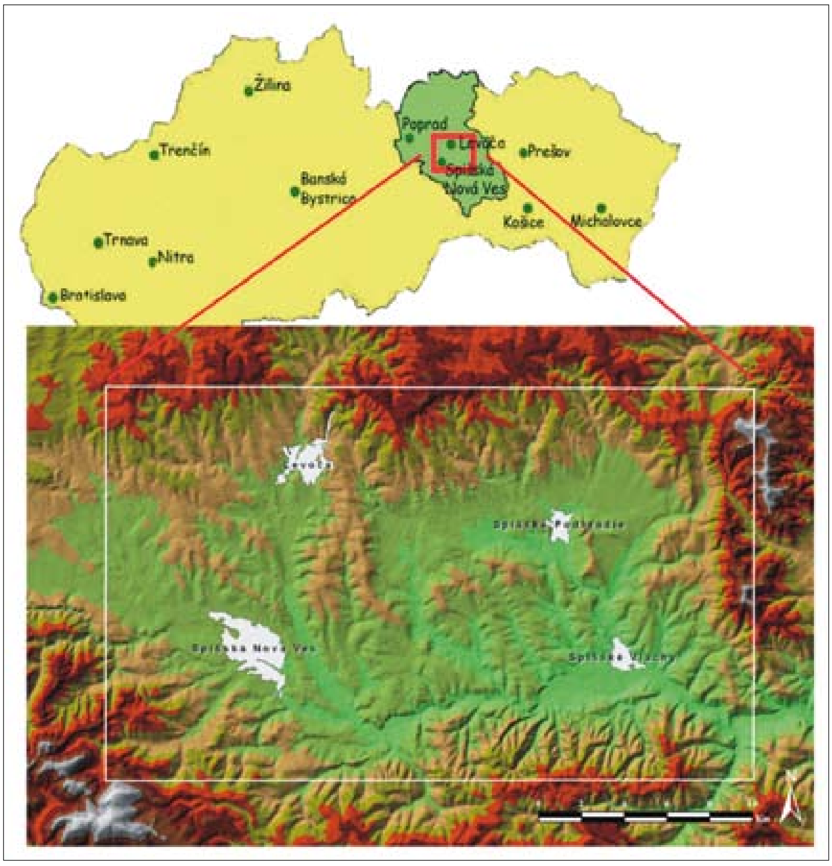

Fig. 1: The study area in the Spiš region

lands but mainly from Saxony were invited what resulted in the development of a significant German minority (so called Carpathian Germans) persisting to the present. The most important profession of the country people from the Hornádska Basin was agriculture and forestry (Michálek et al., 1989; Tibenský, 1971; Plesník, 1974). Since the region was situated on the Via Magna, one of the most important trade routes connecting the Baltic and Mediterranean regions, local towns benefited from trade and craft development.

The merchant towns' prosperity and wealth affected the region's architecture and art. Apart from the trade activities, the region was also important for the Catholic Church (Spišská Kapitula church town with Bishop's residence, Kláštorisko medieval monastery and the Mariánska hora's pilgrimage mountain) and feudal landlords (the Spišský hrad castle and its domain). The medieval prosperity made the region interesting for Polish kings to accept it as a debt deposit in the past but it remains so for the World community at present (UNESCO World Heritage List).

3. Materials and methods

Land use development and land use changes were analysed and evaluated based on historical maps from military mappings (18^{th}–20^{th} century) and aerial orthophotomaps (2003) using ArcGis 9.x software applications. Other analyzed time horizons were as follows: 1782 (1^{st} military mapping, scale 1:28 800), 1822 (2^{nd} military mapping, scale 1 : 28 800), 1900 (3^{rd} military mapping revisions, scale 1 : 25 000), 1956 (military topographic mapping, scale 1 : 50 000) and 2003 (aerial orthophotographs, scaled 1 : 5 000). The historical maps were georeferenced to the S-42 (Pulkovo) coordinate system using affine transformation with the RMS error varying from 120 m in the case of the 1^{st} military mapping to 20 m in the case of the 2^{nd} military mapping, the newer maps were without the RMS error. The 2003 orthophotomaps were in the S-JTSK coordinate system. The final land use vector layers were translated to the common S-JTSK system.

In order to compare land use data from various map sources, 6 main land use categories were identified: forest; shrub (transitional woodland, non forest woody vegetation); grassland (pastures, meadows, wetland grasslands); arable land; built-up area (residential and industrial; bare rock (sub-soil).

Land use changes were identified by overlaying historical land use layers. The overlain land use vector maps created a database of spatial land use changes. The land use change intensity was assessed by assigning a land use intensity coefficient to each land use category. The total land use change intensity was then calculated as a sum of partial intensity subtractions:

$$\mathbf{I_R = i_{2-1} + i_{3-2} + i_{m-n}}$$

where: I_R – relative land use change intensity, i_{2-1} – partial land use intensity change between the 1^{st} and the 2^{nd} time horizon.

The coefficients of land use intensity express the natural value of land use categories regarding to ecosystem dominant (plant) species and their structure (Olah et al., 2006):

1. autochthonous species and structure (forests or other natural ecosystems),
2. autochthonous species but altered structure or size (transitional woodland/shrub, non-forest woody vegetation),
3. allochthonous species but natural structure (grasslands),
4. allochthonous species and structure (arable land),
5. no vegetation or no natural species, introduced species (built-up areas, open quarries).

The land use change intensity can be distinguished as relative or absolute. Relative intensity of land use refers to overall direction of land use changes. Positive numbers express land use intensification and negative numbers refer to land use extensification. Absolute intensity of land use change expresses the total amount of changes in land use regardless of their direction. This expression is useful to point out the least stable land use spots within the landscape.

4. Results and discussion

4.1 Land use development trends

The summarised results from the Spiš region land use development (Tab. 1 and Fig. 2) showed a significant trend towards the steadily decreasing arable land coverage. Initially the trend showed a very slow decrease, which was probably due to a close dependence of the local population on arable land most important for their subsistence. The observed 18^{th} century feudal cultural landscape was used in a similar way for centuries (Fig. 3).

A more rapid decrease of the arable land area occurred only after 1900 as a consequence of various effects such as decrease of population (Fig. 4) after the 1^{st} and 2^{nd} WW, emigration, increasing crops due to new technology and application of soil fertilisers. The last and most rapid decrease was caused by large-scale industrialisation, which created a new form of subsistence, the change of ownership and the loss of attitude to arable land due to socialist collectivisation since the 1950s.

The loss of arable land is interrelated with the increase of forestland and grasslands. The increasing trend of forest area could be observed since 1782. The increase in year 1822 was more rapid (Fig. 5). After this year the forestland area was continuously increasing until 2003 when it reached its maximum and comprised 37% of the whole study area. Forests gained mostly from the consumption of arable land. The present forests are frequently disconnected with areas of shrubs, which are most noticeable in the last time horizon (Fig. 8). Shrub areas reached their maximum in 2003, which could be caused by the used orthophotomap accuracy but also by forest management as well as by damaging and degradation of the forest ecosystems by metallurgy and mining industry in the region and its surroundings (e.g. copper mining and foundry in Krompachy).

Shrubs and non-forest woody vegetation achieved its maximum in year 2003; however these areas have been increasing continuously since 1782. However, the fact that this category was often omitted in military maps must be taken into account. Grasslands were decreasing until 1956, since then their area started to increase to reach its maximum in 2003. Fig. 7 shows the land use forms in year 1956. This trend is different compared to the High Tatras, the northwest part of the whole Spiš region, where the grasslands' area rapidly increased already in 1772 and in 1822 possibly due to previous wind calamities and expansion of cattle grazing in mountains. A similar development was seen in the Slovak Karst region neighbouring with the study area in the south where the main agricultural activities were cattle, pig and sheep grazing. In the selected study part of the Spiš region, the prevailing way of subsistence was agriculture, therefore grasslands were not so intensively exploited. The increase of grassland area has occurred only since 1956 probably as a result of agricultural extensification or even land

Land-use forms	1782		1822		1900		1956		2003	
	[km^2]	%	[km^2]	%	[km^2]	%	[km^2]	%	[km^2]	%
Forest	164.67	29.5	183.84	32.9	186.91	33.5	193.98	34.8	205.27	36.8
Shrub	1.13	0.2	6.85	1.2	6.47	1.2	11.05	2.0	15.72	2.8
Grassland	53.80	9.6	45.54	8.2	41.51	7.4	45.76	8.2	102.54	18.4
Arable land	319.01	57.2	306.01	54.8	308.02	55.2	281.94	50.5	195.45	35.0
Built-up area	18.74	3.4	15.48	2.8	14.61	2.6	25.01	4.5	38.80	7.0
Bare rock	0.63	0.1	0.27	0.0	0.46	0.1	0.25	0.0	0.21	0.0
SUM	**557.99**	**100.0**	**557.99**	**100.0**	**557.98**	**100.0**	**557.99**	**100.0**	**557.99**	**100.0**

Tab. 1: Land-use forms in 1782–2003

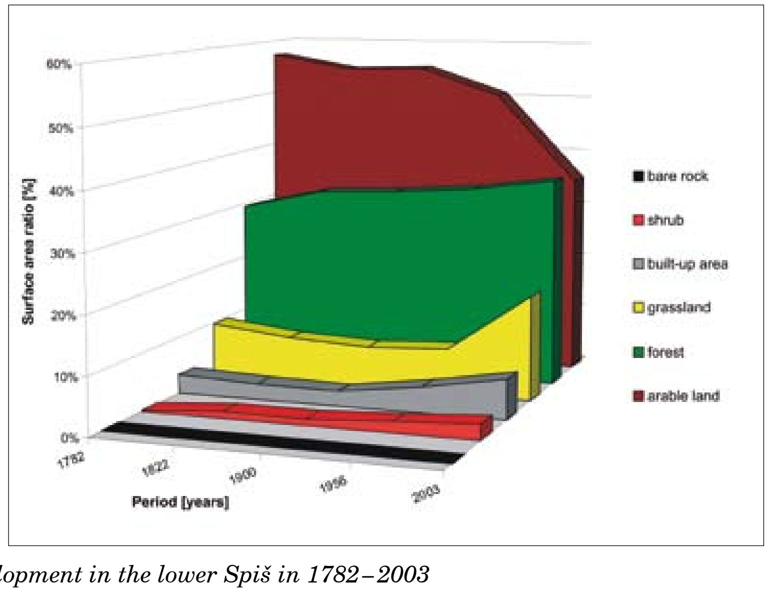

Fig. 2: Land-use development in the lower Spiš in 1782–2003

abandonment. Most of new grassland areas have been created from the former arable land and are located in remote areas near forests.

Built-up areas were slightly decreasing until 1900 since when they started to increase. Fig. 6 shows the land use forms in year 1900. The temporal decrease was likely due to the lower accuracy of historical maps. The urbanised landscape reached its maximum in 2003 as a result of population growth associated with the residential and industrial construction in the second half of the 20th century. A similar trend was observed in the Popradská kotlina Basin (NW part of the Spiš region) with the exception of mountain tourism centres development in the High Tatras.

4.2 Stable land use areas

As shown in Fig. 9 the areas with no change in land use are located more or less equally within the study area. Larger continual unchanged areas lay in SE and

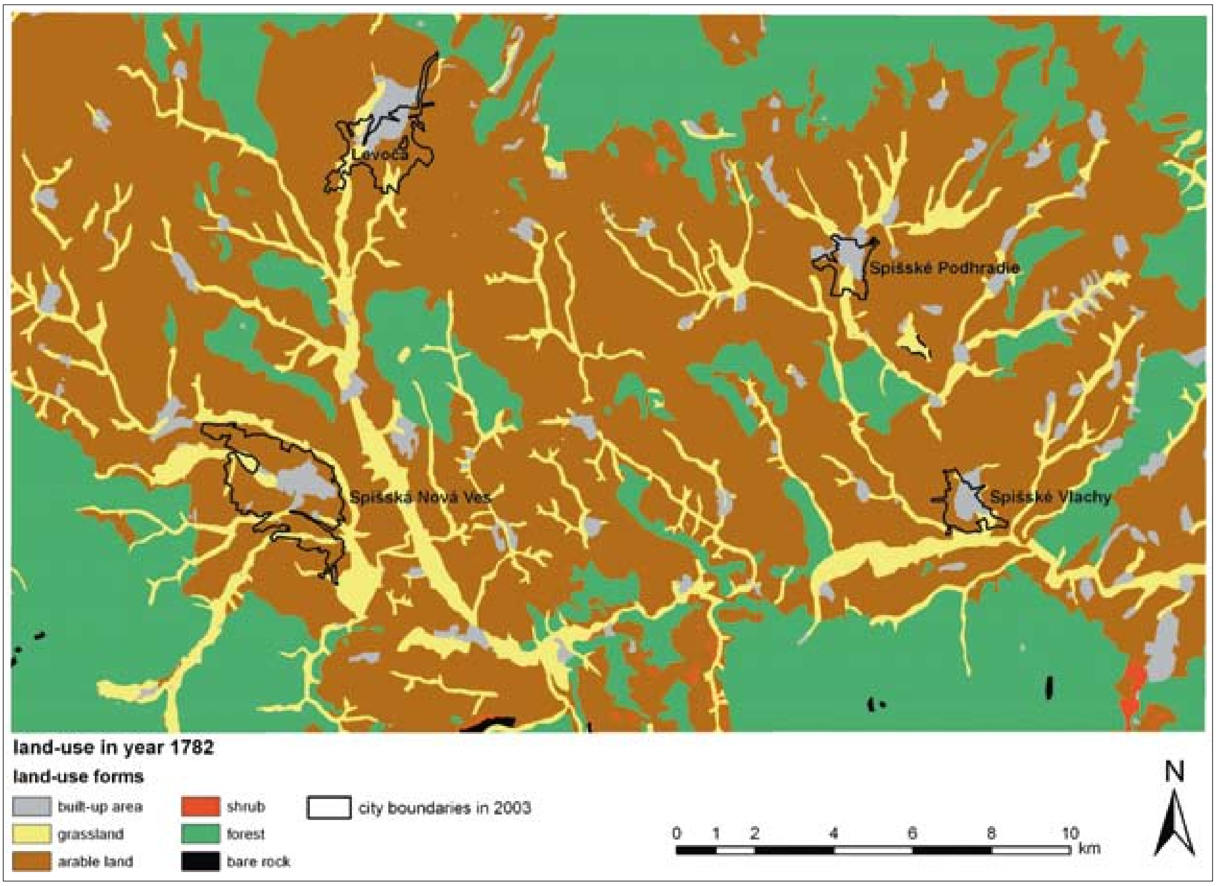

Fig. 3: Land use in year 1782

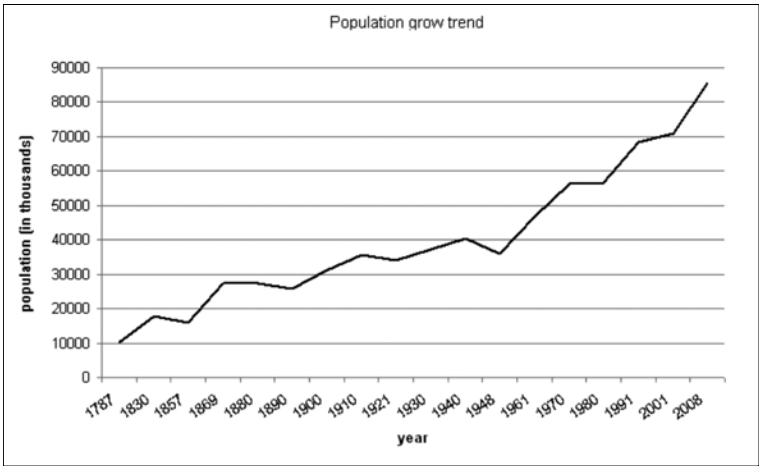

Fig. 4: Population growth trend in the study area
Source: (Kolektív, 1977, 1978), Statistical Office of the Slovak Republic

