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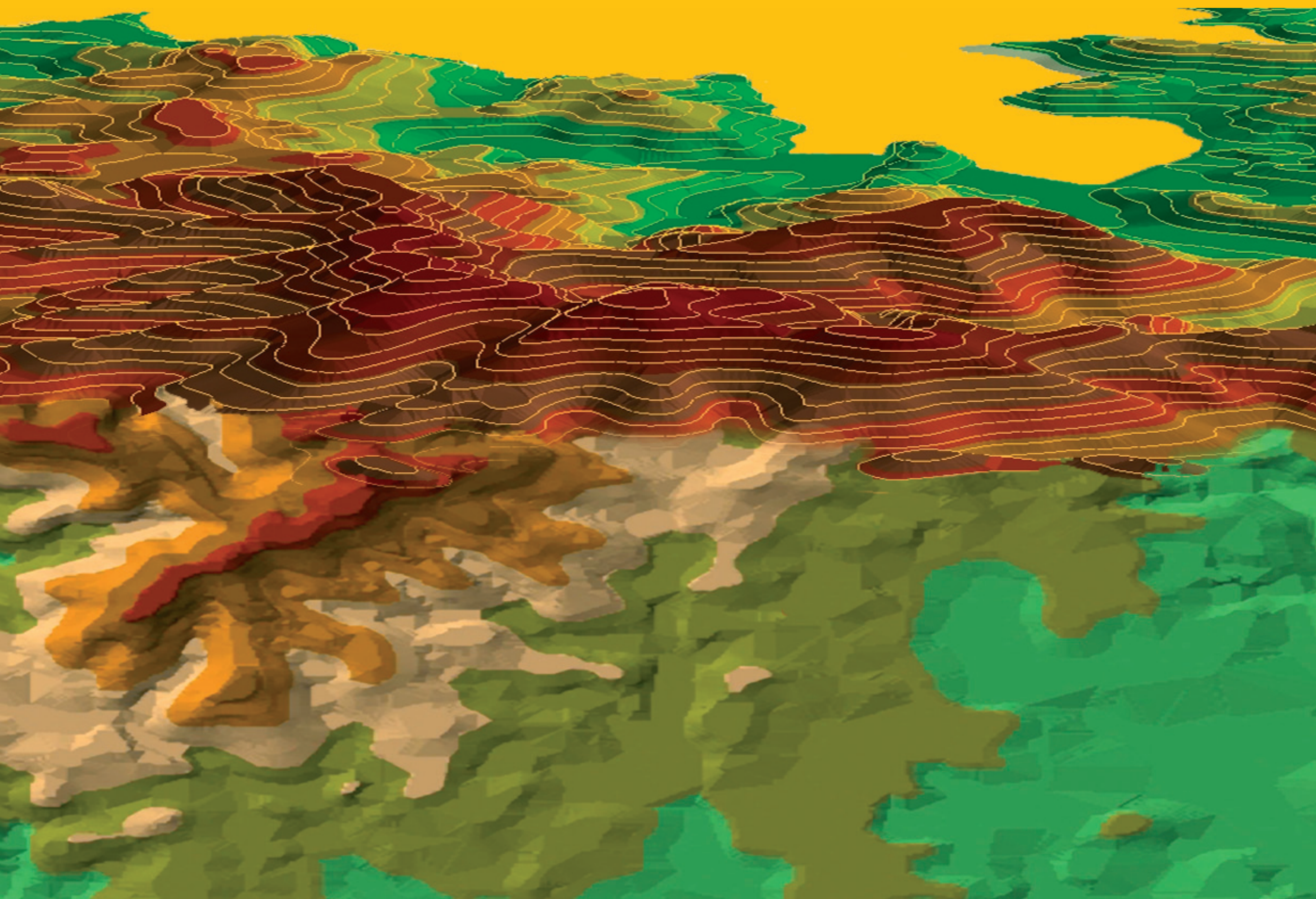

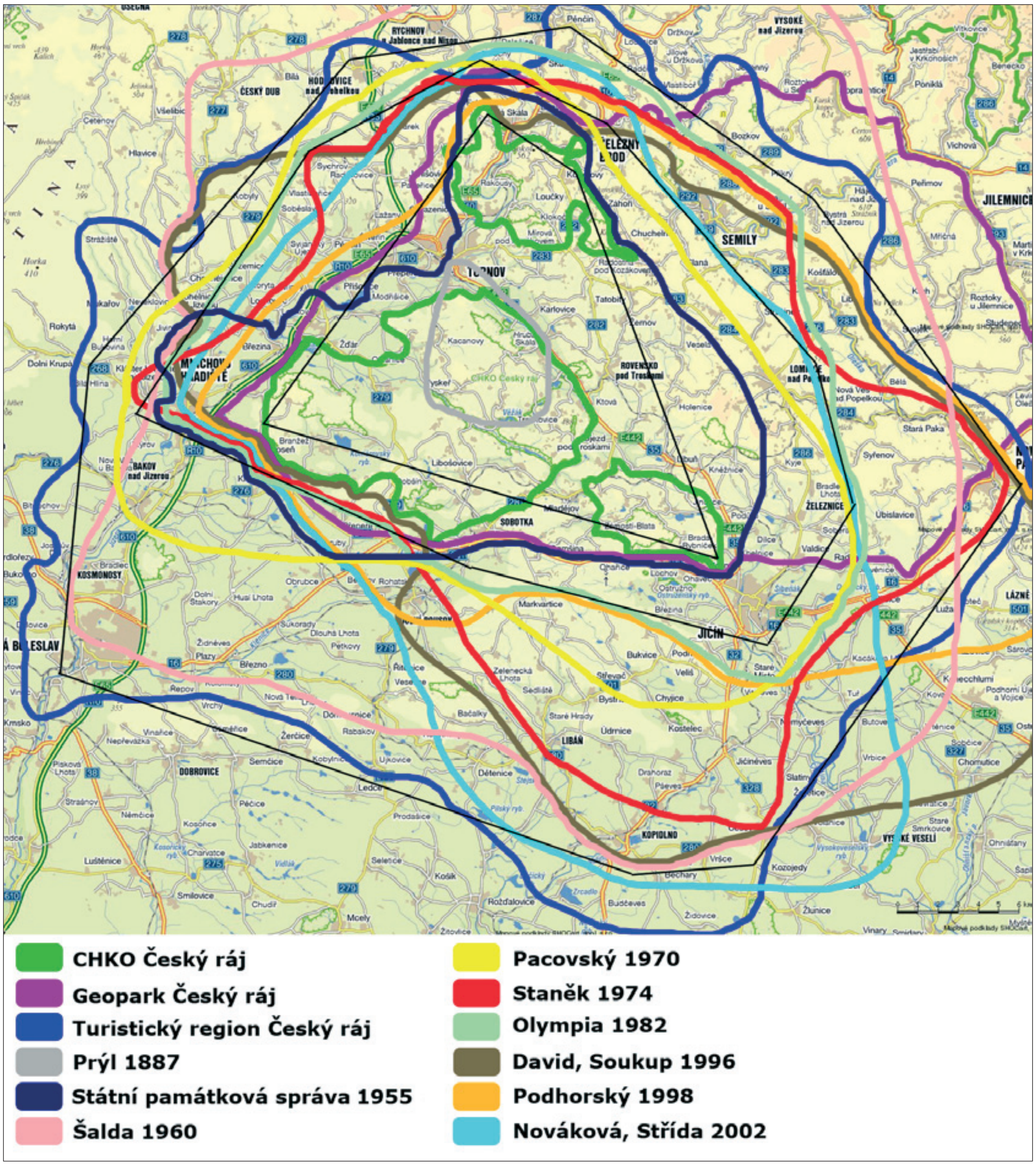

Fig. 2: Discourse on the definition of the Bohemian Paradise
Source: Semian (2010)

Fig. 3: View to the sandstone rock city of Bohemian Paradise – area Hruboskalsko (photo P. Trnka)

Illustration related to the paper by M. Semian

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NEW POST-EXPLOITATION OPEN PIT COAL MINES LANDSCAPES – POTENTIALS FOR RECREATION AND ENERGY BIOMASS PRODUCTION: A CASE STUDY FROM SERBIA

Dragana DRAŽIĆ, Milorad VESELINOVIĆ, Nevena ČULE, Suzana MITROVIĆ

Abstract

Selected results from research on landscape and functional transformations in one of the largest coal basins in Serbia are presented in this paper. Firstly, the site conditions of the Kolubara lignite basin are analyzed, followed by an overview of the success of planted coniferous and deciduous trees used in the process of biological re-cultivation by afforestation. Finally, the possibility of multifunctional uses of reclaimed deposols and of newly-created landscapes is considered, especially for recreation and production of biomass for energy in short-rotation plantations. The study of potential uses of newly created landscapes and ecosystems after coal extraction by open-cast mining and after technical and biological re-cultivation by afforestation, confirms the thesis on the feasibility of sustainable development. It is possible to create extraordinary anthropogenic forest ecosystems rich in biodiversity with multi-functional values that are suitable, inter alia, for recreation and energy biomass production.

Shrnutí

Nová krajina vytvořená na plochách vytěžených povrchových dolů – potenciál pro rekreaci a produkci biomasy: případová studie ze Srbska

Příspěvek přináší vybrané výsledky z výzkumu krajiny a jejích funkčních přeměn v jedné z největších uhelných pánví v Srbsku. V první části práce jsou analyzovány přírodní podmínky lignitové pánve Kolubara, poté úspěšnost výsadby jehličnatých i listnatých dřevin použitých v procesu biologické rekultivace zalesněním a konečně možnost multifunkčního využití rekultivovaných půd (deposolů) a nově vytvořené krajiny zejména pro účely rekreace a produkci energetické biomasy ve výsadbách s krátkým obmýtím. Tato studie potenciálního využití krajiny a ekosystémů nově vytvořených po těžbě uhlí v povrchových dolech a po technické a biologické rekultivaci zalesněním potvrzuje tezi o realizovatelnosti trvale udržitelného rozvoje. Je možné vytvářet jedinečné antropogenní lesní ekosystémy s bohatou biologickou rozmanitostí multifunkčních hodnot, které jsou mimo jiné vhodné i k rekreaci a k produkci biomasy pro energetické účely.

Key words: *open pit coal mines landscapes, biological re-cultivation, recreation, short rotation plantations, biomass for energy, Serbia*

1. Introduction

In Serbia, coal is the major energy raw material and the base of industrial and economic development. Low calorie coal – lignite is the most significant, because its share in geological (total) reserves is 85%, and even 94% of the exploited part. Nearly all lignite supplies are concentrated in several basins of which the most significant is Kolubara.

The Kolubara lignite basin was formed by the deposition and carbonation of plant materials occurring in the swamps and lakes of the Tertiary. It is located 50 km southwest of Belgrade. Geological contours of lignite deposits suitable for exploitation occupy an area of more than 500 km^2. In the Kolubara Basin (Fig. 1), lignite has been extracted exclusively by open cast mining, which results in multiple degradation of the environment. A drastic change of the landscape (Fig. 2) and ecosystems is unavoidable in the course of lignite extraction: artificital sterile mine spoil banks (tailings), immense holes – craters, areas without vegetation and with the destroyed soil cover, formation of lakes, pools and other artificial water bodies give a completely new image of the disturbed landscape.

As the result of different mining activities, especially opencast mining and development of industries, this region had been repeatedly damaged and transformed which seriously affected the landscape's natural balance and visual characteristics. The adverse changes, processes and consequences required parallel works on rehabilitation, i.e. revitalization, recultivation and, in general, works on the management of the disturbed natural units. Open cast coal mining requires the management of the entire space and overburden above the coal deposits. Rehabilitation and restructuring of land offer numerous possibilities of land restoration for the benefit of both human and natural communities.

2. Succesful examples of biological land rehabilitation

Mining has been pursued on a large scale in Central Germany for about 150 years (Hildmann and Wonsche, 1996). Thus it is not strange that Germany was the first country to recognize the importance of biological recultivation in the middle of the 19th century. Following this idea, USA and England made the first attempts for recultivation at the beginning of the 20th century. Real scientific research in this field of land management as well as a more extensive application of recultivation started after the Second World War.

Mining activities were carried out so intensively in the 1970s and 1980s in Germany that the reclamation could not keep up with the area devastated by mining (Hildmann, Wonsche, 1996). Political leaders had other priorities and subsequently state mining companies did not receive funds for remediation and reclamation (Dražić et al., 2011). Overburden consisted of sand and gravel and hardly any topsoil was the major remediation problem (Bismarck, 2000). A new soil cover had to be established and the interrupted nutritional chains had to be built up again to bring back plants and animals. By adopting rigorous legislation which dictated the method of extraction, permitted amounts of harmful substances, solution of social and other problems, and even selective overburden removal (Hildmann, Wonsche, 1996), Germany has managed to recultivate more than 40,000 hectares of mined land. Thanks to this largest European environmental program, established in the early spring of 1999, 65,370 ha of wasteland and dump areas, 27,280 ha of forests, 11,590 ha of agricultural land were reclaimed. Natural re-vegetation

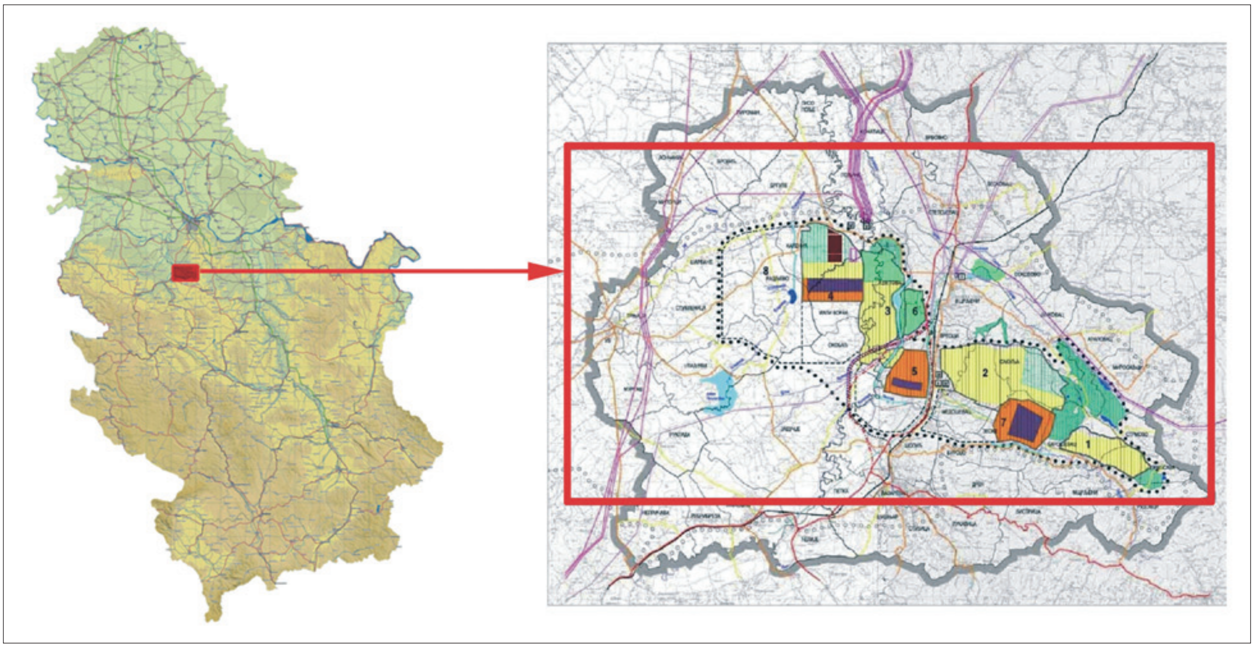

Fig. 1: The Kolubara lignite basin – geographical location in the Republic Serbia

Fig. 2: The Kolubara lignite basin – a panoramic view of the exploitation field "D" (photo: D. Dražić)

and controlled succession was carried out on 5,760 ha. New ecosystems are now established in order to bring the post-mining landscape on the path leading towards sustainable development and achieve the desired future land use – with many new lakes with water of bathing quality and you will also see thousands of acres of young forests and new agricultural land and areas protected for wildlife (Bismarck, 2000).

A particularly interesting idea is the establishment of short rotation plantations on disposal sites. Studies conducted at the disposal sites of open-pit mines in Germany showed that growth increment ranges from 5.3 to 19.6 tones of the dry matter/ha in 4-year old plantations grown even under unfavorable soil conditions (Bungart and Hüttl, 2001).

Germany was not alone in revitalizing the land degraded by coal surface mining and its subsequent multifunctional use, so there are many other examples of successful work. In the USA, thanks to legislation such as the Federal Surface Mining Control and Reclamation Act from 1977 (SMCRA), there are very good examples of successfully revitalized lands, after or in the course of surface mining of mineral ores: e.g. in West Pennsylvania (Ahharach and Hartman, 1973), South Indiana (Byrnes and Miller, 1973; Medvick, 1973; Miles et al., 1973), Pennsylvania (Davis, 1973), Ohio (Funk, 1973), West Virginia, mine Elkins (Hodgson and Townsend, 1973; Thurman and Sencendiver, 1986), and others (cf. Committee on Soil as a Resource in Relation to Surface Mining for Coal et al., 1981). The establishment of farms, reinstated by agro-melioration measures to the state of pre-mining productivity was the most usual practice in Midwest USA in the past. There are frequent cases of the restoration of natural "wildlife" sites nowadays. Very popular method of re-cultivation is the transformation of post-exploitation landscapes into wetlands. Valuable sites for birds resting during their migration are established in this way. It is believed that this aspect of re-cultivation is also financially feasible, because these ecosystems are natural purifiers and water filters to the level prescribed by standards. The establishment of forests and orchards is suggested in former forest regions. Some companies choose primary vegetation and meadows, enabling the natural succession of plant species to the level of climatogenic forest community.

Recently, very significant results have been achieved in the reclamation of regions damaged by mining in the past in Great Britain, especially in England and Wales as well as in Scotland. Only after signing a contract with the National Coal Board (NCB), a mining company can get the permission to open new open cast mines. Twenty-eight out of 65 articles of the contract refer to environment protection, landscape conservation and re-cultivation of damaged land. In this way, large areas are managed in Yorkshire, North Derbyshire and Doncaster (Lindley, Mansfield, 1979).

Inquiries carried out in Bulgaria by Hage et al. (1996) showed that the impact of mining on the environment could be reduced remarkably, if ecological aspects were considered. They suggest further development of open pit mines through the protection of landscape parts by changing the mining edges, a rapid shift from outside to inside dumping and early recultivation of outside dumps. Furthermore, they state that post mining landscapes in Bulgaria have numerous possibilities to create a reasonable environment. This includes among others: areas for agriculture and forestry use, integrated and special areas for nature conservation and development of areas for recreation.

In Poland, coal mining activity covers about 16,000 ha. The establishment of forest ecosystems has priority in post mining landscape. The first afforestation of dumps in Poland was performed in the Turow Mine in the early 1970s (Strzyszcz, 1996). Many leguminous and grass species were introduced and soil cover on slopes was made of trees such as black and grey alder, robinia red oak, larch, Scotch pine, ash, and poplar. The outer dump of the Adamow Mine in Poland, sized about 350 ha, was a second object subjected to afforestation in same period. Vegetation was slightly different, though. Besides leguminous and grass species, trees species such as black and grey alder, red oak, larch, poplar hybrid 275, Norway maple and mountain ash were introduced (Strzyszcz, 1996).

Of the former socialist countries (in addition to the former German Democratic Republic), the then Czechoslovakia was one of the leading countries in revitalization of land degraded by coal surface mining. Re-establishing agricultural ecosystems through recultivation on post-mining landscapes prevails in the northern-Czech Lignite Basin. The approach was regulated by law in 1957 (Strzyszcz, 1996). Forest recultivation is present in the Sokolovský Basin due to the quality of overburden materials. Near the city of Chomutov, an area of 480 ha was agriculturally reclaimed and 100 ha were recultivated by afforestation.

3. Methods

In the first part of the paper, site conditions (climate conditions, characteristics of deposols[1] at disposal sites of barren soil) of the Kolubara basin are analyzed, then the success of planted coniferous and deciduous trees used in the process of biological recultivation by afforestation. Comparative surveys are also conducted of the development of the present dendroflora at disposal sites of the open-pit mines in forest cultures established during the biological recultivation of the Kolubara-Tamnava coal basin. Finally, possibilities of the multifunctional use of reclaimed deposols (see e.g. Kostić et al., 1996) and newly created landscapes are discussed, especially for recreation and production of biomass for energy in short rotation plantations.

This paper also presents research results on the detailed monitoring and analysis of several species suitable for short rotation plantations (*Populus* x *euramericana* cv., *Salix* sp., *Pseudotsuga menziesii* Mirbel Franco, and *Larix decidua* Mill.) that were planted on sample plots on deposols. Total numbers of planted tree seedlings were as follows: 1,008 (European larch), 978 (Douglas fir), 651 (poplar) and 1,449 (willow). The seedlings were watered regularly, depending on meteorological conditions. One year after planting, in spring, initial supplementary nutrition was added at 30 g of NPK mineral fertilizer per seedling in order to provide the best possible thriving and start growth, whereas in the second year the supplementary feeding was added as waste sludge obtained during the process of coal processing.

Monitoring of important parameters until the end of rotation is essential for conclusions and determines optimum technologies for establishing the plantations, silvicultural measures, tending, and utilization of appropriate mechanization and harvesting of biomass obtained in this manner, as well as the assessment of realistically obtainable energy biomass quantities in the areas degraded by the surface exploitation of lignite coal.

In order to determine possibilities of biomass production at the disposal sites of barren soil (deposols), a comparative experiment was established with a number of fast-growing tree species. Trees were planted to determine optimal method and technology of soil preparation (deposols), initial supplementary nutrition by fertilizers and other growth stimulants, planting density and technology for each species, protective measures to be adopted in short rotation plantations against harmful insects and phytopathogens, effects of phyto-remediation, selection of suitable mechanical devices in all work phases and analysis of economic parameters of the establishment of plantations intended for the production of biomass for energy.

The experimental plot in Baroshevac was established at a waste disposal site of barren soil (deposol) within the Kolubara basin during 2006/2007. Parameters monitored on the experimental plot were as follows:

- average length of the above-ground part (m),
- length and diameter of the root collar (cm),
- mass of the above-ground part (g),
- mass (g) and volume (ml) of the root,
- dry matter of the above-ground part of extracted seedlings two years after planting(g),
- high and low calorific value (MJ/kg),
- health condition.

For the assessment of a potential capability of the study sites for recreation, a method developed by Cvejic (1989) was applied to evaluate the potential natural suitability for recreation. This method, as the result of research and detailed comparative analysis of previous methods by Kiemstedt (1969), Ruppert (1971), Schaneich (1972), Turovski (1972), Mrass (1974), Harfst (1975), Kastner et al. (1982) can be characterized by numerous advantages. It belongs to a group of quasi-total, user-independent quantitative methods. The method takes into account natural characteristics of the region and includes ecological and esthetic-psychological aims as well as the aim of potential suitability for outdoor recreation, conditioned by the climate. It should be emphasized that this method evaluates the potential zones for recreation and not the already formed recreation zones.

The method consists of three phases:

1. Elimination of evaluation units, based on elimination features,
2. Designation of potential recreation zones for all types of recreation, and
3. Assessment of a suitability of the land to accommodate recreation: water recreation and recreation in the landscape.

The evaluation was based on detailed aerial photographs made on a scale 1:10,000. The size of the evaluation units of quadrate-raster was 0.25 × 0.25 km. Within each raster, thirteen features were evaluated: relief, forests, waters, banks, meadows, presence of individual trees, hedges, orchards-vineyards, fields-arable land, agricultural, forest roads and walking paths, cultural and natural monuments, settlements, infrastructure, competitive land uses and accessibility, as well as 21 sub-features of the above principal features. A unique four-phase scale was implemented from 1 to 4, where four points represent the highest suitability.

[1] The term "deposols" has been used mostly in the post-Yugoslavian geographical space for a specific type of anthropogenic soils developed in consequence of the storage of surface layers in the process of coal mining and tailing (see e.g. Kostić et al. 1996; Ličina et al. 2012).

4. Results

4.1 Site conditions

The study area is characterized by temperate continental climate (Kerner), sub humid, moister type (Thornthwaite), with mean annual air temperature ranging between 11.0–12.0 °C. Annual rainfall ranges between 583.5 and 783.1 mm, with two maxima: in early summer and in late autumn, and two minima: at the end of winter and at the beginning of autumn. Mean annual relative air humidity is 69.0–76.9%. The most frequent winds are in ESE direction, then WNW, W, N and NW, while average frequency of calms is 629‰. During open cast mining, the previously natural soils in this area were replaced by mine spoil banks, originating from different geological layers. Pontian sands and heavy Pliocene clay are most often found on the surface of the spoil banks.

The plantations were established on very heterogeneous substrates (Figs. 4, 5), which are, after Antonovic (1980) in the class of anthropogeneous soils, special class of technogenic soils, type deposols, subtype deposols formed by open cast mining of lignite. They have very variable properties, which is the consequence of different initial characteristics of deposited materials (Fig. 3). Generally, all of them are characterized by very low amounts of humus and organic matter and by a weak acid to neutral reaction.

4.2 Development of different tree species

During the process of biological recultivation by afforestation, numerous species of trees and shrubs were planted, depending on the type of soil and other micro-habitat conditions (Tab. 1). The largest area is occupied by pure plantations of Austrian pine and Scots pine (27.7%), and by group selection mixtures

Fig. 3: Disposal of overburden tailings in Kolubara – substrates for biological reclamation (photo D. Dražić)

Figs. 4, 5: Cross-section through the substrate (deposols) in Kolubara on which forest plantations are established (photo D. Dražić)

Tree species	Total	
	hectares	%
Pure plantations of Austrian and Scots pines	262.00	27.7
Pure plantations of larch	33.00	3.4
Pure plantations of Douglas-fir	13.00	1.3
Pure plantations of Weymouth pine	21.00	2.1
Pure plantations of oaks	23.00	2.3
Pure plantations of maple	29.00	3.0
Pure plantations of black locust	82.00	8.4
Pure plantations of other broadleaves	78.00	7.9
Mixed stands of conifers	109.00	11.1
Mixed stands of broadleaves	93.00	9.6
Mixed stands of conifers and broadleaves	228.00	23.2
Total:	**971.00**	**100.0**

Tab. 1: Characterization of the area by tree species (Dražić et al., 2007)

of broadleaves and conifers (23.2%). The percentage of group mixtures of coniferous plantations is 11.1% of total afforested area, and mixed plantations of broadleaves account for 9.6%. Other broadleaves - lime, alder, Siberian elm, birch, etc., account for 7.9%, black locust 8.4% in total afforested area, while other species account for 1.3% to 3.4% of the total plantation area (Dražić et al., 2007). Besides the mentioned species, in the process of biological re-cultivation by afforestation, there were planted more than 15 species (Figs. 6 and 7).

In general, parameters of the development of the studied tree species in forest plantations (diameter, height) showed satisfactory results (Tab. 2). All tree species used in afforestation exhibited a high degree of survival after planting, very good dynamics of diameter, height and volume development, but there were differences between the species on the same deposols, and differences in the development of each species on different deposols.

4.3 Potential use of reclaimed lignite strip mine areas for recreation

Of the total evaluated area (1,143 ha) divided into 183 rasters (see Fig. 8), 31% (57 rasters, i.e. 356 hectares) was the first category of suitability for recreation, 56% (103 rasters, i.e. 644 hectares) was the second category of suitability for recreation. Only 13% (23 raster-areas or 144 ha) was the third category of suitability for recreation. No land was classified in the fourth category (Dražić, 2000).