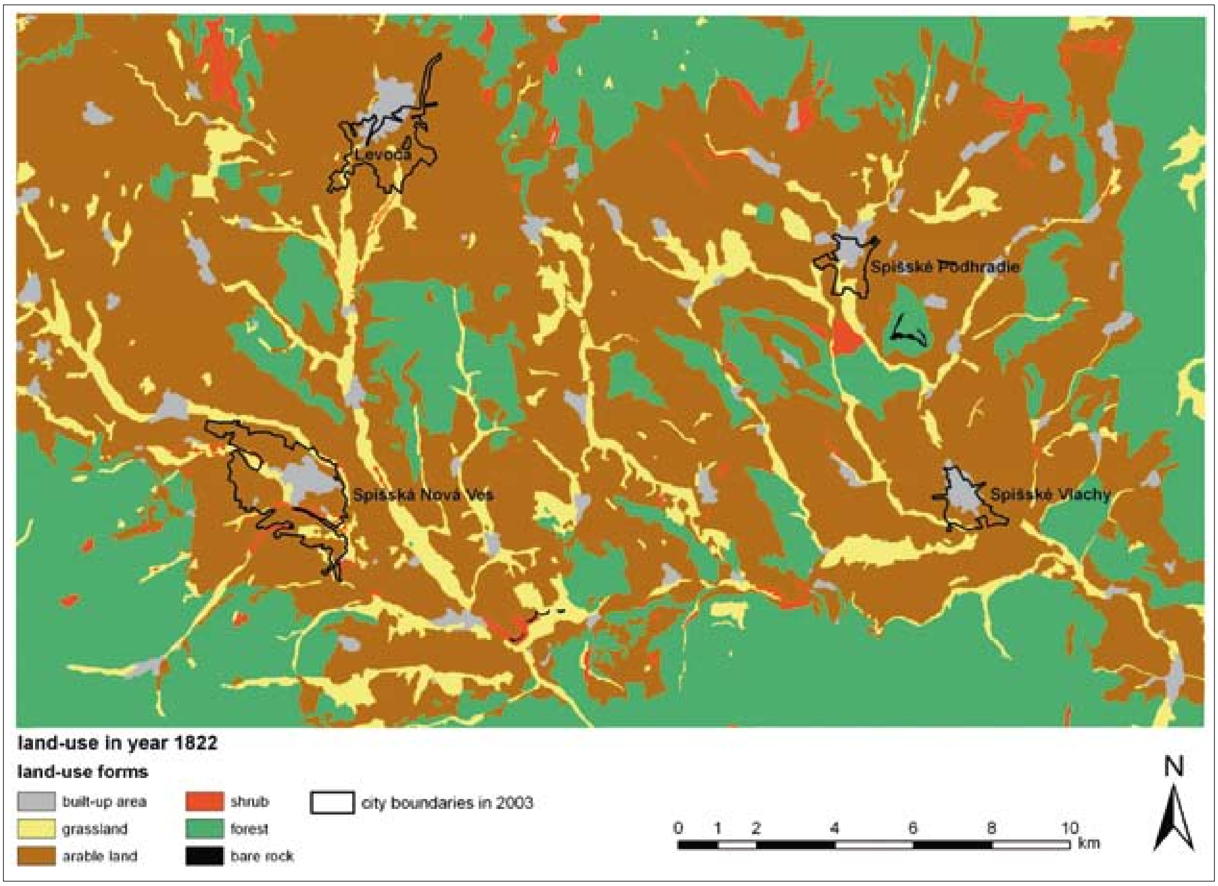

Fig. 5: land use in year 1822

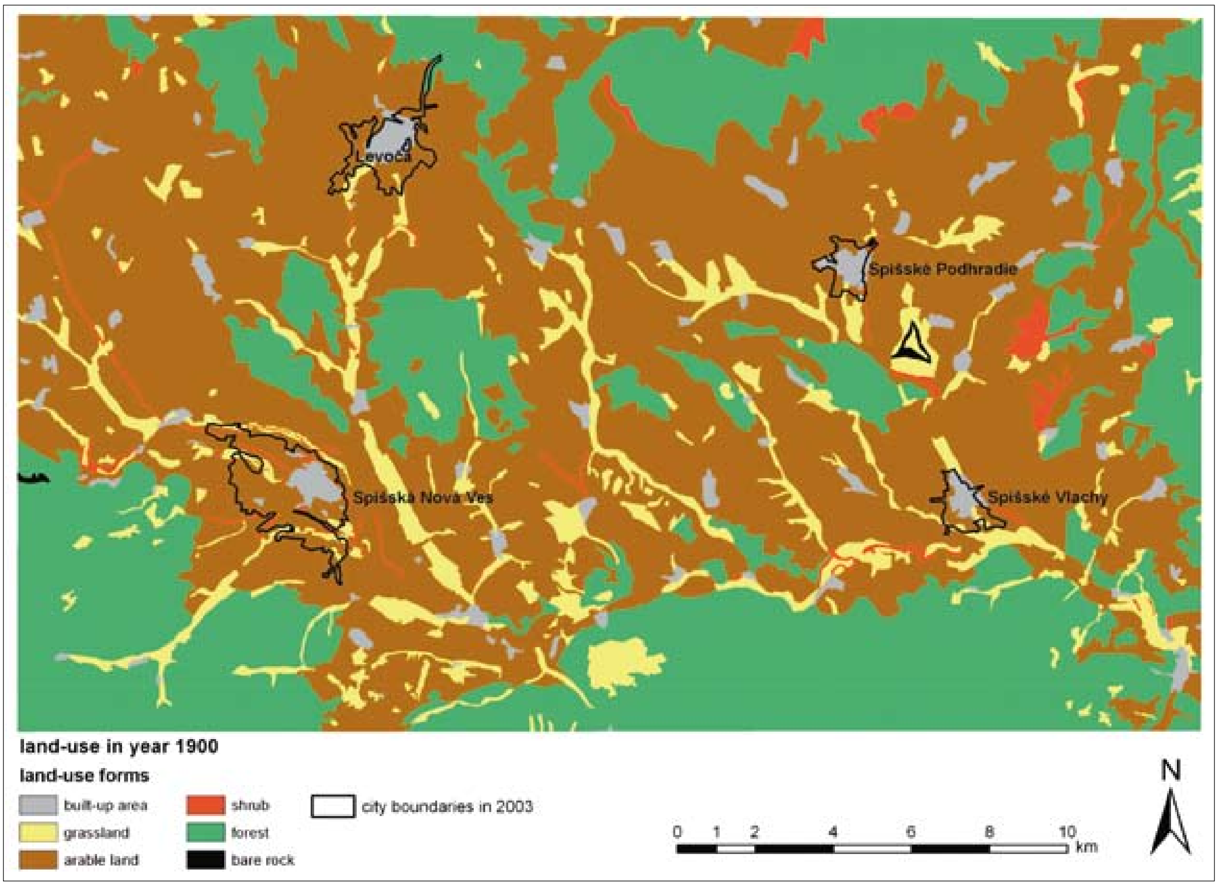

Fig. 6: land use in year 1900

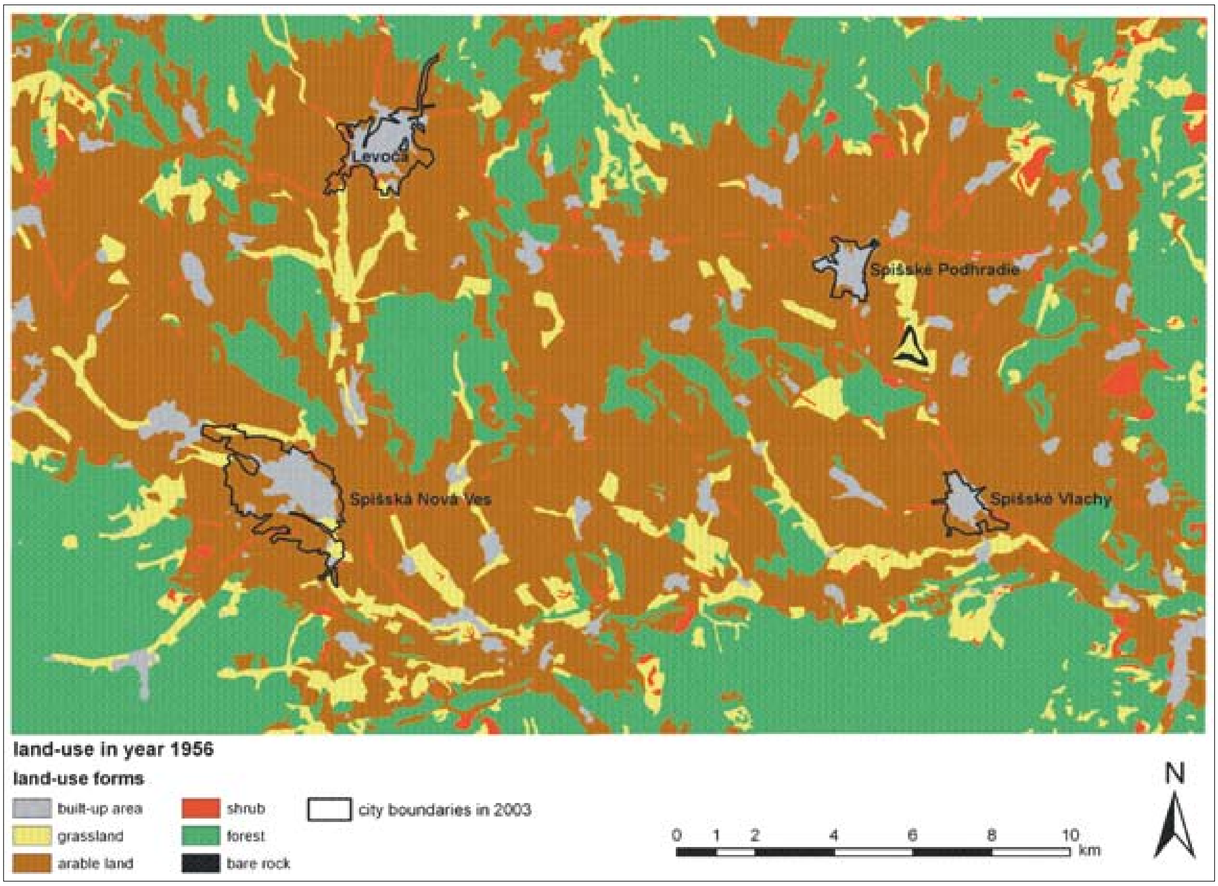

Fig. 7: land use in year 1956

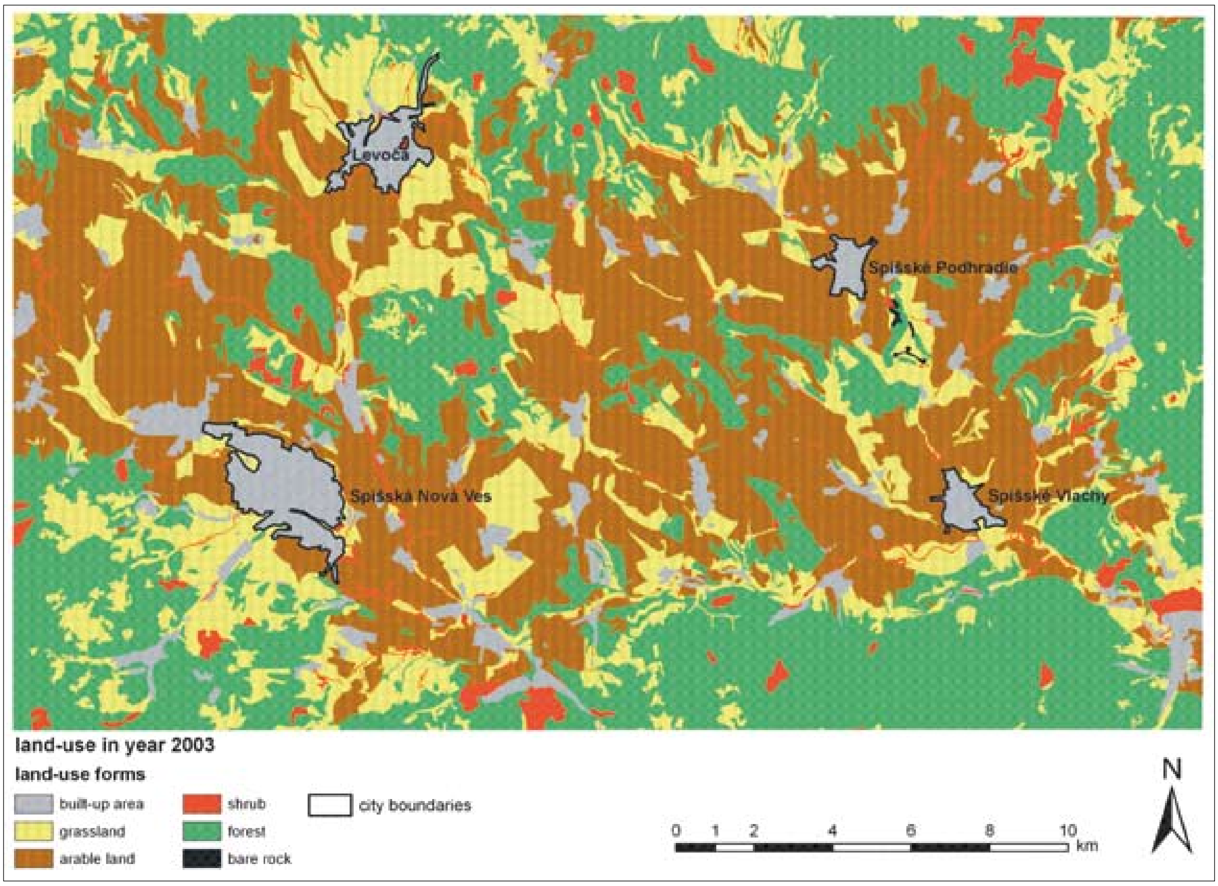

Fig. 8: land use in year 2003

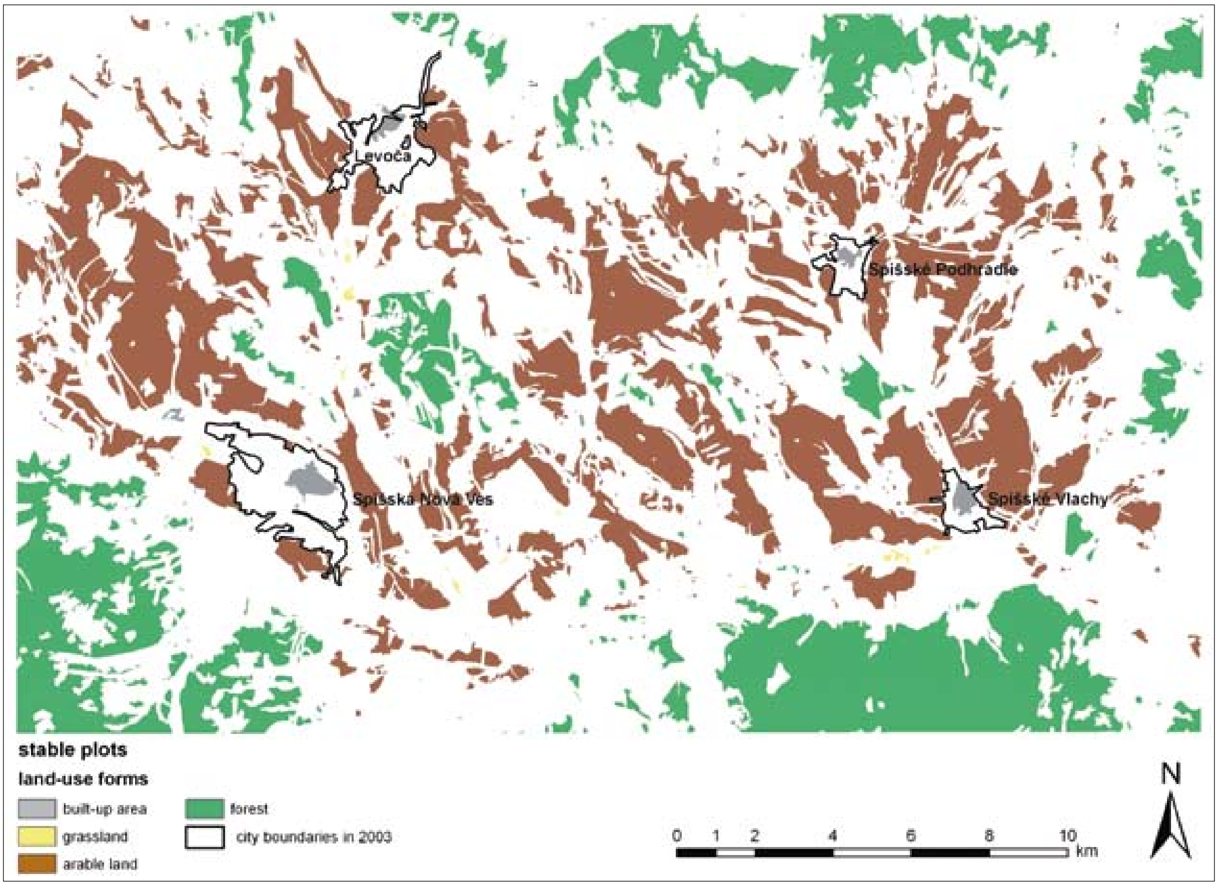

Fig. 9: Stable plots (1782–2003)

SW. These areas represent the best preserved forest ecosystems, which belong to the Slovak Paradise National Park (SW) and the Volovske vrchy Hills (SE). The basin's bottom was mainly used as arable land in the studied period. The total unchanged land use area (mostly forest and arable land) covers 33% of the territory (Tab. 2). Due to the low spatial accuracy of historical maps (1782 and 1822), the results might be biased (for example, grasslands' areas were considerably overestimated in 1782).

4.3 Absolute land use change intensity

Table 3 shows a total sum of changes, which have occurred in the territory, their area and percentage. The largest area belongs to unchanged land use forms, followed by the areas with lesser intensity changes (1–2 or 3–4). Fig. 10 (see cover p. 3) documents the areas that experienced the most intense changes, which are located at the perimeter of the basin, mostly in the N and NW sections. They are obvious in the vicinity of Levoča. These areas mostly refer to the shift between arable land and forest. Areas with a smaller total sum of land use changes are located in the middle of the basin where arable land has changed to grassland. Exceptions to these trends are localities between Spišská Nová Ves and Levoča and in the southeast of the village of Spišský Štvrtok, which lay on a hilly landscape where the change was between forest, grassland and arable land.

4.4 Relative intensity of land use change

Table 4 presents trends of the land use change and its percentage. The largest part of the studied region (67.1%) has experienced either no change or its land use has returned to the original form during the studied period. In the changed areas, extensification (18.2%) slightly prevails over intensification (14.7%). The most preserved or returned areas are located in the SE and

Land-use forms	built-up area	Grassland	Arable land	Forest	SUM	Ratio [%]
Area in [ha]	178.70	43.40	10,528.71	7,835.34	18,586.15	33.3
Number of polygons	30	63	731	295	1,119	
Area of the largest [ha]	67.24	5.61	1,067.83	2,573.47		

Tab. 2: Stable land use forms areas in 1782–2003

Categories (number of changes)	0	1–2	3–4	5–6	7–8	9–16
Ratio	33.4%	21.8%	21.4%	16.0%	4.3%	3.2%

Tab. 3: Absolute intensity of land use change

SW territory (forests) and in the vicinity of the cities (arable land). Areas under a greater human impact are located in the north near the Levoča city; these areas neighbour with the areas of zero intensity (Fig. 11 – see cover p. 3). This area was originally used as forest and later as arable land. Extensification prevails in the E and central S part of the territory. These areas were mostly used as arable land and later as forests or grasslands. The whole study area is transected with lines representing extensification or intensification. However, these lines are mostly results of map sources inaccuracy and represent a spatial shift of grasslands following rivers and streams.

Trend of land use change	Ratio
Extensification	18.2%
Unchanged or restored land use form	67.1%
Intensification	14.7%

Tab. 4: Relative intensity of land use

5. Conclusion

The long term land use development survey of the lower Spiš region uncovered several land use change trends. The most visible trend in the land use is the decrease of arable land since the second half of the 20th century. The trend is mostly in progress in the contact zone between arable land and forest where due to land abandonment the arable land is overgrowing with the secondary succession. It is also reflected in the land use change intensity where the most intensive changes are situated at the perimeter of the basin in the contact zone between forest and arable land. The land use intensification occurred in the N basin part, where forests were changed to arable land or grasslands. Extensification was in progress mostly due the conversion of arable land into forest or grassland especially in the higher situated parts of the basin and steeper slopes of its mountain borders. The comparison of land use development and its main trends in the lower Spiš region and neighbouring regions or in similar landscapes (basins surrounded by mountains or plateaus, Olah et al., 2006, 2010) unveiled several similarities as follows:

a) basic urban/agriculture/forest division of basin landscape was stabilised already before the 1st studied time horizon (18th century),
b) extensification of land use (increase of grasslands, shrubs and forests) since 1950s,
c) rapid urbanisation since the 1900s but mainly since the 1950s,
d) the most stable land use categories occupy the most suitable parts (geomorphology, soil and hydrology),
e) the most land use dynamic zones are situated on the transition of main plains-hills-mountains geomorphological zones.

While the main trends are almost identical for all compared regions, they differ in quantity (more dynamic landscape in the High Tatras) or in the occurrence of special factors (water scarcity on karst plateaus and slopes and wetlands in the basin bottoms in the Slovak Karst). The second part of the picture is the socioeconomic development of the region. Flourishing medieval times contributed to the region's development and conversely the shift of the new development in the 20th cent. to the western part of the region somehow contributed to the preservation of the unique landscape. However, for the future preservation and development of the region the thoughtful regional management based on a sustainable use of landscape is crucial. The results of this study could be applied in understanding the landscape response to human activities.

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Authors' addresses:

Ing. Radoslav KANDRÍK, e-mail: *kandrik.radoslav@gmail.com*
Assoc. Prof. Ing. Branislav OLAH, Ph.D., e-mail: *olah@vsld.tuzvo.sk*
Department of applied ecology, Faculty of ecology and environmental sciences
Technical university in Zvolen
Masaryka 24, 960 53 Zvolen, Slovakia

EXAMPLES OF GREAT CROSS-BORDER FLOODS IN CENTRAL EUROPE AND LESSONS LEARNT (CASE STUDIES OF FLOODS FROM SEPTEMBER AND NOVEMBER 1890 ON THE OCCASION OF THEIR 120TH ANNIVERSARY)

Jan MUNZAR, Mathias DEUTSCH, Stanislav ONDRÁČEK, Eva KALLABOVÁ

Abstract

Seeing that extreme historical floods usually affected territories of multiple countries, their research and comparison are possible only on the basis of long-term international cooperation. Only the knowledge from more affected countries can generate a complex image of their significance and impacts. This applies also to two disastrous floods, which occurred in Central Europe in September and then again in November 1890. The two floods affected a number of Central European countries at the same time and their extent reached beyond their borders. Whereas the flood events of September 1890 were documented in details already in the past, the catastrophic flood of November 1890 is today in the Czech Republic practically without the attention of experts and this is why it is in the focus of our brief reminder.

Shrnutí

Příklady velkých přeshraničních povodní ve střední Evropě ze září a listopadu 1890 a poučení z nich (v souvislosti s jejich 120. výročím)

Velké historické povodně často zasáhly více sousedních zemí současně. Jejich výzkum a srovnání je proto nutné provádět na základě systematické mezinárodní spolupráce. Teprve jejich komplexní přeshraniční dokumentace pak vytváří ucelenou představu o významu dané historické události. Týká se to i dvou katastrofálních povodní, ke kterým došlo ve střední Evropě v roce 1890 jen necelé tři měsíce po sobě, v září a poté v listopadu. Obě katastrofy zasáhly více středoevropských zemí současně a jednalo se tedy o přeshraniční povodně. Zatímco události v září 1890 byly v minulosti již poměrně podrobně dokumentovány, katastrofální povodeň v listopadu 1890 je dnes v České republice odbornou veřejností téměř zapomenutá a proto ji k jejímu výročí v tomto článku stručně připomínáme.

Keywords: *cross-border floods, Central Europe, September 1890, November 1890, lessons learnt*

1. Introduction

The end of the 19th century in Central Europe was a period of the increased incidence of large floods. In 1890 even two catastrophic floods occurred there less than three months apart in September and then again in November. The two floods affected a number of Central European countries at the same time and their extent reached beyond their borders. Whereas in September 1890 mainly the Elbe R. and the Danube R. basins were affected, in November an extensive area in Germany between the Elbe R. and the Rhine R. was affected in particular. It is a little known fact that the floods in November 1890 affected a part of western Bohemia too (mainly the Ohře/Eger R. basin). This November case was certainly overshadowed by tragic events at the beginning of September that affected all of Bohemia.

On 24th November 1890, the world-famous spa of Karlovy Vary/Carlsbad was destroyed by flooding on the Teplá/Tepl R., a right tributary of the German-Czech cross border Ohře/Eger R. Both mentioned floods caused not only catastrophic damage, but also taught many lessons and resulted in the adoption of several measures. Regarding this year's 120th anniversary of the both flood disasters, we attempt in our paper at their brief commemoration.

2. Flood in September 1890

Causes, behaviour and impact of this extreme flood in the Labe/Elbe River basin were described and documented in details already in the past – both in occasional historic prints and in expert studies. The publication of the Prague professor František Augustin titled "The Flood of 1890 in Bohemia" (Augustin 1891) appeared as early as in 1891. The same author described the hydrometeorological extreme in broader relations of Central Europe in the German journal Meteorologische Zeitschrift in an article "Rains and floods in September 1890 to the north of the Alps" (Augustin, 1892). To commemorate the 100th anniversary of this extreme flood, a scientific conference was held in Prague at the beginning of September 1990, which was focused primarily on the flood control.

The main cause of this extreme flood were abundant rains that continued from 1–4th September 1890 and affected a vast territory of Central Europe, especially the Labe/Elbe River basin (in it mostly the Vltava/Moldau River basin) and an adjacent part of the Danube River basin. The synoptic situation, that induced the extreme and several days lasting precipitation was described already by F. Augustin (1891, 1892), but neither aerological measurements nor upper-air charts existed of course in those times. According to Kakos and Kulasová (1990), a likely reason to heavy rains was the upper-level low, which more or less persisted during four days over Central Europe. The highest four-day precipitation amount (245 mm) in the territory of Bohemia – at that time observed here on 715 precipitation stations, surprisingly more than at present – was recorded on the Sofienschloss station (749 m a.s.l.) in the watershed of Malše/Maltsch River near the Vltava R. and Danube R. divide. The size of the flood was significantly influenced by the fact that the above-mentioned rain was preceded by the extremely wet summer, which caused extensive saturation of the territory with water and reduced its retention capacity.

This precipitation, of course, induced extreme floods that caused large damage. In Prague, the water inundated lower-situated parts of the town and some 4,000 houses were flooded. The disaster claimed several tens of human lives (Fig. 1 – see cover p. 4).

However, the greatest casualty was considered the breakage of the Charles Bridge (Fig. 2), where the culmination discharge of the Vltava R. reached 3,980 $m^3 . s^{-1}$on 4th September 1890, which is in total counts the fourth largest assessed flood in Prague (recorded within a period of more than 200 years) and the second greatest summer flood after the extreme flood disaster of August 2002 (Fig. 3 – see cotver p. 4). Discharge in the terminal Czech profile of the Labe/Elbe River in Děčín on 6th September 1890 amounted to 4,450 $m^3 . s^{-1}$, which represents until these days the fourth greatest disaster after the floods of 1845, 1862 and 2002 (from the period of instrumental measurements, of course).

Fig. 2: The catastrophic flood on the Vltava/Moldau R. in September 1890 was the last one to damage the Charles Bridge in Prague. Two of its arches were torn apart on the third day of flooding – 4 September 1890 – as a result of the accumulation of a large amount of logs (Collection of M. Deutsch)

The Elbe/Labe River in Germany was swollen only by water coming from Bohemia. Its main German tributaries Mulde R. and Havel R. did not swell at all after mild rains and their discharges were at normal, i.e. they did not contribute to the flood on the Labe/Elbe River and to damages caused by it. Thus, the course of the flood in the German section of the Elbe/Labe River was milder than in Bohemia although the impact was considerable, too, when some dam failures were recorded namely in Saxony and Prussia (Augustin, 1891). On the chateau Pillnitz near Dresden, high water culminations have been recorded by flood-marks since 1784. The flood from September 1890 represents here (after cases from 1845 and 2002) the third highest (Fig. 4). In Dresden, the Elbe/Labe R. culminated on 7th September 1890 at a water level stage of 837 cm and discharge of 4,350 $m^3 . s^{-1}$, the extreme occupies the sixth place in the historic table of Dresden floods recorded since 1501 according to the level height.

As to the Danube River basin, the highest precipitation amount from 1–4th September 1890 (184 mm) was recorded at the Kempten station situated on the Iller R., the right affluent of the Danube R. in Bavaria. The flood on the Danube R. was of extreme character as well but did not belong to the most disastrous floods recorded here. According to the statistics for the period from 1821–1955 from the Austrian profiles in Linz, Stein-Krems and Wien-Nussdorf, it ranks at the eighth place by the size of culmination discharge reaching 7,765 $m^3 . s^{-1}$ in Vienna on 7th September 1890. For a comparison, the first place is occupied by the flood in September 1899 with a culmination discharge of 10,500 $m^3 . s^{-1}$ (Kresser, 1957).

From the water-gauging station in Bratislava a 130-year series of mean daily discharge values on the Danube R. is available for the period from 1876–2005 (Pekárová et al., 2008). The data were used to construct a table of the most severe floods there (Tab. 1), which contains a chronological list of all cases from the concerned period in which the mean daily discharge exceeded the value of 8,000 $m^3 . s^{-1}$. According to the size of discharge, the flood of September 1890 ranks at the 13th place. Similarly as in Vienna, the most severe floods occurred there in September 1899 and in the 20th century in

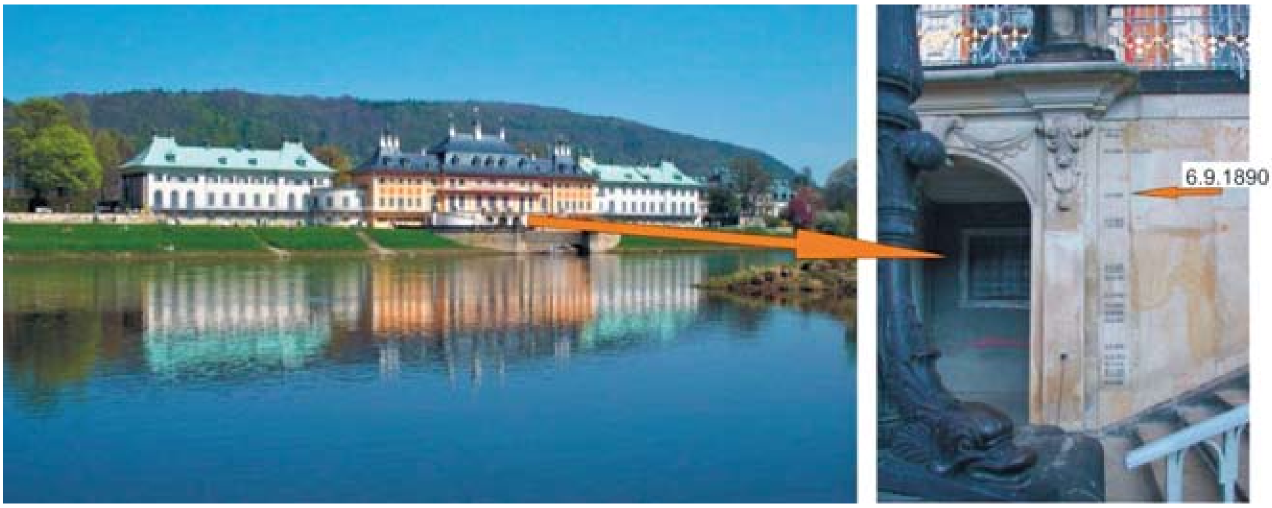

Fig. 4: Flood-marks on the water pavilion of Pillnitz Chateau near Dresden on the right bank of the Elbe R. The culmination of the water level of the Elbe R. from 6 September 1890 indicates that this flood represents (after cases from 2002 and 1845) the third highest (Photo U. Grünewald, distant view www.panoramio.com)

Year	Discharge ($m^3 . s^{-1}$)	Year	Discharge ($m^3 . s^{-1}$)
1876	8,166	1920	8,616
1880	8,722	1923	8,685
1883	8,722	1954	10,400
1890	8,227	1965	9,224
1892	8,380	1975	8,715
1897	10,140	1991	9,430
1899	10,870	2002	10,370

Tab. 1: The greatest floods on the Danube R. in Bratislava in 1876–2005
Source: Pekárová et al., 2008

July 1954. The abundance of great floods at the end of the 19th century is also evidenced by the fact that there were altogether seven high water events in 1876 – 1900 (within only 25 years!), which exceeded the above-mentioned discharge value. The fact is considered remarkable because the number of these floods in the whole following 20th century was lower – "only" six.

3. Flood in November 1890

Not even three months later, in November 1890, other extreme floods occurred in Central Europe, which largely affected a vast area between the Elbe and the Rhine Rivers in Germany and western Bohemia, namely the Ohře/Eger River basin. The floods were caused by three-day abundant rains lasting from 22 – 24th November 1890 (Hellmann, 1891; Weikinn, 2008).

In Germany, the floods affected mainly the watersheds of left-bank tributaries of the Elbe River (Saale R. etc.), headwaters of Weser R. (Fulda R. and Werra R.) and right-bank tributaries of the lower and middle Rhine R. (Wupper R., Ruhr R and other watercourses). The precipitation area of 23rd November 1890 is presented in Fig. 5.

The disastrous rains were caused by the atmospheric low above Central Europe. So classifies the days of 23 – 25th November 1890 the Hess-Brezowsky catalogue of synoptic situations (Gerstengarbe et al., 1999). The location of the barometric depression on 24th November 1890 is illustrated on the reconstructed surface chart (Fig. 6).

In Germany, on the divide of the Saale R. and the Werra R. watersheds, 3-day precipitation amounts (22 – 24th November 1890) exceeded 125 mm. The highest daily totals were recorded on 23rd November – e.g. the Schmücke station recorded nearly 140 mm on that day and the Oberhof station recorded an amount lower by only 10 mm. Flood response to the causal precipitation on the Saale R. in four profiles is illustrated as a course of gauge heights in Fig. 7.

This extreme historic flood incurred damages and casualties for instance in Rhineland; only in the town of Wuppertal the high water on the Wupper River claimed five human lives. Considerably afflicted was also Thuringia where the flood on the Saale River was documented in details only recently (Deutsch, 2004; Deutsch, Pörtge, 2003). Up to now this natural disaster has been reminded here not only by flood marks (Figs. 8, 9), but also e.g. by wall painting in village church in Oelknitz (Fig. 10).

Abundant precipitation and floods at the end of November 1890 affected also western Bohemia, namely the basin of the Ohře/Eger River whose right-bank tributary Teplá/Tepl R. flowing through Karlovy Vary/Carlsbad (Fig. 5) became swollen. The world-known spa town suffered a great destruction due to the flood on the Teplá/Tepl River.

Total precipitation amounts in this region were not as high as in Germany from 22 – 24th November 1890. The highest daily precipitation amounts recorded at the Hůrka and Pila stations in the Teplá/Tepl R. basin on 23rd November were 85 mm and 77 mm, respectively.

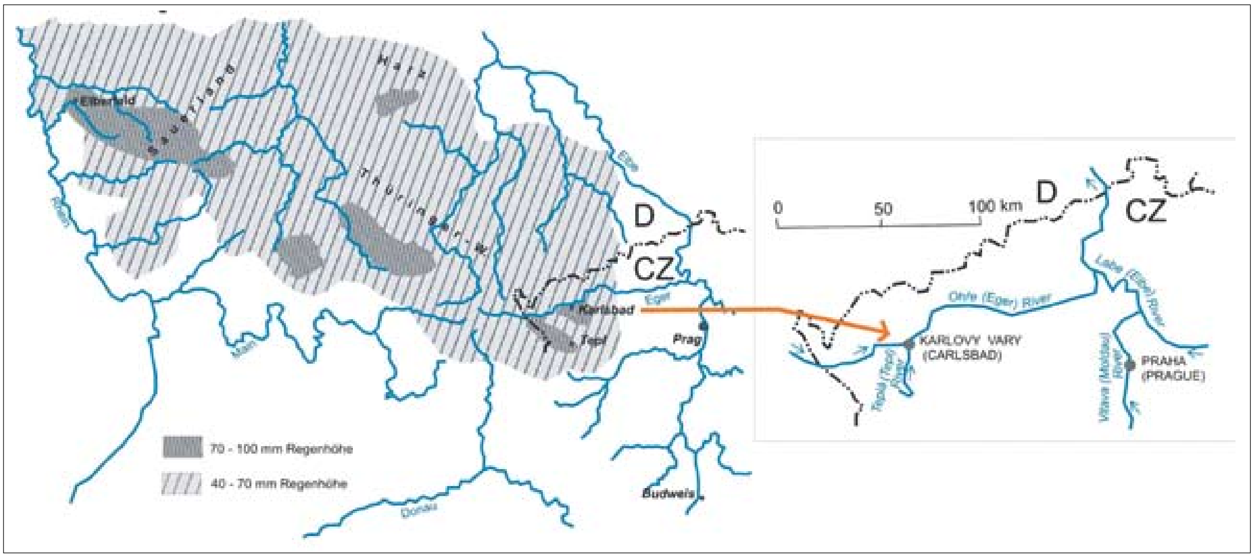

Fig. 5: A period map (supplemented by authors) depicting precipitation amounts (in mm) in Germany and Bohemia from 23rd November 1890. Whereas in Germany an extensive area between the Elbe/Labe R. and the Rhine R. was affected, in Bohemia mainly the Ohře/Eger R. basin was affected. The flood that occurred on the Teplá/Tepl R. (a right tributary of the Eger R.) devastated the well-known spa town of Karlovy Vary/Carlsbad. (Source: Das Hochwasser in Karlsbad vom 24th November 1890, Karlsbad 1893)

A greater amount of the precipitation fell in the night on 23/24th November from 11.00 PM to 04.00 AM, i.e. in just five hours (Kynčil, 1983).

The Teplá/Tepl. R. in Karlovy Vary/Carlsbad was rising already on 23rd November. This day morning, it was approximately one meter above normal and continued to increase especially in the night hours. On 24th November after 8.00 AM, its level swelled rapidly and culminated within a very short time at 4.83 m above normal. The river ran out over quay walls and flooded numerous bridges. Ground floors of houses standing along the both riverbanks were caught immediately under water. The spilled and backwater formed a continuous water surface in the town situated at the bottom of a deep valley (Fig. 11). The municipal theatre and the Thermal spring colonnade (Vřídelní kolonáda) were flooded within a short time. The Market place (Tržiště) was affected most. People were forced to think just about how to rescue bare lives. The

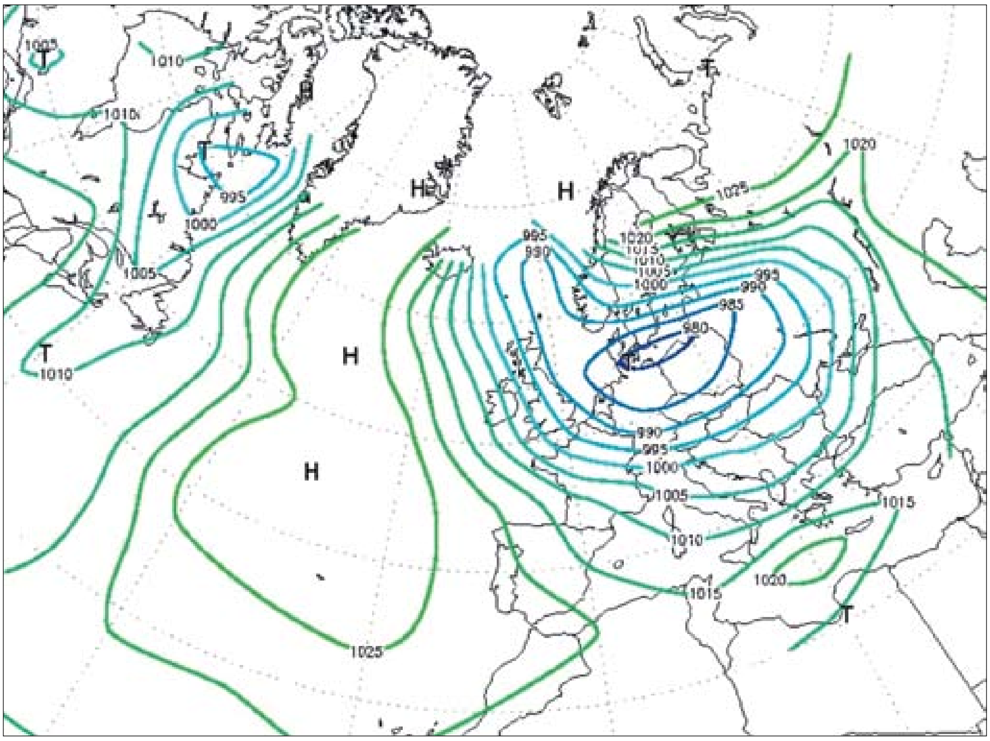

Fig. 6: The synoptic situation on 24th November 1890 according to www.wetterzentrale.de (H = High, T = Low).

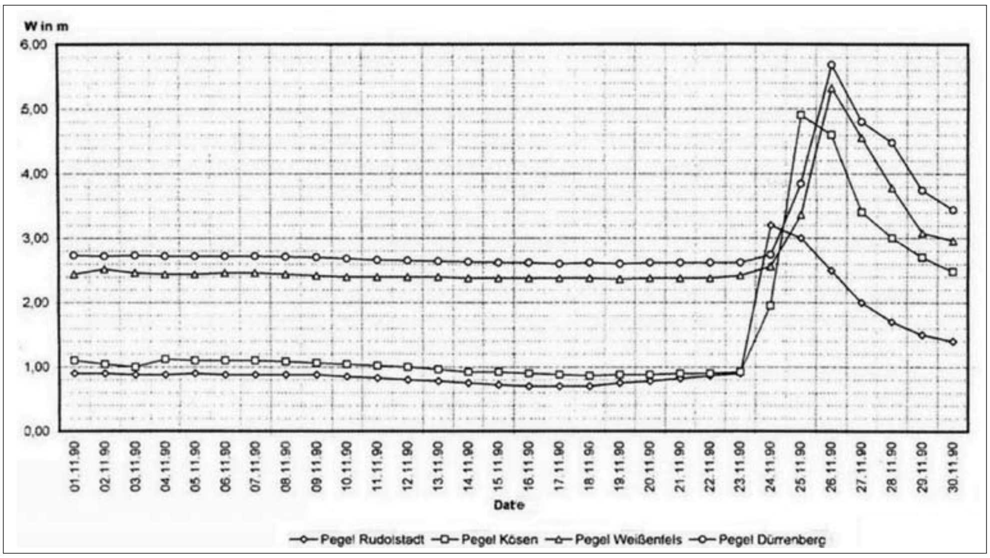

Fig. 7: Water stages on the Saale River recorded during November 1890 on four water gauges (Rudolstadt, Kösen, Weißenfels and Dürrenberg). The graphs clearly demonstrate the start and course of the flood from 23rd to 30th November 1890 (Drawing of M. Deutsch)

reached height of culmination was recorded by flood-marks, one of them being situated by the entrance to the hotel Elefant (Fig. 12); another one can be found in the interior of the theatre. Then the water began to fall rapidly on 24th November after the noon. It left great damages behind – severely destructed were 14 bridges, 240 houses and 400 shops and boutiques. The building of Kafeebaum half-collapsed (Fig. 13) and other two buildings were uninhabitable due to collapse risk. The flood took the life of prominent mayor Eduard Knoll who impressed a modern face to the town of Karlovy Vary/Carlsbad. Organizing with an unflagging zeal all rescue works he suffered heart attack due to exhaustion and died (Schönbach, 1997).

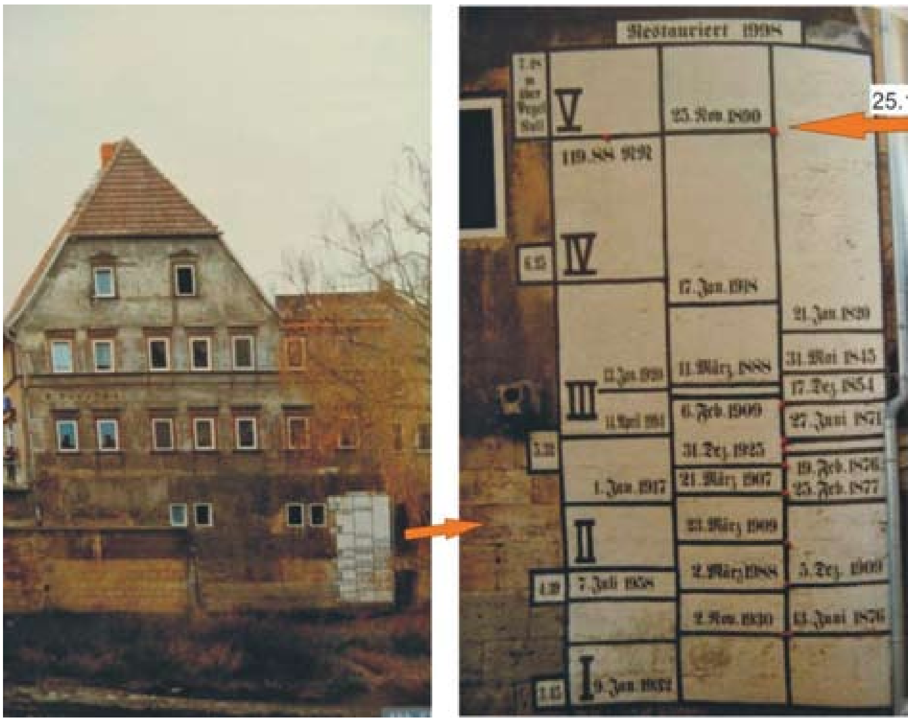

Fig. 8: A residential building in the town of Camburg on the bank of the Saale River. Flood-marks on its wall were restored in 1998. They clearly indicate that the highest recorded flood waters were here on 25th November 1890, which reached 7.18 meters above the water-gauge zero point during the culmination (Photo M. Deutsch)

Fig. 9: A flood-mark on the western portal of the Church of St. Nicholas in the town of Kahla (south of Jena) shows the water level of the Saale R. during the flood of 24–28th November 1890 (Photo V. Tympel)

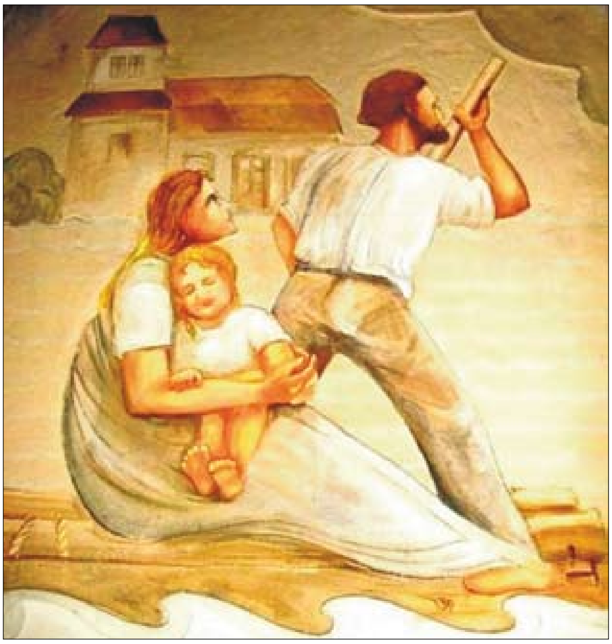

Fig. 10: The reminder of problems during the disastrous flood on the Saale R.in November 1890 was still vivid in peoples' mind after more than 30 years. A wall painting in the Thuringia's village church of Oelknitz (Photo M. Deutsch)

Fig. 11: An old picture depicting the situation in Karlovy Vary/Carlsbad during the catastrophic flood of 24th November 1890. The inundation of this spa town located in a valley was caused by the Teplá/Tepl River, a right tributary of the Ohře/Eger R., overflowing its banks (Collection of M. Deutsch)

Fig. 12: The water level at the culmination during the flood in Carlsbad in November 1890 is recorded by the restored flood mark at the entrance to the hotel Elefant, which is located on the left bank of the Teplá/Tepl R. (Photo J. Daňhelka)

4. Lessons learnt

Both mentioned floods caused not only catastrophic damage, but also taught many lessons and resulted in the adoption of several measures.

In Bohemia, a decree was issued already on 25th January 1891 by Emperor-Royal governor count Thun-Hohenstein instituting a flood warning system on Bohemian rivers, including a requirement to transmit warnings to neighboring Germany (Dresden). In 1892, the following year, the Technical Office of the Agricultural Council for the Kingdom of Bohemia in Prague issued detailed German-Czech instructions that established a forecasting service for water stages on the Labe/Elbe R. and on other rivers in Bohemia. Pursuant to these instructions, forecasts and warnings were to be sent to Germany as well as to other places on the Labe/Elbe R. (Dresden and Torgau). The two

Fig. 13: The destroyed „Kaffeebaum" house in Carlsbad after the flood of November 1890 (Collection of M. Deutsch)

flood control instructions were prepared with taking into account results of unofficial gauge level forecasts for the Labe/Elbe River that had been issued in Prague since 1884 (Deutsch, Munzar, 2008).

Another result of the Czech-German collaboration concerning flood alarms on the Elbe/Labe River in Saxony was the instruction issued by the Königliche Wasserbau – Direction in Dresden in November 1895 and titled "Communication to explain the establishment and operation of the warning system during ice drifts and floods on the Elbe R. in Saxony". The warning system consisted in regular data that were provided particularly by institutions in Bohemia, founded earlier for the observation of watercourses in the Labe/Elbe River basin (Erläuternde Mittheilungen, 1895).

As a result of the great Danube flood in September 1890, which even struck Vienna, the capital city of the Austro-Hungarian Empire, completed the long-term endeavour to establish a hydrological service in its Austrian part. Thus, in 1893 the Central Hydrographic Office (Hydrographische Zentralbüro) of the hydraulic-engineering department of the Ministry of the Interior was eventually founded in Vienna.

The floods in September and November 1890 also motivated a discussion about flood prevention measures, particularly about the construction of water reservoirs in Bohemia and Germany. Several of them were later constructed. For example, the Březová reservoir was constructed in 1932 – 1936 on the Teplá/Tepl R. to protect the spa of Karlovy Vary/Carlsbad.

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Authors' addresses:

RNDr. Jan MUNZAR, CSc., e-mail: *munzar@geonika.cz*
RNDr. Stanislav ONDRÁČEK, e-mail: *ondracek@geonika.cz*
Mgr. Eva KALLABOVÁ, Ph.D., e-mail: *kallabova@geonika.cz*
Academy of Sciences of the Czech Republic, Institute of Geonics, v. v. i., Brno Branch,
Drobného 28, 602 00 Brno, Czech Republic

Dr. rer. nat. Mathias DEUTSCH, M. A., e-mail: *amdeutsch@arcor.de*
Weikinn-Project, Saxonian Academy of Sciences in Leipzig
Karl-Tauchnitz-Strasse 1, D-04107 Leipzig, Germany

TYPES AND CHARACTER OF GEOMORPHIC PROCESSES ON A CENTRAL-EUROPEAN LOW-ALTITUDE SCREE SLOPE (NW CZECHIA) AND THEIR ENVIRONMENTAL INTERPRETATION

Pavel RAŠKA

Abstract

The results of geomorphological research carried out on a low altitude scree slope in the České středohoří Middle Mts. are reported in this article. The locality is represented by the rock cliff and accumulation of basaltic clasts, and is surrounded by forest vegetation. Detailed geomorphological mapping, Schmidt-hammer tests and joint orientation analyses were applied to identify the relations of lithology and morphology. Dendro-geomorphological assessment was applied in analyzing landform-vegetation interactions. Geomorphic processes below the rock cliff and on the open scree were analysed using exposures, and the sedimentological assessment of sieve effect and of clast flows. The results demonstrate the important role of vegetation-controlled dynamics, in contrast to previous emphases ascribed to climate-controlled processes. Finally, the results are discussed in the context of local environmental change.

Shrnutí

Typy a charakter geomorfologických procesů na nízko položeném suťovém svahu ve střední Evropě (SZ Česko) a jejich environmentální interpretace

Příspěvek prezentuje výsledky geomorfologických výzkumů nízko položeného suťového svahu v Českém středohoří. Lokalita je reprezentována skalním srubem a akumulací bazaltických klastů, a je obklopena lesní vegetací. Pro poznání vztahu litologie a morfologie bylo využito detailního geomorfologického mapování, testu Schmidtovým kladívkem a puklinových měření. Dendrogeomorfologické metody byly aplikovány pro hodnocení vztahu reliéfu a vegetace. Geomorfologické procesy pod skalním srubem a na otevřené suti byly interpretovány pomocí kopaných sond a sedimentologickými analýzami „sítového efektu" a drobných suťových proudů. Výsledky ukazují významnou roli dynamiky podmíněné vegetací oproti dříve zdůrazňovaným klimatickým faktorům. V závěru jsou výsledky výzkumů diskutovány v kontextu lokální environmentální změny.

***Key words**: scree slope, surface dynamics, geomorphology, environmental change, České středohoří Middle Mts., Czechia*

1. Introduction

Scree slopes and other types of rock-mantled slopes are frequent landforms across diverse environments (French, 2007). The study of scree slopes was traditionally focused on their palaeogeomorphic evolution (Rea et al., 1996; Curry and Morris, 2004) and recent ecological significance (Kubát, 1971; Gude et al., 2003). Understanding the past development of screes is only possible, while based on the knowledge of recent processes that control their dynamics. Data on the types, frequency and magnitude of geomorphic processes are in turn a basis for the evaluation of past and recent environmental changes. Geomorphological approaches to a study of scree slopes were usually established in cold environments of high altitudes and latitudes. A typical feature of such environment is sparse vegetation cover or its total absence. The dynamics of screes was evaluated in relation to climatic variations, and emphasizing the free face of a rock cliff. In such a case, the scree catena concept may become a basic dynamic model for the explanation of scree slope development (Gerber and Scheidegger, 1974). The concept explains the sequence of processes along the slope profile, but it has certain limits in analyzing the spatial patterns of processes on complex scree slopes. Complex scree slopes are predisposed by palaeotopography and often are composed of manifold micro-landforms such as taluses, clast flows, ridges, depressions, etc. Other limits of scree catena concepts are well apparent on low-altitude screes, which are influenced by surrounding forest stands. Both the palaeotopography and the protective effect of trees (Raška, 2007b) on low-altitude screes in the temperate zone limit and transform the down-slope particle movement, which results in the different character of toposegments in contrast to ideal scree catena. These effects may then result in a different slope profile than that presented in former works of Statham (1973) or Pérez (1998) from screes with a rock cliff without the vegetation cover.

Research on the low-altitude temperate zone scree slopes was often methodologically connected with approaches developed in colder environment. Studies in climatic geomorphology described scree slopes in Central Europe as indirect indications of Pleistocene permafrost (cf. Czudek, 1986) and focused on the climatic interpretation of sedimentary sequences in screes and related slope covers (Kirchner et al., 2007; Pawelec, 2006; Cílek, 2000). On the other hand, there was a lack of considerations on the Holocene development of scree slopes and on the recent geomorphic dynamics of scree slopes (cf. Raška, 2007a, 2007b).

The paper presents results of geomorphological research carried out at a single low-altitude scree slope in the České středohoří Middle Mts. (NW Czechia) during the last four years. The results are discussed in relation to environmental change of the study site and considering the conclusions of other studies aiming at the geomorphology of scree slopes in the region. The main aim of the paper was to determine leading processes that take part in geomorphic dynamics of the studied scree slope, and to discuss their character, causes and relative magnitude. A special focus was put on the role of climate-controlled and vegetation-controlled dynamics of the study site. The results were used to reveal additional information about the recent regional environmental change.

2. Study site

The study site (N 50°37´23´´, E 14°5´54´´) is located in centre of the České středohoří Middle Mts., a SW–NE trending neo-volcanic range in NW Czechia (Fig. 1). Located in an altitude of 430 m a. s. l., the scree itself is situated on a westward slope of the valley of Průčelský potok Brook, a tributary of the Labe River (local altitude 130 m a. s. l.), which is the erosional base of the territory. The origin of the scree may be ascribed to the exposure of the rock cliff in the culmination segment of the slope due to backward

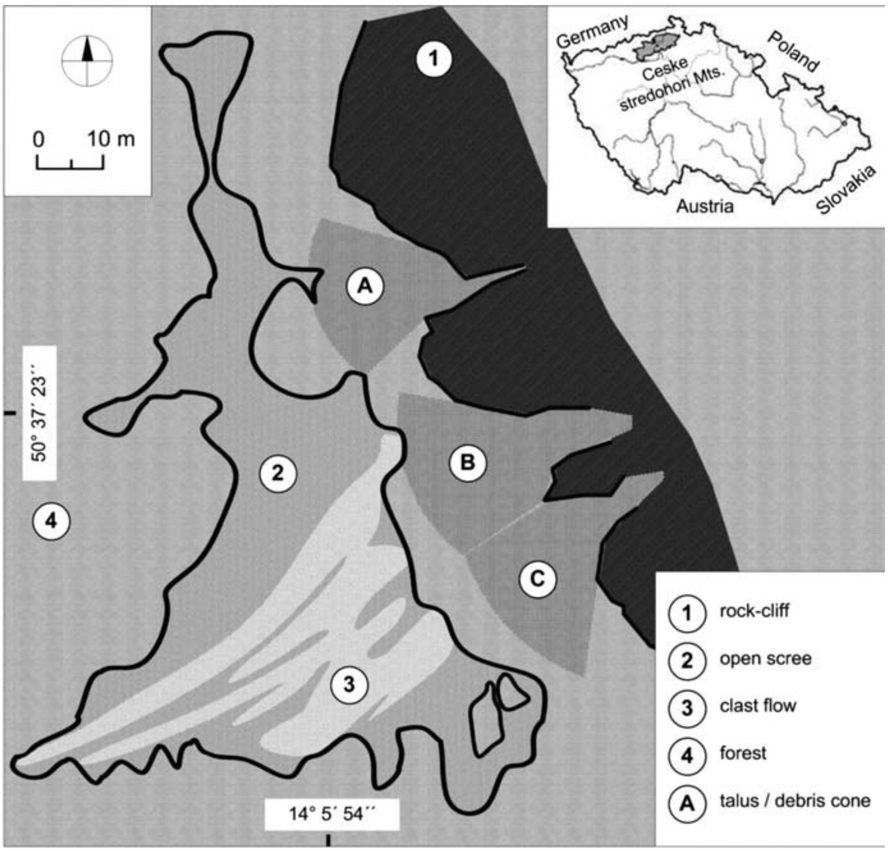

Fig. 1 Location and basic geomorphological setting of the studied scree slope

erosion of the Průčelský potok Brook (Raška and Cajz, 2008) and to probable subsequent mass movements on the slope. The scree is built by clasts of basalts disintegrated from the above-situated rock cliff, and continues down the slope where it covers Tertiary volcanoclastics and younger slope sediments of the Quaternary age (Raška and Cajz, 2008). The size of clasts varies from below 10 cm (clast flows) to above one meter (boulder streams). The contact between the scree and the rock cliff is represented by talus cones and debris slides and flows, some of them being covered by herbs and sparse trees. The scree is surrounded with deciduous forests mostly represented by European beech (*Fagus sylvatica*) which also sporadically penetrates to the open scree. Less frequently, other tree species such as lindens (*Tilia sp.*), oaks (*Quercus sp.*) and maples (*Acer sp.*) penetrate the scree thanks to specifics of the exposition climate and edaphic conditions. The regional climate is moderate with mean annual year temperatures ranging between 6 and 7 °C, approximately 110 days exceeding the rain precipitation of 1 mm, and average inter-annual snow cover of about 40 cm.