Based on the above results, it can be concluded that the study area has an extraordinary potential suitability for recreation, because a significant percentage of the area is under forest, there are water bodies such as lakes, rivers and swamps, there are meadows, terrain dissection is also expressive although at a relatively low altitude. On the other hand, the percentage of fields, developed areas, infrastructure and competitive land uses is small. In the third phase of evaluation,

Figs. 6, 7: Forest plantations of different tree species established in the process of biological re-cultivation in Kolubara (photo D. Drazic)

Tree species	Deposol of lighter mechanical composition		Deposol of heavier mechanical composition	
	Diameter (cm)	Height (m)	Diameter (cm	Height (m)
GYMNOSPERMAE (CONIFERS)				
Alder (*Alnus glutinosa* L. Gaertn)	12.3	10.00	10.0	10.00
Larch (*Larix decidua* Mill.)	11.7	10.80	8.6	10.00
Weymouth pine (*Pinus strobus* L.)	8.6	6.85	9.2	8.00
Douglas fir (*Pseudotsuga menziesii* Mirbel. Franco.)	8.6	6.50	9.1	6.55
Scots pine (*Pinus sylvestris* L.)	8.3	7.10	6.7	4.50
Birch (*Betula verrucosa* Ehrh.)	11.9	9.40	-	-
Austrian pine (*Pinus nigra* Arn.)	7.3	4.60	6.7	4.85
Sequoia (*Sequoiadendron giganteum* (Lindley) J.Buchholz)	10.7	5.00	-	-
Arizona cypress (*Cupressus arizonica* Greene.)	10.6	5.58	-	-
Bhutan pine (*Pinus wallichiana* A.B. Jackson)	10.4	5.05	-	-
Western yellow pine (*Pinus ponderosa* Dougl.)	9.4	4.00	-	-
Atlas cedar (*Cedrus atlantica* Man.)	7.3	6.00	-	-
Lawson's cypress (*Chamaecyparis lawsonianna* Murr.Parl.)	6.9	5.67	-	-
Incense cedar (*Libocedrus decurrens* Torr.)	6.3	4.03	-	-
ANGIOSPERMAE (DECIDUOUS TREES)				
Caucasian fir (*Abies nordmanniana* (Steven) Spach	4.8	3.00	-	-
Serbian spruce (*Picea omorika* Panc.Pyrkine)	4.4	5.05	-	-
Sibirian elm (*Ulmus sibirica*)	11.5	6.33	-	-
Red oak (*Quercus rubra*)	5.1	5.50	-	-
Tulip tree (*Liriodendron tulipifera* L.)	4.4	4.42	-	-

Tab. 2: Development characteristic of some tree species at the age of 10 years

we designated area parts that can accommodate water recreation (Fig. 9) and recreation in the landscape (Fig. 10). Of all evaluated units, water bodies occur in twenty-five percent of raster areas. The River Turija flows along the north-eastern boundary. There are also lakes of various sizes.

The rivers and lakes (Figs 11 and 12 – see cover p. 4) can be used for swimming, fishing, boating and the maintained beaches can be used for sun-bathing, leisure time and other aspects of recreation.

4.4 Sustainable development of renewable and non-renewable energy sources

Apart from lignite coal, which is undoubtedly the most important source of energy in Serbia, a considerably extensive area under coniferous and broadleaved tree plantations was established within the coal basin in the process of biological re-cultivation by afforestation. A significant volume of wood for energy is obtained in the process of regular maintenance of these forest crops (thinning, cleaning, etc.). However, much larger quantities of biomass can be produced in short rotation plantations on waste disposal sites (deposols). In this way, sharing of production and human resources, integrated production and use of renewable energy sources (hereinafter RES) and non-renewable energy sources (hereinafter NON-RES) is possible in the same space.

Biomass represents the most important renewable energy source in Serbia with a share over 60% among renewables (Stojiljkovic et al., 2011). The main reason is a high share of agriculture (arable land constitutes approximately 55% of the territory) and abundance of forests (approximately 30% of the territory is covered by forest and an increased level of forest coverage of 40% is planned). In order to reduce emissions of CO_2, renewable energy must replace fossil fuels. In countries with large forest resources and well developed forest sectors, wood is the primary source of renewable energy (Hakkila, 2000).

It is realistic to utilize energy of 1.0 Mtoe (Million Tons of Oil Equivalent) from the forest biomass and 1.4 Mtoe from the agricultural biomass. Total amounts of forest biomass are estimated at 7 million mł of fuel wood (55% from state forests) and 5 million

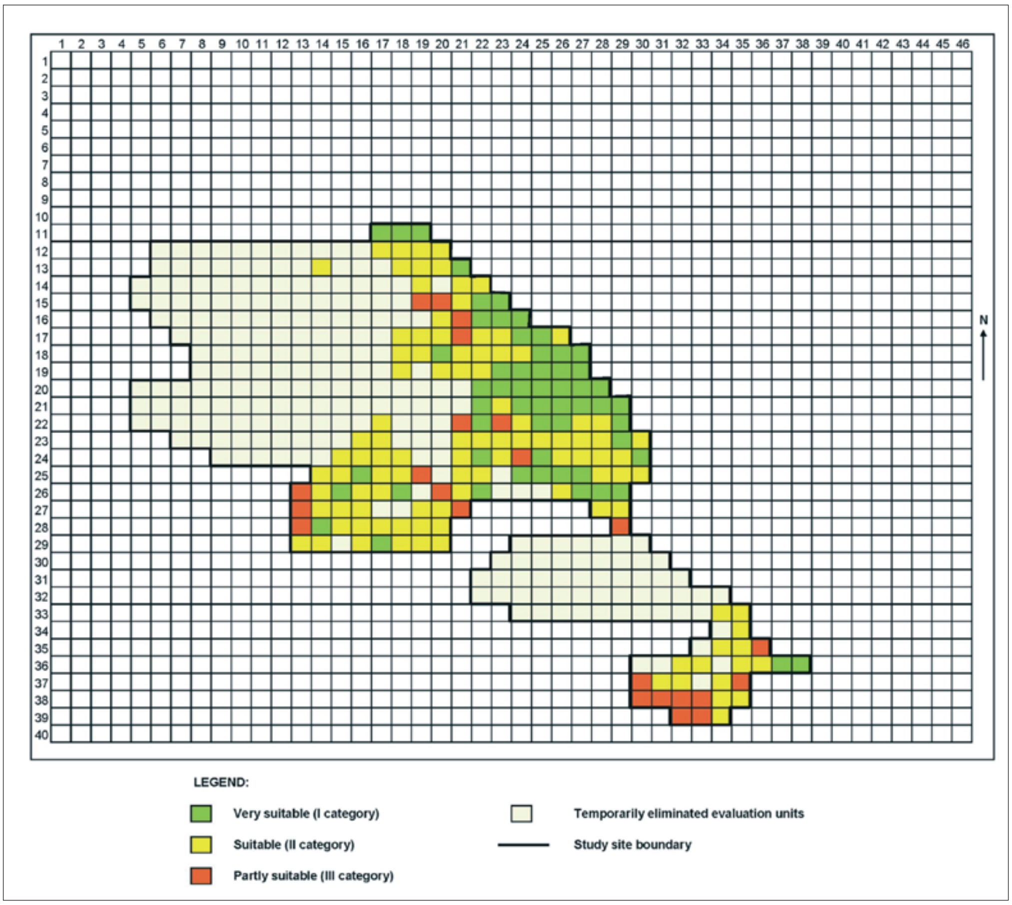

Fig. 8: II phase of evaluation – potential recreation zones on the study site in Kolubara

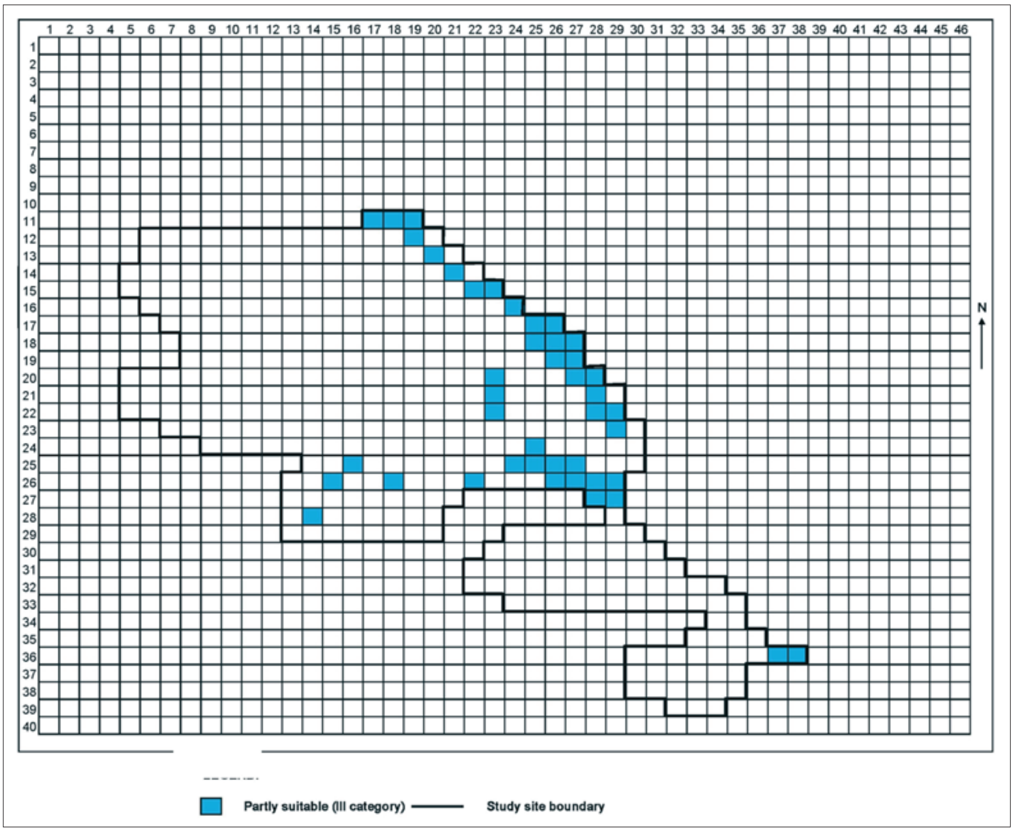

Fig. 9: III phase of evaluation – study site suitability for water recreation

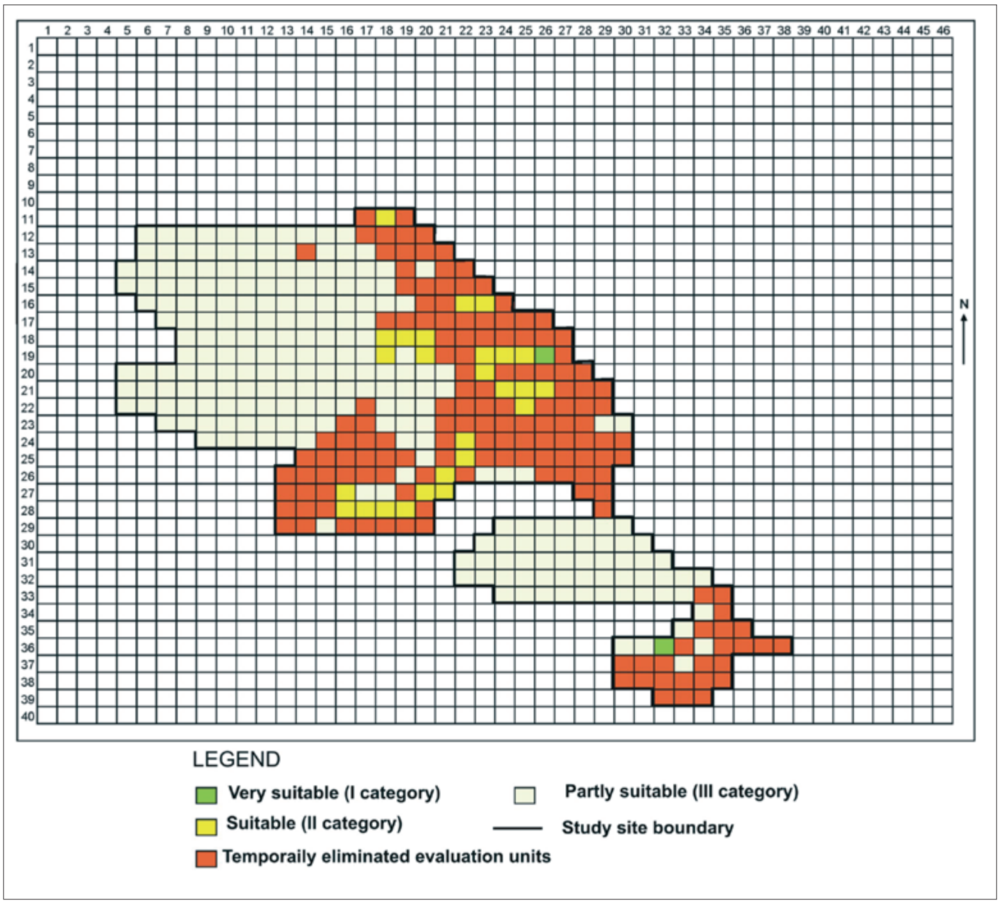

Fig. 10: III phase of evaluation – study site suitability for recreation in the landscape

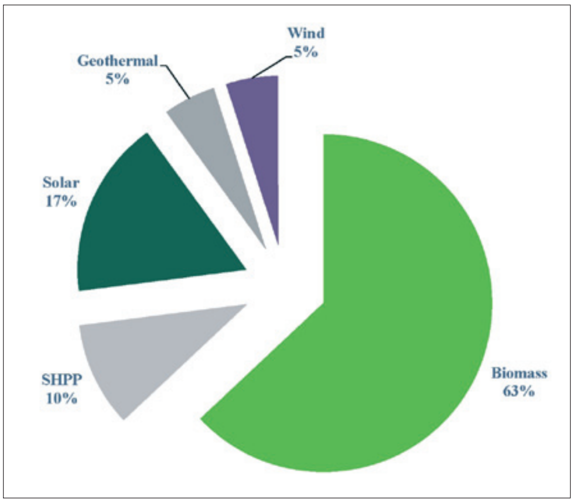

Fig. 13: Potential share of different forms of RES in Serbia

mł of wooden waste. There is an opportunity in Serbia for growing so called "energy forests" on the area of 200,000 ha of untilled land, on which fast growing forests could be planted and further used for energy purposes. The research has shown that 15 to 20 tons of wood biomass per hectare could be obtained per year, which is between three and four million tons of wood biomass. The use of biomass in Serbia has already found its application in heating households with the use of forest biomass briquettes and palettes.

4.5 Biomass production in short rotation plantations on overburden deposits (deposols)

Short rotation plantations for biomass energy production are one of the realistic alternatives, primarily because of their ecological advantages which are as follows:

- Renewable production,
- They emit very small amount of carbon into the atmosphere (1/10 CO_2 in comparison with other fossil fuels),

- Locally, the plantation can reduce the erosion process, provide funds for degraded land restoration, neutralize air pollution and local effect of fossil fuel energy production(for instance SO_2 and NO_x) and reduce further threat to existing woods,
- Different types of dendroflora can be used for a double purpose – biomass production and land decontamination from various pollutants – phyto-remediation,
- Woody plants account for 63% of the total number of short rotation plantations. Poplar trees, willows and alders dominate in moderate climate zones. They are characterized by annual productivity of more than 10–12 t/ha of dry wood and bark, relatively equal quantity of yield for energy capacity provision and cost of less than 50 $ per dry ton,
- For setting up a plantation, selected, fast growing types of trees are used, depending on local conditions – willows, poplar trees and others,
- They are characterized by very high planting densities (poplar trees 6–12,000 plants/ha, willows 10–12,000 plants/ha), and they are harvested every 3 to 10 years,
- In the USA and Europe, hybrid poplar trees and willows are in most cases more suitable than natural species in spite of the fact that some fast growing natural clones have been identified. In some moderate agricultural regions herbaceous crops, grass and others have been researched. One of the advantages of that type of crops is that they can be planted and collected by means of existing agricultural mechanization, without new investments into special forestry equipment,
- Topography, soil, humidity condition variations dictate to use a larger number of different plants in order to optimize sustainable production. From the ecology point of view, it is desirable to have mixed plantations with different types of trees, bushy and grass plants, since that type of plantation provides habitat for different animal and bird species. Besides woody plants, stands of grass, herbaceous, semi-herbaceous vegetable species, such as *Phragmites communis* or *Miscanthus* sp., which behave as long-lived species when planted for this purpose, can be set up, and
- Good plantations on good locations in tropical and moderate climate zones can achieve 2–10 times higher yield compared with natural forests.

Box 1: Legislative framework of renewable energy development in Serbia

There are several government institutions in Serbia responsible for development of renewable energy sources, including biomass – Ministry of Agriculture, Forestry and Waterpower Engineering, Ministry of Science and Technological Development, Ministry of Environment and Spatial Planning, Ministry of Mining and Energy, Ministry of Economy and Regional Development, Agency for Energy Efficiency and Regional Centers, Council for Sustainable Development, etc.

One of the EU membership requirements that Serbia has to comply with is adoption of a series of laws concerning environment protection, based on European standards and their implementation. Until now, Serbia has adopted a so called "Green Package of Laws" which includes the Air Protection Law, since, until recently, carbon dioxide emission in Serbia were double those of countries of similar gross national income.

The "Energy" legislative framework primarily refers to:

- Energy Law (2004);
- The Republic of Serbia Energy Development Strategy by 2015 (2005) which determines the following priority directions in this sector:
- Energy Development Strategy Implementation Programme of the Republic of Serbia 2007-2012 (2006), with amendments and supplements (2009);
- The Republic of Serbia has signed the Treaty of Establishing South-East Europe Energy Community and EU, by ratification of which it assumed the obligation of implementation of directives concerning increased use of renewable sources (2001/77/EC and 2003/30/EC), stating that 20% of the total energy production must be from renewable sources by 2020.
- The Kyoto Protocol Ratification (2007);
- Regulation on conditions concerning acquirement of the status of favoured electric energy producer and criteria for condition compliance assessment;
- Regulation on measures encouraging electric energy production by using RES and combined production of electric and thermal energy;
- The Republic of Serbia has become a founding member of the International Renewable Energy Agency (IRENA) on 26th January 2009, which is the first international (inter-governmental) organization focused exclusively on renewable energy and it will continue to participate actively in its work in accordance with the Agency Statute and its own interests in the area of activating and using renewable energy sources, and
- The Serbian Government has adopted the Regulation on measures encouraging electric energy production by using renewable energy sources and the combined production of electric and thermal energy. The policy of encouragement involves guaranteed purchase price for all electric energy produced in mini hydroelectric power plants, plants using biomass, wind power plants, solar power plants and power plants using biogas, waste or sewerage gas, in the period of 12 months after production start.

Although natural arable lands are most suitable for setting up plantations, lands with moderate limitations can be used, too, with previously resolved problems of water, erosion and lack of fertilizers.

Besides the biomass produced in forest cultures formed in the process of biological re-cultivation by afforestation, the research conducted in surface mine tailing ponds in Germany showed that, even under unfavourable soil conditions, the yield accounted for 5.2 to 19.6 tons of dry matter/ha at the age of four years. Biomass produced in this way is characterized by low concentration of heavy metals, high caloric value and favourable characteristics of ash with the high concentration of macronutrients. Use of ash for land improvement can recompense for the loss of soil nutrients after harvesting biomass. The experience from Germany and some other countries suggested the possibility for the establishment of the plantations of fast-growing woody species at the disposal sites of barren soil (deposols) of open-pit coal mines.

The Government of The Republic of Serbia, via The Ministry of Science and Technological Development, within the framework of the National Programme for Energy Efficiency, supported the projects EE273015 and TR18201 "Opportunities for biomass energy production from wood short rotation plantation within the framework of electro energy systems in Serbia", led by The Institute for Forestry – Belgrade, and with a collaborator, beneficiary and participant: P. K."Kolubara" and S. E. "Srbijasume", whose objectives and research content are the following:

- Biomass volume production increase in fast growing dendroflora plantations in surface coal mine tailing ponds in Serbia,
- Increased share of energy generated from biomass in our country and enabling partial fossil fuels substitution according to the Kyoto Protocol regulations, The Davos summit conclusions and other international treaties,
- Determining the ecologically and economically most suitable tree species,
- Determining optimal technologies for setting up plantations,
- Determining care, protection and supplementary nourishment measures with the aim to obtain the largest possible amount and best quality biomass,
- Determining the opportunities for use of waste mud from coal processing as a rational and accessible growth primer (fertilizers),
- Phyto-remediation of contaminated substratum,
- Determining the economically most acceptable solution,
- Employment of local inhabitants and surplus work force, which will emerge in the process of public company restructuring in the energy sector.

The successful biological recultivation in the Kolubara basin was conducted in the area of about 1,300 ha. Forest cultures of different coniferous and broadleaved species account for 75% of it. The species are very vital and show good growth and development despite the unfavourable site conditions (Dražić et al., 2006).

The research has shown that the potential of the expected production of air-dry biomass in Kolubara basin is very significant and it is estimated to be about 200,000 tons per year, i.e. over 1,200,000 tones in the six year rotation period (Dražić et al., 2005). The experimental plots (Figs. 14–17) with few species of dendroflora (*Populus* x *euramericana* cv. – poplar, *Salix* sp. – willow, *Pseudotsuga menziesii* Mirbel. Franco – Douglas fir and *Larix deciduas* Mill. – common larch, Tab. 3 and 4) have brought evidence to the fact that the establishment of energy plantations for the specific purpose, in which a significant biomass volume of good energy characteristics will be provided, is a feasible project.

Thereby, the production of dendro-biomass for energy will be unified in the influence zone of the open-pit mines of lignite coal, with the capacity of coal processing and thermal power plants, which is important both from the economic and ecological point of view.

There are significant tailing pond areas in Serbia which are not used at present. Similar new areas are created daily. These areas are located primarily within the surface lignite mines (Kolubarsko-tamnavski basin, Kostolački basin and others), surface non-ferrous metal mines, clay, stone and other raw materials exploitation sites. It has been estimated that, in Serbia, an area of approximately 1,000 km^2 will be degraded due to the exploitation of surface minerals and other raw materials. Part of these areas can be used for setting up short rotation plantations for energy biomass production. Lignite deposits in our country stretch across the area of more than 1,000 km^2 and account for 83% of the total reserve of fossil fuels energy potentials. However, due to the fact that it is non-renewable energy source, it is considered that we will exhaust the reserves of this potential in 50 years.

The present experience shows that in the process of the biological re-cultivation of tailing ponds, the ratio of forest to agricultural re-cultivation is most frequently 60:40, which means that in the final phase we can expect the forest ecosystems to be established on 600 km^2 while agricultural areas, urban ecosystems and infrastructure will cover 400 km^2 (Drazic et al., 2005). Taking into account the current experience concerning achieved production effect of ten year old forest cultures set up on deposol soils




Figs. 14, 15, 16, 17: Experimental plots with different fast-growing tree species on deposol in the Kolubara basin (photo D. Dražić)

Analyzed parameters		**Species**			
		Larix decidua	*Pseudotsuga menziesii*	*Populus sp.*	*Salix sp.*
Length of the above-ground part with the main sprout (cm)		60.0	55.0	351.0	276.0
Length of the above-ground part without the main sprout (cm)				326.0	
Length of the main sprout (cm)				24.0	
Length of the root (cm)		32.0	21.0	54.0	43.0
Diameter of the root collar (mm)		9.9	13.8	34.8	15.9
Mass of the above-ground part (g)	Stem	36.3	19.6	860.3	150.0
	Twigs			189.2	
	Leaves			485.3	20.7
	Leaves + twigs	144.0	62.8		
	Total	180.3	82.5	1534.8	170.7
Dry mass of the above-ground part (g)	Stem	11.8	6.5	447.7	80.7
	Twigs			86.7	
	Leaves			176.7	8.2
	Leaves + twigs	68.3	23.5	711.0	88.9
	Total	80.1	30.0		
Mass of the root (g)		46.7	35.2	523.0	41.7
Dry mass of the root (g)		13.9	9.4	246.3	22.2
Volume of the root (ml)		36.7	25.0	444.3	60.0

Tab. 3: Average values of above-ground part length, root collar length and diameter, mass of the above-ground part, mass and volume of the root and dry mass of the above-ground part of extracted seedlings two years after planting

Tree species and tree part	High and low heating value (MJ/kg) for the analyzed species			
	Laboratory values		Values according to literature data	
	High heating value	Low heating value	High heating value	Low heating value
Douglas fir stem	19. 288	18.313	19.18	15.20
Douglas fir needles with twigs	18. 752	17.827		
Poplar stem	17.443	16.468	17.26	13.52
Poplar leaves	17.329	16.404		
Willow stem	17.385	16.410	17.58	13.65
Willow leaves	18.044	17.119		
Common larch stem	18.927	17.952	16.98	14.86
Common larch needles	19.888	18.963		

Tab. 4: High and low heating value (MJ/kg) for the analyzed species

in external surface lignite mine tailing ponds in the Kolubara basin, in extensive plantations without prior technical re-cultivation and application of management measures, it is realistic to expect that the intensive plantations with the previously conducted technical re-cultivation, with the application of optimum agro-technical and agrochemical measures, with the spacing of plants 1.2 × 0.8 m in the short rotation of 6 years, would achieve total potential production of about 1,145,735 tone/year dry biomass on 6,000 hectares.

5. Conclusions

The study of potential uses of newly created landscapes and ecosystems after coal extraction by open-cast mining and after technical and biological recultivation by afforestation confirms the thesis on the feasibility of sustainable development (Dražić and Bojović, 2004).

The research has proven that it is possible to create multi-functional areas of anthropogenically formed aquatic and terrestrial forest – meadow and agricultural, multi purposed ecosystems rich in biodiversity and suitable, inter alia, for recreation and energy biomass production. Significant quantities of biomass can be produced in short rotation plantations on waste disposal sites with deposols (Drazic and Veselinovic, 2006). In this way, in the same space, sharing of production and human resources, integrated production and use of RES and NON-RES is possible.

The data presented above point to the significant, until now unused, woody biomass potential from the existing and future forest and non forest biomass resources, which could be used for energy purposes. Their share in the total energy potential could account for 25–40%, which could be exceptionally beneficial from the economic and ecological point of view, taking into account the fact that carbon dioxide (CO_2) emission in kg/kWh during burning of wood pellets is only 0.03 which is significantly less than coal (0.29) and other types of fuel.

Biomass is of outstanding importance for the Republic of Serbia since, apart from the fact that it represents environment-friendly fuel, which can make significant contribution to efforts aimed at CO_2 emission reduction, it is a renewable energy source, provided that the measures for sustainable forest management are applied. Its intensive use will contribute to decrease dependence on imported energy products and to ensure economic development in rural areas, which is of vital importance for every country.

According to the data from the Ministry for Mining and Energy, biomass could be the source of one fourth of the total energy produced in Serbia. If only one fourth of the above mentioned biomass (more than 2.8 million tons) were used for energy purposes, we would acquire energy that could satisfy all needs of low temperature energy stationed energy systems (heating, product finishing in processing plants, drying in smaller hothouses and others, even cooling machines), of the country's agricultural complex.

The adoption of the Regulation on measures supporting electric energy production from renewable energy sources and combined production of electric and thermal energy will significantly contribute to attract investments in this sector. For that reason, commercial banks, international financial institutions and state development funds are becoming involved in that issue by providing favourable credits.