3. Methods

Different methods were used to assess dynamics of individual segments on the study site. The rock cliff, which is the primary source of material for the open scree slope was analysed as to predisposition to weathering and its spatial pattern. The lithological control of rock cliff disintegration was assessed using the joint orientation measurement on sampling sites along the whole rock cliff. Differences in the rock cliff rate of weathering were analysed by means of Schmidt hammer (NR type) test. A total of 30 hits were made on each of three chosen sites at the compact rock cliff and a similar number of hits at disintegrated parts of the rock cliff (i.e. source zones of talus cones and debris slides and flows; see Fig. 2). Five lowest values from each site were discarded from the statistical processing.

The contact (transport) zone between the rock cliff and the open scree is represented by taluses and debris slides and flows of different character, or by short narrow segments, both being sparsely covered with trees. As this transport zone is fundamental for the delivery of material to the open scree, the attention was focused on the detection of rock fall activity and surface dynamics of taluses and debris slides and flows. The rock fall was assessed using non-destructive techniques, because the site is a subject to nature conservation and it is not possible to take sample discs from the stems. Dendrochronological analyses using the cores from the increment borer were limited by the predominance of deciduous species (see above), most of them being deformed by local conditions and landform dynamics.

Therefore, the present research was based on visual assessment of bioprotective effects of trees proposed by Raška (2007b): bounce-inducing effect (scars on bark as results of rock fall), halt effect and dam-like effect (accumulation of individual clasts, or of heterogeneous material as a result of rolling and sliding). The frequency of these effects was analysed on 67 standing and fallen trees at various distance from the rock cliff. Trees at taluses were mapped in detail as to assess the relation of their position and physiognomy in relation to the debris slide/flow activity (Bollschweiler et al., 2008). The amount of accumulated material was computed for a sample trunk dam at a talus A (Fig. 2) using the EAAM method (Raška and Oršulák, 2009). The activity at taluses and debris slides and flows was indicated using a detailed mapping of landform dynamics and exposures.

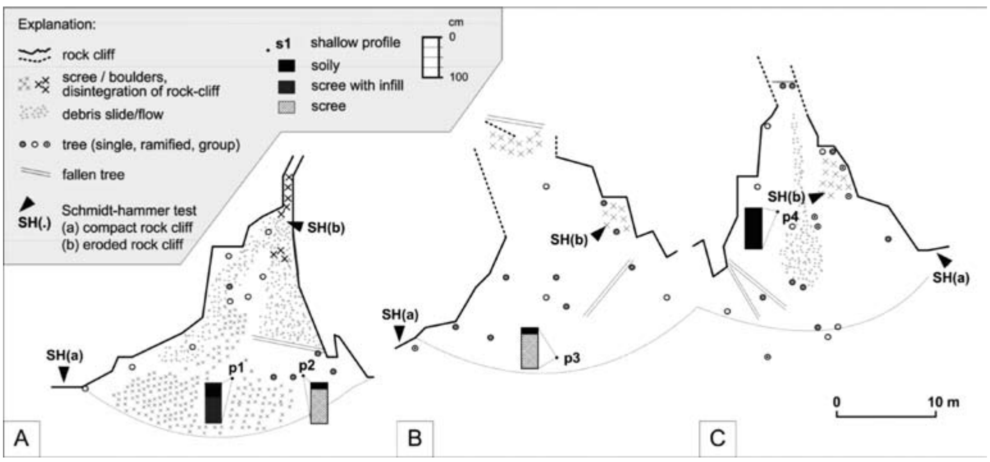

Fig. 2: Detailed geomorphologhical plans of three major taluses with debris slides and flows below the rock cliff. The plan shows the position of landforms, the position of standing and fallen trees, locations and profiles from exposures, and sites of Schmidt hammer testing

The surface dynamics of the open scree was evaluated by means of sedimentological methods. At first, the vertical particle movement (i.e. presence and relative importance of sieve effect; cf. Carniel and Scheidegger, 1974) was assessed. The clast size was measured on 50 regularly distributed sites in the centre of the open scree. On each site, the length of three axes of clasts lying in three subsequent layers (starting with the surface layer) was measured. The size and shape of clasts were statistically evaluated. Secondly, the horizontal downslope clast movement was assessed on a case of individual clast flow (sample of 60 clasts). The dataset was analysed as to the size and shape parameters using the Tri-plot MS Excel spreadsheet (Graham and Midgley, 2000) to determine the level of particle sorting, shape attributes in Sneed-Folk classes (Sneed and Folk, 1958), and C40 index. The size and shape of clasts and their orientation and inclination were considered to evaluate the presence of frost action in the clast flow origin (Hubbard and Glasser, 2005).

4. Results

4.1 Rock cliff: lithological controls in rock disintegration

The rock cliff disintegration in basalts is predisposed by discontinuities of different orders. The most detailed of them are discontinuities formed during the cooling of lava flows and creating of the column structure. These discontinuities were omitted from the measurement and attention was paid only to joints separating the large segments of the rock cliff. Results showed a prevailing NE–SW and a less frequent NW–SE orientation (Fig. 3). The orientation corresponds to regional tectonic patterns in the České středohoří Middle Mts. neovolcanic range. The changing direction of the rock cliff face influences the character of its surface structure. The rock cliff disintegrates in segments where the face is perpendicular to the column structure. In contrast, in segments where the direction of the rock cliff face is close to the direction of the column structure, the disintegration is low. Slightly different rates of weathering were shown

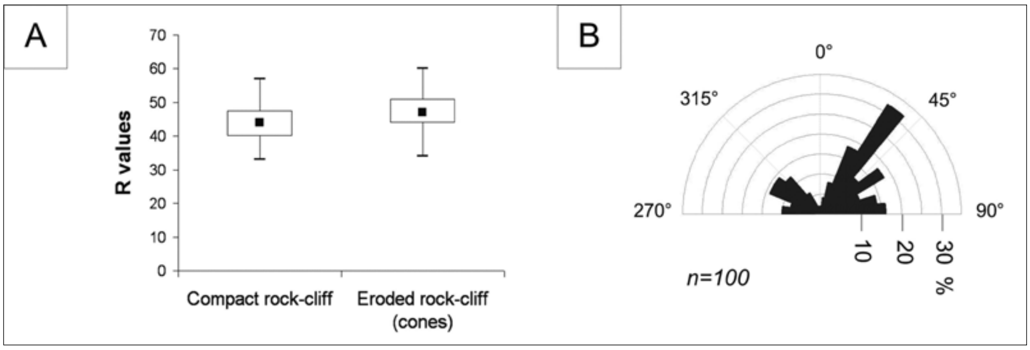

Fig. 3: (A) Results of Schmidt hammer tests and (B)joint orientation diagram at the rock cliff

by Schmidt hammer tests (Fig. 3). The variance of datasets is high, but still it indicates a quite lower relative age of the rock cliff at taluses in comparison with other segments of the cliff.

4.2 Contact zone: bioprotective effects and surface dynamics

The assessment of dendrogeomorphic protective effects reveals a significant protective role of standing and fallen trees (Fig. 4, Fig. 5 – see cover p. 2) and enables to interpret processes, which caused the dynamics of clasts. The most representative results were given by analyses of scars caused by rock fall events (Fig. 6 – see cover p. 2). The results confirm the rock fall activity along the whole rock cliff with apparent dependence on distance from its face and correspond to preliminary results presented by Raška (2007b). The second most frequent protective effect was the halt effect (standing tree stopping clast of a boulder size). The effect represents the rolling activity of clasts, and was also identified at a great distance from the rock cliff (more than 30 m). Finally, the dam-like effect represents the sliding and rolling activity. The occurrence of this effect at the site was not dependent on a distance from the rock cliff, because it was caused by both newly fallen trees and by old large woody debris that moved to lower parts of the scree slope. The volume of accumulated material was calculated for the selected sample trunk dam. This dam, located at talus A, was the only representative sample suitable for the analyses, because it was stabilised in a direction relatively perpendicular to the slope profile. The volume of material for the trunk dam (length 7 m) was 5.7 m^3. The distribution of standing trees (Fig. 2) did not suggest any spatial regularity and/or significant differences among the taluses, but it influences the trace of debris slides and flows at taluses. Most trees were ramified due to the impacts of rock fall clasts.

Exposures showed different structures indicating variable spatial patterns in the talus and debris slides/flows activity (Fig. 2). Profiles p2 (talus A) and p3 (talus B) were typical of thin surface layer of

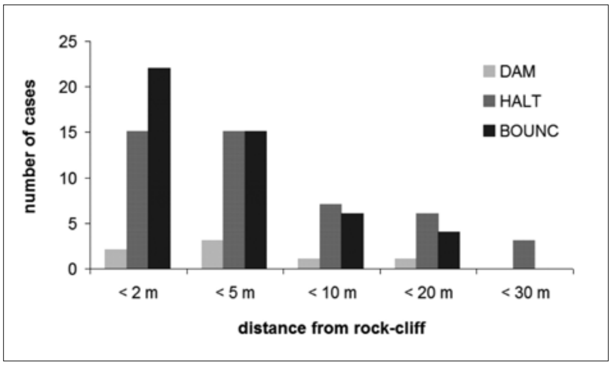

Fig. 4: Dendrogeomorphic protective effects below the rock cliff. DAM – dam-like effect (accumulation of material above the fallen trunk), HALT – halt effect (clasts stopped by the standing tree), BOUNC – bouncing (scars indicating the impact of rock fall)

loamy horizon with finer particles, and subjacent homogeneous horizon of scree (clasts of about 10 cm) with the open-work structure. The clasts showed no imbrication and had different shape and size. The profile p1 (talus A) displayed a deeper surface organic horizon with scree particles, and an underlying horizon built by scree with a loamy infill. The homogeneous last profile p4 (talus C) was by the loamy horizon with less frequent clasts of stones.

4.3 Open scree: vertical and horizontal particle movement

Sedimentological measurements confirmed the presence of the sieve effect at the open scree; however, the significance of the effect was limited. The statistical analyses showed that probability that a clast will move below the surface layer is not linear. As regards the interaction of the first (surface) and the second (first underlying) layer, the size of the underlying clast was limited to 20 cm along the longest axis and the increase in their size did not reflect the increase in size of surface clasts linearly (Fig. 7).

Similar results were obtained for the interaction of the second (first underlying) and the third (second underlying) layer of clasts. In this case, the probability of sieving the larger clasts decreased. The diagonal axis in rectangles in graphs (Fig. 7) delimits the cases, in which larger clasts occurred above the smaller ones (sieve effect) and vice versa (converse sieve effect). The latter cases were detected at sampling sites with surface clast flows reflecting the horizontal down-slope particle movement. Evaluation of clast shape frequency in each layer did not indicate any shape-conditionality in the vertical movement (Fig. 7). Most clasts are bladed or elongate and there are only minor variances among the layers of clasts.

Clast flows are landforms typical of the study site and display a specific spatial pattern. The clast flows are of two types. The first group is represented by elongate flows, which often spread along the whole slope profile and are mostly located in the centre of the open scree below taluses B and C. The second type comprises randomly distributed smaller clast flows with a typical topography including the source channel and the terminal lobe. Sedimentological analyses of sample small clast flow (Fig. 8) pointed to particle sorting resulting in smaller and less variable particles in its terminal lobe. The particles were prevailingly bladed, very bladed and elongate. The representation of C40 index did not indicate the frost action and frost weathering of particles. The assumption of other than frost origin was also supported by the variable orientation and inclination of clasts. Furthermore, small clast flows display high inter-seasonal dynamics of spatial distribution as observed visually during the research period. This fact does not indicate any stable zone of microclimatic or geomorphic controls of their evolution. However, the full understanding of the origin of the clast flow at the study site would require analyses of clast micromorphology and winter season monitoring of clast flow dynamics.

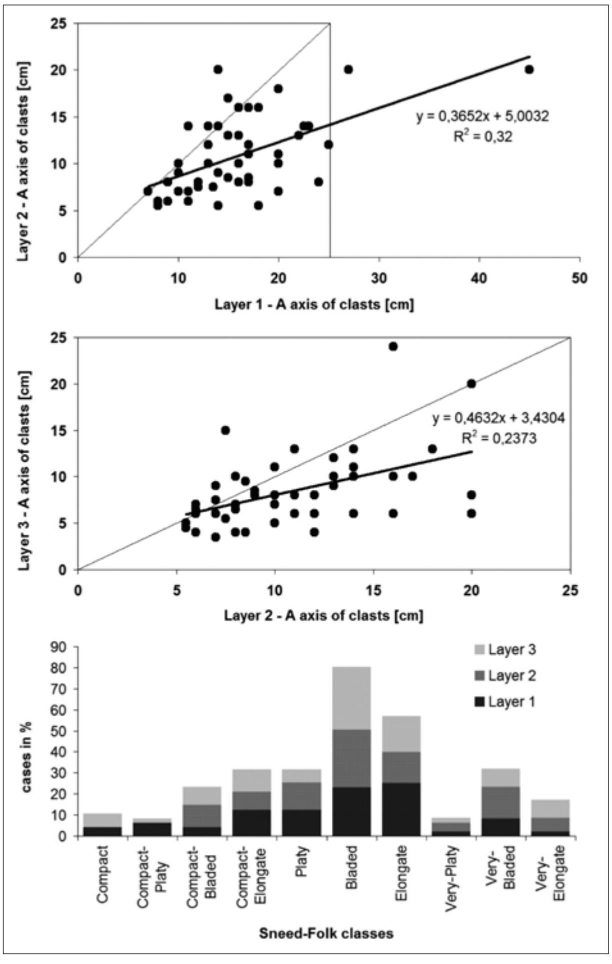

Fig. 7: Sedimentological analyses of sieve effect at the open scree. The first two graphs show the relation of clast size (a axis) between the 1st and 2nd, and the 2nd and 3rd layer of clasts. The third graph represents the frequency of Sneed-Folk classes of clasts in all three layers.

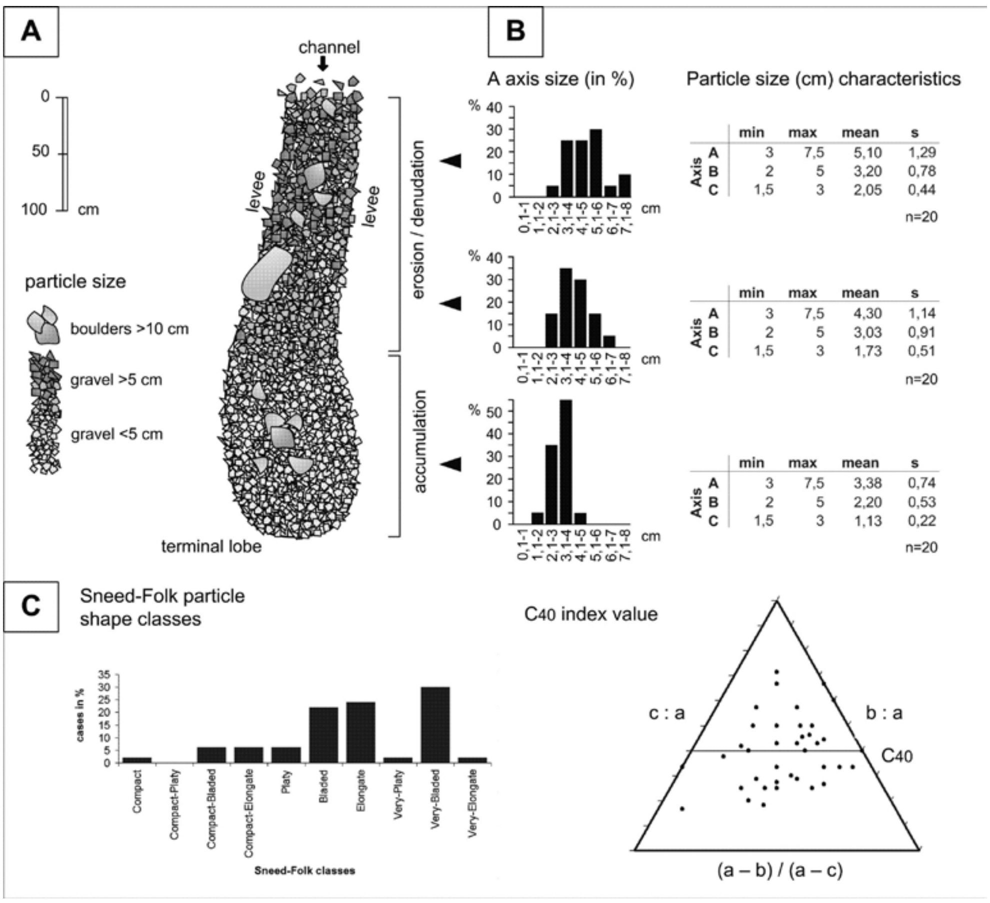

Fig. 8: Sedimentology of a sample clast flow; A – planar scheme of the clast flow, B – basic sedimentological characteristics of particles, C – Sneed-Folk classes and C40 index of particles

5. Discussion and conclusions

The scree catena model (Gerber and Scheidegger, 1974) builds upon assumption that as the rock cliff disintegrates, the loose material moves down the slope and forms the accumulation of scree. This concept is basically correct, but its application in different environments drives at a question of leading factors in the rock cliff disintegration and character of material transport. Such questions may especially arise in a study of low altitude scree slopes, which are surrounded by forest stands that are subject to long-term environmental change.

The changes in vegetation pattern may in turn influence the rate of erosion and accumulation (cf. Phillips, 1995; Corenblit and Steiger, 2009). Scree slopes at higher altitudes and latitudes are usually considered climate-controlled in both local (Hétu and Gray, 2000) and regional (Hales and Roering, 2005) context. Although Lafortune et al. (1997) showed that forest edge expansion on a cold temperate scree slope might also have temporarily occurred during the slope instability, overall conclusions indicated that the forest edge oscillation was rather conditioned by the climate-controlled scree dynamics (frost coated clast flows).

In contrast to the cold environment, scree slopes at low altitudes seem to be of a more complex character as to the controlling factors. The origin of scree slopes in the region is predominantly ascribed to the Late Glacial period (Cílek, 2000; Kirchner et al., 2007) with climate-controlled weathering, and less frequently to the Holocene period with mass movement influence thanks to water stream erosion and meteorological extremes (precipitation, etc.). In both cases, but at different intensities, the subsequent evolution of scree slopes was controlled to a large degree by the expanding vegetation cover. The present results showed the lithological predisposition for rock cliff disintegration at the study site. The disintegration is triggered by both frost action and vegetation growth (visible roots in fissures). The rock fall is the dominant source of material for the scree as indicated by the frequency of scars on trees.

Major role in the spatial pattern of microtopography and sedimentology of the open scree is played by the character of the contact zone between the rock cliff and the open scree. The zone is covered by plants, trees and woody debris. The results confirmed that standing and fallen trees have a significant bioprotective effect and transform the type of clast dynamics on the slope. Clasts from rock fall events are decelerated by trees, so they may be stopped, or continue as rolling and bouncing stones and boulders down the slope. The bioprotective role is especially obvious on taluses, where the decelerated rock fall clasts mix with a finer material. The finer material is both autochtonous (primitive organic horizon on taluses) and alochtonous (delivered from slight slope segments above the rock cliff). Exposures on taluses displayed different activities below the rock cliff. Talus A was most active with two debris slides/flows and sporadic herbs. Talus B was almost totally covered by herbs, while the vegetation cover of talus C was disrupted by a debris flow. The exposures alluded to the different activity in the past as well. While talus C is formed by loams and finer sediments of debris flows, taluses A and B showed a former rockfall-dominated development. The scree horizons with the open-work structure (exposures p1 and p2) indicate the former existence of a forest-free zone.

Changes in geomorphic dynamics within the contact zone are represented by the subsequent movement of clasts downward to the open scree. Larger clasts are accumulated below the compact rock cliff, whereas the large clast flows occur below the taluses. As the most distinct active clast flows were present below the vegetation covered (i.e. relatively stable) taluses, other factor that could influence the occurrence of clast flows had to be taken into consideration, too. The topography analyses showed that the large clast flows are located on a down-slope concave ridge in the centre of the open scree. The occurrence of the large clast flows therefore seems to be conditioned both by the rock cliff morphology/activity, and by palaeotopography and sedimentary history. The sedimentological analyses of small clast flows indicated limited or absent influence of the frost action. The activity of clast flows is likely to be caused by rain and meltwater runoff from the source zone above and on taluses, and by biogeomorphic effects. While the clast flows spreading along the whole slope profile are most likely triggered by surface runoff, small flows could be triggered by both runoff and zoodisturbances (cf. Govers and Poesen, 1998). The zoodisturbances would also explain the random spatial distribution of small clast flows on an inter-seasonal time-scale. This assumption was confirmed by the observation of mouflon hordes (*Ovis musimon*) in the area. The observations implied that scree slopes represent a frequent alternative habitat for this species, which is in agreement with results of other studies (Cransac and Hewison, 1997; Heroldová and Homolka, 2001). On slope segments with coarse material without clast flows, the surface dynamics is under the regime of clast rolling combined with the sieve effect (Carniel and Scheidegger, 1974). This reflects both ways of rock slope development proposed by Poesen and Lavee (1994).

The previous discussion of scree slope dynamics emphasized the vegetation-control of the material transport. The sedimentary sequence in exposures indicates only a short historical record of sedimentary regime on the scree, which – in some cases (taluses A and B) – displays changes of this regime. Chronological interpretation of these changes in relation to recent environmental change is limited. Focusing on the most recent environmental change, old photographs (beg. of the 20th century) and aerial photos (2nd half of the 20th century) were analysed. The analyses of aerial photos from years 1954 and 2004 (Fig. 9) showed that the open scree did not change its shape significantly. The forest edge dynamics is apparent locally (arrows a, c and b in Fig. 9), and has a character of continual forest expansion to the scree. The clast flows in the older photos are more restricted to the central part of the scree. The old photographs from the nearby surrounding of the study site depict a sparse vegetation cover on rock cliffs and rock slopes, which is in agreement with land use and land cover studies from the area (Anděl et al., 2004). The findings presented above support the concept of slow, but continual expansion of forest stands into the study site, and the

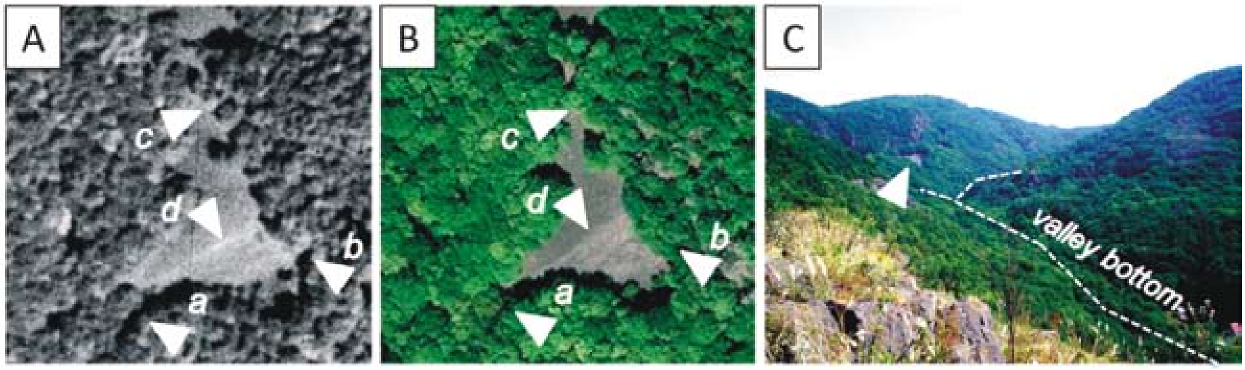

Fig. 9: Vegetation pattern changes between years 1954 (A) and 2004 (B) indicated with lower case letters, and oblique photo of the locality and its surrounding (C).
Source: aerial image VGHMU Dobruška and Geodis; photo author

increasing – though not unique – role of vegetation-controlled mechanisms of rock cliff disintegration and material transport. In this respect, the applications of palaeogeomorphic approaches, which traditionally emphasized the climatic factors, appear to be limited in the study of the recent geomorphology of low-altitude scree slopes in the region.

Acknowledgement

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Author's address:

Mgr. Pavel RAŠKA
Department of Geography, Faculty of Science, J. E. Purkyne University in Ustí nad Labem
České mládeže 8, 400 96 Ústí nad Labem, Czech Republic
e-mail: *pavel.raska@ujep.cz*

GEOGRAPHICAL ORGANISATION OF THE NOVÝ JIČÍN REGION: TRANSFORMATIONS OF ITS SELECTED ASPECTS DURING THE INDUSTRIAL REVOLUTION (CZECH LANDS)

Pavel KLAPKA, Klára NIEDŹWIEDŹOVÁ

Abstract

The 19th century witnessed important processes and changes affecting economic, political, social and cultural life. All these changes, mostly related to the phenomenon of the Industrial Revolution, were reflected in the spatial structures and landscape character. The first objective of the article is to identify and assess transformations of the selected aspects of the geographical organisation in the Nový Jičín region during the second half of the 19th century, the period of accelerating and accomplishing of the Industrial Revolution. The second objective of the article is to introduce possibilities for the delineation of nodal region in a period with insufficient data by applying methods of spatial interaction modelling.

Shrnutí

Geografická organizace Novojičínska: proměny jejích vybraných aspektů během průmyslové revoluce

Devatenácté století bylo svědkem důležitých procesů a změn, které ovlivnily ekonomický, politický, sociální a kulturní život. Všechny tyto změny, většinou spojeny s fenoménem průmyslové revoluce, se odrazily v prostorových strukturách a charakteru krajiny. Prvním cílem článku je identifikace a zhodnocení proměn vybraných aspektů geografické organizace Novojičínska v průběhu druhé poloviny 19. století, tedy v období zrychlování a následného završení průmyslové revoluce. Druhým cílem článku je představit možnosti vymezení nodálního regionu v období, za které nejsou dostatečné datové zdroje, a to pomocí modelování prostorových interakcí.

Key words: *geographical organisation, historical geography, Industrial Revolution, nodal region, spatial interaction models, Nový Jičín region, Czech lands*

1. Introduction

Geographical organisation of space has been for decades one of the key research issues in geography, though its understanding varies considerably in time and within different geographical schools. Seen from a historical point of view, the first major changes in the geographical organisation of space began to occur during the period of the Industrial Revolution, which in the Czech lands dates back to the 19th century.

These changes were reflected in many geographical phenomena and aspects, such as the society, economy, culture and natural environment. The Industrial Revolution initiated a number of innovation processes (industrialization, urbanization, migration of population, transportation and progress in agriculture). Though the transformations of the geographical environment were enormous, they are sometimes hard to assess since certain insufficiencies exist in databases and sources, which are of only limited statistical relevance or are not spatially comparable.

Generally, the Industrial Revolution means "a transition from the manufacturing production and handicrafts towards the factory production" (Purš, 1973). The factory production represents the extensive use of machinery and the application of new technologies, particularly chemical technologies as well as the employment of the steam engine as a major driving force. In the Czech lands, the Industrial Revolution can be classified in three periods (Purš, 1960, 1973) as follows:

1. initial phase from the dawn of the 19th century to the 1820s, which is particularly related to the manufacturing of textile and later food;
2. development phase from the turn of the 1820s and 1830s to 1848; and
3. unfolding and completion phase from 1848 to the beginning of the 1870s, which is marked with the accelerating development of textile and food industries (particularly sugar industry), later with the development of heavy industry and machinery.

The general development continued since the 1870s in the so called Second Industrial Revolution (or scientific and technical revolution) unfolding in the Czech lands in its initial phase during the 1880s and 1890s, which is typical of the use of electric and combustion engines as a major driving force, development of heavy chemistry, introduction of improved machines, and beginnings of automation (Purš, 1973).

The Industrial Revolution crucially influenced the characteristics of basic spatial features: nodes, lines, and areas. The steam engine enabled the separation of the production from the natural energy sources (water, wind) and the separation of the place of residence from the place of work (origin of factories). Both processes increased the tendencies to centralize human activities in the industrial centres (towns – nodes) and accelerated the phenomenon of urbanization (Butlin, 1993; Atkins, Simmons, Roberts, 1998; Pollard, 1999). The general process of concentration produced further demands on the transportation of natural resources (particularly coal, but also for instance sugar beet) and factory products, which was reflected in the development of railway network – lines (Hlavačka, 1990; Vyskočil, 2010; Butlin, 1993). The Industrial Revolution initiated also the agricultural advancements and thus influenced the land use ("use of areas"). This "agricultural" revolution basically featured the introduction of new crops (particularly technical crops), the shift towards animal production, and the introduction of new technologies in agricultural procedures (Jeleček, 1985; Kubačák, 1994).

Main objectives of this article are two. The first objective is an attempt to identify and assess selected changes in the geographical organization of a model region during the second half of the 19th century. In this respect, we are obliged to define briefly our concept of the geographical organization for the purpose of this article, since it is immensely complex and comprises several different approaches. Our attempt is also to make use of available statistical data so that our pursuit and conclusions are sufficiently supported. The second objective is concerned with an issue of the delineation of a model nodal region during the Industrial Revolution. In this respect, we resorted to the application of spatial interaction models, specifically the Reilly's model, with an ambition to introduce them into historical geographical studies.

The region of our interest (i.e. a model region) is organized around the town of Nový Jičín in the north of Moravia (Fig. 1). Since the second half of the 18th century a germanization pressure influenced the population structure of the region, however, in the 19th century the Czech national consciousness started to form. Political interests and attitudes of the Czech and German public reached a considerable discord. The social and political scene was affected by incipient labour movements. Though initially protesting against inadequate economic living conditions, they later began defending national political and national cultural interests. Although the region faced a certain

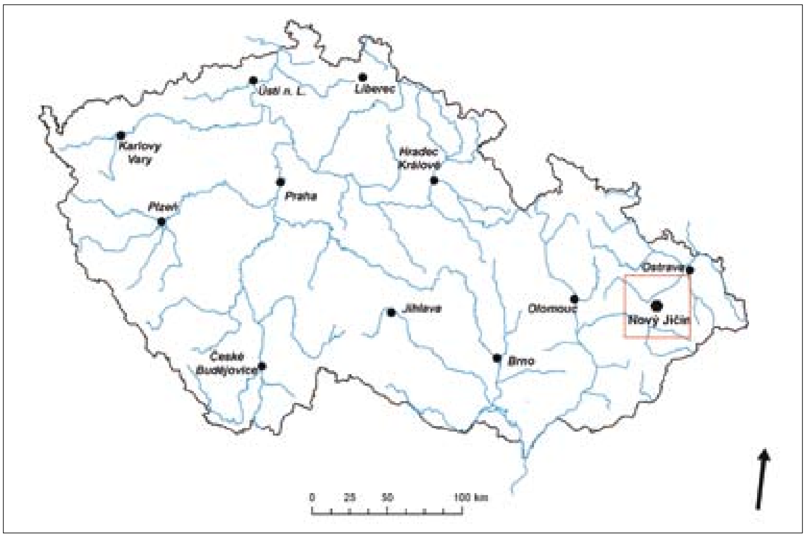

Fig. 1: The localization of the area of interest
Source: own design

level of emigration both to abroad and to industrially more developed areas of northern Moravia and Czech Silesia, its population increased since the second half of the 19th century, particularly the population of its newly industrialized centre, the town of Nový Jičín, fed by immigration from the adjacent rural areas (Chobot et al., 1996; Bartoš, Schulz, Trapl, 1995).

Several factors have influenced the development of its geographical organisation (see for instance Atlas československých dějin, 1965, map sheets 19, 21, 22, 23 and 24). Firstly, the region can be placed among the early industrialized territories within the Czech lands. Nový Jičín was one of the leading centres of textile and clothing industries since the first decades of the 19th century (or since the 18th century if we take into account the traditional manufactory production). Similar industrial development (even more progressive), not driven only by the manufacturing of textile products but also by machinery or metallurgy, can be witnessed in its broader surroundings, particularly in the Ostravsko region, which is an important fact regarding the delineation of the nodal region. Secondly, the location of the region has two distinct features: the vicinity of the resource base in the Ostrava basin, and the position near an important transport corridor at the north-eastern mouth of the Moravian Gate. Although the town of Nový Jičín lies at the important road connection, the main railway has avoided the regional centre (see also Fig. 6), which is the fact that can be seen as an "unnatural" intervention into the development of the geographical organisation of the region.

2. Concise theoretical background

2.1 Geographical organisation

Understanding the geographical organisation in the Czech geography is strongly influenced by geographers from Charles University in Prague (Hampl, Gardavský, Kühnl, 1987; Gardavský, 1988; Hampl, 2005). Their works put forward the population as a main factor of the geographical organisation of society (as they mostly call it). They emphasize the prominence of the population distribution (settlement system, concentration, sub-urbanisation) and its movements (labour and service commuting) in assessing the geographical organisation. They claim that natural, political, cultural, economic or social conditions are well reflected in the population characteristics and traits, although in his theoretical study Gardavský (1988) sees the regional (i.e. geographical) organization as a complex and at the same time substantial arrangement and concurrent action of all geographical phenomena and processes. Such an approach is relatively easy to be applied on larger geographical scales, which is its greatest advantage. On the other hand, we think that particularly the interpretation of the results can be in a way simplified not taking into account other factors than the population-related ones.

The Anglo-Saxon approaches to the geographical organisation vary from very broad understanding of the issue (see for instance Abler, Adams, Gould, 1972 who make the geographical organization identical to complex human geography) to more inspiring and direct concept, which we have decided to favour (see also Klapka et al., 2010). Our concept of the geographical organisation comes out from and follows two seminal works. Haggett (1965) introduces an interesting view of the organisation of a region, later refined by himself (Haggett, 2001). He sees five region-building or spatial structure factors: movements, networks, nodes, surfaces and diffusion stages. He also introduces a concept of hierarchies into his concept.

Morrill (1974) provides many inspirations and suggestions regarding the location choice, emergence of hierarchies, spatial interactions through which he reaches a complex assessment of the spatial organisation of the regions. He puts a primary stress on the population, its spatial distribution and movements, but he also emphasizes the role of such varied factors as the physical environment, land use and space use, distance, distribution of economic activities and wealth, cultural and political conditions, historical development of a territory etc. He concludes that the spatial organization is best described by the intensity and extent of land use and by the pattern of complex interactions, which a location has within its environment.

Owing to the period when both works were published, they do not directly incorporate to their schemes the role of human behaviour, although they mention in several places its importance. However, they primarily stress the principles of maximum profit and minimum effort that are valid only to a limited extent. We suggest that human behaviour, political decision processes, cultural and historical background should be taken into account too when assessing the geographical organization if and when possible.

To be more factual and to sum up the above mentioned inspirations (both Czech and Anglo-Saxon), we see in an assessment of the geographical organisation three important factors (Klapka et al., 2010):

1. population (its distribution and interactions),
2. land use (in its very broad meaning including the location of activities and networks of different types), and

3. living environment (natural, economic, cultural, political and social),

when the crucial importance is attributed to the first factor.

We also feel the need for introducing a system of constraints of non-economic and non-quantitative nature in order to represent reality in a better way. Otherwise, there is an actual threat of succumbing to spatial (or space) determinism, which has been a main critique of the concept for over 30 years.

It is also to be noted at this place that
1. the hierarchical level of researched territory and
2. the time span (or period) matter to a great extent.

If we are for instance dealing with the organisation of a city our effort is centred merely on people, while large regions on the mezzo or macro level should be apart from their population studied also in terms of their land use and environment. The time span or period substantially influences the variety and liability of sources and data and thus possibilities of geographical organisation assessment. For instance, statistical data on the spatial interaction that can be used for the delineation of nodal regions (e.g. daily labour commuting) are available only since the second half of the 20th century. Approaches should be also slightly different and stress slightly shifted in case we study either the dynamic or the static geographical organisation of a territory. Finally, we have to admit that actually not every theoretical suggestion made above can be applied in a historical geographical study such as this article.

2.2 Delineation of region

The area of interest was already in the 19th century dominated by a centre in Nový Jičín, which gradually organised a nodal region around this centre. The problem of its delineation lies in the definition of relation between the centre and its hinterland. As there is no adequate record of horizontal population flows in the 19th century, we used one of spatial interaction models, the Reilly's model (Reilly, 1931), in order to delineate a nodal region.

A detailed general discussion of the Reilly's model and its applications, including other references, is provided by Řehák, Halás, Klapka (2009) and Halás, Klapka (2010). We applied one of its variants: the topographic version (Řehák, Halás, Klapka, 2009). The model is determined to identify a breaking point, or a set of breaking points, (see Equation 1) between two or more competing centres and their zones of influence. An expression of mass (e.g. population of a centre) and distance between the competing centres are needed as input model variables. The topographic version makes use of real distances measured on a real transport network.

The principle lies in the determination of a set of competing centres (including the centre that is examined) and in the subsequent assignment of the tested location (or municipality in the sense of a spatial zone) to one of the defined centres by the constant comparison of the breaking point position to the position of the tested location in the following manner. First, the breaking point is calculated:

$$BP = \frac{d_{ALB}}{1 + \sqrt[x]{\frac{M_A}{M_B}}} \qquad (1)$$

where BP is a distance of breaking point plotted on the line (in our case a road) from the smaller centre, d_{ALB} is a distance between the competing centre A, the tested location L, and the competing centre B, and M_A and M_B are masses (populations) of centres A (larger centre) and B (smaller centre) respectively.

Then, the tested location is assigned to one of the competing centres according to the following procedure: if $d_{LB} > BP$ then the tested location belongs to the sphere of influence of the centre A, and if $d_{LB} < BP$ then the tested location belongs to the sphere of influence of the centre B. Then the whole procedure is systematically repeated with a different pair of competing centres within the defined set of centres until the tested location is unambiguously assigned to one of the competing centres. After we have tested all locations that can be theoretically taken into consideration, we reach the final delineation of the nodal region of the examined centre. The boundary of the region is constructed according to the territorial delimitation of basic spatial units/zones (e.g. municipalities).

Finally, we provide a note regarding the value of root in the Equation 1. If we were to follow the physical analogy, we would have to use the square root. Of course, we can use also the cube root, the fourth or a higher root. The higher the value the larger is the influence of smaller centres and the smaller is a tributary area of larger centres.

3. The Nový Jičín region: historical geographical organisation

If the preceding section provided some general notes, we have to specify how we are going to tackle with the geographical organisation of the model region. This task is determined by its hierarchical level and by the period in question. The former defines the aspects of the geographical organisation that are going to be analysed – i.e. population development, population concentration, inner structure of the region on one hand and dynamic land use in the region on the other. The latter, then, defines the character of population and land use data. This will be briefly commented in the below sections.

If we are dealing with the dynamic aspect of geographical organization, we have to secure comparability of the used data. We define municipalities as of the 1900 census as the basic spatial units and the nodal region delineation also dwells on the 1900 data. All earlier data regarding the population and land use, available for cadastral areas, were adjusted to the areas of municipalities in this year if needed. Fortunately, the spatial structure of the selected region was relatively stable during the second half of the 19th century. There were only minor differences between the municipalities in the surveyed periods in the order of units of hectares that could not be easily eliminated anyway.

The main data sources on the population were lexicons from the 1869, 1880, 1890 and 1900 censuses as well as the Retrospective lexicon of municipalities in the Czechoslovak Socialist Republic 1850–1970 (1978) and the Historical lexicon of municipalities in the Czech Republic (2006). The data on land use were retrieved from cadastral records of the Czech Office for Surveying, Mapping and Cadastre for 1845 (http://archivnimapy.cuzk.cz/) and for 1897 in the lexicon from the 1900 census. A note regarding the years of 1845 and 1900 should be made here. These are the years of the publishing of the data. The "1845" data are based on the cadastral mapping carried out in the Czech lands between 1821 and 1843 (in the researched region between 1833 and 1834), the "1900" data are then based on the revision of the cadastre from January 1st, 1897. However, in case of the first time horizon, we stick to the year of publishing when using and commenting upon these data in this article.

3.1 Nový Jičín as a centre of the nodal region

The first task is to identify municipalities that represent a competition to the town of Nový Jičín as potential centres of nodal regions and carriers of masses entering the Reilly's model. Competing centres were selected according to several criteria (apart from the approximate neighbouring position towards Nový Jičín). The first criterion sets the level of a minimum population in the competing centre to 5,000 inhabitants. In several cases, we have taken into account the population of structurally and functionally interconnected urban zones consisting of two or more independent administrative municipalities. The first one is the town of Nový Jičín itself, which has been connected with the municipalities of Šenov and Žilina. Then we have these urban zones, each consisting of a dominating centre and a smaller settlement in its close vicinity: Valašské Meziříčí and Krásno, Fulnek and Jerlochovice, Studénka and Butovice. Finally, we have defined an urban zone consisting of the municipalities of Kopřivnice and Štramberk.

In case that some of the towns did not exceed the level of 5,000 inhabitants closely, two auxiliary criteria were used in order to assess the quality of the town as a potential centre:

1. location of industry (attractive force of the centre is enhanced by the presence of factories, which is the case of Fulnek, Odry and Studénka),
2. location of public service facilities (again the presence of an administrative office or an educational institution increases the nodal importance of the centre, which is the case of Fulnek and Odry, seats of judicial districts and schools).

These two criteria were almost completely valid also for competing centres exceeding the level of 5,000 inhabitants. Thus, we have defined following centres as representing a nodal competition to Nový Jičín (Tab. 1): Bílovec, Frenštát pod Radhoštěm, Fulnek, Hranice, Kopřivnice with Štramberk, Odry, Příbor, Studénka and Valašské Meziříčí. The issue of the competing centres selection in broader spatial context (larger area of central and northern Moravia and Silesia as well as the inclusion of the influence of Prague and Brno) using various versions of the Reilly's model is extensively discussed by Niedzwiedzová (2010).

The second task is to distribute all suitable municipalities (those roughly placed among centres) towards the selected centres by applying the procedure based on the Reilly's model as described earlier. However, two notes have to be made in this place (of course the masses in the model are the populations of centres as of 1900 – Tab. 1). The first one concerns the issue of a distance entering the model. The distance is measured along the actual road network in the shortest way in 1900. It has the advantage of taking into account physical geographical and human geographical characteristics of the space reducing thus slightly a possible geometric distortion. The second note, then, concerns the question of a root value in the model (x in Relation 1). We decided to use the cube root, which favours smaller centres with regard to their influence since Nový Jičín is considerably larger in its mass and thus the cube root is a tool for a certain levelling of its importance.

Centre	Population			
	1869	1880	1890	1900
Bílovec	4,217	4,626	4,764	5,125
Frenštát pod Radhoštěm	6,563	6,107	5,767	5,757
Fulnek*	4,267	4,362	4,111	4,182
Hranice	6,735	7,384	8,136	8,185
Kopřivnice and Štramberk	3,676	3,790	4,765	6,371
Nový Jičín*	11,656	13,908	15,848	16,969
Odry	4,182	3,678	3,990	4,191
Příbor	4,950	4,710	4,674	5,007
Studénka*	3,679	3,836	4,108	4,708
Valašské Meziříčí*	4,075	4,489	4,799	4,906

Tab. 1: The population of Nový Jičín and competing centres in 1869 – 1900
Note: Fulnek, Kopřivnice and Štramberk, Nový Jičín, Studénka, Valašské Meziříčí are defined as urban zones, see the text above.
Source: Retrospektivní lexikon obcí ČSSR, 1978; Historický lexikon obcí ČR, 2006; Lexikon obcí pro Moravu, 1906

After the procedure had been applied, we reached the required nodal region with the centre in Nový Jičín consisting of 37 municipalities (including Nový Jičín) – Fig. 2 and Tab. 2. The region is based on the 1900 data (number of municipalities, their area and population) and as such will be analyzed in the following section. The total area of the region is 27,821 ha and the total population is 41,895. Municipalities are already considered in their administrative boundaries, thence the difference in the population of Nový Jičín between tables 1 and 2. Twenty-eight municipalities were the part of the judicial district of Nový Jičín. Only four municipalities of the judicial district were not the part of the nodal region at the same time. Bartošovice were in the judicial district of Příbor, Suchdol nad Odrou and Hladké Životice in the judicial district of Fulnek, Perná in the judicial district of Valašské Meziříčí, and Dub, Hustopeče nad Bečvou, Heřmanice u Polomi, Poruba and Vysoká u Hustopečí nad Bečvou were parts of the judicial district of Hranice.

3.2 Development of the selected aspects of geographical organisation: interpretation

As noted earlier, our interest concerns the population development, population concentration, inner structure of the region, and dynamic land use as the selected aspects of the geographical organisation.

3.2.1 Population development and concentration

Let us begin with a simple tabular presentation of the very basic population development in the Nový Jičín region and its municipalities (Tab. 3) in the period from 1869 – 1900 to get a preliminary notion of the most important aspect of the geographical organization. Again, we remind that the territorial structure of the municipalities is as of 1900.

General population development is determined by several interconnected factors related to innovation processes of the Industrial Revolution and does not differ from the development in the Czech lands or Europe in the second half of the 19th century (cf. for instance Fialová, Kučera, Maur, 1996; Semotanová, 2002; or Butlin, Dodgshon, 1999). Improving life conditions, among other things e.g. sanitation, health care, stable political situation or social changes, supported the increasing birth rate and the consequent population growth in the region and in a majority of its municipalities. Figs. 3 and 4 present a general image of the population development between the two boundary years – 1869 and 1900. A more detailed commentary of the population development is provided in connection with the population concentration issue in the paragraphs below since both these aspects of the geographical organisation are closely related.