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References:

AHHARACH, E. C., HARTMAN, R. T. (1973): Survival and growth of red pine on coal spoil and disturbed soil in western Pennsylvania. In: Hutnik, R. J. and Davis, G. [eds.]: Ecology and Reclamation of Devastated Land, Vol. 1. New York: Gordon and Breach, p. 429–444.

ANTONOVIĆ, G. (1980): Oštećenje zemljišta i problem njegove zaštite. Zemljište i biljka, Vol. 29, No. 2, p. 99–106.

BISMARCK, F. (2000): Reclamation of post-mining landscapes in Eastern Germany – The largest environmental protection project of Europe. Governmental Program for the Rehabilitation and Reclamation for East-German Lignite Mines, Berlin, Germany.

BUNGART, R., HÜTTL, R. F. (2001): Production of biomass for energy in post-mining landscapes and nutrient dynamics. Biomass and Bioenergy, Vol. 20, No. 3, p. 181–187.

BYRNES, W. R., MILLER, J. H. (1973): Natural revegetation of surface-mined coal land in southern Indiana. In. Hutnik, R.J., Davis, G. [eds.]: Ecology and Reclamation of devastated land. Vol.1. New York: Gordon and Breach, p. 285–307.

COMMITTEE on soil as a Resource in Relation to Surface Mining for Coal, Board on Mineral and Energy Resources, Commission on Natural Resources, National Research Council (1981): Surface mining: soil, coal, and society. Washington, D.C.: National Academy Press, 233 pp.

CVEJIĆ, J. (1989): Evaluation of Recreative Areas of Large Cities – Belgrade Area. Doctoral Thesis. Faculty of Forestry, University in Belgrade, Department of Landscape Architecture, 294 pp.

DIRECTIVES No. 2001/77/EC and 2003/30/EC

DRAŽIĆ, D. (2000): Polyfunctional evaluation of the landscape and ecosystems formed by the recultivation of minespoil banks of opencast mines in the Kolubara basin (in Serbian). Belgrade: Secretary of State, Environmental Department, 261 pp.

DRAŽIĆ, D. (2001): Role and significance of landscape architecture in the revitalization and modeling of spaces degraded by opencast mining. Third Balkan Scientific Conference: Study, Conservation and Utilization of Forest Resources, 2–6 October, Sofia. Proceedings, Volume III, p. 402–412.

DRAŽIĆ, D., BOJOVIĆ, S. (2004): Reclamation, revitalization, landscaping and multifunctional valorization of areas degraded by opencast coal exploitation in Serbia. Ecologia i industrija, Vol. 6, No. 2, p. 267–270.

DRAŽIĆ, D., JOVANOVIĆ, L., VESELINOVIĆ, M. (2005): Mining-energetic complexes and biomass production, Proceedings of the XXXII SYM-OP-IS, September 27–30, Vrnjačka Banja, p. 447– 451.

DRAŽIĆ, D., VESELINOVIĆ, M. (2006): Integral valorization of forests formed in the process of biological recultivation, Proceedings from the International Mining Symposium „Exploration, exploitation and processing of solid raw materials“, Dubrovnik, Croatia 8–10 November, p. 323–329.

DRAŽIĆ, D., VESELINOVIĆ, M., KATIĆ, M., GOLUBOVIĆ-CURGUZ, V., MIHAJLOVIĆ, D. (2006): Rehabilitation and Management of Landscapes Degraded by Opencast Mining, Proceedings from the Scientific Conference „Implementation of Remediation in Environmental Quality Improvement“, Belgrade.

DRAŽIĆ, D., VESELINOVIĆ, M., RATKNIĆ, M., RAKONJAC, L., (2007): Biological recultivation by the reforestation and arrangement of the areas degraded by the surface exploitation, In. Reforestation of the barrens and anthropogenically damaged soils. Belgrade: Institute of Forestry, p. 109–129.

DRAŽIĆ, D., VESELINOVIĆ, M., BATOS, B., RAKONJAC, Lj., ČULE, N., MITROVIĆ, S., DJUROVIĆ-PETROVIĆ, M. (2011): Energy plantations of dendroflora species on open-pit coal mines overburden deposits. African Journal of Agricultural Research, Vol. 6, No. 14, p. 3272–3283.

EDWARDS, P., LUKER, S. (2000): Biomass for the Post-Industrial Landscape. In: Pelkonen, P. et al. [eds.]: Woody Biomass as an Energy Source – Challenges in Europe. Proceedings, No. 39. Joensuu: European Forest Institute, p. 139-146.

Energy Development Strategy Implementation Programme of The Republic of Serbia 2007–2012 (2006), with amendments and supplements (2009).

FUNK, D. T. (1973): Growth and development of alder plantings on Ohio strip-mine banks. In: Hutnik, R. J. and Davis, G. [eds.]: Ecology and reclamation of devastated land, Vol. 1. New York: Gordon and Breach, p. 483–491.

HAGE, K., DREBENSTEDT, C., ANGELOV, E. (1996): Landscaping and Ecology In: The Lignite Mining Area Of Maritza-East, Bulgaria. Water, Air and Soil Pollution, 91, p. 135–144.

HAKKILA, P. (2000): Wood Energy in Nordic Countries. In: Pelkonen, P. et al. [eds.]: Woody Biomass as an Energy Source - Challenges in Europe. Proceedings, No. 39. Joensuu: European Forest Institute, p. 7–21.

HARFST, W. (1975): Bewertung natürlicher Gewässer für Erholungszwecke. Das Gartenamt, Vol. 24, No. 6, p. 351–357.

HILDMANN, E., WONSCHE, M. (1996): Lignite Mining And Its After-Effects On The Central German Landscape. Water, Air, and Soil Pollution, 91, p. 79–87.

HODGSON, D. R., TOWNSEND, W. N. (1973): The amelioration and revegetation of pulverized fuel ash. In: Hutnik, R. J., Davis, G. [eds.]: Ecology and reclamation of devastated land, Vol. 1. New York: Gordon and Breach, p. 247–270.

KASTNER, M., NAGL, H., POZAREK, W., WAHL, H., WALDER, R. (1982): Gutachten Landschaftsrahmenplan Region Wiener Neustadt, Modellstudie. Wien.

KIEMSTEDT, H. (1969): Bewertungsverfahren als Planungsgrundlage in der Landschaftspflege. Landschaft und Stadt, Vol. 1, No. 4, p. 154–158.

KOSTIĆ, N. M., WILSON, M. J., JAKOVLJEVIĆ, M. D., STEVANOVIĆ, D. (1996): Chemical and mineralogical studies of some Yugoslav Deposols in relation to their possible agricultural use. Journal of Environmental Science and Health. Part A: Environmental Science and Engineering and Toxicology. Vol. 31, No. 7, p. 1575–1594.

LIČINA, V., TRAJKOVIĆ, I., MARKOVIĆ, N., ATANACKOVIĆ, Z. (2012): Physico-chemical properties of sandy deposols and their convenience for grapevine growing. In: Proceedings of the 47th Croatian and 7th International Symposium on Agriculture, Opatija, Croatia, p. 766–769.

LINDLEY, G. F., MANSFILD, B. H. (1979): Opencast Coal Mining in Great Britain, Braunkohle. Heft 8, p. 230–234.

MEDVICK, C. (1973): Selecting plant species for revegetating surface coal mined lands in Indiana – a forty-year record. In: Hutnik, R. J., Davis, G. [eds.]: Ecology and reclamation of devastated land, Vol. 1. New York: Gordon and Breach, p. 65–80.

MILES, V. C., RUBLE, R. W., BOND, R. L. (1973): Performance of plants in relation to spoil classification in Pennsylvania. In: Hutnik, R. J., Davis, G. [eds.]: Ecology and reclamation of devastated land, Vol. 1. New York: Gordon and Breach, p. 13–31.

MRASS, W. (1974): Ermittlung von aktuellen und potentiellen Erholungsgebieten in der BRD. Bonn: Bundesforschungsanstalt für Naturschutz und Landschaftsökologie.

RUPPERT, K. (1971): Zur Beurteilung der Erholungsfunktion siedlungsnaher Wälder. Mitteilungen der Hessischen Landesforstverwaltung, Band 8. Bad Orb: Sauerländer Verlag, 142 pp.

SCHÖNEICH, R. (1972): Untersuchung zur Bewertung von Erholungsmöglichkeiten in der Schweriner Seenlandschaft. Geographische Berichte, Vol. 17, No. 3/4, p. 243–256.

STOJILJKOVIĆ, D. (2011): Potential of Biomass in Serbia. European Union Sustainable Energy Week, 11 April, Drustvo termicara Srbije, Belgrade: Energoprojekt Holding a.d. Oral presentation.

STRZYSZCZ, Z. (1996): Recultivation And Landscaping in Areas After Brown-Coal Mining In: Middle-East European Countries. Water, Air, and Soil Pollution, 91, p. 145–157.

SURFACE MINING: Soil, Coal, and Society: A Report prepared by the Committee on Soil as a Resource in Relation to Surface Mining for Coal (1981). National Research Council-National Academy Press, 2101 Connecticut Avenue NW, Washington, DC 20418, USA: xiii + 220 pp.

THE REPUBLIC OF SERBIA energy development strategy by 2015 (2005).

THE REPUBLIC OF SERBIA Energy Law (2004).

THURMAN, N. C., SENCINDIVER, J. C (1986): Properties, classification, and interpretations of minesoils at two sites in West Virginia. Soil Science Society of America Journal, No. 50, p. 181–185.

TUROWSKI, G. (1972): Bewertung und Auswahl von Freizeit regionen. Karlsruhe: Institut für Städtebau und Landesplanung der Universität Karlsruhe, 130 pp.

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METHODS OF DETERMINING LANDSCAPE FUNCTIONS AND THEIR EVALUATION: A CASE STUDY OF HUSTOPEČE, CZECH REPUBLIC

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Abstract

The determination and evaluation of landscape functions by means of the index of functions in space and time is discussed in this paper. The analysis and quantification of landscape functions on the basis of landscape structure changes (landscape categories) can be used as background data for proposals and implementation of long-term measures that are part of the proposal for complex land consolidation (CLC), and for proposals of changes in functional land use in land-use plans (LUP). The method of determination and evaluation of landscape functions is based on seeking a correlation between landscape structure and prevailing functions, and on an attempt to quantify temporal changes in landscape functions (similar to the quantification of changes in landscape structure). The Hustopeče study area was chosen for the analysis and evaluation of landscape functions.

Shrnutí

Metody stanovení krajinných funkcí a jejich hodnocení: případová studie Hustopeče, Česká republika

Předmětem příspěvku je stanovení a vyhodnocení funkcí krajiny formou indexu funkcí v prostoru a čase. Analýza a kvantifikace krajinných funkcí na podkladě změn krajinné struktury (krajinných kategorií) lze využít jako podkladu pro návrhy a realizace opatření dlouhodobého charakteru, která jsou součástí návrhu komplexních pozemkových úprav (KPÚ) a pro návrhy změn funkčního využití krajiny v územních plánech (ÚP). K analýze a hodnocení krajinných funkcí je vybráno modelové území Hustopeče. Metoda stanovení a vyhodnocení krajinných funkcí je postavena na hledání korelací mezi krajinnou strukturou a převládajícími funkcemi a pokusu o kvantifikaci proměn krajinných funkcí v čase (podobně jako kvantifikace proměn krajinné struktury).

Keywords: *Landscape structure, landscape function, index of functions, land use, Hustopeče, Czech Republic*

1. Introduction

Landscape structure has a crucial influence on landscape functional characteristics. Any change in the landscape structure – in space and in time – affects the flows of energy and material in the landscape, landscape crossing capacity and habitability, its ecological stability and other properties and characteristics. Landscape functions can be defined as a set of functional effects, needs and phenomena complementing or conditioning one another, which are required by the society or directly emanate from the landscape itself (Krečmer, 1994). Landscape has a number of irreplaceable functions for the human society (Hradecký, Buzek, 2001), while these functions have changed in their priorities with the development of the human society. The quantification of these functions is very difficult. Landscape functions complement and condition one another; they are closely connected with landscape structures (categories) and are provided energies that are necessary for their maintenance at places where they would be unsustainable according to the natural potential of the territory. In general, landscape functions are divided according to the actual sight of the landscape. In this project, the terminology of production, residential and recreational functions (Havrlant, Buzek, 1985) is used, while other authors speak about natural (climatic, geological, hydrological and biological) functions, socio-economic and cultural functions (secondary functions when humans suppress natural functions and prefer socio-economic functions, which has a negative impact both on the landscape and on the living environment). In connection with landscape functions, landscape structure can be defined as a set of landscape categories exerting a set of functional effects (Krečmer, 1994). Consequently, the spectrum of these effects should be specified in detail. The concept of functional objectives of the landscape may be determined by locality, i.e. "by a land charge" in the transferred meaning of the word, plans of land owners, designs of land-use planning documentation and government bodies. In general terms, the concept declared in a number of publications (Hradecký, Buzek, 2001; Demek, 1999) distinguishes two basic groups of landscape functions: natural functions (including natural processes creating conditions for life) and social and cultural functions (activities of humans exploiting the natural environment to their own benefits). In this context we speak about an economic function (including the production complex), ecological, recreational, cultural functions, etc. Some landscape functions cannot be quantified, e.g. the psychological function (Cílek, 2005).

The LANDEP method (Růžička, Miklos, 1982) is one of modern approaches to landscape evaluation and determination of its ecologically optimum use: it determines an optimum functional categorization of landscape based on a proposed grid of stable elements.

For our analysis and for the proposal of the evaluation of landscape functions we chose the classification of production and non-production functions (Tab. 1). Because we wanted to express functional effects, the landscape in our evaluation is considered a cadastral territory or a model territory in the wider sense of the word.

2. Material and methods

2.1 Data

Background data for the analysis of landscape functions were taken from the database of the multi-temporal analysis of landscape structures (Balej, 2006). The analysis consists in the evaluation of statistical

No.	Landscape function
1	production
2	ecological
3	hydrological
4	aesthetic
5	recreational
6	residential
7	others

Tab. 1: Selection of assessable landscape functions (the rank of selected functions corresponds to a certain extent with the assessment of functions according to available data)

and metric analyses (Godron, Forman, 1993) of three temporal horizons. The landscape structures are represented by classes of land use/land cover (LU/LC) of three temporal horizons (1st half of the 19th century and aerial photographs from the 1960s) and at the present (orthophotos from 2006). The database of the multi-temporal analysis of LU/LC was elaborated in 2010–2011.

Landscape functions must be interpretable from the local to the regional perspective not only for the purpose of appropriate planning and management but also to enable the assessment of sustainable landscape development (Bastian et al., 2006).

2.2 Study area

The Hustopeče study area includes seven cadastres. The area of this territory is 9,237.9 ha and it is an intensively farmed landscape in southern Moravia with dynamic natural conditions.

In the study area, the functional use is predetermined by natural conditions, land use intensity in the last century and particularly by current requirements. It is necessary to conserve the landscape character and to increase the fineness of the grid of landscape segments.

A suitable procedure allowing the descriptive demonstration of actual land use and assertion of priority interests is variant visualization (3D visualization of landscape segments) when the necessary priorities of functional land use are projected into a new spatial landscape arrangement (Griffon, Nespoulous, Cheylan et al., 2011).This procedure will be applied at the end of the project to formulate the principles of preferable functional land use according to requirements for land use priorities (infiltration territory, nature conservation, etc.).

2.3 Evaluation of landscape functions

Many users and institutions participate in using the landscape (and/or the agricultural landscape). Using the multi-criterial analysis, a design of the optimum land use should be developed before a decision on land use is made. There are relatively few projects solving land use optimization because most frequently the essential data are missing (Assfalg, Werner, 1992). In other countries, optimization models are mainly used to address ecological and economic objectives (Centre of Common Research on Environment and Friendly Use of Agricultural Landscape at the University of Hohenheim).

Landscape functions can be evaluated either in absolute values of land use when one main function (hydrological, ecological, production, recreational, aesthetic) is assigned to each category or by means of an index of functions when a certain weight (level) of the function concerned is assigned to each category of LU/LC (see below).

In this project, production and non-production functions are defined as follows:

- Agricultural production (arable land, cultivated meadows, intensive orchards and vineyards),
- Forest stands of spruce monocultures,
- Extraction of raw materials (quarries).

Non-production functions:

- Ecological function – the selection of landscape categories corresponds with the methodology for the determination of ecological stability coefficient – ESC (Míchal, 1985), the ecological function is represented by stable landscape segments (stable landscape structures – forests with natural species composition, pastures, scattered green vegetation, bodies of water, riparian stands, etc.),
- Hydrological function (bodies of water, water-courses, soil-conservation measures – balks),
- Aesthetic function – corresponds with the frequency of the occurrence of landscape categories that improve landscape impressiveness; in general, the criteria of landscape evaluation are based on the assessment of terrain slope, heterogeneity of the vegetation cover, representation of landscape elements, anthropogenic activity and its influence on the landscape both in positive and negative sense (Stejskalová, 2007), (in this project, the selection and assessment of landscape elements were simplified to the representation of linear green vegetation, scattered green vegetation, natural forest stands, bodies of water, water-courses, solitaires, certain spatial arrangement of landscape structure), and
- Recreational function (in fact all stable landscape structures, bodies of water).

2.4 Determination of the level (weight) of particular landscape function

To a selected category of LU/LC, a function fulfilled by this category will be assigned. However, this model is not applicable in practice, in a specific landscape. Each category in the landscape (if it is not fully supported and maintained anthropogenically, e.g. arable land) always fulfils several functions. for example, the production function it may fulfill the ecological function (permanent grassland, extensive orchard), the hydrological function (body of water) and may overlap with the landscape-aesthetic function (natural water-course with riparian stands), and some functions cannot be quantified at all, e.g. the psychological function in the landscape concept as our home or the space of our existence.

Level	Weight of evaluated function	Description
Level A	1.00	Landscape category fulfils one function
Level B	0.75	Landscape category fulfils two functions
Level C	0.50	Landscape category fulfils another function besides two functions
Level D	0.25	Landscape category fulfils more than 3 functions

Tab. 2: Determination of the level (weight) of landscape functions

Due to time consumption and costly database construction, three temporal horizons were selected (stable cadastre – 1st half of the 19th century, aerial photographs from the 1960s and contemporary orthophotos). LU/LC classes were determined based on the analysis of these data. This selection corresponds to the landscape use under feudalism, in the socialist era and under present market economy conditions. The stable cadastre provides information on landscape that was not yet affected by significant changes. Processes and impacts that resulted from a radical change in land use were already significant in the 1960s. In the 1990s, tendencies to remedy the past radical interventions continued; however, they currently bring about many negative trends (unification of agricultural landscape, building up of open space, etc.).

The following is an example of the evaluation and determination of function levels for landscape classes of stable cadastre: *arable land* – fulfils production function (level A); *vineyards* – fulfill production function (level A), on other levels they fulfill hydrological (level B), ecological (level C) and aesthetic (level D) functions; *gardens* – production (level A), ecological (level B) functions; *fruit orchards* – production function (level A); *permanent grasslands* – production (level A), hydrological (level B), ecological (level C) functions; *wetlands* – ecological (level A), hydrological (level B) functions; *forests* – ecological (level A), hydrological (level B), production (level A) functions; *bodies of water* – hydrological (level A), ecological (level B), production (level C) functions; *built-up areas* – residential functions (level A); *other areas* – other functions (level A); *scattered vegetation* – production (level A), ecological (level B) functions; *balks* – hydrological (level A), ecological (level B) functions; *quarries* – economic function (level A).

3. Results

Based on the evaluated landscape categories, selected landscape functions and determined levels of respective functions, the quantification of functions was performed by means of the index of functions and the intensity of the functional land use in the study area was evaluated.

3.1 Determination of indices of landscape functions (LF index)

Identical landscape categories (e.g. forest) do not always fulfill the same functions in each landscape (and at each time). For this reason, it is necessary to determine what "functional weight" is represented by a specific LU/LC category in a specific territory at a specific time.

The LF index is a unique value. In the study area, each LU/LC element is assigned a "weight" (level) of the function (see Tab. 2) – hence each category may fulfill up to four functions at the same time. The LU/LC areas with the same function (always within one level) are summed up and their proportion in the total studied area is calculated.

The proportion of each function is multiplied by the coefficient of weight (see Tab. 3). The weights of the coefficient were determined to be 1.0 for level A (i.e. prevailing – dominant function), 0.75 (for level B), 0.50 (for the third most important function – level C) and 0.25 (for the fourth most important function level D).

To calculate the index of landscape functions, the representation of selected functions in absolute areas (in hectares) was used. The areas of LU/LC with the same function are added up (always within one level). The total area of a given function (within a particular level) is multiplied by the respective coefficient. The results are added up and divided by the total area of the territory.

Formula for the calculation of the index of landscape functions – LF Index – see bellow (Formula 1).

Trends of the functional use of the territory will be expressed using the indices of landscape functions determined in different time periods. Determination of the indices of chosen functions:

Index $LF_{production}$ = [(5925.6 × 1) + (2307.4 × 0.75) + (0 × 0.50) + (503.6 × 0.25)] / 9266.9 = **0.840**

Index $LF_{ecological}$ = [(569.2 × 1) + (568.7 × 0.75) + (813.2 × 0.50) + (1786.8 × 0.25)] / 9266.9 = **0.200**

Formula 1

$$LF\ index = \frac{(LF_{level}\ A \times 1) + (LF_{level}\ B \times 0.75) + (LF_{level}\ C \times 0.50) + (LF_{level}\ D \times 0.25)}{total\ area\ of\ territory}$$

LU/LC	mid-19th century				1960s				2006			
	level*				level				level			
	A	B	C	D	A	B	C	D	A	B	C	D
Arable land	1	-	-	-	1	-	-	-	1	-	-	-
Vineyards	1	3	2	4	1	3	2	4	1	-	-	-
Gardens	1	2	3	4	1	3	2	4	2	1	3	4
Fruit orchards	1	2	3	4	1	3	2	4	1	-	-	-
Permanent grassland	1	3	4	2	3	1	2	4	3	2	4	1
Wetlands	3	2	4	-	2	3	4	-	2	4	3	-
Forests	3	1	2	4	1	3	2	4	1	3	2	4
Bodies of water	3	1	4	2	3	2	1	4	3	1	5	2
Built-up areas	6	1	-	-	6	1	-	-	6	1	-	-
Other areas	7	-	-	-	7	-	-	-	7	-	-	-
Scattered vegetation	1	4	2	3	2	4	2	1	2	5	4	3
Balks	3	4	1	2	3	4	2	1	3	2	4	-
Quarries	1	-	-	-	1	-	-	-	1	-	-	-

Tab. 3: Determination of the level (weight) of some functions for individual LU/LC classes. The numbers designate the functions listed in Tab. 1

** The evaluation of the above-mentioned functions in the period of stable cadastre is a theoretical problem but it is of significance as a comparative base for the evaluation of other periods. The LU/LC classes listed in Tab. 3 represent the result of unified legends from the period of stable cadastre, the 1960s and the present time. Other areas represent segments that cannot be included among other ones, neither is it possible to determine their functional use. Scattered vegetation represents alleys of trees, solitary trees, groups of trees and shrubs.*

3.2 Index of production land use

The Index of production land use (PLU) is absolute (dimensionless) value that is determined as a quotient of landscape categories fulfilling the production function and lands fulfilling non-production functions. It expresses the summarized evaluation of functional land use based on the representation of different landscape segments bearing different functional use on different levels while the production, hydrological and ecological functions are investigated in particular (i.e. functions that are significantly indicative of stability and/or non-stability of a particular territory at the present time). It is expressed by the indices of functions (Tab. 5) and is applicable to the assessment and comparison of trends of production use in various territories. Index PLU is expressed in the following form:

$$\mathbf{PLU} = LF_{production} / (LF_{hydrological} + LF_{ecological} + LF_{aesthetic} + LF_{recreational} + LF_{residental} + LF_{others})$$

Landscape function	area (ha)			
	level A	level B	level C	level D
production	5,925.6	2,307.4	0.0	503.6
ecological	569.2	568.7	813.2	1,786.8
hydrological	2,355.5	813.2	132.0	437.2
aesthetic	0.0	0.0	1005.9	945.2
recreational	0.0	437.2	1,786.8	0.0
residential	388.6	0.0	0.0	0.0
others	28.1	0.0	0.0	0.0
Total area	**9,266.9**			

Tab. 4: Proportions of selected functions and their levels (Hustopeče microregion, 2006)
Note: Method of calculation: LU/LC classes representing production function (No. 1) on level A are determined from Tab. 3. Areas of these classes (in ha) are added up. The addition gives a total area of the production function on level A (LU/LC: arable land, vineyards, fruit orchards, forests, quarries, etc.). Values for all functions on all levels are calculated in this manner.

where
- PLU < 1 – non-production landscape functions prevail (landscape categories fulfilling other functions in the landscape than production ones are dominant)
- PLU = 1 – balanced level of production and non-production landscape functions (landscape categories fulfilling non-production and production functions are in equilibrium)
- PLU > 1 – production landscape function prevails (landscape categories fulfilling mostly production functions are dominant)

3.3 Analysis of landscape functions in the study area

The Hustopeče study area includes 7 cadastral areas in southern Moravia and its total area is 9.2 km^2. The LU/LC evaluation was followed by the assessment of functional land use based on the LF index.

Evaluation based on the indices of functions (Tab. 7)
- 94–84% of landscape categories fulfill production function,
- Production function is a priority, but it shows a downward trend,
- 28–19% of landscape categories fulfill ecological function,
- Ecological function shows a downward trend all the time (regardless of the construction of hydrological structures),
- 39–34% of landscape categories fulfill hydrological function (the decreasing trend from the first half of the 19th century was stopped by the construction of the Nové Mlýny Water Reservoir in the Hustopeče micro-region),

PLU	Prevailing land use
< 0.5	Exclusively non-production land use
0.5 – 1.0	Non-production or production land use
1 – 1.5	Production land use
1.5 >	Exclusively production land use

Tab. 6: Determination of production land use intervals based on the indices of landscape functions

1825		1968		2006	
Landscape function	LF index	Landscape function	LF index	Landscape function	LF index
production	0.937	production	0.872	production	0.840
ecological	0.190	ecological	0.282	ecological	0.200
hydrological	0.386	hydrological	0.338	hydrological	0.339
aesthetic	0.170	aesthetic	0.136	aesthetic	0.080
recreational	0.000	recreational	0.000	recreational	0.132
residential	0.021	residential	0.035	residential	0.042
other	0.003	other	0.001	other	0.003

Tab. 5: Indices of landscape functions in the Hustopeče microregion in selected temporal horizons

- Aesthetic function shows a downward trend,
- Recreational and residential functions show a continually upward trend,
- Other functions are difficult to evaluate.

3.4 Comparison of the functional use of model territories according to PLU

From Table 8 the following inferences can be made:

- Study area has been used for production purposes since the first half of the 19th century,
- Obvious downward trend of production land use (by 0.16) related to the development of non-production functions (mainly hydrological, ecological, etc.),
- If the first half of the 19th century is taken as the initial period, a change by 13.1% in the correlation between production function and non-production functions occurred in the region.