Population development is usually an uneven phenomenon, our region not being an exception. One of general processes during the Industrial Revolution is the population concentration, which was conditioned by the emigration of freed labour force released from relatively overpopulated rural areas to cities and towns with emerging factories after the revolution in 1848/9 (Jeleček, 1985). It is assessed by using a simple index proposed in the form used in this article by Hampl, Gardavský and Kühnl (1987) to express the spatial heterogeneity of population distribution, so called H index. It is defined as a minimal area of the territory (according to units of internal division – in our case the municipalities as of 1900) with a half concentration of the population in the territory (consequence of addition follows the population densities in the municipalities). The percentage of this area in the area

Municipality	Area (ha)	Population	Municipality	Area (ha)	Population
Bartošovice	1,899	2,006	Loučka	649	808
Bernartice nad Odrou	938	832	Mořkov	1,085	1,597
Blahutovice	599	401	Nový Jičín	558	12,003
Bludovice	522	609	Palačov	415	354
Dub	278	202	Perná*	304	262
Heřmanice*	396	247	Petřkovice	283	245
Hladké Životice	1,598	895	Polouvsí	342	317
Hodslavice	1,103	1,682	Poruba	412	282
Hostašovice	928	559	Rybí	902	905
Hrabětice	440	87	Starojická Lhota	554	364
Hukovice	498	632	Starý Jičín	347	657
Hůrka	441	293	Straník	480	472
Hustopeče nad Bečvou	1,144	1,162	Suchdol nad Odrou	1,684	2,010
Janovice	336	270	Šenov*	1,564	2,584
Jeseník nad Odrou	1,070	1,215	Vlčnov	441	431
Jičina	326	394	Vysoká*	474	206
Kojetín	267	206	Žilina*	1,138	2,382
Kunín	1,732	2,116	Životice*	905	835
Libhošť	769	1,373	**Total**	**27,821**	**41,895**

Tab. 2: Basic characteristics of municipalities in the Nový Jičín region (1900)
Note: Full names of municipalities marked with an asterisk are in the alphabetical order: Heřmanice u Polomi, Perná u Valašského Meziříčí, Šenov u Nového Jičína, Vysoká u Hustopečí nad Bečvou, Žilina u Nového Jičína, Životice u Nového Jičína. Maps and tables presented below include shortened names of the municipalities.
Source: Lexikon obcí pro Moravu, 1906

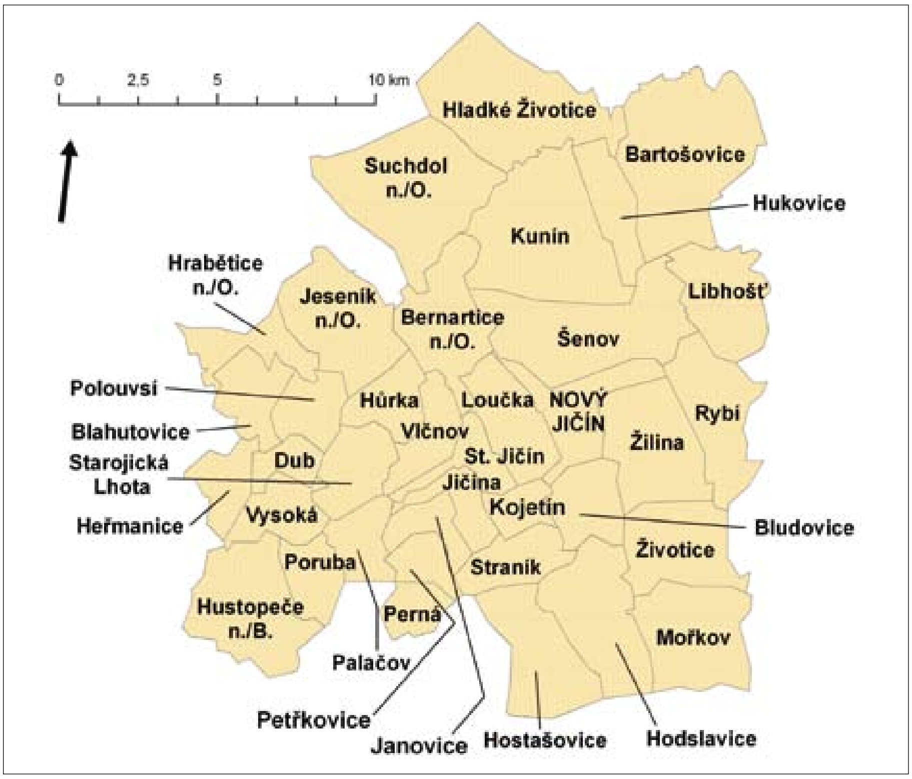

Fig. 2: The region of Nový Jičín according to the topographic version of the Reilly's model
Source: own design

Municipality	Population				Change index (in percentage points)		
	1869	1880	1890	1900	1880/ 1869	1890/ 1880	1900/ 1890
Bartošovice	1,848	2,023	2,032	2,006	9.5	0.4	-1.3
Bernartice nad Odrou	715	794	817	832	11.0	2.9	1.8
Blahutovice	401	381	363	401	-5.0	-4.7	10.5
Bludovice	538	563	558	609	4.6	-0.9	9.1
Dub	180	185	187	202	2.8	1.1	8.0
Heřmanice	212	240	243	247	13.2	1.3	1.6
Hladké Životice	934	976	958	895	4.5	-1.8	-6.6
Hodslavice	1,289	1,386	1,491	1,682	7.5	7.6	12.8
Hostašovice	466	484	556	559	3.9	14.9	0.5
Hrabětice	105	93	89	87	-11.4	-4.3	-2.2
Hukovice	526	569	567	632	8.2	-0.4	11.5
Hůrka	266	286	296	293	7.5	3.5	-1.0
Hustopeče n./B.	982	1,091	1,216	1,162	11.1	11.5	-4.4
Janovice	279	273	285	270	-2.2	4.4	-5.3
Jeseník nad Odrou	1,178	1,249	1,211	1,215	6.0	-3.0	0.3
Jičina	375	402	409	394	7.2	1.7	-3.7
Kojetín	213	187	191	206	-12.2	2.1	7.9
Kunín	1,954	2,105	2,159	2,116	7.7	2.6	-2.0
Libhošť	1,049	1,149	1,250	1,373	9.5	8.8	9.8
Loučka	628	742	754	808	18.2	1.6	7.2
Mořkov	1,315	1,371	1,497	1,597	4.3	9.2	6.7
Nový Jičín	8,723	10,274	11,562	12,003	17.8	12.5	3.8
Palačov	343	367	372	354	7.0	1.4	-4.8
Perná	239	261	251	262	9.2	-3.8	4.4
Petřkovice	217	252	252	245	16.1	0.0	-2.8
Polouvsí	391	333	312	317	-14.8	-6.3	1.6
Poruba	294	279	287	282	-5.1	2.9	-1.7
Rybí	788	817	890	905	3.7	8.9	1.7
Starojická Lhota	360	381	379	364	5.8	-0.5	-4.0
Starý Jičín	560	601	590	657	7.3	-1.8	11.4
Straník	445	436	449	472	-2.0	3.0	5.1
Suchdol nad Odrou	1,495	1,804	1,899	2,010	20.7	5.3	5.8
Šenov	1,189	1,631	2,105	2,584	37.2	29.1	22.8
Vlčnov	353	350	366	431	-0.8	4.6	17.8
Vysoká	230	249	233	206	8.3	-6.4	-11.6
Žilina	1,744	2,003	2,181	2,382	14.9	8.9	9.2
Životice	722	755	857	835	4.6	13.5	-2.6
Total	**35, 415**	**39,222**	**42,004**	**43,795**	**10.7**	**7.1**	**4.3**

Tab. 3: Population development in municipalities of the Nový Jičín region in 1869–1900
Source: Retrospektivní lexikon obcí ČSSR, 1978; Historický lexikon obcí ČR, 2006; Vollstandiges Orts-Verzeichniss des Markgrafenthumes Mähren, 1872; Special Orts-Repertorium von Mähren, 1885; Special Orts-Repertorium von Mähren, 1893; Lexikon obcí pro Moravu, 1906

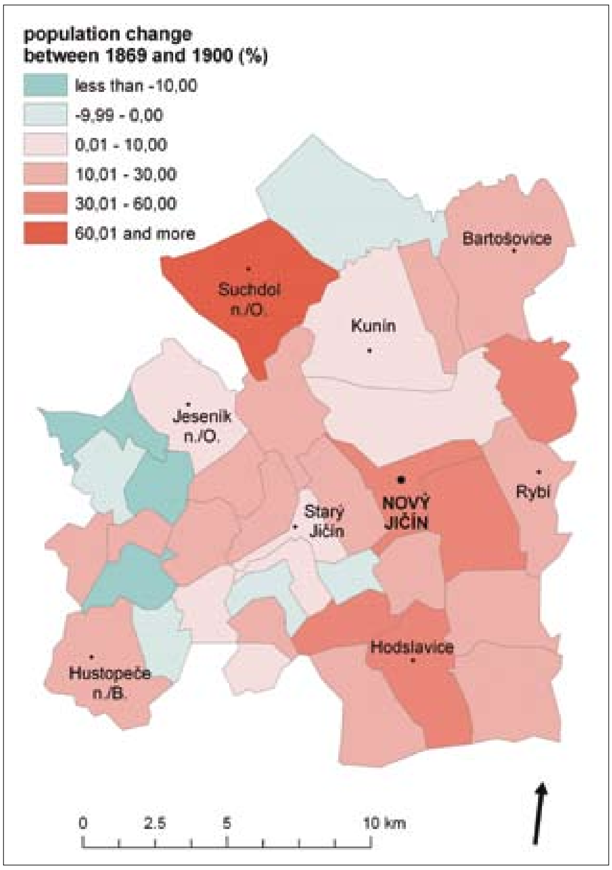

Fig. 3: Population development between 1869 and 1900
Source: Historický lexikon obcí ČR, 2006

of the whole researched territory is then subtracted from 100. Theoretically it assumes values ranging between 50 (maximal dispersion of the phenomenon) and 100 (maximal concentration of the phenomenon).

The development of the population concentration in the Nový Jičín region is, as the H index and its changes between consequent years, presented in Tab. 4. We see an accelerating concentration process in the Nový Jičín region with its maximum between 1890 and 1900. The general development of this process is in accord with the findings of Hampl, Gardavský, Kühnl (1987) and Hampl (2005) from the territory of the Czech lands.

Now, let us analyze more closely the population concentration and its development, since Tab. 4 does not say anything about the spatial image of the H index. The concentration process was in the Czech lands related to the process of industrialisation and consequent phenomena. Both 1850 and 1869 present a relatively fragmented pattern of municipalities with about a half of the population in the region (Fig. 5). In 1880, we see an increasing concentration in the eastern and southern part of the Nový Jičín region, which is accented in 1890 and 1900 (in these years the municipalities forming half a population of the region are the same, which is a sign of the completion of the process and stability of the settlement system) – Fig. 5.

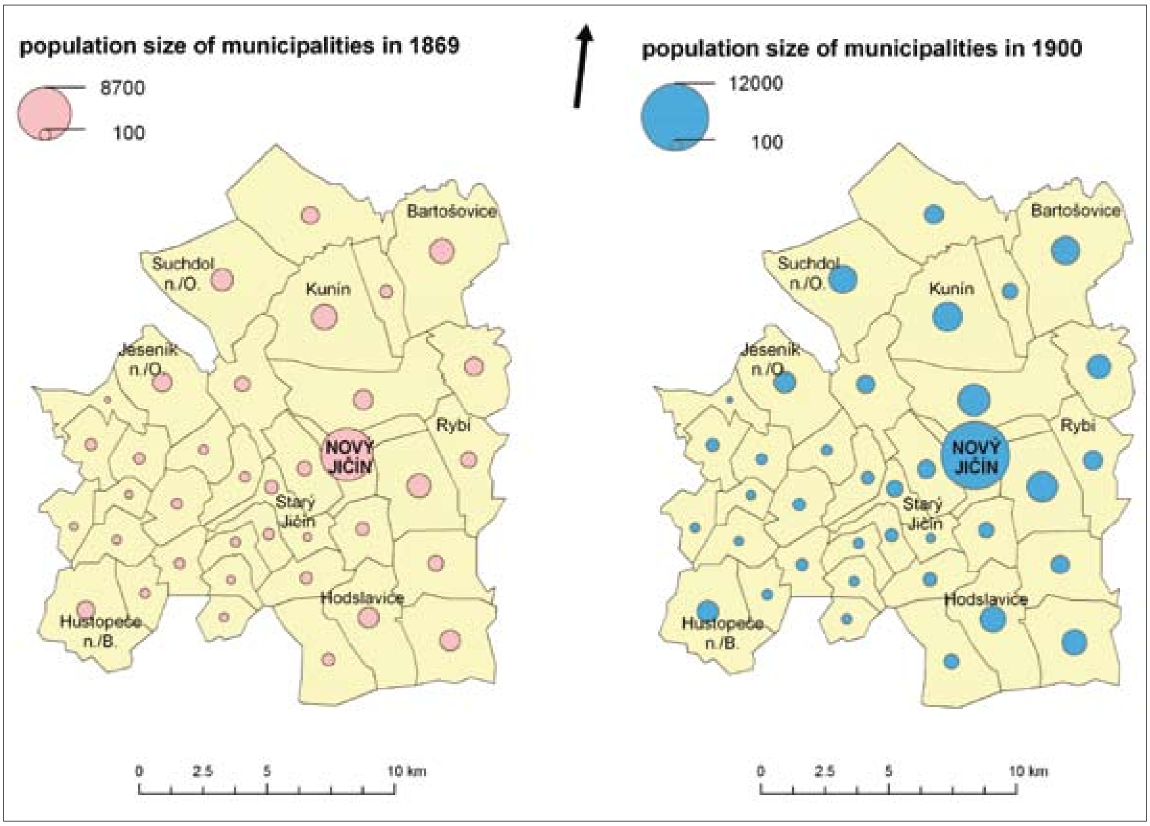

Fig. 4: The population size of municipalities in 1869 and 1900
Source: Historický lexikon obcí ČR, 2006

The population was concentrated in the town of Nový Jičín and its immediate hinterland in the first place as a response to the accelerating industrialization of the region, mainly of its centre. The prominence of Nový Jičín as a centre of the region is clearly documented in Fig. 4 both in 1869 and 1900. Fig. 4 also presents the population increase in municipalities situated in the immediate hinterland of the town of Nový Jičín (today being administratively a part of the town): Kunín, Šenov, and Žilina. In1848, the first factory with steam engines was established in Nový Jičín by J. N. Preisenhammer. From that time on, the number of factories increased and in 1865, a hat-making factory was established by the Hückel family in Nový Jičín. J. Hückle became a pioneer in the mechanized production of felt hats in the entire Austrian Empire. Since the capacity of the original factory became insufficient, he built a new factory with the modern technical equipment employing around 1,000 workers with a daily production of 1,800 hats. Moreover, he built several tens of blocks of houses, supporting thus the immigration into the town. In 1870, the production of tobacco was launched in the town and during the 1880s the tobacco factory became one of the largest employers in the region. By the end of the 1870s, J. Rotter established the production of carriage lamps, which was during the 1890s moved to Šenov. There, a hat-making factory of A. Peschel had been already located (Bartoš, Schulz, Trapl, 1995; Chobot, 1996).

Year	H index	Change of H index
(1850)	73.92	*X*
1869	73.44	– 0.48
1880	74.67	1.23
1890	76.44	1.77
1900	80.31	3.87

Tab. 4: Development of the spatial concentration of population in the Nový Jičín region in (1850) 1869–1900
Note: Year 1850 serves only for illustration as it is not comparable with the regular censuses from 1869, 1880, 1890 and 1900 since the method of data collection somewhat differed
Source: Retrospektivní lexikon obcí ČSSR, 1978; Historický lexikon obcí ČR, 2006; Vollstandiges Orts-Verzeichniss des Markgrafenthumes Mahren, 1872; Special Orts-Repertorium von Mähren, 1885; Special Orts-Repertorium von Mähren, 1893; Lexikon obcí pro Moravu, 1906

As a consequence of the establishment of factories and creation of new job opportunities Nový Jičín and some of the adjacent municipalities experienced

Fig. 5: Spatial expression of the H index in the Nový Jičín region in (1850) 1869–1900
Note: Year 1850 serves only for illustration as it is not comparable with the regular censuses from 1869, 1880, 1890 and 1900 since the method of data collection somewhat differed
Source: Retrospektivní lexikon obcí ČSSR, 1978; Historický lexikon obcí ČR, 2006; Vollstandiges Orts-Verzeichniss des Markgrafenthumes Mahren, 1872; Special Orts-Repertorium von Mähren, 1885; Special Orts-Repertorium von Mähren, 1893; Lexikon obcí pro Moravu, 1906

a massive increase in their populations. Nový Jičín itself grew by 3,280 inhabitants in just 31 years (by 37 percentage points). Šenov grew rapidly by 117 percentage points, Žilina by 36, Libhošť by almost 31, Loučka by 29 percentage points, and Rybí and Bludovice by more than one eighth. Then we can see the formation of an important core in the Nový Jičín region exceeding the administrative boundaries of the town of Nový Jičín and the functional and structural interconnection of municipalities forming this agglomeration.

Besides the Nový Jičín agglomeration area, we can see the population concentrating in the south of the region – municipalities Hodslavice and Mořkov. Rather than the industrialization, the reason is a relatively large population of these municipalities in comparison to the rest of the region, of course excluding the agglomeration municipalities around Nový Jičín and some other settlements, for instance Suchdol nad Odrou. The last settlement included into the set of municipalities comprising half a population of the region is Starý Jičín. Though its population is not large within the region, the population density is relatively high.

The last mentioned municipalities (Suchdol nad Odrou and Starý Jičín) are connected with a transport phenomenon. The development of transport networks, mainly railways, is either a supporting factor of the population concentration or its main cause (an illustrative transport scheme is provided in Fig. 6). Nový Jičín and adjacent municipalities were connected to the railway network in 1881 (with Suchdol nad Odrou, through Šenov) and in 1889 (with Hostašovice through Žilina and Bludovice). Suchdol nad Odrou became an important railway junction on the Northern railway of the Emperor Ferdinand (opened in 1847) and its population grew considerably by almost 35 percentage points within 31 years.

A somewhat lesser importance has the road network, mainly a so-called imperial road through the whole region between Heřmanice, Dub, Starojická Lhota, Vlčnov, Starý Jičín, Loučka, Nový Jičín, and Libhošť. It can be put into connection with the population concentration in Starý Jičín and with the increasing population in some municipalities in the immediate hinterland of Nový Jičín (for instance Libhošť, which grew by more than 40 percentage points).

Together with the processes of the population concentration, we can see also the process of depopulation in marginal or peripheral areas of the Nový Jičín region. We can only guess that it was the emigration from these areas to industrial centres that was responsible for the population decrease, since we can assume a positive natural population growth in the whole region during the second half of the 19^{th} century (cf. also Fialová, Kučera, Maur, 1996). The largest population decrease between 1869 and 1900 can be seen in Polouvsí (by almost 19 percentage points), followed by Hrabětice and Vysoká (decrease by more than 17 and 10 percentage points respectively). In general, the process of depopulation was accelerated in the region between 1880 and 1900 in accord with the accomplishment of industrialization.

3.2.2 Inner structure of the region

The process of the population concentration raises a question of the inner structure of the region and its nodal character. Since we do not have data on the horizontal flows between the municipalities of the region, we are forced to model these interactions, this time by applying a simple gravity model in the following form:

$$T_{AB} = \frac{M_A M_B}{{d_{AB}}^2} \quad (2)$$

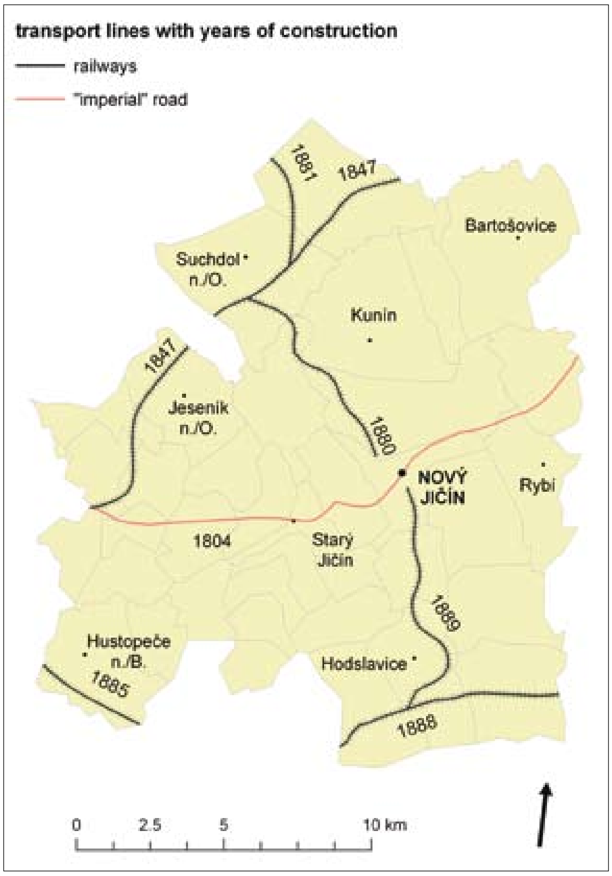

Fig. 6: The development of major transport lines in the Nový Jičín region
Source: Atlas československých dějin, 1965; Pavlíček, 2002

where T_{AB} is the interaction between municipalities A and B, M is the population, d_{AB} is the road distance between the municipalities A and B. The gravity model expresses the expected level of interaction between all municipalities of the region organised in the symmetric origin destination matrix.

All interactions in the matrix were relativized to the strongest interaction (taken as 100%) and distributed according to their intensities into three intervals according to a 1/3 step. Thus, we gained strong, medium and weak levels of interaction (Fig. 7). Fig. 7 presents graphically the strongest interaction (link) of each municipality in the region to a relevant municipality of the region in the period between 1850 and 1900. The theoretical orientation of the interactions is of course bidirectional because of the model variant used, but we can assume that the flow is usually oriented from the smaller to the larger municipality.

A simple graphical expression of the interactions in Fig. 7 confirms the increasing nodal character of the region with its very dominant centre in Nový Jičín, which gains gradually the links with almost all municipalities of the region and their intensity is increasing. If there is a link that does not include the town of Nový Jičín (mainly in marginal areas of the region), these municipalities are anyway linked to the centre indirectly, see for instance the case of Hustopeče nad Bečvou in the south western part of the region. The only exception is Starý Jičín, which has the strongest links to Jičina and Vlčnov in the whole period from 1850 to 1900 and does not link to Nový Jičín at all. In general, we can observe more significant changes in the direction and intensity of the interaction between 1850 and 1880, during 1890 and 1900 these interactions were already stable (cf. stability of the population concentration in these years as mentioned several paragraphs above).

3.2.3 Land use development

The last aspect of the geographical organisation surveyed in this article is the land use change. We analyzed the following categories between 1845 and 1897: arable land, forests, permanent grassland, gardens, and others (including built-up areas and water bodies). The development of land use is characterized by three processes: increasing area of arable land, decreasing area of permanent grassland, and namely the fragmented development of the area covered by forests.

The share of arable land in the total area of municipalities increased mainly in the floodplains of watercourses, particularly along the Odra River (Fig. 8). The maximum value was reached in Hrabětice

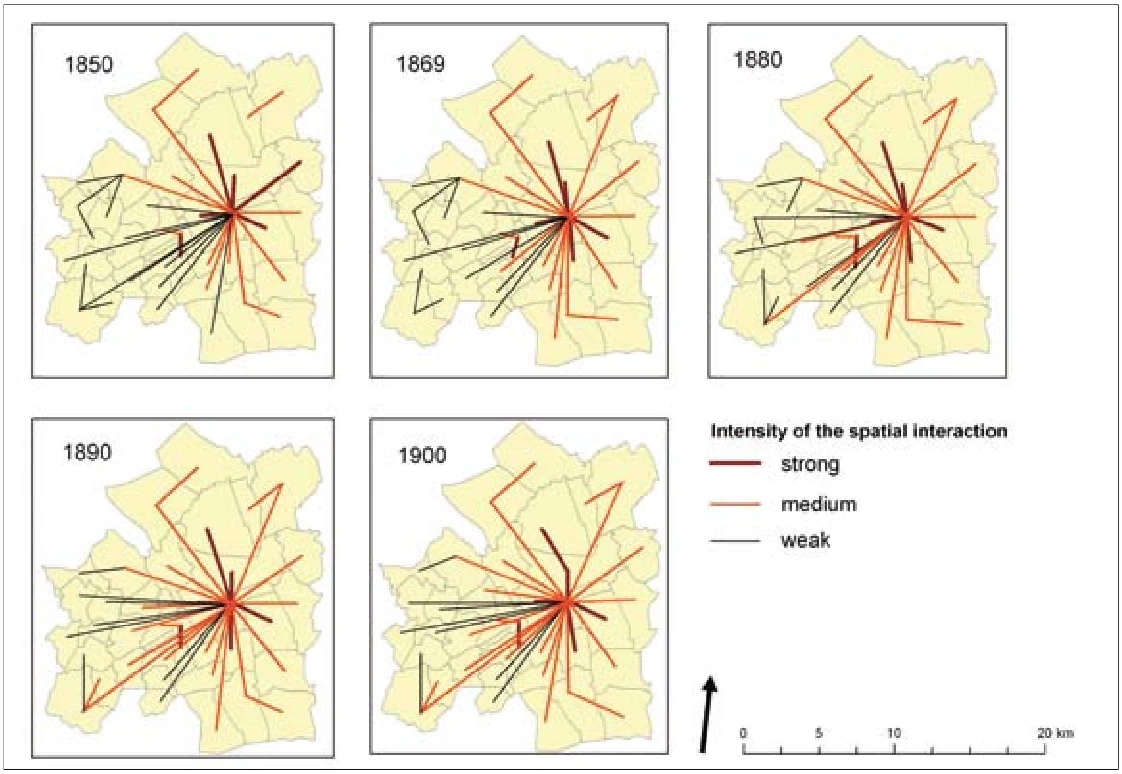

Fig. 7: The development of region's inner structure
Source: Retrospektivní lexikon obcí ČSSR, 1978; Historický lexikon obcí ČR, 2006; Vollstandiges Orts-Verzeichniss des Markgrafenthumes Mähren, 1872; Special Orts-Repertorium von Mähren, 1885; Special Orts-Repertorium von Mähren, 1893; Lexikon obcí pro Moravu, 1906

(increase by 133 percentage points) at the expense of bottomland forests. Most municipalities experienced an increase by 5–10 percentage points. On the other hand, the share of arable land decreased in Nový Jičín due to the urbanisation process and building construction. The increases in the shares of arable land can be related to the growing population and to the need for producing more foodstuffs, which meant the pressure mainly on bottomland forests and wetlands in lower parts of the region, and also on permanent grassland (see the next paragraphs).

An opposite development is seen in the permanent grassland (Fig. 9). The share of permanent grassland decreased almost in all municipalities. It is to be noted here that we have to be aware of the problem of "small" numbers in the case of permanent grasslands. Their share in the areas of the municipalities is low (around 5%) and this has to be taken into account in their interpretation, since the significance of such a change is lower.