4. Summary

Research on correlations between the landscape structure and the functional use of agricultural landscape was conducted in the study area for two years. It is a part of the five-year project of Research Plan MZE0002704902 Integrated Systems of Soil, Water and Land Conservation and Use in Agriculture and Rural Development. Only partial results are presented; nevertheless, they can be applied as

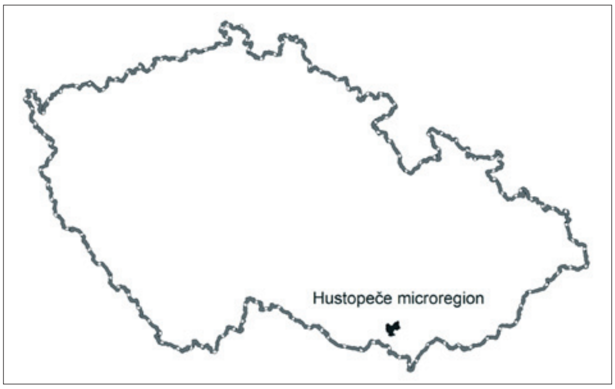

Fig. 1: The study area in the Czech Republic

Landscape function	1825	1968	2006
production	0.937	0.872	0.840
ecological	0.190	0.282	0.200
hydrological	0.386	0.338	0.339
aesthetic	0.170	0.136	0.080
recreational	0.000	0.000	0.132
residential	0.021	0.035	0.042
other	0.003	0.001	0.003

Tab. 7: Indices of landscape functions in the Hustopeče micro-region

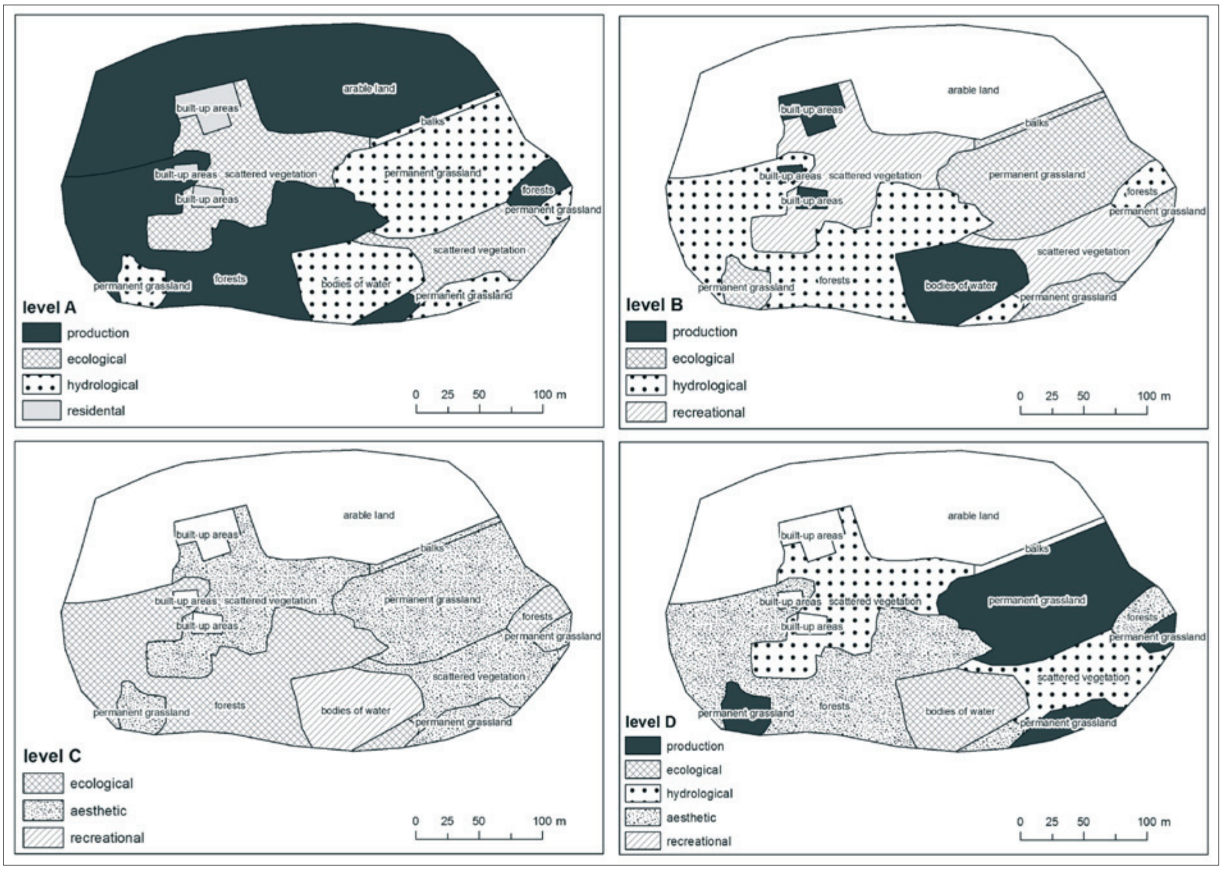

Fig. 2: Example of functional land use evaluation in a part of the study area (Hustopeče micro-region, 2006)

background data for proposing an optimization model of landscape structure and functional use of the study area. The functional use of the study area will be defined to propose optimization on the basis of preferable needs of land conservation. The analyses of landscape structure document that the landscape in the study area has undergone high unification, geometrization and reduction of grid fineness. Since the 1960s, the Hustopeče micro-region has moved into the category of coarse-grained landscape. In the distribution of the present landscape categories, it is very difficult to trace the original spatial arrangement.

Hustopeče micro-region	1825	1968	2006
PLU	1.22	1.10	1.06

Tab. 8: Production land use in the study area

The analyses of landscape functions illustrate the fact that the correlation between landscape category and function does not show direct proportionality. The Hustopeče micro-region has always been used for production purposes. Non-production landscape functions cannot be increased only by the large-scale extension of the proportion of landscape categories fulfilling the non-production functions (i.e. quantitatively), but their spatial arrangement and quality are very important (naturalness), too. A decrease in the production function by 5–10% and an increase in non-production functions by 10% would contribute to the balanced functional land use (to landscape stability). For the evaluation of the functional land

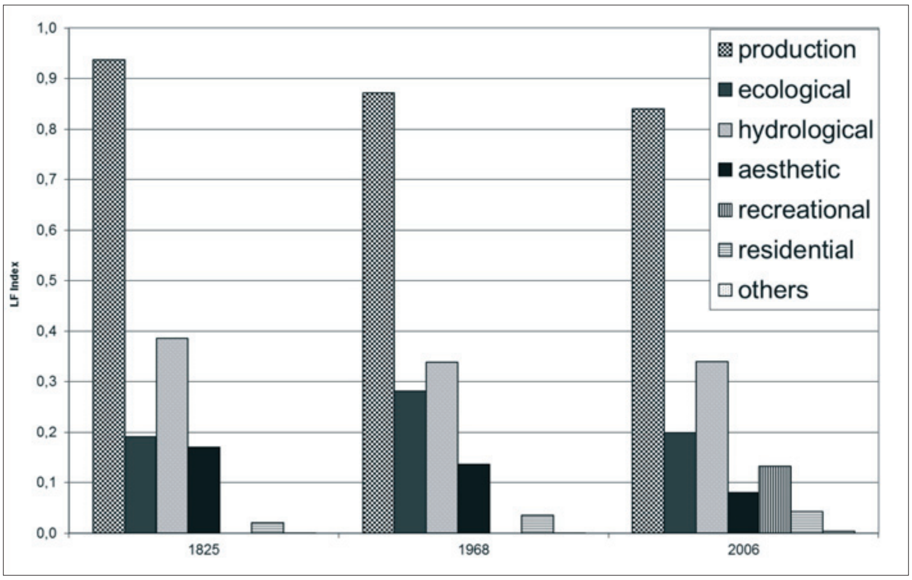

Fig. 3: Indices of functional land use in the Hustopeče micro-region at three temporal horizons (Tab. 7)

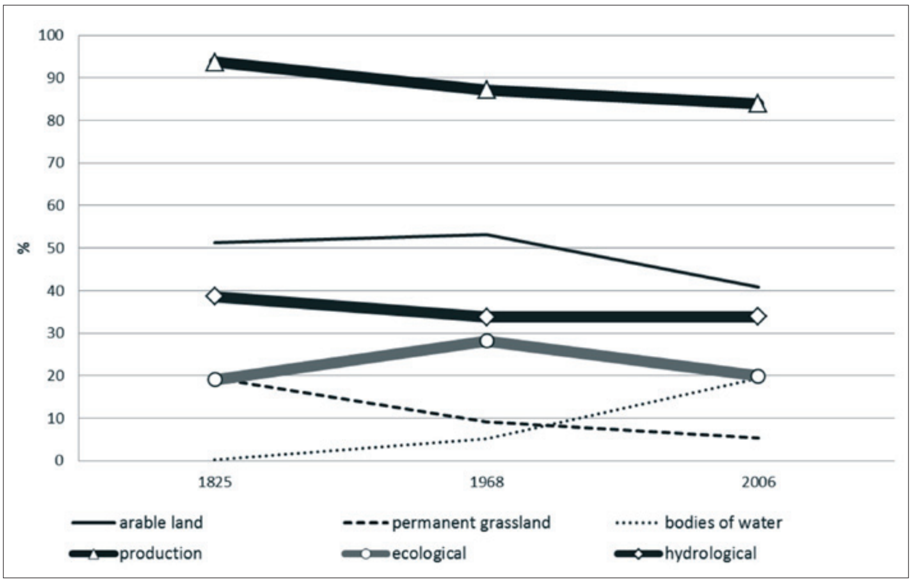

Fig. 4: Correlations between selected LU/LC classes and prevailing functions (Hustopeče micro-region)

use, it is more appropriate to use the index of functions rather than the evaluation according to one (dominant) function. In spite of all above-mentioned evaluations, it is to state that the economic pressure from the sixties has receded in favour of the non-production land use.

Changes in landscape categories representing non-production functions have the lowest influence on functions. Although there have been changes in the structures representing non-production functions in the study area, their influence on selected functions is not identical. The ecological function does not show an upward trend. To improve this function, more complex changes in landscape structure are necessary (mainly changes in the size and spatial arrangement of landscape categories

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References:

ASSFALG, W., WERNER, R. (1992): The optimal use of agricultural landscapes. In: Berichte uber Landwirtschaft, SEP, Vol. 70, No. 3, p. 358–386.

BALEJ, M. (2006): Indices of anthropopressure multifunctional and sustainable landscape. Geografické informácie 9, Zborník abstraktov z XIV. Konferencie Geografické aspekty stredoeurópskeho priestoru. Nitra, SR. 15 pp.

BASTIAN, O., KRONERT, R., LIPSKÝ, Z. (2006): Landscape diagnosis on different space and time scales – a challenge for landcape planning. Landscape ecology, No. 21, p. 359–374.

CÍLEK, V. (2005): Krajiny vnitřní a vnější. Dokořán, 269 pp.

DEMEK, J. (1999): Úvod do krajinné ekologie. Scripta. UP Olomouc, 102 pp.

DEMEK, J. (1999): Krajinná ekologie a geoekologie na přelomu tisíciletí. In: Geografie XI. – sborník prací Pedagogické fakulty Masarykovy univerzity. MU Brno, p. 25–32.

GODRON, M., FORMAN, R. (1993): Krajinná ekologie. Academia AV ČR, 583 pp.

GRIFFON, S., NESPOULOUS, A., CHEYLAN, J. P. et al. (2011): Virtual reality for cultural Landscape visualization. NOV, Vol. 15, No. 4, p. 279–294.

HAVRLANT, L. (1985): Metody v geomorfologii. PF Ostrava, 155 pp.

HRADECKÝ, J., BUZEK, V. (2001): Nauka o krajině. Ostravská univerzita, 215 pp.

KREČMER, V. (1993): Trvale udržitelný rozvoj a lesní hospodářství v České republice. VÚLHM.

KREČMER, V. (1994): První veřejná služba pro stabilitu kulturní krajiny. In: Eko – ekologie a společnost, Vol. 5, No. 4, p. 9–12.

MÍCHAL, I. (1985): Ekologická stabilita. Veronica, Brno, 212 pp.

RŮŽIČKA, M., MIKLOS, L. (1982): Krajinoekologické plánovanie – LANDEP 1. Biosféra. 120 pp.

RŮŽIČKA, M., MIKLOS, L. (1982): Ekologické plánovanie krajiny. VŠLD, 102 pp.

STEJSKALOVÁ, D. (2007): Funkčně-estetické hodnocení krajiny. MZLU, Vol. LV, No. 5, p. 155–164.

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SEARCHING FOR THE TERRITORIAL SHAPE OF A REGION IN REGIONAL CONSCIOUSNESS: THE ČESKÝ RÁJ (BOHEMIAN PARADISE), CZECH REPUBLIC

Michal SEMIAN

Abstract

The concept of "region" as a social construction is discussed in this paper, as well as the question of how such a conceived region can be defined. The discourse of different territorial delimitations and mental maps of respondents are used in a case study of Český ráj (Bohemian Paradise). With these methods, we are able to prove the possibility of defining a region and its loose boundaries through exploring regional identity.

Shrnutí

Hledání územního tvaru regionu ve vědomí obyvatel na příkladu Českého ráje, Česká republika

Tato studie se zabývá konceptem regionu jako sociální konstrukce a klade si otázku, jak je možné takový region definovat. V případové studii regionu Český ráj využívá diskurzu různých územních vymezení a mentálních map respondentů. Použitím těchto metod prokazuje možnost vymezení regionu a jeho volných hranic prostřednictvím regionální identity.

Keywords: *new regionalism; boundaries; regional identity; cognitive maps; Český ráj (Bohemian Paradise), Czech Republic*

1. Introduction

In relation to the transformation of subject orientation in humanities-focused geographic studies, the topics of region, regional identity, and identity of region have been in the forefront of interest since the 1980s (e.g. Pred, 1984; Paasi, 1986; Allen, Massey, Cochrane, 1998; Raagmaa, 2001; Hampl, Dostál, Drbohlav, 2007). Czech social geography has thus far focused mainly on socio-geographic regionalization (Hampl, 2005).

Defining regions on the bases of the consciousness of belonging, or regional identity, has come to the forefront of interest for Czech geographers in recent years (Chromý, 2003b; Chromý, Janů, 2003; and in relation to border regions Siwek, Kaňok, 2000; Siwek, Bogdová, 2007; Chromý, Skála, 2010). Last but not least the contemporary literature focuses on the significance of regional identity for regional development (Raagmaa, 2002; Frisvoll, Rye, 2009). A strong feeling of belonging to a certain territory may provide significant activation to a local community and encourage regional development "from below".

In this study we deal with the concept of region as a social construction and with the question of how such a conceived region can be defined and whether this is possible on the basis of self-identification and consciousness of belonging and community. In relation to regional development in the post-socialist period, methods for activating society are searched. Collective consciousness of belonging to a certain territory has a significant influence on activating society. In order to strengthen it, old regional identities, or modifications thereof, are used, which at the same time results in the development of entirely new identity. In the post-socialist Czechia, alternatives to regional development are constantly being sought. Recently in this regard there has been great emphasis on strengthening the regional identity of inhabitants as a tool for their activation. Very old identities whose traditions reach back to the 19th century are used for this purpose. For this case study we chose the Bohemian Paradise region. This region is culturally defined by strong regional identity and strong identity of region (Jeřábek, 2005; Semian, 2010).

The name "Bohemian Paradise" is used by many formal and informal bodies in the area. Thus, boundaries of the region are relatively vague and of rather zonal nature. The aim of this study is to compare the territorial delineation of the Bohemian Paradise based on the discourse analysis of academic and popular literature as well as on the analysis of the consciousness of the inhabitants. We are interested in the question whether these individual definitions correspond to each other and to what extent are the current definitions of the Bohemian Paradise reflected in the consciousness of its inhabitants. Considering the zonal nature of the region's boundaries, it can be assumed that we will not be able to define a single boundary, but several wider and variously important "loose" boundaries instead. At the same time, it can be assumed that for mental maps the importance of each boundary definition further away from the historical core of the region will be lower, but that the discourse analysis does not necessarily have to yield the same results. We also make an assumption that in defining boundaries, formal boundaries will be above all reflected in the sense of Paasi (1986), as fully institutionalized regions bearing the name Bohemian Paradise; the longest functioning of these boundaries contains the Bohemian Paradise protected landscape area.

Furthermore, we will be interested in how the resulting mental maps of different types of respondents differ. It is our assumption that officials from the regional authority will include under the name Bohemian Paradise a larger area than other respondents, as it can be expected that in their mental maps of the Bohemian Paradise, the formal administrative borders will be reflected as in their line of work because they regularly deal with them.

2. The conceptualization of region

The "region", just like the concepts of "place" and "space", is one of the basic concepts of geography. Most often regions are understood to be "areas or zones of indeterminate size on the surface of the Earth, whose diverse elements form a functional association; one such region as part of a system of regions covering the globe; or a portion of one feature of the Earth" (Gregory et al., 2009, p. 630).

Since the 1980s, there have been attempts in regional geography to shift away from such purely descriptive approaches to the study of "invisible" phenomena and connections. This movement in geography is often labelled as "new" regional geography (e.g. Paasi, 1986; Gilbert, 1988; Claval, 2007), or "new" regionalism (e.g. Fawn, 2009). The concept of regional homogeneity is also questioned (Hampl, Ježek, Kühnl, 1978). In the 1990s, the discussions of "new" regional approaches were driven mainly by the processes of globalization and integration and the paradigm of the "Europe of regions" (Keating, 1998; 2004; Paasi, 2009). Therefore, many "new" concepts and understandings of region have appeared during this period. On the other hand, there is a common basis of these "new" concepts: understanding a region as a "social construction" (Paasi, 2010). This allows for the reproduction of social forms, the formulation of the biographies of individuals, and the transformation of natural and landscape components (Pred, 1984; Paasi, 1986; Allen, Massey, Cochrane, 1998; Heřmanová, Chromý et al., 2009). Whereas the regionalism of the 1990s was mainly connected with formal inter-state regional organizations focused on economic integration, the contemporary regionalism should go beyond these and try to emphasize social, political and cultural dimensions of the region as well (Claval, 1987; Paasi, 2009).

Following many other scholars, Fawn (2009) warns of the fragmentation and division within the "new" regionalism and states that a widely accepted definition of it is still missing, despite many scholars call for it in their papers. On the other hand, it is also possible to state that there is not only one regionalism, simply because approaches differ among sciences (geographers see the region typically as a sub-state category while political scientists and economists as a supra state; Paasi, 2009). Therefore, the effort should be turned to setting an order among the different approaches. Schmitt-Egner (2002) brings one such attempt and defines different types of regionalism through a combination of two regional dimension: region as an action unit (vertical division, typical for political scientists) and region as an action space (horizontal division, typical for geographers).

As mentioned above, the unifying basis of the "new" approaches is region as a "social construction". Thus, regions connect individual and institutional spheres (Pred, 1984) and initiate civic activity and at the same time are created by the activities of the inhabitants. These activities may be of generative, reproductive or transformative nature, as long as they are in the consciousness of local or other inhabitants or as long as they play a role in public space or governance (Paasi, 2002). If regions stop existing in the consciousness of their inhabitants and stop playing a role in public life, they disappear even despite objective preconditions for their existence (Siwek, Bogdová, 2007; Chromý, Kučerová, Kučera, 2009). On the other hand, these regions should remain as residual or historical entity in the regional system (Paasi, 2010) and can be revitalized through the mobilization of identity. Regions therefore do not last forever. Raagmaa (2001) outlines two forms of the development of regions (Fig. 1). The first form is constant renewal. This involves constant natural or artificial changes in the physical appearance of a territory (landscape, boundaries, etc.). These changes are reflected in constant transformations of symbolic and institutional shape. The second form is disappearance of a region. This form relates to fundamental intervention from without (e.g. invasion, war, etc.), which results in changes in the population with different values and ethos. This climaxes in significant changes in the regional institutional framework and in symbols, and thus a "new" region is formed, as the "old" disappears. Thus, regions are dynamic; they are a constantly changing element of the spatial structure of the society.

The process of the development of a region, wherein a region is created, exists for some period, changes and then disappears, can be called "the institutionalization of a region" (Paasi, 1986). The institutionalization of a region is a historically contiguous process (Paasi, 1986), which means that once a region acquires a place in the regional system and the regional consciousness it becomes a part of the reproductive and transformative process of society. Regions thus influence and are at the same time influenced by political, economic, social and cultural processes, i.e. by the basic mechanisms of all societal changes. Paasi (1986) defines four phases of the process of the institutionalization of regions (Fig. 1) as follows:

1. The assumption of the territorial shape of a region,
2. The development of the symbolic shape of a region,
3. The development of regional institutions (institutional shape), and
4. The establishment of region as a part of a regional system.

The order of these phases is purely theoretical. In practice, these phases can take place simultaneously or in a different order, which varies according to the different purpose (type) of region (Schmitt-Egner, 2002; for more about the individual phases see e.g. Chromý, 2003a).

The fourth phase gives the power to the region to reproduce „itself" (Paasi, 2010). The most formal manifestation of the fourth phase is when a region gains an administrative function in the system. Acquiring an administrative function does not necessarily have to be the most important and most effective step towards renewal of a region. The acknowledgement of the region in the regional consciousness of its inhabitants is a more important manifestation. Thus it is the fourth phase that combines the institutional and individual spheres of the region. In this respect it takes place in all phases, and is created by them and at the same time contributes to their formation. According to Paasi (1986), it is this fourth phase that de facto gives the region an identity. Acquiring a regional identity is thus an essential condition for the existence of a region.

In this study we recognize regional identity as two connected parts: identity of region and regional consciousness of inhabitants (Paasi, 1986). The first one can be understood as a region image projected both inside and outside the region. The regional consciousness of inhabitants is collective sense of belonging to region (regional community). Thus, regional identity contains natural, cultural and historical as well as emotional, social and cognitive dimensions. Together these dimensions constitute the potential of region in the context of regional development (Schmitt-Egner, 2002). That is why the

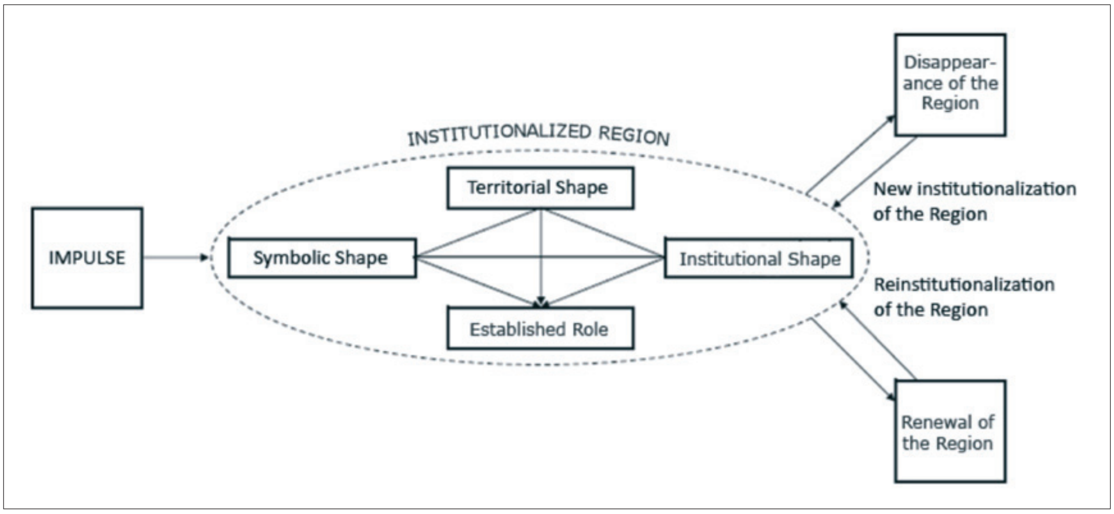


Fig. 1: The process of the institutionalization and reinstitutionalization of a region
Source: according to Paasi (1986) and Raagmaa (2001)
Note: The strength and nature of the impulse lead to whether a region is renewed or disappears.

regional identity is nowadays often connected with regional marketing strategies and misused by them too (Hospers, 2011). Generally, these strategies reduce regional identity only to a commodified image and sell this image outside the region. What they miss is the shared vision of such an image by inhabitants within of the region. As stated by Antonsich (2010), it is not important for the very existence of the region to have both components of regional identity. Therefore, region without regional consciousness of inhabitants can exists, but such a region is not fully developed and in long-term reproduction can disappear more easily.

3. Conceptualizing regional boundaries

The concept of region as a social construction means that regional boundaries cannot just be taken as lines on the map, because relationships creating regions reach beyond such boundaries. Based on the level of these relationships, geographers can differentiate boundaries based on their "scope" as either being linear or zonal (Jeřábek, Dokoupil, Havlíček et al., 2004). A typical example of the second type of boundary is represented by ethnic boundaries between territories populated by different ethnicities (Siwek, 1996). The "scope" of the boundaries however does not influence the objective appearance of a given phenomenon, but subjective factors are also important such as the position from which the observer is looking at the boundaries, i.e. centre vs. periphery (Siwek, 1999). Boundaries are social, cultural, and political constructions, created and used by people in the process of the institutionalization of regions (Paasi, 2001). For creating regional identity, boundaries have two immediate roles. First of all they determine the "inhabitants" of a region, i.e. people who belong to a region, and secondly they define the "others" who do not belong to a region (Massey, Jess, 1995). The principle of the relationship between "us" and "them" and its expression in boundaries is what makes up the essence of regional identity. In the relationship between those on the "inside" and those on the "outside", boundaries can have either a barrier function or a contact function (Dokoupil, 2000). If boundaries lose their function, but their reflection is preserved in the consciousness of the population, a historical geographic boundary is formed (Chromý, 2000; Kučerová-Kuldová, 2008).

Massey and Jess (1995) summarize the basic principles of understanding boundaries into four points:

1. Boundaries do not represent an eternal truth about a territory, but instead are social constructions serving specific purposes,
2. Boundaries must inevitably intersect with other social relationships creating the social space. No bordered territory can be "pure",
3. Boundaries are determined by human potential and thus in this case are one of the elements responsible for organizing the social space. Thus, they may become a part of the process of "creating a place",
4. Creating boundaries is always an act of force.

It is clear that regions determined for various purposes may mutually spatially overlap or supplement each other. In a territory there may be multiple formal and informal regions bearing the same name (Semian, 2012). All of these regions have different functions and meanings, but exist concurrently. They all have their own boundaries, which mutually overlap territorially. Assuming that we consider the fourth phase of the institutionalization of a region as essential for the existence of a region in the regional system, we can determine the general boundaries of a region on the basis of the confrontation between individual boundaries with the analysis of the territorial shape of the region in the consciousness of its inhabitants.

4. Methodology

Methods used in the research for this article can be broken into two parts. In the first part we focus on the discourse analysis of the territorial shape of the Bohemian Paradise and on defining boundaries of the Bohemian Paradise based on the heuristics of academic and popular literature available in the library of the Museum of the Bohemian Paradise in Turnov and in the geography library of the Faculty of Science at Charles University in Prague. Sources for the discourse analysis are literature and other sources published since the 19th century, mainly focused on tourism (guidebooks, photographic books, etc.). We have based this part on previous papers (Semian, 2010; 2012).

The critical part of the paper is the analysis of mental maps collected during field research in 2009 and 2010 focused on the identity of the inhabitants of the Bohemian Paradise. This method was chosen as the most suitable for determining thoughts of the inhabitants in the study area about the territorial shape of the Bohemian Paradise and, at the same time to find out to what extent various definitions of the Bohemian Paradise are reflected in the consciousness of its inhabitants. Due to the fact that the construction and evaluation of mental maps is relatively difficult, only three groups of actors in forming regional identity were selected for the research: teachers, mayors, and officials from the regional authorities. These actors influence the regional consciousness of inhabitants either through the process of education or by contributing to the creation of the regional identity of each municipality or the entire region. We are aware of the restrictions on the validity of the results related to the selected targeted actors. It can be assumed that thanks to greater levels of awareness and a greater overview of the links between actors in the territory, the resulting definition will be somewhat broader than if all respondents were included. Mental maps were a crucial part of the questionnaires distributed to mayors and elementary school teachers, and they were also included in interviews held with officials from the regional authorities (Semian, 2010). In total we worked with 126 completed mental maps. Of these, 99 mental maps were from elementary school teachers, 23 maps from mayors and 4 maps from officials from the regional authorities.

While incorporating the construction of mental maps into field research we worked with the geographical concept of mental maps as with a "graphical (cartographical or schematic) expression of people's ideas about the geographical space, most frequently about its quality or arrangement" (Drbohlav, 1991, p. 164). Respondents were given a small map on which all important settlements in the model area were drawn. The respondents had to record their visualization of the territorial definition of the Bohemian Paradise on this map. Each of these drawings was evaluated using a grid network, where the side of each square represented 5 km in reality. If an entire square fell into the territory defined on the mental map as belonging to the Bohemian Paradise, the square was allocated two points. If it was only partially within it, such "bordering" squares were allocated just one point. Then we added up the values of each square and ascertained their relative abundance in the mental maps of the respondents. On the basis of relative abundance in the resulting mental map we subsequently defined several broader definitions of the Bohemian Paradise and retrospectively drew their boundaries into the original map. In conclusion, we compared the resulting mental map with the discourse on the Bohemian Paradise.

5. Brief characteristics of the model territory

The Bohemian Paradise is located nearly 100 kilometres northeast of the capital of Prague, in between the towns of Mladá Boleslav, Hodkovice nad Mohelkou, Semily, Nová Paka, and Kopidlno. The territory of the Bohemian Paradise is included in three of 14 administrative regions (NUTS III): Hradec Králové (Eastern Bohemia), Liberec (Northern Bohemia), and the Central Bohemian Region. With its position in the regional system of settlement, the Bohemian Paradise can be defined as being within the inner macro-regional periphery of Prague (Musil, Müller, 2008). The name Bohemian Paradise is used by many formal and informal regions, each of which has its own boundaries, institutions and significance. In its maximum defined size, the Bohemian Paradise is more than 1,400 km^2, and has more than 200,000 inhabitants.

The roots of the name "Bohemian Paradise" can be found in the late Romantic period of the National Revival (in the 1870s), when the Czech intelligentsia surrounding the director of the spa at Sedmihorky, Dr. Antonín Šlechta, started using the name Bohemian Paradise to refer to the rocky landscape immediately surrounding the spa (Prýl, 1887; for alternative theory see Zylinskyj, 2005). Since then, the area known as Bohemian Paradise has gradually expanded. This further addition of territory took place mainly based on association with similar landscapes. The identity of the region was mainly created by its visitors. The name however quickly found its way into the consciousness of local inhabitants. The Bohemian Paradise is a cultural region institutionalized mainly on the basis of tourism (Nováková, Střída, 2002).

From the landscape perspective, the Bohemian Paradise is a transition zone between the lowland of Polabí (Elbe River Basin) in the south and the Jizerské Mts. and Krkonoše Mts. including their foothills in the north. The "heart" of the region is the Bohemian Paradise protected landscape area. Sandstone rock cities, volcanic knobs and many ponds as well as a large concentration of historical and cultural monuments are typical of the Bohemian Paradise landscape. Historical and cultural monuments are frequently landscape landmarks. Together they create a varied landscape character, which makes the Bohemian Paradise unique. According to Jeřábek (2005), the central part of the Bohemian Paradise has characteristically highly stable population and strong Bohemian Paradise identity.

6. Discourse on the definition of the Bohemian Paradise

The discourse analysis of the territorial shape of the Bohemian Paradise indicates a plurality of approaches to defining the region. An overview of the discourse defining the Bohemian Paradise is given in Fig. 2 (see cover p. 2). A more detailed description of each definition is beyond the scope of this article; we have dealt with it in earlier papers (Semian, 2010; 2012). From Fig. 2 it is clear that the discourse on the territorial shape of the Bohemian Paradise is relatively heterogeneous. In general we can define three boundaries in the region. The first delineation is the "core" of the Bohemian Paradise. We do not necessarily have to understand this to mean the "historical" core (Hruboskalsko –Fig. 3 – see cover p. 2), but it can also be described as a triangular area connecting the main rock areas: Maloskalsko in the north, Příhrazské Rocks in the west and Prachovské Rocks in the east. This area essentially corresponds to the connected territory of the Bohemian Paradise protected landscape area and from the perspective of nature, landscape and cultural history, it is the most valuable. The middle demarcation is bordered by the towns of Mnichovo Hradiště, Sobotka, Jičín, Lomnice nad Popelkou, and Železný Brod, Kopanina Hill and the Sychrov Chateau. This variant adds the surrounding towns to the core rock area. It is attractive for tourists, too and broadens the interest in the region mainly with its cultural and historical offerings. The last, broadest delineation includes the area joining the towns of Mladá Boleslav, Kopidlno, Nová Paka, Semily, Hodkovice nad Mohelkou, and Mnichovo Hradiště. This is a very broad and diverse area, which is supposed to serve as an alternative to the tourist core, and which can at least partly profit from the good name of the region for its own development.

From the discourse on the territorial shape of the Bohemian Paradise, the Bohemian Paradise region is most often defined using the second definition. The boundaries of the second definition have a zonal character. The discourse defines the north and west boundaries most distinctly. On the contrary, the south and east boundaries are the most open and poorly definable. The south the boundary is loose, most likely due to the absence of a clearly institutionalized neighbour, and as a result, the Bohemian Paradise area expands into "no man's" territory. The east boundary relatively clearly borders with the "Podkrkonoší" region, whose landscape character is very similar to the eastern part of the Bohemian Paradise. Thus, in the literature these two regions are often joined.

7. Mental maps of the Bohemian Paradise

The analysis of mental maps of the Bohemian Paradise took place in several steps. First we categorized the breadth of mental maps based on the percentage of grid squares contained therein. We worked with values calculated from all mental maps. In Fig. 4, which depicts individual values of squares in the graph, certain value clusters are clear. The first cluster is between 80% and 100%. The second is between 40% and 66%. These two clusters can be considered to indicate the first two categories for defining the Bohemian Paradise. Values between these clusters can be left as transitional. A further cluster is found approximately between 15% and 25%. This cluster however is not enough for a further definition. Together with other values they create the third category of definitions of the Bohemian Paradise. For this category we removed isolated definitions that were too broad. The lower boundary of the third category is made up of values in the range from 3% to 5.5%, which is not sufficiently clear from Fig. 4. Not to leave out too many values, we chose another transitional category between 2.5% and 5.5%. An accurate overview of definitions is included in Fig. 5, which also serves as a legend for other mental maps. The boundaries could not be redrawn accurately according to the categories of squares, nor using a ratio; it was necessary to take into account the surrounding values instead. Therefore, we have to emphasize that the resulting boundaries are just a possible "sharp" record of otherwise "loose" boundaries.

In the regional consciousness of the inhabitants we could identify three variously broad definitions of the Bohemian Paradise region (Fig. 6). The majority of respondents included the narrowest definition of the Bohemian Paradise in their mental maps. Thus, we shall name this definition as the "core" of the Bohemian Paradise. This definition includes the entire territory of the Bohemian Paradise as described by Prýl (1887), and is narrower than the definition of the core area acquired based on the discourse analysis (Fig. 2). The difference is mainly in the northern part of the protected landscape area surrounding the municipality of Malá Skála and Kozákov Hill, which is not included in the mental map, in contrast to the results of the discourse analysis.

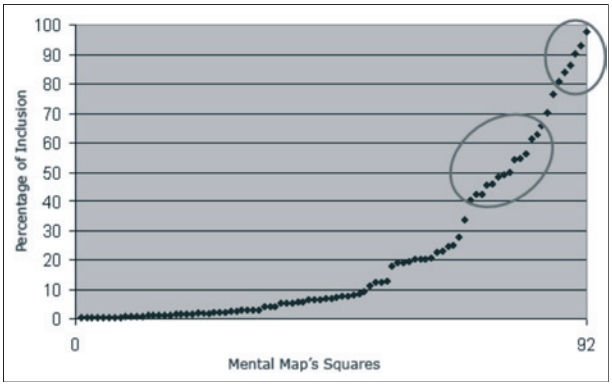


Fig. 4: Clusters of mental map squares by percentage of inclusion. Source: Semian (2010)

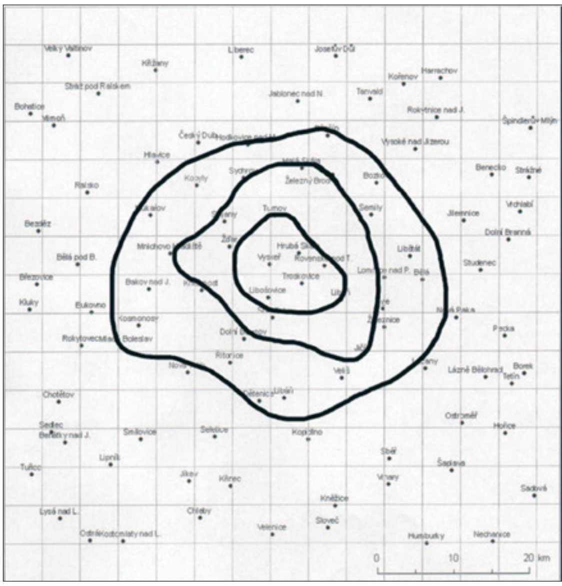
Category	
< 2,50	Exclude
2,50 – 5,49	1st transitional
5,50 – 24,99	Outer
25,00 – 39,99	2nd transitional
40,00 – 65,99	Middle
66,00 – 79,99	3rd transitional
80,00 +	Core

Fig. 5: Categories for evaluating mental maps (% of inclusion). Source: Semian (2010)

The middle definition contains areas that were included in mental maps about half of the time. This can be described as a triangular region between the municipalities of Mnichovo Hradiště, Jičín, and Malá Skála. This definition significantly corresponds with the second definition from the discourse analysis of the Bohemian Paradise, which found this definition to be the most frequent. The region thus defined best describes the Bohemian Paradise as a region. According to Semian (2010), it is this area, which the inhabitants most often identify as the Bohemian Paradise. The third and most "loose" definition corresponds approximately to the outer definition from the discourse (Fig. 2). Only in the southern part (around the town of Kopidlno) is this outer definition somewhat narrower.

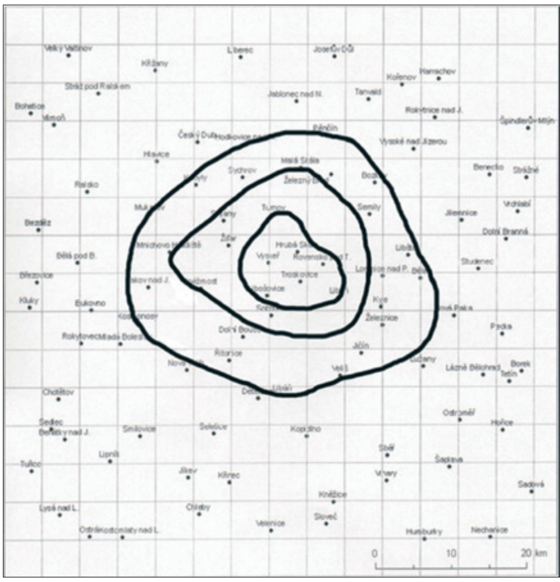
From comparing the mental maps of the groups of actors (Figs. 7–9) it is clear that officials from the regional authority define the Bohemian Paradise most broadly, as expected. They have a certain distance from the Bohemian Paradise area, and therefore define it based on information they have gained. Therefore, in this case we can talk about two types of the Bohemian Paradise: first, the core delineation including the entire Bohemian Paradise protected landscape area, and the second wider Bohemian Paradise tourism region. These two territorial definitions are based on the most important institutions of the Bohemian Paradise (Semian, 2010).

The mental maps of mayors and elementary school teachers are in relative correspondence, and the categories of the Bohemian Paradise are defined



							0,79	0,79					
			0,79	1,59	5,56	12,70	19,44	20,24	5,95	1,59			
		0,40	2,78	7,94	19,05	42,46	54,37	45,63	22,62	6,75	1,59		
		1,19	7,54	20,24	42,46	70,24	80,95	65,87	40,48	13,10	4,37		
	0,40	3,17	9,52	33,73	62,70	90,08	97,62	83,73	50,00	17,86	6,75	0,79	
		3,17	8,73	24,60	48,41	76,59	92,86	86,11	53,97	23,02	7,94	1,98	
	1,19	3,17	5,56	11,51	20,24	46,03	55,95	61,11	49,21	19,05	7,14	2,38	0,40
	1,19	2,38	3,17	4,37	5,56	12,70	20,63	27,78	25,00	8,33	2,78	0,40	0,40
			1,19	1,59	2,38	5,95	7,14	6,75	4,37	0,40			
					0,40	1,19	1,98	1,98	0,40				

Fig. 6: Mental map of the Bohemian Paradise (N = 126). Source: Semian (2010)



							1,01	0,51					
				1,01	4,55	13,13	18,69	19,70	4,04	0,51			
			2,02	6,57	19,70	42,93	54,04	44,44	20,20	4,04			
		1,01	6,57	19,70	41,41	69,70	80,81	66,16	40,40	10,10	2,53		
	0,51	3,03	9,09	32,83	62,63	89,90	97,98	84,85	48,99	15,15	4,55	0,51	
		3,54	9,09	24,75	47,47	74,75	91,92	84,85	49,49	20,20	5,56	1,52	
	1,52	3,54	5,56	11,11	18,18	42,93	50,51	57,07	43,94	15,66	5,56	2,02	0,51
	1,52	2,53	3,03	4,55	5,56	10,10	16,67	23,74	22,73	6,57	2,53	0,51	0,51
			1,01	1,52	2,02	4,04	5,56	4,55	2,53				
						1,01	1,52	1,52					

Fig. 7: Mental map of the Bohemian Paradise according to elementary school teachers (N = 99)

more narrowly than they were in the mental maps of regional authority officials. The most significant difference was the fact that the Mladá Boleslav region was not included in the outer definition of the Bohemian Paradise by mayors. This fact is most likely related to the low return rate of mental maps from mayors in this region, as according to Semian (2010), the territory included in definitions widens to include the place of residence of respondents in 75% of cases.

It can be stated that the definitions of the Bohemian Paradise based on the analysis of the discourse and on the basis of the analysis of mental maps more or less correspond with each other, although the definitions from the mental maps are generally somewhat narrower. It can also be stated that the discourse on the Bohemian Paradise influences how the region is perceived from the outside. However, it is also necessary to note that respondents in this category were from a narrow group of well informed people. If we asked other groups of people, we could obtain completely different and most likely narrower results.

8. Conclusion

The aim of this article was to describe and compare the territorial shape of the Bohemian Paradise region, based both on the discourse analysis of academic and popular literature, and on the basis of the analysis of the consciousness of inhabitants, or mental maps. In both cases we were able to independently identify three variously broad definitions of the Bohemian Paradise

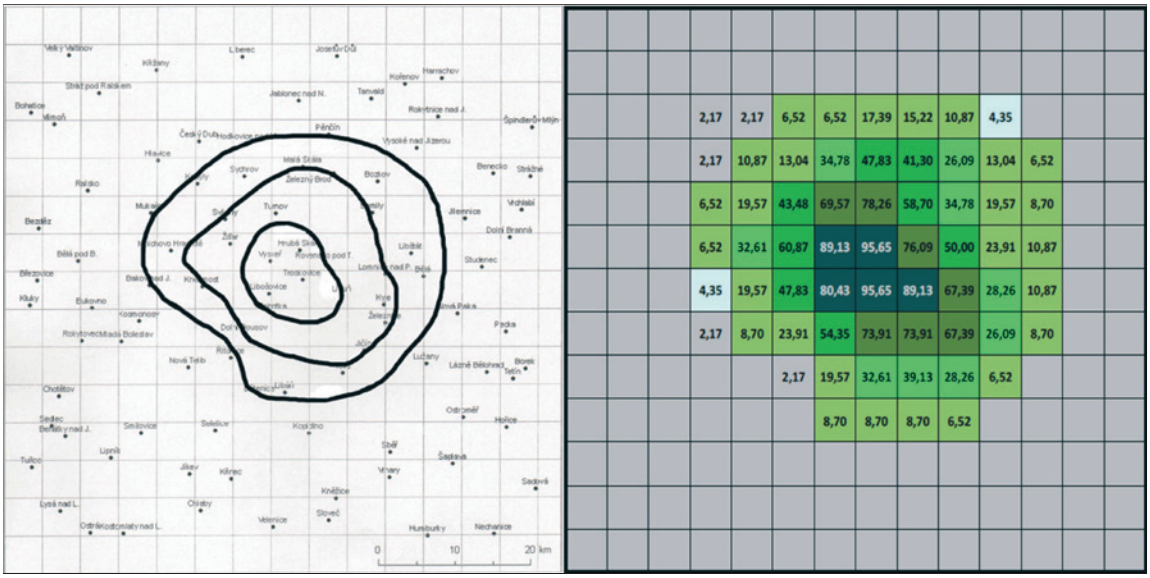


Fig. 8: Mental map of the Bohemian Paradise according to mayors (N = 23)

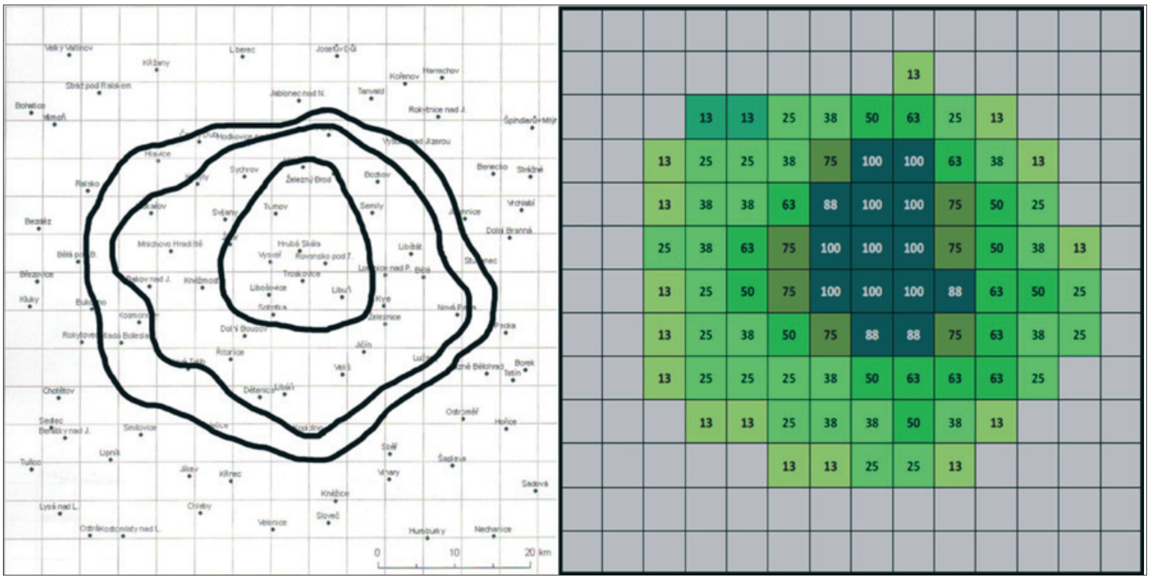


Fig. 9: Mental map of the Bohemian Paradise according to officials from the regional authority (N = 4)

(Fig. 2, Fig. 6). The definitions of core, middle and outer zones based on the discourse analysis and on the analysis of mental maps corresponded relatively well. The largest differences are found in the definitions of the core zone. Whereas in the consciousness of the inhabitants this definition approaches the historical core of the region and almost 100% of respondents included it in their mental maps of the Bohemian Paradise, based on the analysis of literature, this definition is broader and includes the entire area of the Bohemian Paradise protected landscape area; it is spatially smaller, but at the same time, it is the most well-known formal region titled Bohemian Paradise. In contrast to mental maps, the most frequent definition of the Bohemian Paradise in the discourse was the middle zone, which includes the protected landscape area and the towns immediately surrounding it.

The middle definition seems to be the view of the Bohemian Paradise that best describes the region, as it is very similar in both the discourse analysis and in the analysis of the consciousness of the inhabitants. In the discourse analysis, this definition was the most frequent; roughly 40% to 66% of respondents included it as part of the Bohemian Paradise in mental maps. This definition includes not only the historical core, but also the entire territory of the Bohemian Paradise protected landscape area. Besides this, the middle definition also includes towns that function as service centres for most of the territory of the middle definition of the Bohemian Paradise (Hampl, 2005).

The assumption that formalized wholes will most often be reflected in the definitions proved to be correct. In particular, the Bohemian Paradise protected landscape area and to a lesser extent the Bohemian Paradise tourist region served as reference categories with which authors of the literature or mental map interviewees compared their view of the Bohemian Paradise. Whereas the boundaries of the protected landscape area can be characterized in the discourse as the core definition, the boundaries of the tourist region on the other hand make up the broadest definition of the Bohemian Paradise, whose boundaries are reached only really in the discourse and from mental map interviewees.

We were able to confirm the assumption that officials from the regional authorities would define the Bohemian Paradise most broadly. In the mental maps of officials from the regional authorities the boundaries of the two most important institutional units are reflected in particular: the Bohemian Paradise protected landscape area and the Bohemian Paradise tourist region. The mental maps of mayors and elementary school teachers are very similar.

Using the Bohemian Paradise as an example we wanted to show that there is sense in monitoring the territorial regionalization in relation to the regional identity. We are aware of the restrictions of selecting the model territory and the groups of respondents. Despite this it is correct to assume that through the regional identity general loose regional boundaries can be defined in a territory, and that the regional consciousness of inhabitants can be a vehicle for connecting purely functional socio-geographic regionalization with geo-social regionalization. For regions that are not only functional but whose inhabitants feel a great sense of belonging to, we can assume a strong activation of local actors, which has the potential to be a significant tool for the regional development of the territory.

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References:

ALLEN, J., MASSEY, D.; COCHRANE, A. (1998): Rethinking the region. Routledge, London, 159 pp.

DAVID, P., SOUKUP, V. (1996): Český ráj – Jičínsko. Soukup & David, Praha, 160 pp.

DOKOUPIL, J. (2000): Teoretické přístupy k problematice pohraničí s aplikací v Česko-bavorském prostoru. Geografie, Sborník ČGS, Vol. 105, No. 1, p. 10–18.

DRBOHLAV, D. (1991): Mentální mapa ČSFR: definice, aplikace, podmíněnost. Geografie, Sborník ČGS, Vol. 96, No. 3, p. 163–176.

FRISVOLL, S., RYE, J. F. (2009): Elite discourses of regional identity in a new regionalism development scheme: The case of the "Mountain Region" in Norway. Norsk Geografisk Tidsskrift, Vol. 63, p. 175–190.

GREGORY, D. et al. [eds.] (2009): The dictionary of human geography. Blackwell, Malden, 1052 pp.

HAMPL, M. (2005): Geografická organizace společnosti v České republice: transformační procesy a jejich obecný kontext. UK v Praze, PřF, katedra sociální geografie a regionálního rozvoje, Praha, 147 pp.

HAMPL, M., DOSTÁL, P., DRBOHLAV, D. (2007): Social and cultural geography in the Czech Republic: under prassures of globalization and post-totalitarian transformation. Social & Cultural Geography, Vol. 8, No. 3, p. 475–493.

HAMPL, M., JEŽEK, J., KÜHNL, K. (1978): Sociálněgeografická regionalizace ČSR. Výzkumný ústav sociálně ekonomických informací, Praha, 304 pp.

HEŘMANOVÁ, E.; CHROMÝ, P. et al. (2009): Kulturní regiony a geografie kultury. ASPI, Praha, 348 pp.

CHROMÝ, P. (2000): Historickogeografické aspekty vymezování pohraničí jako součást geografické analýzy. Geografie, Sborník ČGS, Vol. 105, No. 1, p. 63–76.

CHROMÝ, P. (2003): Formování regionální identity: nezbytná součást geografických výzkumů. In: JANČÁK, V.; CHROMÝ, P.; MARADA, M. [eds.]: Geografie na cestách poznání. UK v Praze, PřF, katedra sociální geografie a regionálního rozvoje, Praha, p. 163–178.

CHROMÝ, P.; JANŮ, H. (2003): Regional identity, activation of territorial communities and the potential of the development of peripheral regions. Acta Universitatis Carolinae Geographica, Vol. 38, No. 1, p. 105–117.

CHROMÝ, P., KUČEROVÁ, S., KUČERA, Z. (2009): Regional identity, contemporary and historical regions and the issue of relict borders: the case of Czechia. Region and regionalism, Vol. 9, No. 2, p. 9–19.

CHROMÝ, P., SKÁLA, J. (2010): Kulturněgeografické aspekty rozvoje příhraničních periferií: analýza vybraných složek územní identity obyvatelstva Sušicka. Geografie, Sborník ČGS, Vol. 115, No. 2, p. 223–246.

JEŘÁBEK, M. (2005): Subjektivní vnímání území mezi Kozákovem a Troskami. In: NOVOTNÁ, M. [ed.]: Problémy periferních oblastí. UK v Praze, PřF, katedra sociální geografie a regionálního rozvoje, Praha, p. 109–117.

JEŘÁBEK, M., DOKOUPIL, J., HAVLÍČEK, T. et al. (2004): České pohraničí: bariéra nebo prostor zprostředkování? Academia, Praha, 296 pp.

MASSEY, D., JESS, P. [eds.] (1995): A place in the world? Open University, Oxford, 247 pp.

MUSIL, J., MÜLLER, J. (2008): Vnitřní periferie v České republice jako mechanismus sociální exkluze. Sociologický časopis, Vol. 44, No. 2, p. 321–348.

NOVÁKOVÁ, M.; STŘÍDA, M. (2002): Český ráj. Olympia, Praha, 127 pp.

Olympia (1982): Český ráj a Podkrkonoší. Praha, 381 pp.

PAASI, A. (1986): The institutionalization of regions: a theoretical framework for understanding the emergence of regions and the constitution of regional identity. Fennia, Vol. 164, No. 1, p. 105–146.

PAASI, A. (2001): Europe as a social process and discourse: consideration of place, boundaries and identity. European Urban and Regional Studies, Vol. 8, No. 1, p. 7–28.

PAASI, A. (2002): Place and region: regional worlds and words. Progress in Human Geography, Vol. 26, No. 6, p. 802–811.

PACOVSKÝ, J. (1970): Český ráj. Olympia, Praha, 184 pp.

PODHORSKÝ, M. (1998): Český ráj a Podkrkonoší. Freytag & Berndt, Praha, 128 pp.

PRED, A. (1984): Place as historically contingent process: structuration and the time-geography of becoming places. Annals of the Association of American Geographers, Vol. 74, No. 2, p. 279–297.

PRÝL, J. Z. (1887): Průvodce Českým rájem. Turnov, 49 pp.

RAAGMAA, G. (2001): Regional identity and social capital in regional economic development and planning. ERSA Conference Papers 01/194, 20 pp.