The development of the forest area differs in the region considerably. We can see (Fig. 10) both a decrease and an increase of this land use category. The increase exceeds in some municipalities 100 percentage points. The share of forests increased mainly in areas inconvenient for agricultural production (southern hilly part of the region – Dub, Jeseník nad Odrou, Mořkov, Hodslavice, Hostašovice, Starý Jičín, Straník). These areas could not compete with the lower-situated parts of the region. The share of forests decreased either in lowland areas along the main watercourses in favour of arable land (Hrabětice, Blahutovice, Heřmanice and Hustopeče nad Bečvou) or in the eastern part of the region in the vicinity of the town of Nový Jičín (Žilina, Rybí, Životice, Bludovice, Kojetín, Loučka, Kunín, Libhošť, Bartošovice, Hukovice).The latter areas had probably several different reasons for the decreased share of forests: changes into arable land, changes into built-up areas, and sometimes even changes into permanent grassland.

A synthetic index of the land use change assessment was proposed by Bičík et al. (2001) as follows:

$$LUC_{index} = \frac{\sum_{i=1}^{n} |A_{t1i} - A_{t2i}|}{TA_{t1} + TA_{t2}} * 100 \qquad (3)$$

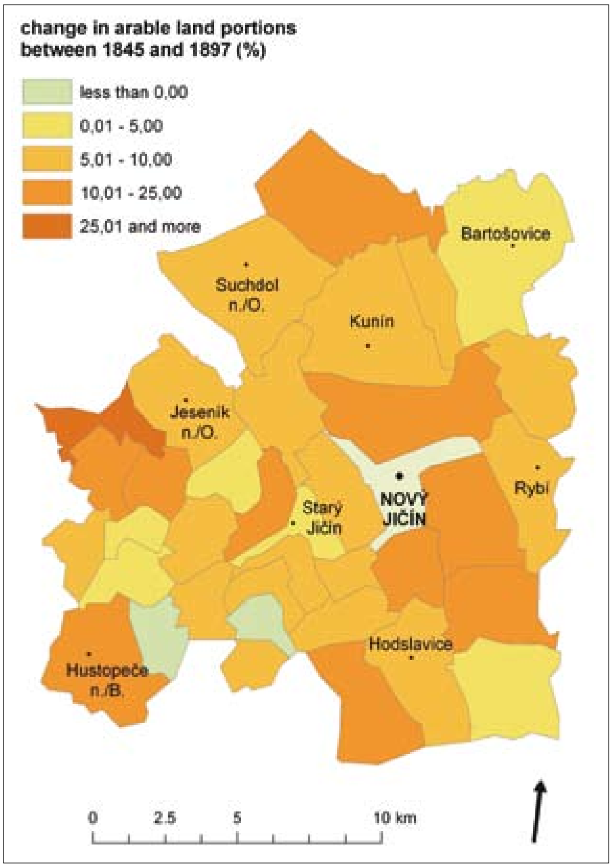

Fig. 8: Development of arable land in the period from 1845–1897
Sources: http://archivnimapy.cuzk.cz/; Lexikon obcí pro Moravu, 1906

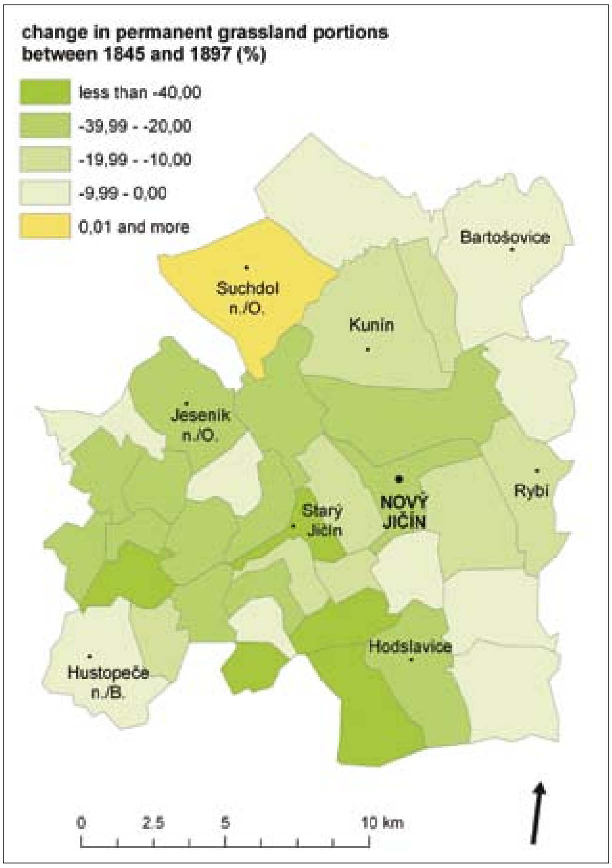

Fig. 9: Development of permanent grassland in the period from 1845–1897
Sources: http://archivnimapy.cuzk.cz/; Lexikon obcí pro Moravu, 1906

where LUC_{index} is the land use change index based on two time horizons $t1$ and $t2$, A is the area of i land use type and TA is the total area of the researched spatial unit, in our case of the municipality. The index expresses the share of areas within a spatial unit whose land use has changed between the given time horizons. In our case, the categories of arable land, permanent grassland, forests, permanent crops (gardens and orchards) and other land (including built-up areas, water bodies, factory yards, handling and transport areas) entered the Equation 3 and results are presented in Fig. 11.

Generally speaking the land use change index reached higher values in the peripheral depopulating lowland western parts of the Nový Jičín region (e.g. the floodplain of the Odra River) as a probable result of the relative instability of rural areas enabling an easy change from permanent grassland to arable land. Peripheral hilly areas of the eastern and south-eastern parts of the region with a higher representation of forested (i.e. more stable) areas show lower values of the land use change index. The central part of the region (town of Nový Jičín and parts of its immediate hinterland) shows a relative stability of land use. It is to be noted here that the results are influenced by the area of the municipalities but the basic image of the land use change can be relatively sufficiently retrieved from Fig. 11. The land use change index for the whole region makes 5.66%, which does not differ much from similar regions in industrially developed areas with a similar natural environment in the north-eastern Bohemia, northern Moravia and Czech Silesia, all being characteristic of the textile and clothing production.

4. Conclusion

According to the analysis of the development of selected aspects, the geographical organisation of the Nový Jičín region was during the second half of the 19th century significantly affected by processes related to the industrial revolution, such as industrialization, urbanization, or agricultural and transport innovations. The development of industrial production and partly of railway network supported the dynamic population concentration in the eastern and south-eastern parts of the region, around its centre of Nový Jičín (Šenov, Žilina, Libhošť, Starý Jičín, Hodslavice, Mořkov). Municipalities situated near Nový Jičín were functionally and structurally

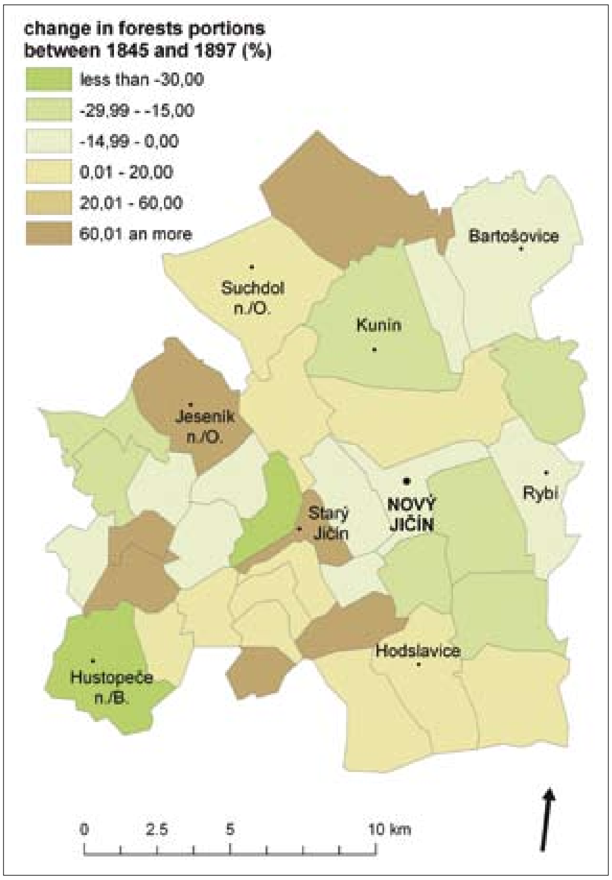

Fig. 10: Development of forest areas in the period from 1845–1897
Sources: http://archivnimapy.cuzk.cz/; Lexikon obcí pro Moravu, 1906

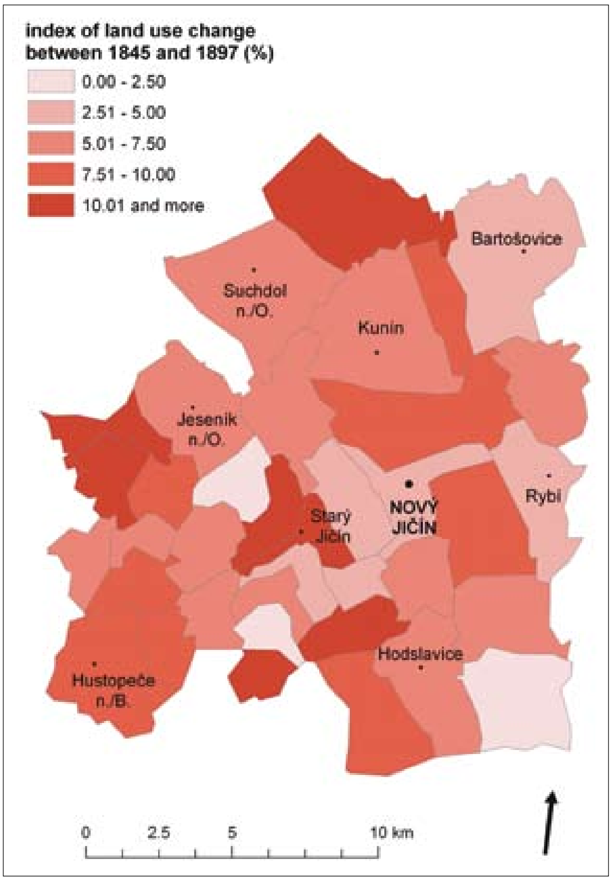

Fig. 11: Index of land use change between 1845 and 1897
Sources: http://archivnimapy.cuzk.cz/; Lexikon obcí pro Moravu, 1906

interconnected with the region's centre in the processes of urbanization and an agglomeration urban area was formed around Nový Jičín.

The population growth and concentration (mutually connected with the processes of industrialization and urbanization) resulted in new demands for agricultural production and considerably changed the landscape of the hinterland of the Nový Jičín agglomeration. Agriculture was intensified (production of cereals and potatoes) and the land was more effectively used in the convenient lower parts of the region at the expense of permanent grasslands and forests. Areas less convenient as well as areas affected by the depopulation process experienced an increase in the share of forests, which is confirmed also by the findings of Bartoš, Schulz, Trapl (1995) and Chobot (1996). The agglomeration of Nový Jičín witnessed also an increase in the built-up areas (both factories and houses for the increasing population, particularly workers).

The development of the selected aspects of geographical organisation in the Nový Jičín region in the surveyed period as presented in this article conforms to some earlier findings: those regarding the population made by Fialová, Kučera, Maur (1996) and its concentration made by Hampl, Gardavský, Kühnl (1987) and Hampl (2005) on the Czech lands, and also those regarding the land use in the Czech lands published by e.g. Jeleček (1985), Bičík (1998), Jeleček, Burda, Chromý (1999), Bičík et al. (2001), and on a region of similar size and structure (the Blansko region) by Vyskočil, Klapka, Martinát (2006) and Vyskočil, Klapka, Nováková (2007). We can conclude that general trends of the Industrial Revolution, as already briefly outlined above in the introduction (e.g. Purš, 1960, 1973; Hlavačka, 1990; Butlin, 1993; Atkins, Simmons, Roberts, 1998; Pollard, 1999), were confirmed to exist also in the Nový Jičín region.

As far as the issue of nodal regions in the second half of the 19^{th} century is concerned, we can conclude that the period represented an important phase in the formation of nodal regions, mainly thanks to industrialization and urbanization but also thanks to the increasing mobility of the population, related to the development of railway network. This period significantly affected the hierarchical and organizational structure of the territory of the Czech lands (see also Hampl, Gardavský, Kühnl, 1987; Hampl, 2005) that is reflected for instance in the settlement system until today. It also witnessed the formation of the region's internal heterogeneity as presented in this article. The region has an unchallenged centre, which was not affected either by inconvenient tracking of the main railway outside the town of Nový Jičín; the immediate hinterland of the centre and the periphery of the region can be defined as well. In this sense, we consider the article as a contribution of historical geography to the issue of spatial organisation.

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Authors' addresses:

Mgr. Pavel KLAPKA, Ph.D.
Institute of Geonics, Academy of Sciences of the Czech Republic
Department of Environmental Geography
Drobného 28, 602 00 Brno, Czech Republic
e-mail: *klapka@geonika.cz*

Bc. Klára NIEDŹWIEDŹOVÁ
Department of Geography, Palacký University in Olomouc
Třída 17. listopadu 12, 771 46 Olomouc, Czech Republic
e-mail: *klanie@seznam.cz*

THE DISTRIBUTION AND PROTECTION OF CRYOGENIC RELIEF MESOFORMS ON MT. VYSOKÁ IN THE NOVOHRADSKÉ HORY MTS. (CZECH REPUBLIC)

Jiří RYPL

Abstract

The aim of this work is to introduce the distribution of cryogenic relief mesoforms on Mt.Vysoká, located in the Novohradské hory Mts. Mt.Vysoká (1,034 m a.s.l.) is situated in the northeastern part of the Novohradské hory Mts. and at the same time, it is the third highest mountain on the Czech side of the Novohradské hory Mts. The protection of the most interesting cryogenic relief mesoforms is emphasized, in describing some of the possibilities which could ensure conservation of Mt. Vysoká (following the framework for nature conservation in the Czech Republic).

Shrnutí

Rozšíření a ochrana kryogenních mezoforem reliéfu na Vysoké v Novohradských horách (Česká republika)

Článek seznamuje čtenáře s rozšířením kryogenních mezoforem reliéfu na Vysoké v Novohradských horách. Vysoká (1 034 m n.m.) se nachází v severovýchodní části Novohradských hor a je zároveň třetím nejvyšším vrcholem na české straně Novohradských hor. Dalším aspektem, kterým se článek zabývá, je možnost ochrany nejzajímavějších kryogenních mezoforem reliéfu na Vysoké (resp. možnost ochrany celé lokality Vysoká) v systému ochrany přírody České republiky.

Key words: *frost weathering, cryogenic relief mesoforms, Mt. Vysoká, Novohradské hory Mts., Czech Republic*

1. Introduction

The Novohradské hory Mts. have become a centre of interest for the public, investors and environmentalists as a result of the process of European integration. Their unique qualities and position along the border with Austria are of particular importance.

The Novohradské hory Mts. create a unique area, which has been until today almost untouched by the influence of human, industrial and agricultural activities. Because of this, many rare plant species and natural formations can still be found in this area.

The geomorphological unit of Novohradské hory Mts. is a part of the Šumava Subprovince. Their main part is located on the Austrian side and is called the "Waldviertel". The altitude of the Novohradské hory Mts. reaches over 1,000 m a.s.l. The highest mountain, Viehberg (1,111 metres) is on the Austrian side, while on the Czech side the highest mountain is Kamenec (1,072 metres). Location of the Novohradské hory Mts. within the Czech Republic and their basic geomorphological division are shown in Fig. 1.

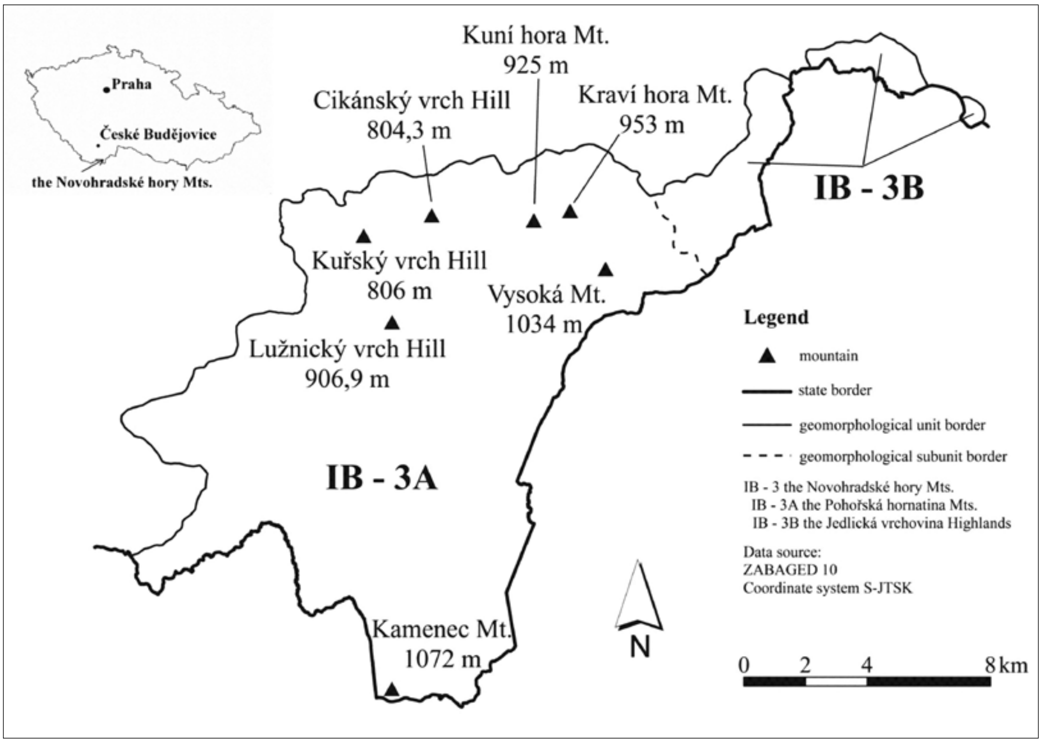

Fig. 1: The location map of the Novohradské hory Mts. within the Czech Republic and their basic geomorphological division

2. Methods

The distribution of cryogenic relief mesoforms on the Mt.Vysoká was specified by using methods of geomorphological inventory according to Kirchner, Krejčí (1996) and Kirchner, Roštínský (2007). The article characterizes the cryogenic relief mesoforms and focuses on their potential protection.

The first phase was the evaluation of source materials related to local geological and geomorphological conditions. These characteristics were depicted on the basis of a geological map on a scale 1 : 50 000 (www.geology.cz). Information about the geomorphological conditions can be also found in older specialized literature, for example in Demek (1964, 1972c) or in Chábera (1972).

The second phase was focused on field research. The area of research was widened to include the surroundings of the Mt. Vysoká. A topographical map (map sheet number 33 – 133 Horní Stropnice) was used on a scale 1 : 25 000. The local mapping of the Mt.Vysoká and its surroundings was based on detailed geomorphological mapping methods as described in Bezvodová et al. (1985) and Demek et al. (1972b). On the Mt.Vysoká itself GPS mapping was performed according to Voženílek et al. (2001) using Garmin GPS V Deluxe. Further simple measuring devices (telemeter HD 150, measuring tape) were used to describe rock forms and their properties. A geological compass was used to measure structural elements of the geologic basement. Photodocumentation was an important part of the field research. The Létal´s legend (Létal, 1998) was used for the processing of geomorphological plans.

The third and final phase was devoted to the evaluation of source materials collected during the field research. This article specifies the localization, basic geological profile, macro and mesoforms of the relief, structural characteristics of elements, influence of human activity and presents a proposal for the protection of cryogenic relief mesoforms. Destructive and alluvial relief forms are terminologically and genetically classified according to Demek (1972a), Demek et al. (1987), Rubín et al. (1986), Summerfield (1991) and Thomas and Goudie (2000).

3. Results – Mt. Vysoká (1,034 m a.s.l.)

Localization

The Mt. Vysoká peak is situated 1.8 km southeast of the village Hojná Voda, near the Austrian border in the Hojná Voda cadastral area. As for the geomorphological hierarchy, the locality is placed in the southeastern part of the geomorphological subunit of the Pohořská upland, which belongs to the geomorphological unit called the Novohradské hory Mts. (Demek, Mackovčin [eds.], 2006).

Basic geological characteristics

The Novohradské hory Mts. form a part of several basic geological units. Late Variscan magmatites of the Central Moldanubic Pluton are of the largest extension here. These are represented by several different types (Weinsberg granite, Freistad granodiorit and Mrákotín granite). The cordiritic gneiss and unbulitic migmatites partially cover late Variscan magmatites of the Central Moldanubic Pluton (as original pluton mantle remains). The Weinsberg granite forms the Vysoká locality itself.

The characteristics of the main forms of relief

The Mt. Vysoká (Fig. 2) is a bornhardt, which developed from a 500 m long shelf ridge. The shelf ridge is elongated in the NE–SW direction. The northeastern tectonic slope (Demek, 1972c) has an inclination of over 20 °. The other slopes around the top of the shelf ridge are of denudation character with slope inclines of 10 – 20 ° which merge into more gentle slopes. The two most pronounced peaks are found on the top shelf ridge. The main, higher peak rises in the southwest and reaches an altitude of 1,034 m a.s.l. The secondary, lower peak rises in the northeast and reaches an altitude of 1,001 m a.s.l. It merges directly into the tectonic slope. At the top of Mt. Vysoká, there are two castle koppies. The first castle koppie is 18 × 15 × 6 metres (length x width x height) and the second is 40 × 12 × 15 m. A cryogenic plane of approximately 150 × 100 m surrounds them. In the castle koppie, there is a large fissure cave. The cave was formed by the expansion of a fissure due to frost weathering. The cave is 6 m long and has an entrance that is 2 m wide (Demek, 1964). The tor that dominates the secondary lower peak is about 40 × 40 × 60 m.

The castle koppie extends to the northwest from this peak. It was perhaps originally a ruware. The ruware was shaped by frost activity during the cold periods of the Pleistocene. It is currently disintegrating and is bipartite over a length of 200 m, with a width of 15 m. The face of the castle koppie in the lower area is relatively high (with a maximum height of 25 m). The mushroom rock (Fig. 3) in the higher area has dimensions of approximately 6 × 6 × 6 m.

The cryogenic relief mesoforms are situated on the northern and northeastern tectonic slopes where the gradients are over 20 °. A tor, which is approximately 5 × 5 × 10 m, dominates the slope at an altitude of 930 m a.s.l. A castle koppie is also situated here. It is also disintegrating and bipartite over a total length of 300 m, with a width of 20 m and a max. height of 35 m. We can deduce that the structural fundament of the castle koppie is a result of pronounced exfoliation processes.

More cryogenic relief mesoforms are situated on the western slope of the Mt. Vysoká A frost–riven cliff is situated on the edge of the shelf ridge at an altitude of 1,015 m a.s.l. It is 30 m long and 15 m high. A group of frost–riven cliffs is situated at an altitude of 975 m a.s.l. Dimensions of this group vary between 5 – 10 m in length and 3 – 10 m in height. Below these cliffs, there is a block field (600 × 350 m). Two castle koppies of about 50 × 8 × 15 m and 15 × 3 × 4 m resp. can be found on the northern part of the western slope at an altitude of 975 m a.s.l. The castle koppie on the southern part of the western slope, at an altitude of 945 m a.s.l. is also disintegrating and bipartite over a length of 100 m with a width of 10 m and a max. height of 20 m. We can deduce from the pronounced exfoliation processes that it is a ruware shaped by frost activities during the cold periods of the Pleistocene.

Fig. 2: Mt. Vysoká – 1,034 m a.s.l. high peak (Photo Jiří Rypl)

Fig. 3: The mushroom rock on the Mt. Vysoká (Photo Jiří Rypl)

A pronounced slope plane at the end of the frost weathering can be found on the western part of the slope at an altitude of 928 m a.s.l. It ends with a group of frost–riven cliffs in the two elevation level. A tor on the slope, which is about 2 × 4 × 6 m, is surrounded by frost–riven cliffs and a block field (300 × 120 m).

Cryogenic relief mesoforms are a rare sight on the southern and southeastern slopes of the Mt. Vysoká The castle koppie is once again situated on the southern slope at 1,005 m a.s.l. It is also weathering and bipartite over a length of 100 m with a width of 8 m and a height between 10 – 15 m. Two slope planes at the end of frost weathering sized 300 × 170 m and 50 × 220 m can be found on the southeastern part of the slope at an altitude of 950 m a.s.l. and 925 m a.s.l. respectively. The slope planes always end with frost–riven cliffs. These are respectively 4 and 8 m long and 3 and 8 m high with cryogenic planes of about 10 × 25 m and 30 × 50 m, resp. The block field is approximately 270 × 270 m and is found to the east of the slope platform at an altitude of 925 m a.s.l. The distribution of cryogenic relief mesoforms on the Mt. Vysoká are shown in Fig. 4.