SEMIAN, M. (2010): Regionální identita Českého ráje (diploma thesis). UK v Praze, PřF, katedra sociální geografie a regionálního rozvoje, Praha, 102 pp.

SEMIAN, M. (2012): Český ráj. Ale který? Geografické rozhledy, Vol. 21, No. 3, p. 26–27.

SIWEK, T. (1996): Česko-polská etnická hranice. Spis Filozofické fakulty ostravské univerzity 97, Ostrava, 96 pp.

SIWEK, T. (1999): Příspěvek ke zkoumání etnické hranice. Geografie, Sborník ČGS, Vol. 104, No. 1, p. 1–12.

SIWEK, T., BOGDOVÁ, K. (2007): České kulturně-historické regiony ve vědomí svých obyvatel. Sociologický časopis, Vol. 43, No. 5, p. 1039–1053.

SIWEK, T.; KAŇOK, J. (2000): Mapping Silesian identity in Czechia. Geografie, Sborník ČGS, Vol. 105, No. 2, p. 190–200.

STANĚK, J. (1974): Český ráj a Máchův kraj. Olympia, Praha, 166 pp.

Státní památková správa (1955): Český ráj: přírodní reservace a kulturní památky. Státní tělovýchovné nakladatelství, Praha, 52 pp.

ŠALDA, F. (1960): Český ráj. Sportovní a turistické nakladatelství, Praha, 184 pp.

ZILYNSKYJ, B. (2005): Co je nám do jejich ráje: stěhování Českého ráje od Litoměřic k Turnovu na konci 19. století. Dějiny a současnost, Vol. 27, No. 5, pp. 14–18.

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PERCEPTION OF THE HISTORICAL BORDER BETWEEN MORAVIA AND SILESIA BY RESIDENTS OF THE JESENÍK AREA AS A PARTIAL ASPECT OF THEIR REGIONAL IDENTITY (CZECH REPUBLIC)

Miloslav ŠERÝ, Petr ŠIMÁČEK

Abstract

A border is considered to be very important for regional identity. It is used not only for the creation of regional identity from the outside by inhabitants living outside the particular region, but especially for generating regional identity within the population of that region. The Jeseník area is delimited by the border between Moravia and Silesia. It is also regarded as a territory of weak regional identity. This contribution deals with an empirical analysis of perceptions of this historical border by inhabitants of the Jeseník area through applying a mental map concept. The main objective is to verify the hypothesis about the weak regional identity of the population in the Jeseník area using this analytical approach.

Shrnutí

Vnímání historické hranice mezi Moravou a Slezskem obyvateli Jesenicka jako dílčí aspekt jejich regionální identity (Česká republika)

Hranice je považována za významný atribut územní identity. Bývá využívána jednak pro vytváření identity regionu z vnějšku obyvatelstvem žijícím mimo daný region a hlavně pak pro generování regionální identity zevnitř obyvatelstvem daného regionu. Jesenicko je oblastí z části vymezené zemskou hranicí Moravy a Slezska. Zároveň je považováno za oblast, jejíž obyvatelé jsou nositeli nízké úrovně regionální identity. Předložený příspěvek přináší empirickou analýzu percepce zmíněné hranice obyvateli Jesenicka, a to za využití konceptu mentální mapy. Hlavním cílem je dílčí ověření hypotézy o slabé regionální identitě zdejších obyvatel s pomocí výše zmíněné analýzy.

Keywords: *regional identity, border, perception, mental map, centrography, Jeseník area, Czech Republic*

1. Introduction

This article deals with the evaluation of the 'relict' boundary between Moravia and Silesia or, rather the role which it plays in minds of local people in the context of their regional identity. Identity is one of the means by which people differ. One of its fundamental dimensions is space: the relation of people to their region is a natural part of their lives. The importance of regional identity can be acquired, for example, in relation to regional development of smaller territorial units (Chromý, Skála, 2003) or in connection with their administrative demarcation (Žigrai, 2000).

The current Jeseník area is situated in the northwest corner of the Czech part of Silesia (with the exception of the village of Ostružná, the built-up area of which is located in Moravia). The toponymic Jeseník area can be considered as spatially inexact for several reasons. The first can be seen in the objective historical-administrative development of the area, which was the reason for changes in the administrative demarcation of this territory. In the latter case, it is a subjective attribution of the territorial scope of each individual, which may vary from case to case. The authors do not claim any right to their own exclusive spatial definition of the Jeseník area, and therefore for the purposes of this paper they used the administrative demarcation valid at the time of field research (2009). Thus, they pinpoint the Jeseník area and identify it de facto with the administrative district of Jeseník with extended authority (hereinafter the Jeseník administrative district). The area under study is shown in Fig. 1.

The region was chosen for study because of its post-war development. Dynamic social processes represented mainly by the post-war transfer of the

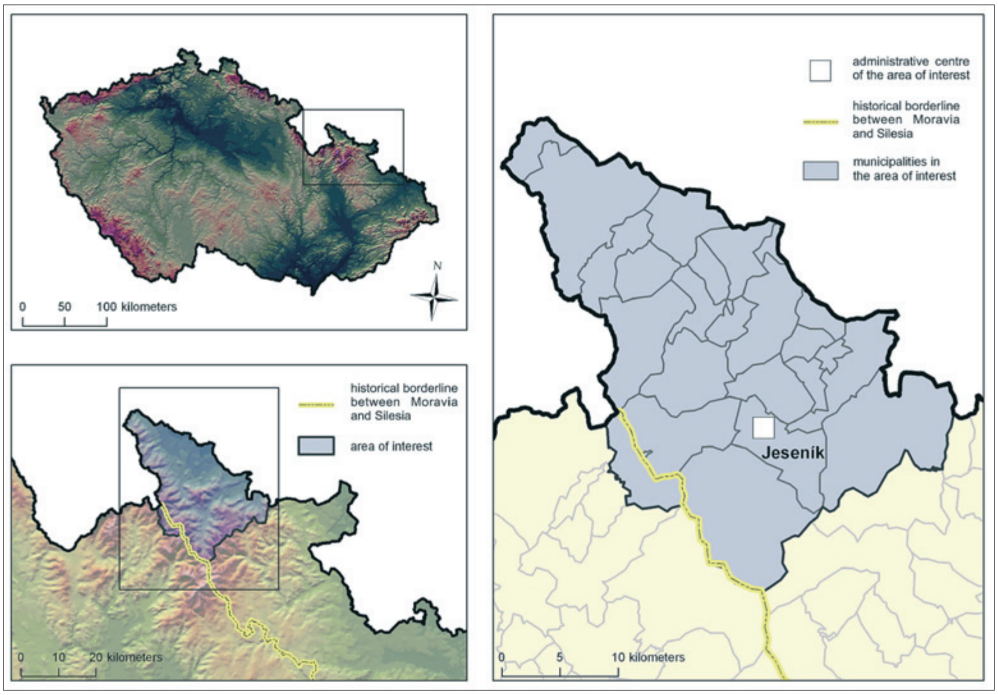

Fig. 1: Area under study (Sources: ArcČR 500 version 2.0a; Siwek and Kaňok 2000; Compiled by authors)

autochthonous German population from their homes and by the subsequent resettlement of the area with a geographically heterogeneous mass of migrants, led to the loss of regional identity carriers. The regional identity of the Jeseník area was then completely transformed by the population of newcomers and therefore it is possible to say that the Jeseník area is a region with interrupted traditions.

According to Häkli (2008), borders and boundaries are everywhere. As he continues individuals and human communities define and structure the social world by making distinctions between groups, spaces, times, objects and meanings. We encounter borders constantly in our everyday lives. The border can also be seen as an important constituent in the process of identifying communities in general (Paasi, 2002). For residents of the Jeseník area, this function was fulfilled by the border between the historical lands of Moravia and Silesia (until the above-mentioned processes emerged), which defines the area under study from the South and de facto represented the spatial range of regional identity for inhabitants of the Jeseník area. Reflecting this fact, the question is whether this relict borderline, which is however a substantial part of the administrative delimitation of the area, still performs a similar function in the present. If the answer is yes, then it leads to another question. Is the current function more significant in the case of the older generation, i.e. as possible witnesses, as compared to younger generations? The influence on the character of border perception by locals may be seen also in phenomena such as education and place of birth. Are there any fundamental differences in such determined population sub-groups? This paper can be understood as an attempt to answer these questions. The main goal of this work is to assess the level of boundary perception described by the contemporary population of the Jeseník administrative district. Partial goals of the work consist in the analysis of differences in the perception quality of the assessed entity by various population structures (gender, education, birthplace, age) and also in outlining the spatial range of the regional identity of the local residents.

2. Theoretical and methodological basis

Identity is a term that seems self-explanatory and unproblematic until people really stop and think about it (Penrose, Mole, 2008). At its simplest, identity is who we are. Strictly speaking, the issue is how to construct and understand the fact of who we are. Everyone is confronted with questions such as "Who am I? and Who are they?, Where do I belong?, How do I differ?", etc. Asking these questions is rooted in the fact that identity, or the need to belong somewhere, is considered to be a basic social need of every human being. The crucial importance of this need was recognised by the American psychologist Maslow more than sixty years ago (1943), who was the author of the pyramid of human needs, constructed in the context of his theory of a hierarchy of needs. As regards the pyramid of human needs, its base is formed by basic physical needs (hunger, thirst) whose satisfaction is a prerequisite for the survival of an individual. This essential kind of needs is followed by the need of safety, and further by the need of belonging somewhere, which is hierarchically the third most important. The successful meeting of these three forms of needs is necessary for the development of further needs, such as aesthetic needs or the need to be respected by others (Brown, Cullen, 2006).

The phenomenon of identity includes many dimensions whose interactions, i.e. mutual complementarity but also replacement or overlapping, form its final nature. Identity is similarly described by Zich (2003) who argues that human identity consists of several identifications. Personal identity may thus arise through the integration of aspects such as the specific characteristics of a person, their profession, ethnicity, membership in a religious community and, last but not least, the space in which the person lives. The spatial (geographical) factor of an individual's identity often serves as a common denominator with identities of other people and can be considered to be one of the essential characteristics of collective identity. The collective identity of a community, expressed by the relation to an area where everyday activities take place, or its living space, can be called the regional identity.

The creation of regional identity is, according to Raagmaa (2002), a profoundly social, spatial, cultural and historical phenomenon that embodies both stabilization and also variable character. The historical context of the process of building regional identity is of crucial significance. The regional identity contains images of the past closely connected with events which have influenced the region's development, its attractiveness, patriotism or emotional aspects of the regional identity of its inhabitants (Balek, 2005). In connection with the history of the region, traditions must be taken into account as well, especially if they were interrupted during its historical development or, to the contrary, if the traditions were continually maintained. The importance of the continuity or discontinuity of traditions lies in their direct impact on the character of local communities that bear the territorial identity.

The formative constituents mentioned above are included also in the concept of territorial identity creation by the Finnish geographer Paasi (2003). Furthermore, he points out the meaning of economic and political dimensions that are, in his opinion, also essential for the genesis and further development of regional identity. In this context, a process of region forming which Chromý (2003) divides into individual and institutional, can be included. Every region would change over time and it is always a matter of community that would shape the regions. Regions can be delimited subjectively on the basis of territory perception and attribution of particular importance compared to other regions. Likewise, there can appear an institutionalized definition of regions, which can be considered a political process. The course of region creation and the strong connection with institutions is described in detail by Paasi (1986) who divided the process of region creation into several consecutive stages. The core of the very first stage is acquisition of a spatial form where the significant phenomenon of the delimitation of regional boundaries can be observed. These boundaries do not have to be understood as purely political lines, they can be defined on the basis of physical-geographical conditions or cultural features. Thus, the definition of a region's territory is a condition for creation of the spatial awareness of the local population. Particularly, due to the existence of boundaries, which give these spatial concepts a certain form, the residents dichotomously realize their own peculiarity, specificity and uniqueness in comparison with 'the others' living beyond this border.

This argument suggests that there are two points of view as to how the entity, such as a boundary, can be analyzed. Firstly, it can be analyzed as an external factor of regional identity. It studies how inhabitants of other regions perceive such a region, which generates the identity of the region created from the outside. Secondly, the boundary plays an important role in defining the region's identity from inside. In this case it is a process when a region is perceived by its own inhabitants who thus reproduce the regional identity of their region (Hubáčková, 2006; Siwek, Bogdová, 2007). This fact demonstrates that the border is a significant component of regional identity and its existence can be used in research dealing with the phenomenon of territorial identity.

Given the above, the area of Jeseník can be described as a region which shows, compared with most of the remaining regions in the Czech Republic, significant differences in formative aspects that condition the nature of the regional identity of the local population. From historical, social and cultural points of view, it is an area with lost identity. This apt term was used by Chromý (2003) to describe the areas depopulated after World War II. The Jeseník area can be undoubtedly considered such a region because it was one of the areas where the autochthonous German population, as the majority of the local population until the end of the war, was displaced from their homes. Full details of the population dynamics of this period are given in Tab. 1.

The forced migration of people who carried the regional identity of the Jeseník area represented a significant break of traditions and an important intervention into the local regional identity. A wave of geographically

1930								
total	Czechoslovaks		Germans		Others		Foreigners	
	abs.	rel. (%)	abs.	rel. (%)	abs.	rel. (%)	abs.	rel. (%)
71,717	2,703	3.77	66,987	93.4	135	0.19	1,892	2.64
1947								
total	Persons of 2 years and older	Persons of 2 years of age and older presented on 1st may 1945						
		Same municipality	Same municipality in borderland	Inland		Slovakia	Germany, Austria	Else, unknown
				Bohemia	Moravia, Silesia			
35,836	*abs.*	*Abs.*						
	33,778	5,592	1,814	1,710	19,923	2,958	545	1,236
	rel. (%)	*rel. (%)*						
	94.26	16.56	5.37	5.06	58.98	8.76	1.61	3.66

Tab. 1: Population dynamics in the area under study after the end of World War II
Sources: Bartoš, Schulz, Trapl (1994); CZSO (1951); authors' tabulations

heterogeneous settlers immigrating to the Jeseník area to substitute for the displaced Germans transformed the original regional identity completely.

There is an assumption suggesting that the current regional identity of the Jeseník area's population is very weak. This claim can be supported by articles published in local newspapers appealing to the inhabitants that the city of Jeseník, or even the whole Jeseník area, is a particular city/region located in Silesia.

The analyzed region belongs to Silesia and it makes the Jeseník area strange if we take into account the political factors that had been shaping regional identity. The fact that the Jeseník area belongs to Silesia was formerly generally accepted by local inhabitants. Moreover, this fact was one of the important attributes of the Jeseník area regional identity, which can be demonstrated by testimonies of displaced witnesses (Procházka, 2007). The border between Moravia and Silesia, then, represented a certain limit of the thus conceived regional identity of the local population in the Jeseník area. It was probably a very good image of the border that helped generate a relatively strong connection between residents and the Jeseník area.

As outlined above, it was the level of awareness of the boundary that was analyzed among the Jeseník area population. In other words, we compared an objective reality, i.e. the real behaviour of the boundary, with a subjective image of this entity as created by people living in the Jeseník area. These subjective images are the results of processes of perception. Definitions of perception can be found for example in The Dictionary of Human Geography (2009): perception should be understood in the widest sense, referring to both the bio-psychological idiosyncrasies of individual sensing, information processing and cognition, and the issue of collective cultural beliefs, values and aesthetic judgements concerning natural and built environments. An alternative definition of perception is offered by Golledge and Stimson (1997), who see it as the immediate apprehension of information about the environment by one or more of the senses, as well as secondary environmental information culled from the media and through hearsay via communication with fellow human beings.

Thus, perception is considered to be the result of mental activity which is produced by noticing current stimuli in the environment and the ability of imagination. Images which are the results of such a process are stored in the human mind and can be recalled, if necessary. What shapes its actual form are circumstances in which it is necessary to use perception. The quality of these perceptions is also affected by various factors such as age and related personal experience, education, information given by people we meet every day, media or a relationship to the object perceived. Therefore, perception cannot be understood as something static, fixed in the mind – it develops and transforms. Concerning these changes, we can define two basic trends. The first one is reduction of image quality as a result of forgetfulness; the second is, on the contrary, improvement of images particularly due to their frequent recall.

Although geographical research of perception has never been at the core of human geography research, the significance of perception surveys can be demonstrated by a relatively early interest in this issue in geography from the 1940s and the 1950s. In the 1960s, the systematic understanding of perception of the geographical environment as a new and significant topic relevant to geography emerged. Bunting and Guelke (1979) point out that the realisation of many studies of this phenomenon began in this period. Such a boom led to perceptual geography being recognized as a separate discipline by some researchers (Tuan, 2003). Although many experts argue against or even disagree with such a defined sub-branch of the scientific discipline, the influence of perception studies on the later focus of cultural geographic studies is, according to Tuan (2003), evident.

The authors of this paper decided to use the mental map as a tool for testing the perception quality of the entity analyzed – the border between two historical lands. A definition of the meaning of the term 'mental map' is not easy because the concept is used in many disciplines, such as psychology (the idea of a mental, or more specifically of a cognitive map was invented by the psychologist E. C. Tolman), sociology, cartography, and last but not least geography (Lloyd, 1989). The geographical concept of mental maps can be represented by Yi-Fu Tuan, one of the main representatives of humanistic geography in the 20th century. Tuan (1975) believes that a mental map is a special kind of image which is even less directly related to sensory experience – that the mental map could be the cartographic representation of peoples' attitudes toward places for geographers. In the Czech context, 'mental map' was defined by Drbohlav (1991), who described it as a graphic, cartographic or schematic expression of a man's concepts of geographical space, often about its quality or organization. Mental maps can be understood as a construct arising from internal psychological processes. However, there are also external factors influencing mental maps (e.g. the length of stay in a place we create the image of) which form this construct carefully. Mental maps have very important functions and one of them is that they are sources of information for decision-making processes that result in spatial behaviour within an environment (Lloyd, 1989). They could be viewed as a mnemonic device; it allows mental practice which promotes assurance in subsequent physical performance. Mental maps have yet another function in geographical knowledge (Tuan, 1975). Like real maps, they are means to structure and store knowledge. It is a way to organize data.

The latter function makes the mental map an appropriate tool for the assessment of mental images of the boundary among the Jeseník area population. This choice is also supported by one of the attributes of a mental map, which is its graphics, its visualisation. Graphically depicted images of space or perceptions of specific entities that are part of a certain space, can be readily analyzed. In the case of a relatively specific entity, which the border undoubtedly is, it is a complicated but achievable process. This method was used in Polish geography for research dealing with the subjective perception of borders and spatial delimitation of Greater Poland Voivodeship by local youth (Dolata, Konecka-Szydłowska, Perdał, 2009). Even despite the fact that the study of borders, and in the narrow sense the study of a relict border of historical lands (Toušek, Šich, Vašíček, 1991), is part of contemporary geographical research, in the Czech Republic no analysis of a specific boundary on the basis of a mental map has been done so far.

Despite this finding, this contribution is not the first case when a mental map has been used for research in the Czech environment; on the contrary, the concept of mental maps has been known in Czech geography for quite a long time. Hynek (1991) points out that geographers from Charles University informed their students about the existence of spatial image mapping in the 1970s. Although mental maps were not used in research on geographical environment perception at that time and not even the above-mentioned geographers used them, the introduction of mental maps to the Czech environment is ascribed explicitly to these geographers from Charles University.

The application of mental maps in the research of spatial images was introduced at the beginning of the 1980s when Hynek's studies using mental maps, which analyzed the nature of perception of the environment, cities or landscape, emerged (e.g. Hynek, Hynková, 1980; Hynek, 1984).

In spite of this quite early application of mental maps in geographical research, it must be mentioned that the use of mental maps as a component of methodological apparatus in Czech geographical research is relatively rare. However, there are a few exceptions. Even before 1989, the concept of mental maps was applied by Siwek (1988) who studied the attractiveness of individual regions of the former Czechoslovakia. In the early '90s, the issue of mental maps was discussed by Drbohlav (1991), who attempted to define the term 'mental map', thought about the formative factors of mental maps, and suggested possibilities for their application. In the second half of the '90s, Voženílek (1997) tried to assess the mutual relation of mental maps and mental spatial images. In the current millennium, it is mainly Siwek who uses mental maps in his scientific research, thanks to which he analyzed the current situation of Silesian identity (Siwek, Kaňok, 2000). He later used mental maps in a survey dealing with the identity of cultural historical regions of the Czech Republic (Siwek, Bogdová, 2007).

3. Research methods

In order to obtain sufficient data to assess the quality of perception of the historical border by local inhabitants, a questionnaire survey was carried out in May 2009, with a final sample size of 420.

The questionnaire focused on issues reflecting some aspects of regional identity, including part of a map containing the basic settlement structure and communication network. Respondents were asked to draw their image of where the border between Moravia and Silesia lies.

The assignment of a particular area to a given historical land was then defined by whether such area was regarded as Moravia or Silesia by an absolute majority of all respondents. It can then be said that the final delimitation of the border was based on the median value of the analyzed questionnaire data.

The term 'median' is a well-known statistic equivalent to the value which divides the studied sample into two equal sections. However, in geography the median is understood differently (it is not of purely numerical nature) and is defined by centrographic methods. Centrography is a descriptive statistical method used for measuring and spatial delimitation of various (even weighted) average or mean values of the sample or for the definition of spatial dispersion of its values. Kellerman (1981) considers centrography a powerful tool for the description and analysis of data in all branches of geography.

The use of centrography in the study of mental maps is demonstrated by Ebdon (1977), who tried to assess the results of mental spatial images drawn by students at the University of Nottingham by defining mean centres and ellipses of dispersion.

As mentioned above, the centrographic method is most often used to construct a 'mean centre' or 'median centre' (sometimes also misleadingly called the centre of gravity) which, however, characterize the whole sample of geographical diversity by one item, and so they deprive it of a part of its geographical nature. As to the studied phenomenon of the Moravia-Silesian border, which has a linear character, the authors were concerned not only with the creation of the median centre but they attempted a more geographical concept of median creation by curve construction.

Geographical information systems (GIS) seemed to be the most appropriate for the processing of mental maps, or more specifically of borders depicted on them, their analysis and the further visualisation of results.

The first step of the procedure was to transfer the completed questionnaires into a digital form, putting all the responses into a database and to scan the mental maps. Then the scanned maps in the form of images were uploaded into the GIS where they were georeferenced, and borders made by respondents were digitized into the format of vector polyline layers.

The pre-prepared vector polygon layer (made by one polygon) which delimited the area given to respondents for drawing the boundary, was then for every questionnaire split according to the recorded border into sections (polygons). Thus, 420 new polygon layers emerged that were used in the next phase of the analysis.

At this point it was necessary to define every polygon, whether it is labelled Moravia or Silesia. This was achieved through changing values for all records (polygons) in a column 'ID' in an attribute table of each layer depending on whether a respondent selected Moravia or Silesia according to the key: Moravia = 0; Silesia = 1.

Each polygon layer modified in this way was converted into a raster layer (all layers were set to the same pixel size which corresponded to a square of 50 × 50 metres in reality, which provides sufficient detail for further analysis) while keeping the 'ID' attribute values – every pixel of a newly created raster layer bearing either the value 0 (Moravia) or 1 (Silesia). Raster layers made by the process described above were subsequently layered and counted up. Strictly speaking, values of pixels lying in the straight vertical succession were counted up, which led to the creation of a new raster layer as shown schematically in Fig. 2.

Pixels bearing the same counted value were logically located in clusters whose presence was of a linear character, in other words, these clusters occurred in some 'stripes'.

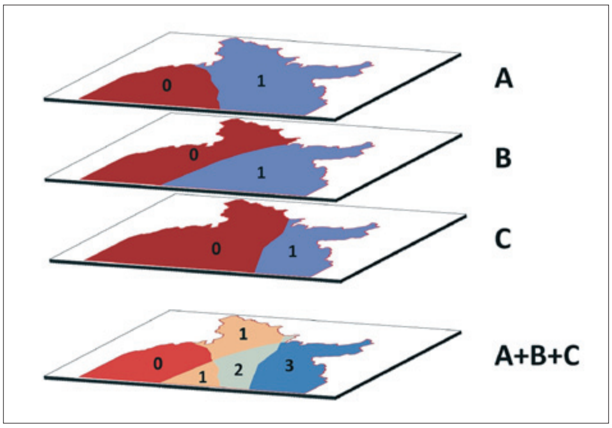

Fig. 2: Schematic representation of raster addition (Compiled by authors)

A median value of the sample which was used to draw mental images of the border line helps to define each pixel if it is Moravia or Silesia – i.e. if that pixel was classified by an absolute majority of respondents as Moravia or Silesia.

One of the centrographic methods was also used in processing the border line itself. At this point, however, it was the calculation of geometric centres of polygons (centroids) in the layer which was created by the conversion of pixel clusters carrying the value of the median from the raster to the vector form. Due to the nature of centroids, a new point vector layer depicting geometric centres of polygons emerged. From the spatial sequence of these points, a line representing the desired border of the two areas was created by connecting these points.

4. Characteristics of the sample

The questionnaire survey was conducted in May 2009 in the Jeseník administrative district. In total, 420 persons were surveyed, residents of the district. The respondents were subsequently divided into four main categories, according to identifiers that were included in the questionnaires. The identifiers generating the final form of the structure were: sex, age, level of education and place of birth, or more specifically the length of time during which the person had lived in the municipality of the study area (Tab. 2).

The similarity of age and education structures, structures by gender and birth place of the sample inhabitants with the same structures of total population living in the Jeseník area, was verified by a χ^2 test: see the following Tab. 3.

The χ^2 test showed at a significance level of 5%, agreement between the sampled set of respondents with the total population of the Jeseník area in the case of gender, age and birthplace structures. On the other hand, a substantial disagreement was identified in education structures of the sample which is indicated by the fact that the resulting value of the criterion significantly exceeded the critical value. The reason of this incongruity lies in the exceptionally high proportion (11.3%) of people having a university diploma in the sample.

In summary, it can be said that the sample group forms a representative sample of the total population in the Jeseník area with the only exception being the education structure.

5. Results

The analysis of collected mental maps offered quite interesting findings. Based on our analysis, it can be said that the perceptions of Jeseník area residents about the border lying between Moravia and Silesia does not correspond with its real position. The resulting perception of all respondents can be characterised as follows: the image of the border was perceived by respondents similarly to the actual border, from northwest to southeast, while the spatial localisation of lines significantly differed. Throughout all the course of the mental image of the border, it 'cuts off' part of Silesia in favour of Moravia, and this tendency is more obvious in the north rather than in the south. The resulting image of the border is inappropriately settled outside the peak parts of the Jeseník mountain range into low elevated areas located to the north of the massif. This is quite a surprising finding because

<table>
<tr><th colspan="6">Time spent in the area as resident</th></tr>
<tr><td>Natives</td><td colspan="2">Bigger part of life</td><td colspan="2">Lesser part of life</td><td>Short-lived</td></tr>
<tr><td>45.5</td><td colspan="2">33.5</td><td colspan="2">14.0</td><td>7.0</td></tr>
<tr><th colspan="6">Age group</th></tr>
<tr><td>15–24</td><td>25–34</td><td>35–44</td><td>45–54</td><td>55–64</td><td>65+</td></tr>
<tr><td>21.6</td><td>14.3</td><td>16.9</td><td>14.6</td><td>18.9</td><td>13.7</td></tr>
<tr><th colspan="6">Education</th></tr>
<tr><td>Elementary</td><td colspan="2">Secondary school without graduation</td><td colspan="2">Secondary schoowith graduation</td><td>University</td></tr>
<tr><td>19.6</td><td colspan="2">37.2</td><td colspan="2">31.9</td><td>11.3</td></tr>
<tr><th colspan="6">Gender</th></tr>
<tr><td colspan="3">males</td><td colspan="3">females</td></tr>
<tr><td colspan="3">50.8</td><td colspan="3">49.2</td></tr>
</table>

Tab. 2: Characteristics of respondents (%), authors' processing

	Value of criteria	Critical value	Structure answers
structure by gender	0.16	χ^2 (0.05;1)	Yes
		3.84	
age structure	11.05	χ^2 (0.05;5)	Yes
		11.07	
educational structure	32.04	χ^2 (0.05;3)	No
		7.81	
structure by a birthplace	1.12	χ^2 (0.05;1)	Yes
		3.84	

Tab. 3: χ^2 test results (Sources: CZSO 2003, CZSO 2010, field survey, authors' processing)

the administrative boundary is, in this case, connected with a conspicuous physical geographical barrier (the Hrubý Jeseník Mts). The connection of the physical barrier with the assessed boundary should make the accuracy of the perception easier.

There were a few findings that are surprising. Firstly, the region's centre, the city of Jeseník, was intersected by the mental image of the border; the respondents did not assign it to Silesia unequivocally. Secondly, the line that defined the Moravian Osoblaha exclave (the foreland located to the east of the area studied) whose genesis and delimitation was described in detail by Trávníček (1966), was not drawn by any respondent.

The extent of border images drawn by the respondents significantly differed. These differences are most apparent in the north-western part of the analyzed area where the respondents showed greatest uncertainty. On the other hand, much more confidence was shown in depicting the course of the border in its southern part. Thus, we have a paradoxical situation when the respondents were able to agree on the course of the boundary which is perceived outside the analyzed region, while its course in the Jeseník area and its surroundings is much more ambiguous, as demonstrated in Fig. 3.

Partial analyses of the maps drawn by respondents showed significant differences between the identified structures. The differences appear in perceptions of women and men, with the men's perception more accurate. Men's notion about the border is located to the north of the actual border, while its course is oriented similarly from the northwest to the southeast. The mental image of women is situated in the approximate direction from the north to the south, which leads to a more significant deviation from the actual territorial border. With respect to the time they have had their abode in the Jeseník area, it was surprising that the most accurate notion about the border was given by people living in this region for a short period. Respondents living in this region for only a short part of their lives and also respondents who declared they had lived there most of their lives, indicated a deformed mental image of the border; its course significantly deviated from the actual border in both cases. Paradoxically, the results of countrymen, whose mental images of the border were expected to be the most accurate, corresponded least with the objective reality.

Concerning the age structure of respondents, inhabitants from 45 to 54 years can be regarded, from all the categories, as bearers of the most accurate image about the course of the border. Also the notions of the oldest respondents are very close to the actual border. The least credible image was produced by the age group from 35 to 44 – children of the generation that appeared in the Jeseník area after the war. In their case, we noticed a significant deformation of the image of the analyzed border.

The analysis also showed that the quality of the image is influenced by the level of education. Perceptions of university educated people create an image that corresponds to the objective boundary the most of all structural subcategories. Regarding the respondents with primary or secondary education, the course of the subjectively perceived border did not differ a lot. These groups showed similar depictions of very inaccurate images of the border (Fig. 4).

6. Conclusions

This analysis represents an effort to map the level of perception of a specific entity – a relict border, respectively administrative border of the territory. The authors tried to contribute to knowledge (in their opinion not so much hitherto reflected in Czech geography) of spatial concepts of border regions, as they are stored in the minds of people living in these spatial units. If we consider only regions with interrupted tradition, areas affected by a significant change in post-war population, the study can be seen as the first effort in trying to penetrate beneath the surface of this issue.

From the North, the Jeseník area is defined by the state border with Poland. In the case of this border, an accurate fixation of the entity in the minds of local inhabitants was expected. This is the reason why the authors focused their attention on the land border demarcating the studied area from the South.

Based on results of the analysis, the perception of the historical border between Moravia and Silesia by the local population can be identified as having only little correspondence to the objective reality. Nor did the above-average representation of university-educated people, whose presence among the respondents acted demonstrably positively on image quality, guarantee a more accurate perception of the land border. In the background of the negative finding may be the nature of the relict border, although this can be viewed on the border since 1928, when it lost its function as a land border (its administrative function was still preserved by defining the political district of Jeseník), and yet the border was most likely generally anchored in the

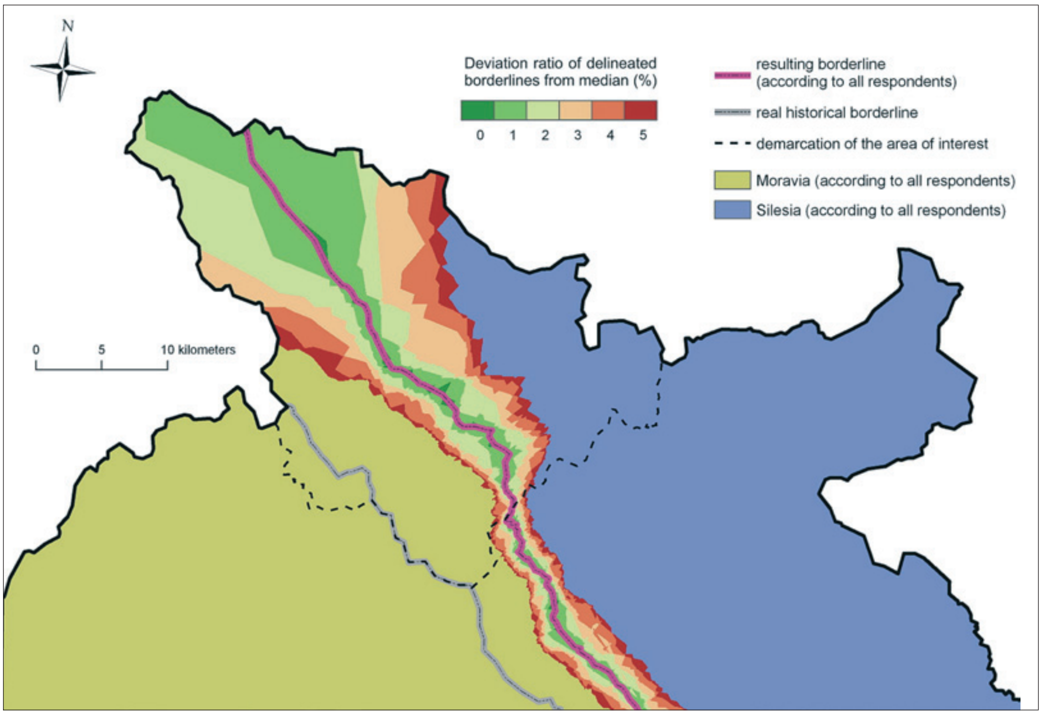

Fig. 3: Final resulting image of border according to all respondents
Source: authors' processing of survey data

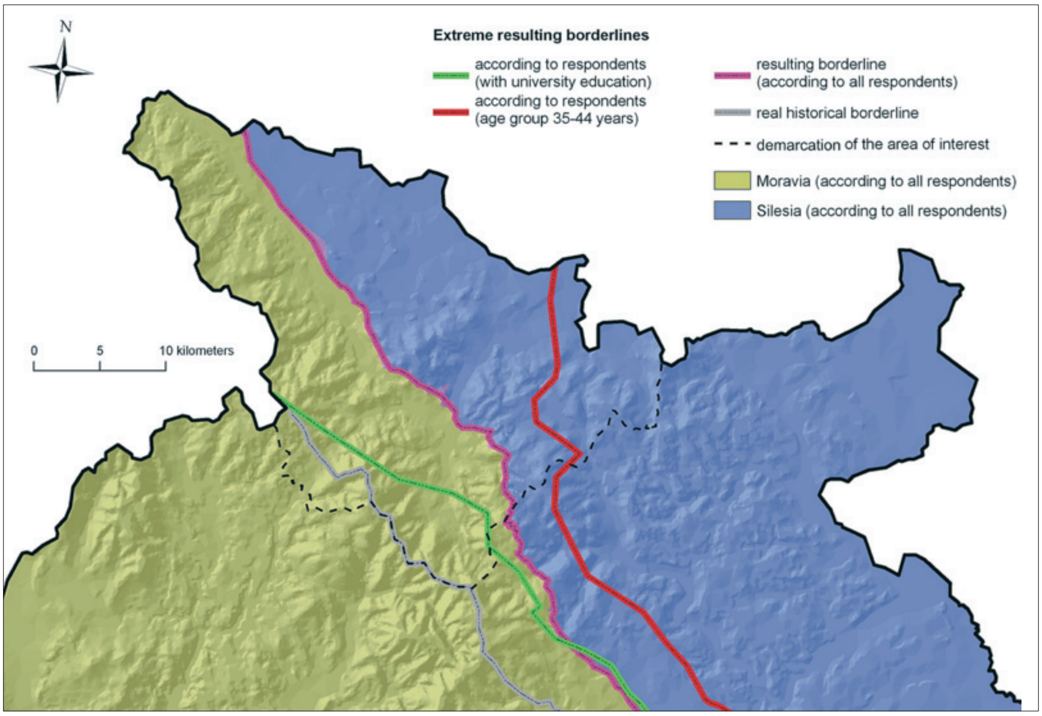

Fig. 4: The best and the worst resulting images according to population sub-groups
Source: authors' processing of survey data

consciousness of local people. On the other hand, an essential part of the evaluated entity is created by the current borderline of a relatively new administrative unit, which apparently is not in the public awareness (not only in the Jeseník area).

The relatively inaccurate image of the border can also be due to poor geographical knowledge of residents about their territory. Another reason could be the fact that the border does not have much significance for the current population of the Jeseník area. This statement implicitly emerged from informal interviews conducted with some of the respondents. From this finding, we can identify the position held by the assessed border as an eventual constituent of regional identity of the population, as very weak. This position expressed by the surveyed mental images evokes presumption of a deformed spatial range of regional identity of the Jeseník area inhabitants. This deformation manifests a lack of clarity and particularly spatial shrinkage in comparison with the probable regional identity of the population that had been displaced from this territory after the war.

One group of respondents was found from the sample whose image of the borderline was very accurate. The analysis showed that they were university-educated respondents and people from 45 to 54 years of age. The spatial range of regional identity of these groups can therefore be seen as broader than the spatial range of the remaining respondents.

The current results of this study can not be generalized yet. The creation of unambiguous conclusions from the analysis of one region would be misleading. Comparison of findings presented in this study with the knowledge that would emerge from research on other regions with interrupted traditions, seems to be inspiring for further research. Also, a comparison with areas that could be identified as traditional, could help formulate more general conclusions about the true nature of border perceptions, especially the spatial range of regional identities of inhabitants in regions with interrupted or continuous traditions.

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References:

BALEK, P. (2005): Některé aspekty regionální identity v českém pohraničí. In: Zich, F. [ed.]: Přeshraniční vlivy působící na místní společenství pohraničí České republiky. UJEP, Ústí nad Labem, p. 89–103.

BARTOŠ, J., SCHULZ, J., TRAPL, M. (1994): Historický místopis Moravy a Slezska v letech 1848–1960. Svazek XIII. Vydavatelství UP v Olomouci, Olomouc, 228 pp.

BROWN, K., CULLEN, C. (2006): Maslow's hierarchy of needs used to measure motivation for religious behaviour. Mental Health, Religion & Culture March, Vol. 9, No. 1, p. 99–108.

BUNTING, T. E., GUELKE, E. (1979): Behavioral and perception geography: A critical appraisal. Annals of the Association of American Geographers, Vol. 69, p. 448–462.

CZSO (1951): Soupisy obyvatelstva v Československu v letech 1946 a 1947. Český statitsktický úřad, Praha.

CZSO (2003): Sčítání lidu, domů a bytů 2001 – okres Jeseník [online]. Olomouc: CZSO, 2003 [cit. 2010-11-23]. URL: <http://www.czso.cz/xm/edicniplan.nsf/p/13-7103-03>.

CZSO (2010): Statistická ročenka Olomouckého kraje [online]. Olomouc: CZSO, 2010 [cit. 2010-11-24]. URL: <http://www.czso.cz/xm/edicniplan.nsf/kapitola/711011-09-2009-14>.

DOLATA, M., KONECKA-SZYDŁOWSKA, B., PERDAŁ, R. (2009): Świadomość regionalna młodego pokolenia Wielkopolan. Biuletyn Instytutu Geografii Społeczno-Ekonomicznej i Gospodarki Przestrzennej Uniwersytetu im. Adama Mickiewicza w Poznaniu. No. 9, p. 21–43.

DRBOHLAV, D. (1991): Mentální mapa ČSFR. Definice, aplikace, podmíněnost. Sborník České geografické společnosti, Vol. 96, No. 3, p. 163–176.

EBDON, D. (1977): Statistics in Geography: A Practical approach. Blackwell Publisher, Oxford.

GOLLEDGE, R. G., STIMSON, R. J. (1997): Spatial Behavior: A Geographic Perspective. Guilford Press, New York, 620 pp.

GREGORY, D., JOHNSTON, J. et al. (2009): The Dictionary of Human Geography. 5th edition. Wiley-Blackwell, Chichester, 1 052 pp.

HÄKLI, J. (2008): Re-bordering Spaces. In: The SAGE Handbook of Political Geography. SAGE, London, p. 471–482.

HUBÁČKOVÁ, V. (2006): Slovácko: vymezení hranic regionu. Česká geografie v evropském prostoru. Pedagogická fakulta Jihočeské univerzity, České Budějovice, p. 577–582.

HYNEK, A., HYNKOVÁ, J. (1980): Percepce prostředí a mentální mapy ve výchově k péči o životní prostředí. Scripta fac. sci. nat. Univ. Purk. Brun., Vol. 10, No. 5, p. 233–248.

HYNEK, A. (1984): Percepce krajinného životního prostředí. Folia fac. sci. nat. Univ. Purk. Brun., Vol. 25, No. 11, p. 55–69.

HYNEK, A. (1991): Ke geografii nejen behaviorální. Sborník ČSGS, Vol. 96, No. 3, p. 192–194.

CHROMÝ, P. (2003): Formování regionální identity. In: Geografie na cestách poznání: Sborník příspěvků k šedesátinám Ivana Bičíka. Univerzita Karlova, Praha, p. 163–178.

CHROMÝ, P., SKÁLA, J. (2010): Kulturněgeografické aspekty rozvoje příhraničních periferií: analýza vybraných složek územní identity obyvatelstva Sušicka. Geografie. Sborník ČGS, Vol. 115, No. 2, p. 223–246.

KELLERMAN, A. (1981): Centrographic methods in geography. Concepts and techniques in modern geography. Geobooks, Norwich.

LLOYD, R. (1989): Cognitive maps: Encoding and Decoding Information. Annals of the Association of American Geographers, Vol. 79, No. 1, p. 101–124.

PAASI, A. (1986): The institutionalization of regions: a theoretical framework for understanding the emergence of regions and the constitution of regional identity. Fennia 164, pp. 105–46.

PAASI, A. (2002): Place and region: regional worlds and words. Progress in Human Geography, Vol. 26, No. 6, p. 802–811.

PAASI, A. (2003): Region and place: regional identity in question. Progress in Human Geography, Vol. 27, No. 4, p. 475–485.

PENROSE, J., MOLE, R. C. M. (2008): Nation-States and National Identity. In: The SAGE Handbook of Political Geography. SAGE, London, p. 271–285.

PROCHÁZKA, P. (2007): Příběhy z pohraničí. Brontosaurus, Jeseník, 151 pp.

RAAGMAA, G. (2002): Regional identity in regional development and planning. European Planning Studies, Vol. 10, p. 55–76.

SIWEK, T. (1988): Území Československa očima studentů geografie. Sborník ČSGS, Vol. 93, No. 1, p. 31–37.

SIWEK, T., KAŇOK, J. (2000): Vědomí slezské identity v mentální mapě. Ostravská univerzita, Ostrava, 97 pp.

SIWEK, T., BOGDOVÁ, K. (2007): České kulturně historické regiony ve vědomí svých obyvatel. Sociologický časopis, Vol. 43, No. 4, p. 1039–1053.

TRÁVNÍČEK, D. (1966): Příspěvek k historicko-geografickému vývoji moravských enkláv ve Slezsku. Acta Universitatis Palackianae Olomucensis Facultas Rerum Naturalium. Tom 20, Geographica – Geologica VII., p. 341–355.

TOUŠEK, V., ŠICH, P., VAŠÍČEK, P. (1991): Zemská hranice mezi Čechami a Moravou. Sborník ČSGS, Vol. 96, No. 1, p. 45–48.

TUAN, Y. F. (1975): Images and mental maps. Annals of the Association of American Geographers, Vol. 65, No. 2, p. 205–213.

TUAN, Y. F. (2003): Perceptual and cultural geography: a commentary. Annals of the Association of American Geographers, Vol. 93, No. 4, p. 878–881.

VOŽENÍLEK, V. (1997): Mentální mapa a mentální prostorové představy. Geodetický a kartografický obzor, Vol. 43, No. 1, p. 9–14.

ZICH, F. (2003): Regionální identita Euroregionu Nisa. In: Zich, F. [ed.]: Regionální identita obyvatel v pohraničí. Sociologický ústav Akademie věd ČR, Praha, p. 17–57.

ŽIGRAI, F. (2000): Možnosť použiťia územnej identity ako kritéria při vymedzování územno-správnych jednotek. Geografické štúdie, No. 7, p. 2–11.

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AN EXAMINATION OF PROPOSALS FOR BANK STABILIZATION: THE CASE OF THE BRNO WATER RESERVOIR (CZECH REPUBLIC)

Miloslav ŠLEZINGR, Jitka FIALOVÁ

Abstract

The design of reliable bank stabilization of streams and dams, functional from a long-term perspective, has been long discussed worldwide. For centuries, we have been dealing with the problem of depositing the flow-transported material and material from eroding banks or soil washed off directly to the reservoir due to surface erosion. The main stress has been laid on the minimum amount of this transported material and on minimized wash off into the stream channel. Significantly less energy has been put into reservoir bank stabilization. This problem is solved in this article and results are presented.

Shrnutí

Posouzení návrhů na stabilizaci břehů: Případ přehrady v Brně, Česká republika

Návrhy spolehlivé stabilizace břehů toků a přehrad, funkční z dlouhodobého hlediska, jsou již dlouho diskutovány po celém světě. Po staletí jsme se zabývali jako lidstvo problematikou ukládání transportovaného materiálu a materiálu z erodovaných břehů nebo zeminou, která je smývána přímo do nádrže v důsledku povrchové eroze. Hlavní důraz je kladen na minimalizaci množství tohoto transportovaného materiálu a minimalizaci smyvů do koryta toků. Podstatně méně energie bylo vkládáno do oblasti stabilizace břehů nádrží. Tento problém je řešen v článku a jsou prezentovány výsledky.

Keywords: *erosion, vegetation, geosynthetics, Brno Water reservoir, Czech Republic*

1. Introduction

Reservoir bank erosion may occur in two ways. A major problem is usually aeolian erosion caused by wave action (from wind). Although, problems are also caused by wave action caused by the movement of boats, fluctuating water levels, cycles of frost and snowmelt, etc., not to mention erosion caused by direct anthropogenic interference, initial bank instability of the newly filled reservoir, etc. The subject of the grant project GAČR 103/04/0731 and follow-up projects was to design reliable, cost-effective stabilization of banks exposed to abrasion by using biological or biotechnical stabilization elements. One option is to design biotechnical bank stabilization with geosynthetic nets (geonets). Geonets may be used directly as a stabilization element for reservoir banks susceptible to less serious bank erosion or as a functional supplement to the biotechnical bank stabilization. Here, the main stabilization element is usually a riprap toe, and further reinforcement may be designed up the bank with earth armouring – using geonets. It is worth explaining at the beginning what a bank susceptible to abrasion means.

The Brno Water reservoir was chosen as a model area. For the water reservoir localization – see Fig. 1. The Brno Water reservoir is located in the Podkomorský les Forest northwest of the Brno city, on the Svratka River. It is one of water works the history of which dates back before

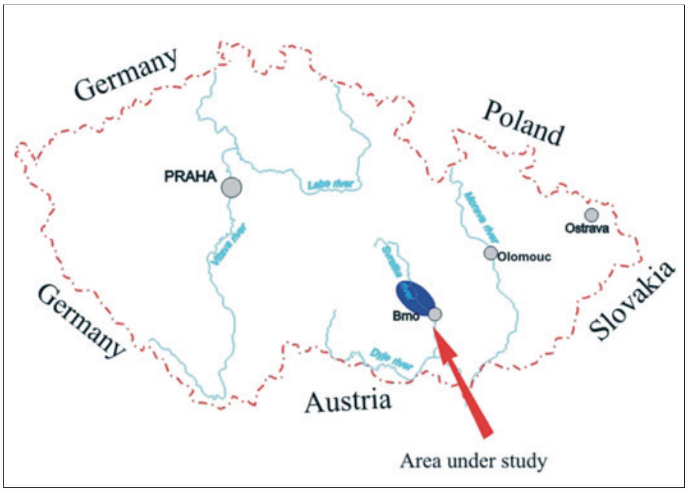


Fig. 1 Area under study

World War II. The water reservoir was put into operation in 1940. The main purpose for the water reservoir construction was to ensure a sufficient amount of irrigation and drinking water for the Brno agglomeration, and the next purpose was protection from floods. From the very beginning, it was planned also as a source of energy and a place for recreation.

Water capacity is 21 million m^3 and altitude is 229.08 m a.s.l. The reservoir occupies an area of about 270 hectares, has a length of 10 km and stretches up to the town of Veverská Bitýška. The maximum reservoir depth is 23.5 m (Šlezingr, 1998).

The underlying bedrock of the reservoir is built mainly of the Brno pluton. The Svratka R. cuts its valley through massive diorite rocks bordering a greater part of the left bank of the main reservoir basin. In the middle part of the reservoir, diorite alternates with biotitic granite, only the end of the inundated area is reached by Permian conglomerates of the Boskovická brázda Furrow, continued by a narrow stripe of upper Devonian limestones. To the southwest of the reservoir, the depression in the Brno pluton is filled by the Tertiary clay (Kubíček, 1987).

Linhart (1954) states that loess is eroded by flowing water more than other rocks, so the occasional torrent rains formed a narrow gorge with vertical walls at the Brno water reservoir, in rare cases reaching a depth from 8 to 10 m. When examining the effect of water on the coast, wind and water level surface have to be taken into account. The prevailing wind direction at the Brno water reservoir is northwest and the abraded coast area is situated just against the prevailing winds. Waves occurring in this area are high from 50 to 100 cm and surf is very effective. In addition to the waves of wind and waves caused by motor boat traffic especially in spring and summer months, can we observe free and forced waves.

For bank abrasion to form and develop, three basic conditions must be met concurrently (Šlezingr, 2011):

1. Reservoir bank slope exceeding 5–7%,
2. Reservoir bank consisting of erodible material, and
3. Wind "run" on the water level reaching towards the problematic bank (see points 1 and 2) of at least dozens of metres. Upon meeting these conditions, a formation and subsequent development of bank abrasion may be anticipated almost surely (the Osada locality on the Brno reservoir may be mentioned as an example, Fig. 2 – see cover p. 3). However, all three conditions must be met at the same time; otherwise no significant abrasion/erosion would occur (e.g. banks of the Brno reservoir in the Kozí Horka locality). The extent and dangerousness of bank erosion depend on the combination of the above factors. The biggest problems occur with steep slopes formed of easily eroded material (e.g. loess) in shoreline areas with a wind run of many kilometres.

2. Material and methods

Agharazi (2004) carried out research in the region of Gharechy River (Iran). The region was visited to consider tree cover effects on decreasing bank erosion. Four treatments were chosen as follows: 1) direct way with the tree cover, 2) indirect way without the tree cover, 3) meanders with trees, and, 4) meanders without trees. Field observations show that there were serious erosion and destruction in outer bends without the tree cover. In direct ways and outer bends with willow trees which grew in two rows at the river bank, erosion and destruction were under control. In direct ways without trees, more erosion and destruction in erect parapets occurred because of underscouring and overturning of parapets. Trees were taken from the flooded and coastal fields of this region. It is recommended that in erect parapets, one row of cut willow and on low slopes two or three rows of cut willow are cultivated.

As revealed by experiments (e.g. Šlezingr, 2010, 2007), river beds with cohesive sediments under constant flow conditions stabilize themselves after showing extensive initial erosion. During erosion, grain size distribution of the upper soil layer considerably changes. Neither clay nor silt nor sand were oriented in a preferential direction. Every alteration of flow conditions however, causes adaption of water content in soil, changing the soil properties. It is for this reason that the hydraulic behaviour of the bed differs considerably from that of a technical rough surface. (Krier, Schroeder, 1988).

Another example is the Harland Creek, in east-central Mississippi. It is a rapidly migrating, meandering stream that is experiencing severe bank erosion. More than 9,000 willow (*Salix nigra*) posts were emplaced in February 1994 by the U.S. Army, Corps of Engineers in an effort to stabilize the eroding stream banks using an experimental bioengineering technique. Monitoring of this stream reach and the willow post bank stabilization resulted in a data base to assess willow mortality as related to bank aspect, post diameter, cover, and base elevation above low water. Monitoring has also resulted in the development of revised construction guidelines. The survivability of the posts, a necessary condition for long-term success, was found to be on average 81% in May 1994, 43% in October 1994 and 41% in August 1995. Even with survivability as low as 29–34% at specific bending reaches, willow posts are documented to be successful in bank stabilization for the period of monitoring as compared with more traditional riprap stabilization methods. Guidelines for improved survivability and recommended site selection are presented. The cost of willow post bank stabilization is less than riprap, which is the traditional form of bank protection, and willow posts can be emplaced using readily available equipment and materials. (Watson et al., 1997).

Kubíček (1987) found out that the abrasion progress rate is dropping in the same way as the abrasion volume depending on time, in the case of the Brno reservoir. On steep slopes a hollow is formed in the summer season due to the action of waves.

Root-shoot dimensions and dry biomass of samples of ten dominant species from the bank profiles of the Neebing-McIntyre Floodway, Thunder Bay (Ontario, Canada) were significantly different from one micro-habitat to another. These differences were used as the basis for interpreting the allocation of energy in different components of plants that helped them colonize specific micro-habitats along the bank profiles of the floodway. Thus, *Deschampsia flexuosa*, the dominant plant on the bank slope, allocates about 90% of its biomass in its shallow but dense root systems (compared to its shoots), which provides protection to the bank slope from surface runoff. *Alnus rugosa* and *Salix bebbiana*, dominant on erosional scarps, allocate almost equal amounts of biomass in their above-ground and below-ground components, but have long tap roots, which help them colonize the steep scarp face. Plants on the bench and under-water shelf, such as *Juncus nodosus* and *Saggitaria latifolia*, allocate disproportionately large amounts of biomass to their above-ground components, which are exposed to the dynamic forces of waves and currents. Overall, the study indicates that root-shoot architecture and biomass can be used as biotechnical criteria in selecting riparian plants for bank stabilization of flood control channels. (Mallik, Rashid, 1993).