The characteristics of structural elements

124 measurements were performed to scan the fissure system at the Mt. Vysoká and according to these measurements, a fissure diagram was constructed. The research has shown that the area disposes of an almost ideally and regularly developed fissure system. The NW–SE

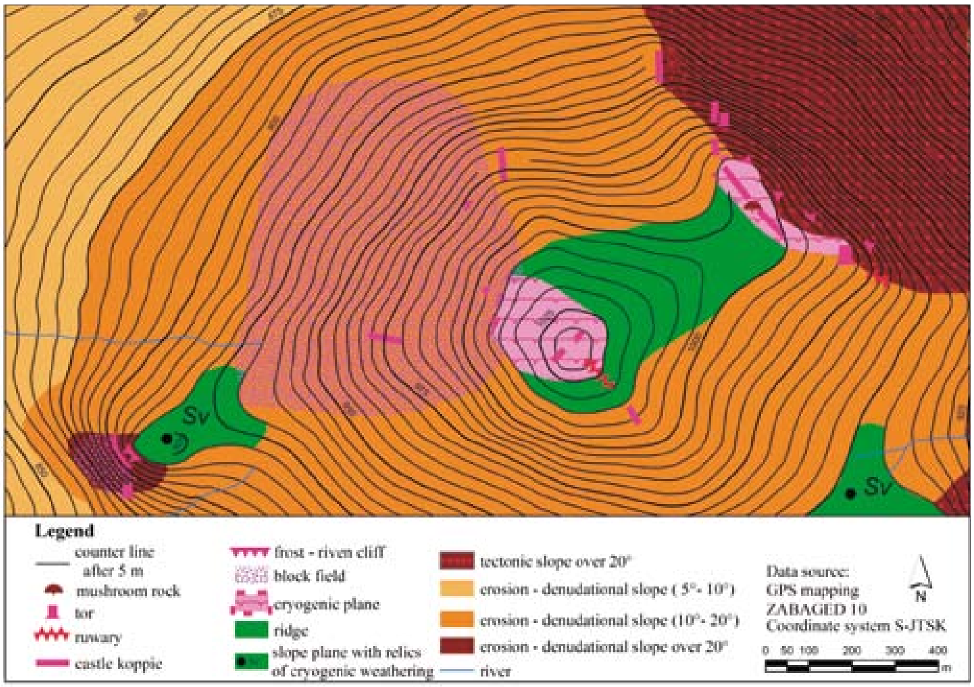

Fig. 4: The geomorphological map of the Mt. Vysoká

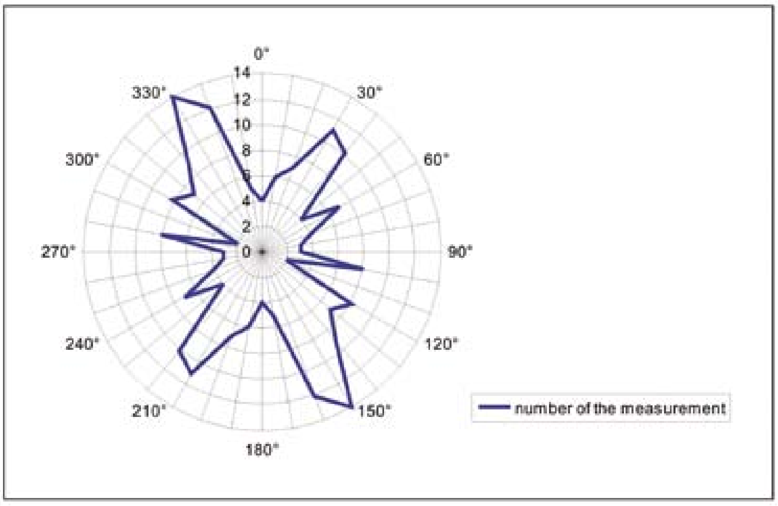

Fig. 5: The fissure diagram of the Mt. Vysoká

directions (especially 150 – 160 °) and the almost vertical NE–SW (30 – 40 °) directions are dominant. The direction of these massive and morphologically significant fissures (some of them participate in the division of the cryogenic relief mesoforms into large blocks) have been termed as a primary fissure system. A group of indistinctive fissures oriented in the direction of 60 ° and 100 ° respectively, make up a secondary fissure system. A fissure diagram of the Mt. Vysoká is presented in Fig. 5.

The influence of human activities

There is a hiking trail leading over the main ridge of the Mt.Vysoká starting and finishing in Hojná Voda. The trail is frequently used during summer and that is why the close surroundings of significant cryogenic relief mesoforms (the castle koppie and the tor situated on the lower peak) suffer from subsoil disturbance. The tor on the lower peak is often used by mountaineers who have nailed down pegs and marked out the mountaineering path. There is a fireplace inside the fissure cave. This cave is a part of the castle koppie.

A proposal for the protection of the cryogenic relief mesoforms

In 2000, the regional authority in České Budějovice town declared the Novohradské hory Mts. a nature park. Unfortunately, this legal status does not provide enough protection to the cryogenic relief mesoforms situated in the top part of the Mt. Vysoká (such as the tor, the mushroom rock and the castle koppie). This is why the Czech Geological Survey has started to prepare source materials, which would make it possible to declare the Mt.Vysoká a geologically significant locality.

4. Conclusions

The completion of gathering the source material, which is important for declaring the locality a Protected Landscape Area called for a more detailed geomorphological research. In 2005, the Czech government refused to approve the Protected Landscape Area declaration. In consequence of this refusal, additional research was realized (a detailed GPS mapping and geomorphological inventory). The aim was to provide more protection for the most interesting localities of the Novohradské hory Mts. The Mt. Vysoká is one of these localities too (viewed from the aspect of basement and from the aspect of macro- and meso- relief forms). An attempt was also made to characterize structural elements and the influence of human activities. Novel methods were finally proposed for the conservation of the cryogenic relief mesoforms.

Acknowledgements

The geomorphological research in the area was part of a grant project supported by the Czech Academy of Science and titled "Comparison of the Quaternary Relief Development of the Novohradské hory Mts. and of a selected part of the Šumava Mts", project number KJB 300460501.

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Author´s address:

Mgr. Jiří RYPL
University of South Bohemia, Department of Geography, Faculty of Education,
Jeronýmova 10, 371 15 České Budějovice, Czech Republic
e-mail: *rypl@pf.jcu.cz*

MORAVIAN GEOGRAPHICAL REPORTS IN THE GEOBIBLINE DATABASE

Eva NOVOTNÁ

The database Geographical Bibliography of the Czech Republic on-line (www.geobibline.cz) is built with the support of the Ministry of Culture of the Czech Republic thanks to the cooperation of specialised research libraries with the National Library and with libraries of the Academy of Sciences. The groundwork of the database was created in the Geographical Library of the Faculty of Science, Charles University in Prague in partnership with the library of the Faculty of Science, Masaryk University in Brno and with the geography department of J. E. Purkyně University in Ústí nad Labem. There are currently 16 libraries working on the project. Important partners include the Research Library in Olomouc, the Moravian Library in Brno and the Education and Research Library in Pilsen. The basic beta version of the stand-alone database and OPAC in SW Aleph 500 environment was created in the first phase at Charles University. Save for imports, the formation of the database is proceeding with the original cataloguing of monographs, periodicals, cartographic documents, Master's theses, electronic documents and particularly 39 titles of profile departmental periodicals.

The file of selected titles also contained a product of the Institute of Geonics, v. v. i. (Academy of Sciences of the Czech Republic), **Moravian Geographical Reports** (MGR), issued since 1993. The records of titles from years 1997–2008 excerpted from the periodicals by Moravian Library were, within the cooperative formation, loaded to the National Library of the Czech Republic database for analytical indexing where our bibliography draws records. The articles were imported to the GEOBIBLINE database in 2009. Our colleague Věra Anthová from the Library of the Faculty of Science, Masaryk University in Brno, completed the bibliography of articles with the missing volumes from the period1993–1996. In the mid-2010 the database already contained a total of 280 articles from MGR. Newly issued volumes will be gradually excerpted.

The survey of publishing full texts of the articles was carried out already earlier. The MGR editorial used to publish via Internet the full texts with one-year delay. We started negotiations with the Institute management. Vladimír Herber (Faculty of Science, Masaryk University) in agreement with colleagues from the Institute of Geonics scanned individual articles namely from older volumes. Each article was appended with relevant periodical cover. The director of the Institute of Geonics, prof. Radim Blaheta agreed at the beginning of 2010 with saving data to the server of the Department of Applied Cartography, Faculty of Science, Charles University and with publishing the full texts within the GEOBIBLINE database. The condition was the mentioned one-year delay. The advantage of this type of processing and storing full texts is primarily the guarantee of the fixed address, which allows the user the access at any time even when the web pages change. The articles were, in the noted field, supplemented with the copyright information of the Institute of Geonics, v. v. i., Academy of Sciences of the Czech Republic for the full texts. The texts could not have been attached to the field MARC21 856 for URL address since the Institute's internet version makes accessible only the whole issue in PDF, i.e. several articles at one go, which would be too a long browsing for the readers. The article texts were saved under pre-specified conventions – year, volume, author and title – separated and added as objects to bibliographical records. It was possible to link the articles through ADAM software, which serves for adding objects to the database of Aleph system.

The best way to search all issues of the title is through the name index. Here you can enter a particular title of the **Moravian Geographical reports** and the title with the number plus 99 will appear in the index below the search window. However, there are in fact more records in the database, 280 bibliographic records for now. The user will have a condensed view but by clicking the number on the left, the record will pop up. Each underlined text is in other words linked-through and it is possible to continue in hypertext search. Individual issues and volumes can be searched in the index under expression: Source document – volume, issue.

A total of 130,000 bibliographic records in the database (2010) can be searched in simple or combined searching through browsing the indexes or with the help of command language. Found and selected records can be saved in a box, then it is possible to elaborate the search and send it to the email address in various formats, including the tagged format ISI for EndNote. In addition, there is also a service of the server citace.com available since 2010 that enables an automatic display of the record in the format of ISO 690 – international standard for bibliographic referencing. The documents can be located, i.e. it is possible to determine in which library it physically exists, or the SFX service can be used for the same purpose.

Before opening any PDF file, the user will see detailed information about possibilities of using the full text, in accordance with the copyright law in force.

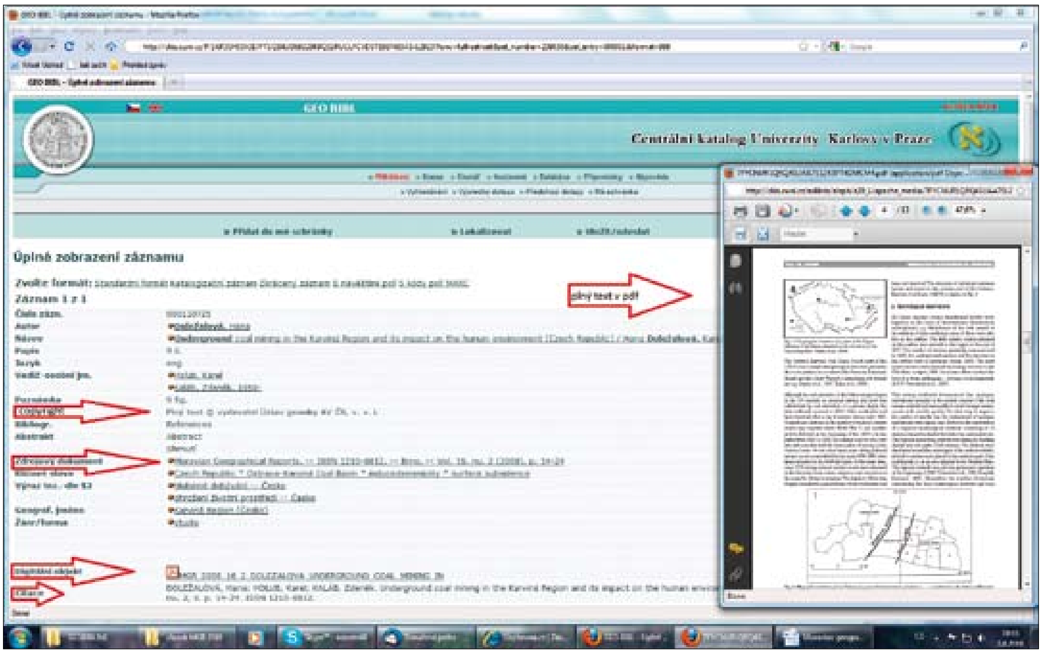

Fig. 1: Sample of bibliographic record with a full text from MGR. Underlined data can be further searched

Researches can begin to search for the first time in the articles of MGR by many access points, by author, title, subject headings, date of issue, geographical authorities etc. Furthermore, they have an opportunity to work with the full texts from the comfort of their office or home. Considering high database attendance from all over the world, the readership could rise but also the interest in the title, merchantability and finally also the citations of the authors publishing in this journal.

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Author's address:

PhDr. Eva NOVOTNÁ
Geographical library, Faculty of Science, Charles University in Prague,
Albertov 6, 128 43 Prague, Czech Republic
e-mail: *novotn48@natur.cuni.cz*

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All scientific papers are subject to a peer review process, with two anonymous independent reviewers (one of whom preferably would be from outside the Czech Republic) appointed by the Editorial Board. The criteria for the review process include the following: an evaluation of the topicality and originality of the research problem; level of theoretical and methodological understanding of the problem; the methods used; the relevance of sources and references to the literature; and contribution to the development of the scientific area under study.

Scientific communications are meant to inform the public about current research projects, scientific hypotheses or findings. The section is also used for discussion of scientific debates or refining scientific opinions. Some contributions may be reviewed at the discretion of the Editorial Board. The maximum text length of a scientific communication is 12 thousand characters.

Scientific announcements present information about scientific conferences, events and international cooperation, about journals with geographical and related issues, and about the activities of geographical and related scientific workplaces. The scientific announcements preferably will be published with colour photographs. Contributions to jubilees or obituaries of prominent scientific personalities are supplied exclusively by request from the Editorial Board. The maximum text length of a scientific announcement is 5 thousand characters.

Moravian Geographical Reports also publishes reviews of major studies in 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. Normally, graphics are not included.

More detailed instructions can be found at **http://www.geonika.cz/EN/research/ENMgr.html**

The journal Moravian Geographical Reports is monitored in the SCOPUS database. Information about the journal can also be found on other web sites, such as the site of the American Geographical Society Library (**http://www.uwm.edu/Library/AGSL/**) or the site of the University of Colorado at Boulder (**http://www.colorado.edu/geography/virtdept/resources/journal/journals.htm**).

REVIEWERS OF PAPERS PUBLISHED IN MGR VOL. 18/2010

In the alphabetical order, we present a list of reviewers who reviewed articles published in numbers 1–4 of Vol. 2010. **The Editorial Board thanks them for the cooperation**.

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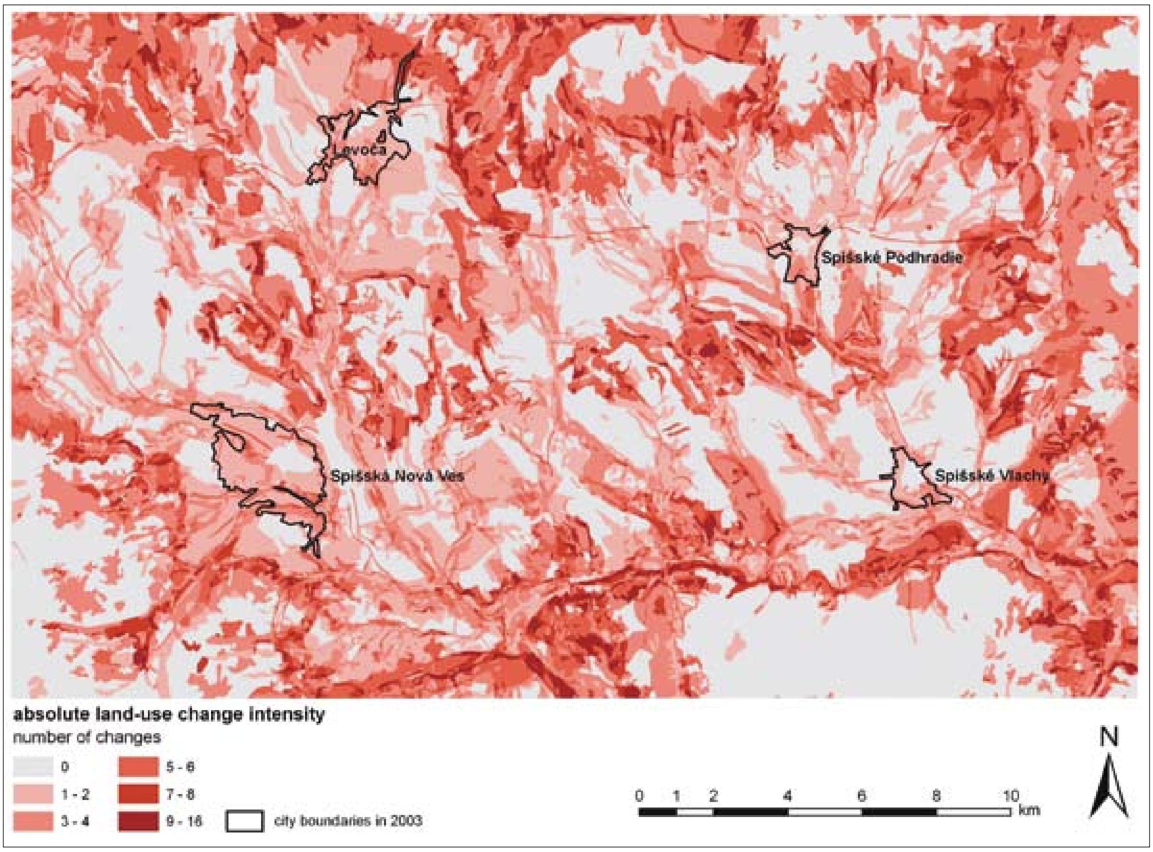

Fig. 10: Absolute intensity (1782–2003)

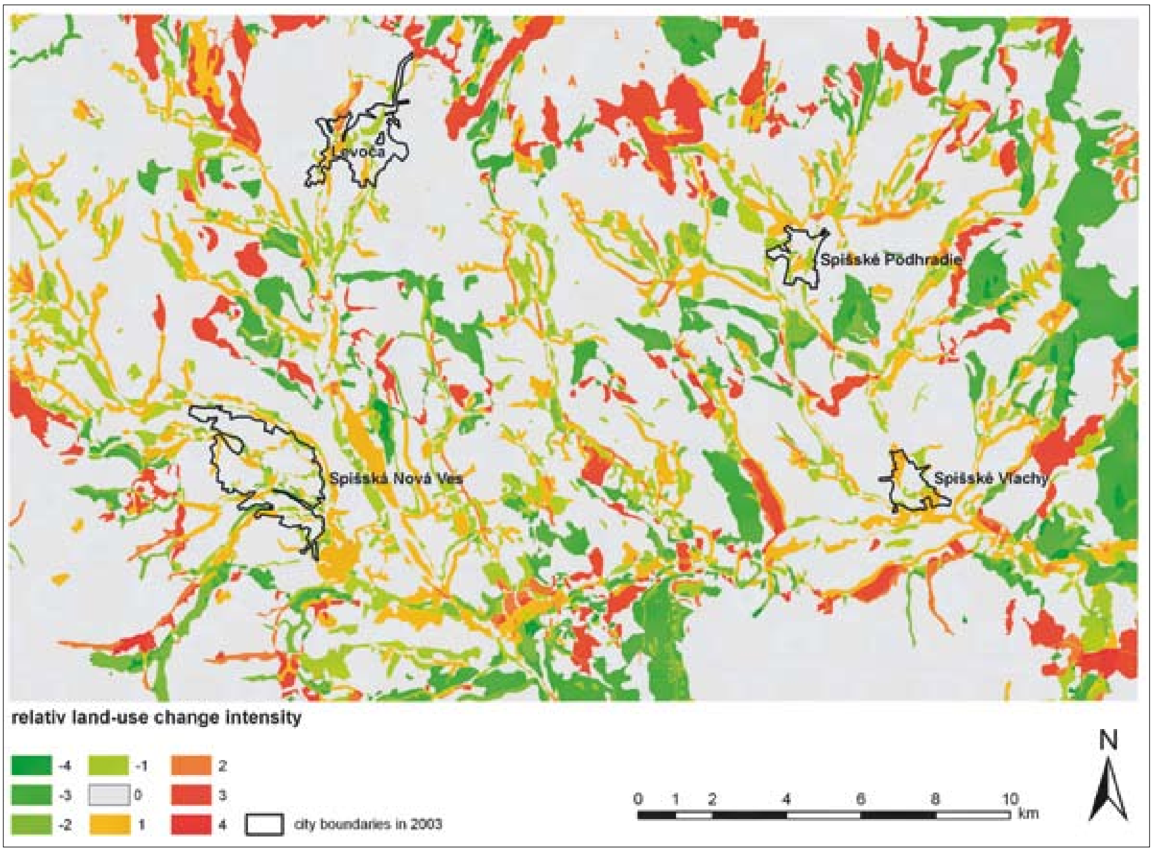

Fig. 11: Relative intensity (1782–2003)

Illustrations related to the paper by R. Kandrík and J. Olah

Fig. 1: Most of the human victims of the flood in Prague in September 1890 were 20 sappers who perished. They were sent to the raging river in rain and dark to disassemble a pontoon bridge. A monument to the soldiers who perished due to this senseless tragedy was erected near Invalidovna – a historical pension for disabled veterans in Prague (Photo E. Jelínková)

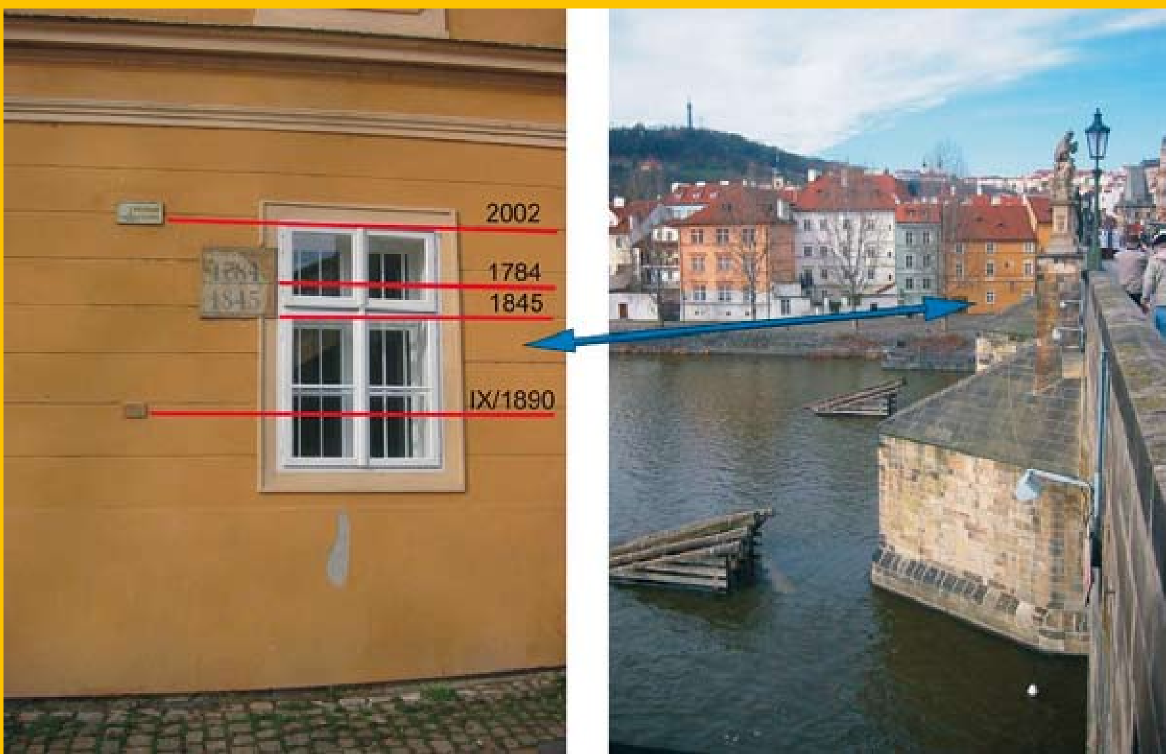

Fig. 3: Flood-marks on the house situated on the left bank of the Vltava/Moldau R. in Prague (detailed and distant view) at the Charles Bridge: historical floods in 1784, 1845, September 1890 and the greatest flood in 2002 (Photo E. Jelínková)

Illustrations related to the paper by J. Munzar, M. Deutsch, S. Ondráček and E. Kallabová