Geosynthetic meshes (geomeshes) ENKAMAT 7220, 7010 and Tensar Mat were used for „earth armour“. A number of obtained specimens of particular geomeshes were examined, even in laboratory conditions, including their technical parameters. After fitting the three types of geomeshes (ENKAMAT 7220, 7010 and Tensar Mat) in the modified slope (laying and fixing of geomesh + filling) we proceeded to plant cuttings of suitable woody plants chosen beforehand. They were selected species of shrubby willows, namely Salix fluviatilis, Salix purpurea and Salix triandra. Of course, a number of plantations in experimental boxes had to be ruined due to educational reasons in the course of the experiment. Differences in the receding shore line between the slope stabilised with a suitable earth armour supported by root systems of selected woody plants and the slope stabilised only with using biological stabilisation, i.e. only willow cuttings without the earth armour, were visible after one vegetation season. (Šlezingr, 2007).

3. Theory

The aim of this article is to present newly designed bank stabilization with the use of geonets (geo-mattresses). They are used relatively often for bank stabilization, but mostly in road, railway and civil engineering. They have only been used rarely for the stabilization of stream banks and reservoir shoreline (Fig. 3).

A big advantage of earth reinforcement – i.e. the use of geonets (geo-mattresses), with the contribution of root systems of suitable woody plants and herbs – is their “invisibility” in the stabilized bank. Geonet is incorporated into the bank, upon laying it is filled with bank soil, becoming a part of it. In a bank slope of approximately 1 : 2, it takes a stabilizing function, one could say, in the horizontal direction, while the root system plays the same role in a more vertical direction. The combination of these two systems provides for a greater soil “bonding” in the created earth armouring, enhancing its stability.

During the work on the above mentioned grant project, partial tasks of bank slope stability were resolved. We focused on ascertaining root tensile strength, joint action of roots and soil, selection of suitable woody plants, problems of suitable earth reinforcement design and the method of its working into the bank.

Before presenting some results, it is important to present a scale of possible bank erosion. This problem was studied by Lukáč and Abaffy (1980), by Šlezingr (2005) among others.

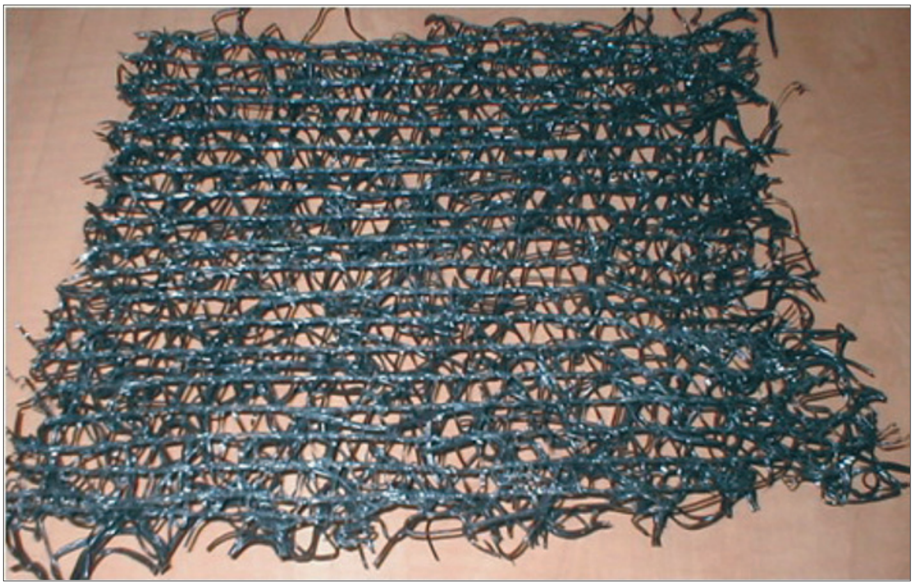
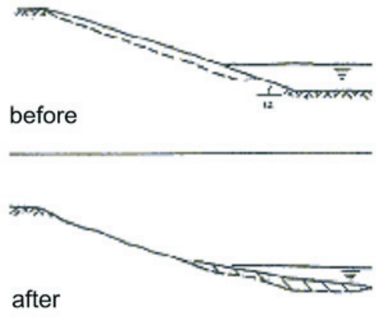
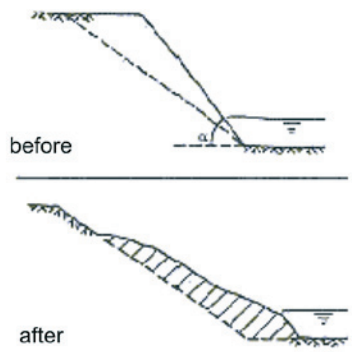
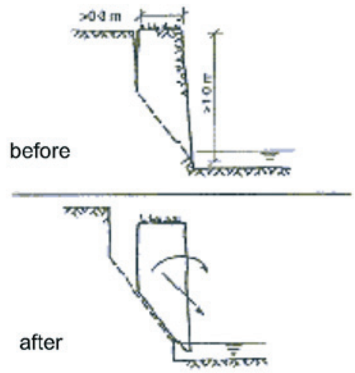
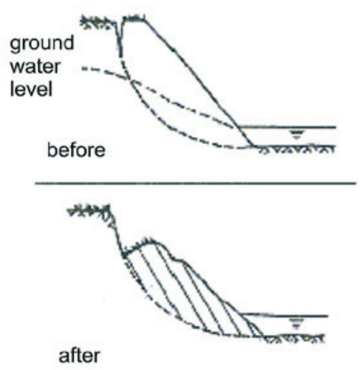
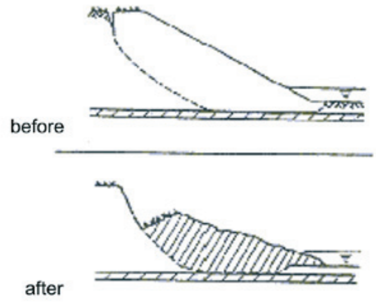
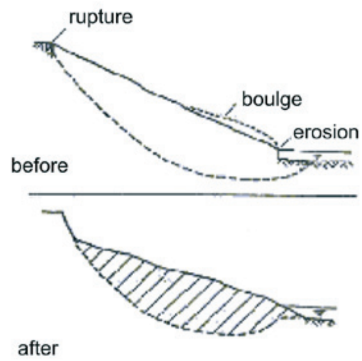
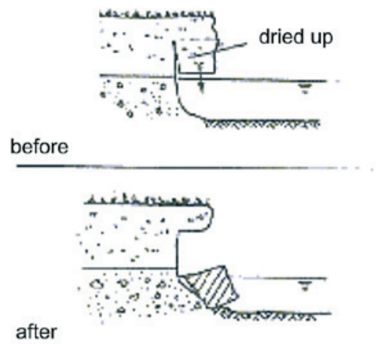
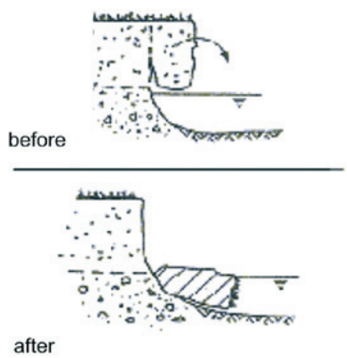


Fig. 3: Sample of one type of spatial geonets, which can serve as a stabilizing element in the body of the slope (photo M. Šlezingr)

a) surface • mild bank slope • usually non-cohesive soil • erosion almost parallel to the slope • vegetation may help stabilization	
b) sheet • steep or vertical bank slope • often non-cohesive soil	
c) planary • almost vertical banks • deep tension crack • occurs in shear or over-tipping • risk increases if the crack is filled with water • partially influenced by ground water	
d) rotational in homogenous materials • usually in medium high or steep banks • usually in coherent materials • ruptures disturb stability, especially if filled with water • significantly influenced by ground water level	

Tab. 1: Possible bank erosion (Valouchová, 2004) – to be continued

e) rotational with the depleted zone • the failure zone shape depends on the location of depleted zone • similar properties as d) type	
f) massive rotational failure • bank erosion threatens the stability of the entire surrounding valley • big volume of failure material rupture • in the upper part, bulging over toe or noticeable movement are signs of possible erosion	
g) erosion of non-homogeneous (composite) bank I • appears only when the top coherent layer is above erodible sand / gravel • lower overhanging part damaged by tension	
h) erosion of non-homogenous (composite) bank II • appears similarly as type g) • tensile failure in the upper soil, followed with rotation • after the fall of the block, vegetation usually remains intact • damage may also be due to sliding	

Tab. 1 – continue

4. Results

In previous chapters, we presented a basic idea of bank stabilization by means of earth reinforcement consisting of geonets (geo-mattresses) overgrown with the root system of suitable woody plants.

Now we will focus on the presentation of particular application possibilities. One possibility is to use geo-mattresses, which are laid on the surface of a prepared slope, and subsequently filled with a layer of approx. 3–5 cm of soil, which is seeded with suitable grass. In this case, the stabilized area is minimally protected against erosion in the first weeks; bank stabilization only starts to be effective after the grass turf becomes established. Subsequently – for a period of several months – a sufficient root system capable of growing through the geo-mattress is being established, fixing properly to the slope. This stabilization becomes fully functional after several months; some authors suggest that full functionality is reached only in the following vegetation season (Šlezingr, 2005; Švecová, Zeleňáková, 2005; Zeleňáková, 2007).

A precondition is that water flow rate and hence bank stress are not high in the first months after the installation of the stabilization elements, otherwise they would be damaged.

However, if the geo-mattress is placed on a bank sloping directly to the river channel, it is most probable that soil will be taken away including vegetation seeds from the geo-mattress structure. Stabilization is then not efficient.

Therefore, procedures were designed to stabilize the slopes – banks also under these conditions. One option is to use grown turf with the geo-mattress, anchoring it to the slope. The geo-mattress is thus a part of the turf. Most often used are geo-mattresses wrapped with soil and grass seeds. The stabilization turf belt is brought to the place of laying at the stage of grown grass with a sufficiently developed root system growing through the geo-mattress. This is laid in belts on the prepared bank. The turf must be properly anchored using stakes, or also metal pins approx. 0.3 m long are often used.

Subsequently, the slope stabilized with the pre-grown grass turf with a geo-grid may also be planted with shrubs or trees. In this event, it is necessary to cut the geo-mattress. It is recommended to cut it crosswise to create four points and to insert the plant in the cut. Afterwards, it is necessary to put anchoring around the plant so as not to damage stabilization around the cut.

Another method is to combine vegetation and the structure reinforced with geosynthetics with a wrapped front. This hybrid structure is based on bio-stabilization by so-called brush-layering (Fig. 4) and reinforcement of a steep slope. Brush-layering means installing branches

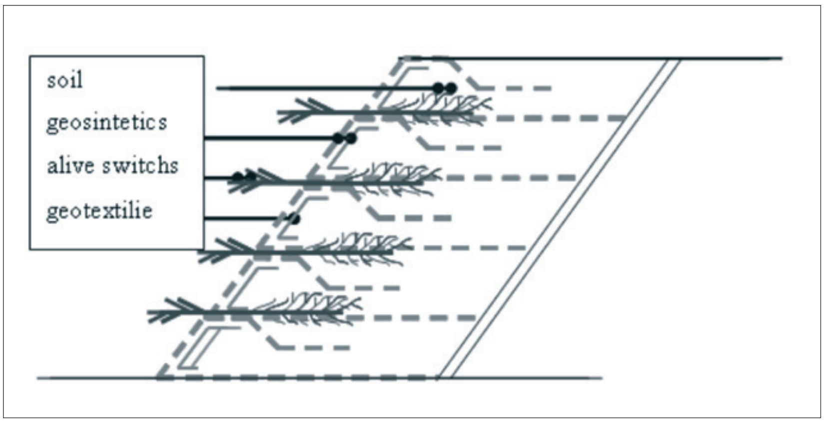


Fig. 4: Shoreline stabilization scheme (Úradníček, Šlezingr, 2007)

in the ground, among the layers in the case of a fill, or in the hole in the case of a vegetated slope. It is used for slopes from 1 : 2 and less. If we want to create a steeper slope, we must give preference to using soil. This is done by means of geosynthetics-geogrids, which help form slopes up to 90°. A new structure is created by placing branches at the point of reinforcement. These would gradually strike roots, growing through the geogrids (hole size of approx. 10 mm), reinforcing the structure further. Because the geogrids may have openings which are much bigger than earth particles, the latter may fall through the holes. Therefore, a geotextile is used at the front, with μm-sized holes, capturing even very fine particles. A characteristic cross section of this hybrid stabilization system is depicted in Fig. 5.

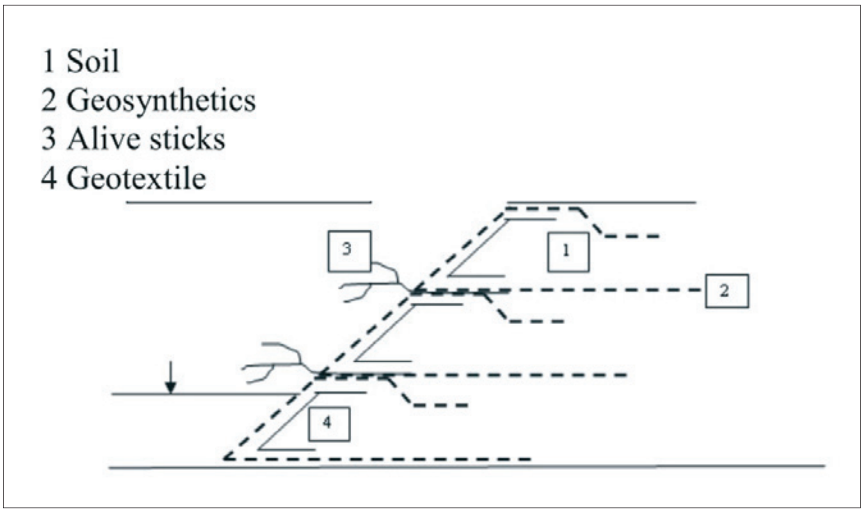


Fig. 5: Reinforced structure combined with vegetation – scheme (Úradníček, Šlezingr, 2007)

Summary of experimental results – the Bílovec irrigation reservoir

The Bílovec irrigation reservoir is located south of Brno, near the municipality of Velké Bílovice, on the Prušánka stream.

Abrasion has considerably damaged the south-eastern part of the bank where abrasion damage reaches a height of about 2 m. In 2003, stabilization with geonets was installed and since then the condition of the bank has been monitored. The detailed has been monitored for 8 years, whereas the experience with the stabilization in the Brno Reservoir is only three years in duration.

The basis for the modification and installation of stabilization elements was a bank slope 1 : 1.7. The stabilization geonet was fixed to the bottom by a series of willow sticks of Salix fluviatilis species. Cuttings of this species were also used higher on the slope as a part of stabilization. They were planted in four rows with twenty individuals each in a square spacing of 0.4 × 0.4. Twenty-five meters of the bank were stabilized using ENKAMAT 7220 geonet and with the help of the root system of woody plants and grass (Fig. 6). The adjacent part of the bank was stabilized in the same way, only without the geonet. In this way, a site for comparison was created. Since then, the condition of the bank has been monitored regularly.

The effect of the stabilization was manifested as early as in the first growing season when the retreat of bank line at the comparison site was clearly visible. The bank stabilized with the geonet was not damaged (Fig. 7 – see cover p. 3).

The stabilized bank was not considerably damaged in the following years; the comparison site had to be partially repaired in 2008. Thanks to good experience with the stabilization using geonets and pre-grown stabilization carpets, the same method was used for the Brno reservoir in the localities of Osada and Rokle.

Fig. 6: Geonet was attached to the bottom range of Salix fluviatilis rods 0.7 m in length. Subsequently, geonet stabilized the slope of the same kind of willow cuttings in four rows. In conclusion, we stabilized the slope by a layer of soil of about 3 cm and sown grass mixtures (photo: M. Šlezingr)

5. Discussion

The above stated possibility of stabilization was tested in our conditions at the Bílovec irrigation reservoir and partially also on the Brno Water reservoir banks. The stabilization was installed in a bank with major stress by water runoff and treading. After three years, it may be stated that stabilization also worked well in the conditions when broken woody vegetation was additionally "planted" into the stabilized shore (Reservoir Bilovec, Brno – Osada and Rokle).

The stabilization effect of this structure is questionable to a certain extent with significant wave action or flowing water. The bank of the irrigation reservoir in Bílovec has been stabilized like this for seven years and only local erosion by wave action is observed. Vegetation (both herbs and shrubs) has grown through the geonet very suitably, stabilizing the toe of the endangered bank and slopes. In the area of water flow, it would have probably been more suitable to choose a vegetated stone stabilization toe, supplemented with bank stabilization using soil reinforcement.

6. Conclusions

A summary of the experimental results is presented from the "stabilization of the Bílovec reservoir bank" The basis of the experiment was verification of the effectiveness of bank stabilization using a geosynthetic net and with the help of the root system of woody plants and grass.

The results are as follows:
1. 25 m of endangered bank were stabilized, using geonet ENKAMAT 7220, four rows of *Salix fluviatilis* cuttings, each with 20 individuals, a grass mixture,
2. In the first year, all 80 cuttings stroke root (100% survival rate),
3. In the following years, two individuals died; abundant natural succession appeared in the stabilization, mainly in the herbal layer, and
4. When compared to the control site, the bank stabilized with the geonet is markedly better reinforced and resists waves. Unfavourable changes are only visible at the bottom of the slope where stabilization sticks of *Salix fluviatilis* were planted as the root system of willows has been uncovered and the geonet has appeared.

After eight years of regular monitoring of the stabilized area we can consider the experiment successful. The bank reinforced biotechnically with the geonet resists waves substantially better than the bank reinforced only biologically. After this experience the experiment was transferred to the banks of Brno Reservoir. Three years later we can conclude that the stabilization using geonets has proven successful even there (the assessment of effects of various types of geosynthetics is currently under investigation).

Bank stabilization of dams is an important prerequisite for ensuring the long life and utility value of water area. Especially the life of reservoirs is often defined particularly by the time until they become silted. It is often not the dyke stability that is limiting, but rather the stability of banks, the extent of wash off from surrounding lands and the quantity of sediments transported by the flow.

The design and implementation of suitable bank stabilization is a task being undertaken at many specialized and scientific workplaces. Today, this does not merely concern the simple employment of technical stabilization elements – because the stabilization of many kilometres of banks of water streams and dams is significantly influenced by the character of the surroundings, vegetation and the entire complex ensuring environmental stability of the alluvial plain. Therefore, various types of biotechnical and biological bank reinforcement are being designed, verified and implemented.

One of the possible and non-traditional designs is the use of geosynthetics for stabilization of streams and dams. These materials are not natural, but in spite of the fact, they can significantly contribute to suitable bank stabilization. They form internal earth armouring, which is – with the help of suitable rooting – a highly efficient stabilization factor. The problem consists namely in the selection of suitable types of geo-mattresses (geonets, geogrids, etc., according to the purpose of application) and their subsequent installation in the slope forming the bank of a stream or reservoir. Further, we have to carefully consider the selection of suitable grass and/or woody plants and select only from native species; species of invasive character should be avoided. This is a relatively complex topic, which has been dealt with in separate publication (Uradníček, Šlezingr, 2007; Míča, 2006; Powrie, 2004, etc.).

In the current report, we have focused on the justification of the suitability of this stabilization material and on the presentation of designed structures. Geosynthetic nets (geonets) and/or geo-mattresses are produced in a wide range of (for our application) more or less suitable shapes and forms. Their purpose is a decisive factor in their selection. For stabilization of a slope forming a bank of a stream or a dam, we prefer three-dimensional geo-mattresses with a thickness of ca. 2 cm, consisting of matted thin plastic fibres suitable to be overgrown with roots. As a matter of course, hygiene and other certificates are needed. The strength characteristics should be as follows: tensile strength at least 1–3 $kN.m^{-1}$.

Upon being installed in the slope, geo-mattresses significantly help stabilization, especially, in combination with the root system growing through them. For this reason, it is also necessary to select suitable woody plants.

For the stabilization of banks in areas more exposed to flow or wave action, we suggest using a pre-grown turf with the internal reinforcement by geo-mattress. This pre-grown turf is then installed in the bank for stabilization. It is necessary to properly fix them to the slope and subsequently let them become "established".

It is also possible to use willow shoots as a part of bank stabilization. By their planting in the slope, the stabilization effect of geosynthetics is enhanced.

Acknowledgements

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References:

AGHARAZI, H. (2004): An Investigation on bank erosion of vegetated and non-vegetated reach of Gharahchay River. Soil Conservation and Watershed Management Reseach Institute, Tehran (Iran), 54 pp.

BROOKES, A. (1985): River channelization: traditional engineering methods, physical consequences and alternative practices, Prog. Phys. Geogr., Vol. 9, p. 44–73.

HENDERSON, E., SHIELDS, F. D. Jr. (1984): Environmental features for stream bank protection projects, Technical Report E-84-11, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

KO, J. Y., LEE, J. S., JUNG, K. Y. et al. (2006): Soil Erosion Risk Assessment of Arable Land in the Seonakdong River Watershed using GIS, RS and USLE. Korean Journal of Soil Science and Fertilizer, Vol. 39, No. 3, p. 178–183.

JEDLIČKA, L., ŠLEZINGR, M. (2010): Bankside trees and shrubs. Colloquium on landscape management, Brno 2010, p. 14–17.

KRIER, H., SCHOEDER, W. (1988): Erosion properties of cohesive river bed material. Wasser und Boden. Zeitschrift fuer die gesamte Wasserwirtschaft (Germany, F.R.). Vol. 40, No. 3, p. 133–136.

KUBÍČEK, P. (1987): Development of abrasion on the banks of the Brno reservoir. Scripta Fac.Nat.Univ. Purk.Brun. (ser. Geographia), Vol. 17, No. 2, p. 63–72.

LINHART, J. (1954): Abrasní činnost na Kníničské přehradě. Sborník Československé společnosti zeměpisné, Vol. 14, No. 4, p. 185–196.

LUKÁČ, M., ABAFFY, D. (1980): Vlnenie na nádržiach. Výzkumná zpráva. Príroda, Bratislava, 108 pp.

MALLIK, A. U., RASHID, H. (1993): Root-shoot characteristics of riparian plants in a flood control channel: implications for bank stabilization. Ecological Engineering, Vol. 2, No. 2, p. 149–158.

MÍČA, L. (2005): Geosyntetické materiály ve vodním stavitelství, In: Interní seminář VUT FAST Brno.

POWRIE, W. (2004): Soil Mechanics, Concepts and Applications, 2nd edition, SPON Press London.

SCHOLITSCH, A. (1930): Der Wasserbau, Verlag von Julius SPRINGER, Zweiter Band Wien.

ŠLEZINGR, M. (1998): Brněnská přehrada a lidé kolem ní. Brno, VUT – FAST, 84 pp.

ŠLEZINGR, M. (2007): Stabilisation of reservoir banks using an "armoured earth structure". Journal of Hydrology and Hydromechanics, Vol. 55, No. 1, p. 64–69.

ŠLEZINGR, M. (2005): Stabilizace říčních ekosystémů. 1. vydání. CERM Brno, 353 pp.

ŠLEZINGR, M. (2011) Břehová abraze – třetí doplněné vydání, FOLIA , 174 pp.

ŠLEZINGR, M., JEDLIČKA, L. (2010): Accompanying vegeationn – grassland. Colloquium on Landscape Management Location. Mendel University Brno, p. 28–30.

ŠLEZINGR, M. (2007) Stabilisation of reservoir banks using an "armoured earth structure". Journal of hydrology and hydromechanics, Vol. 55, No. 1, p. 64–69.

ŠVECOVÁ, A., ZELEŇÁKOVÁ, M. (2005): Vodné stavby. Košice, TU, SvF, 190 pp.

ÚRADNÍČEK, L., ŠLEZINGR, M. (2007): Stabilizace břehů, 1. vydání, Akademické nakladatelství CERM Brno, 210 pp.

VALOUCHOVÁ, K., 2004: Návrh řešení stability břehů nádrží, DP, VUT FAST Brno.

ZELEŇÁKOVÁ, M. (2007): Vodné stavby. E-learningová podpora výučby predmetu. CD. 240 pp.

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MORAVIAN GEOGRAPHICAL REPORTS

Aims and Scope of the Journal

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

Instructions for authors

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

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

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

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

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

Fig. 2: Brno Water reservoir shoreline damaged by erosion, locality Osada (photo: M. Šlezingr)

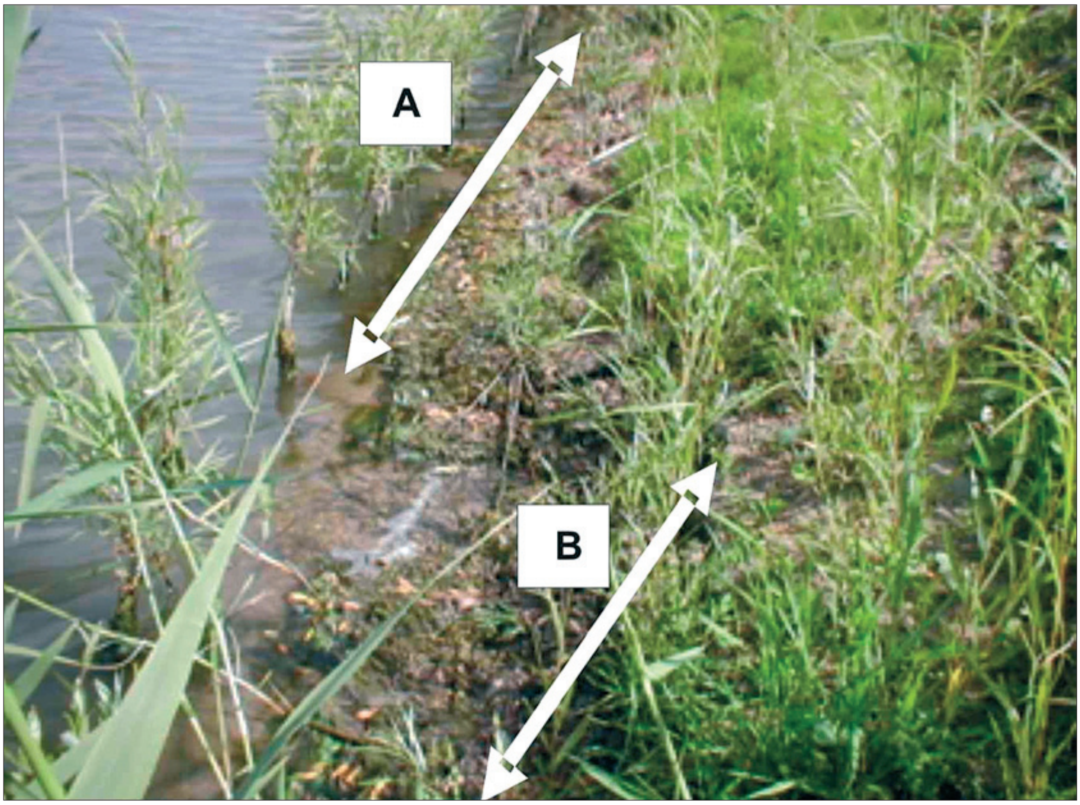

Fig. 7: The condition of the bank after 5 months – the bank retreat of the comparative area is apparent with vigorous growth of willows and a very good effect of the proposed stabilization: A) stabilized by geonet, B) without geonet – the Bílovec reservoir, Moravia, Czech Republic (photo: M. Šlezingr)

Illustration related to the paper by M. Šlezingr and J. Fialová

Figs. 11, 12: Forest and aquatic ecosystems in Kolubara as excellent potential sites for recreation and parts of the reclaimed area which has been already used for water sports and recreation in Kolubara (photo D. Dražić)

Illustration related to the paper by D. Dražić, M. Veselinović, N. Čule and S. Mitrović