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EVALUATION OF THE COURSE OF METEOROLOGICAL PHENOMENA IN THE DECADE OF 1993–2002 IN RELATION TO VINE GROWING IN THE SOUTHERN MORAVIA (THE CZECH REPUBLIC)

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Abstract

Knowledge of vine growing has been changing throughout history. Viniculture and its branches have become separate scientific fields with a wide sphere of activities. Natural conditions do not allow vine growing in the whole territory of the Czech Republic. South Moravia is almost a synonym for this agriculture branch in our country. In the macroclimatic perspective, this part of the republic is quite a large continuous area with good conditions for vine growing. It is important to know that the basic climatological characteristics of specific localities are modified by various factors (inclination of terrain, orientation of slope, land use, anthropogenic activity). That is why local climate plays such an important role and particularly with specific vineyards it is also microclimate.

KEY WORDS: vine growing, active temperatures sums, local climate, South Moravia, decade 1993–2002.

1. INTRODUCTION

1.1. Main goals

This article deals with results of the diploma dissertation called "The agro-climatic conditions of vine growing in the area of South Moravia" (researched in cooperation with the Department of Geography of the Natural Science Faculty of Palacký University in Olomouc CZ). The main part of this dissertation was the actual analysis of the agro-climatic conditions in specific locations in the chosen period of time (the decade 1993–2002).

In the branches of agroclimatology, viniculture and classification of potential areas for vine growing, the following publications were published in the Czech Republic:

Bláha, J. (1948): Katastr viničních tratí, Horniak, V. (1962): Organizace vinohradnictví, Klobáska, Z. (1987): Rajonizace révy vinné, Valachovič, A. (1990): Zhodnocení agroekologických podmínek vinohradů v ČSFR.

The most important project of this branch in the Czech Republic has been "Rajonizace vinohradnictví", which was finished for all vine–growing regions in 2003 – 2004. The main goal of this project has been in a long run to eliminate vine growing in the least favourable areas and to inform all possible vine growers about land which is recommended for vine growing. This project is consequent upon the activities of the Central Control and Test Institute in Agriculture in Brno CZ which is under Act No 321/2004 Coll., on vine growing, as amended (the Viniculture Act) responsible for the supervision of viniculture in the Czech Republic.

1.2. The territory in question

On the territory of the Czech Republic, there are two principal vine-growing regions: the Moravian Vine Region (situated in the Morava/March River basin and the Dyje/Thaya River basin) and the Bohemian Vine Region (only small areas along the Labe/Elbe, Vltava/Moldau and Ohře/Eger rivers). This article only deals with the Moravian Vine Region. Its southern boundary is marked by the Czech/Austrian frontier line, the western boundary lies on the touching line between the Dyje/Thaya-Svratka/Schwarzawa Lowlands and the Jevišovice Downs, i.e. the line between Znojmo, Moravsky Krumlov and Ivancice. The northernmost parts of vine growing in South Moravia spread as far as the Gully of Boskovice (Boskovická brázda), the southern slopes of the Drahany Uplands and the Chriby. The eastern boundary goes along the western slopes of the White Carpathians and the Czech-Slovak frontier line.

With regard to the characteristics of the researched topic, it is possible to use biogeographic regionalization (Culek 1996) for a more exact definition of the territory. Moravian vine sub-regions are parts of specific bioregions, situated mostly in the northern *Pannonicum* subprovince. The *Pannonicum* features very warm climate with continental influences from the east and Mediterranean ones from the south. The relief of *pannonicum* is not rugged in most parts except for the northern region – i.e. Moravia. On the slopes of downs there, there are well-located areas suitable for vine growing. In the Czech Republic the north *Pannonicum* subprovince consists of these bioregions: Lechovice, Mikulov, Hustopeče and Morava/March - Svratka/Schwarzawa. On the north-east borders of the Moravian Wine Region, influences of West-Carpathian subprovince (in north-east) are perceptible. Here the climate is more continental, influenced by warm and drier *Pannonicum* climate.

After the Czech Republic joined the EU in 2004, there have been changes to the titles and number of vine regions and sub-regions (Regulation No 324/2004 Coll.). Currently, there are: ”Čechy (Bohemia)” and ”Morava (Moravia)”. The Moravian Vine Region is divided into four sub-regions: Mikulov, Znojmo, Velké Pavlovice and Moravian Slovakia ("Slovácko"). Vine sub-regions are then divided into smaller districts (in Czech so called: „rajón"). And the smallest unit in this division is a wine community.

Fig. 1.2.1. Vine sub-regions – The Moravian Vine Region

2. AGROCLIMATIC CONDITIONS OF VINE – GROWING IN SOUTH MORAVIA

2.1. Methods and data

For analysis two main characteristics were used: air temperature and precipitation sums. These characteristics were elaborated for selected meteorological stations in southern Moravia: Znojmo – Kuchařovice, Dyjákovice, Brno – Tuřany, Velké Pavlovice and Strážnice na Moravě.

For these stations, graphs of the course of meteorological characteristics during the decade 1993 – 2002 were created and from these basic characteristics other meteorological parameters (mainly active temperatures sums) were consequently derived.

Very important and inseparable part of the paper is the chapter called "Local air currents", which describes the most typical air-currents in the area of South Moravia affecting vine-growing. This information about air-currents was taken from Blaha (1940).

Table 2.1.1. Selected meteorological stations in South Moravia (CHMI, 2003)

Name of station	Altitude (m)	Geographical location
Znojmo - Kuchařovice	334	48° 52‘ 57“ N, 16° 05‘ 11“ E
Dyjákovice	201	48° 46‘ 24“ N, 16° 17‘ 51“ E
Brno - Tuřany	241	49° 09‘ 35“ N, 16° 41‘ 44“ E
Velké Pavlovice	196	48° 53‘ 57“ N, 16° 49‘ 28“ E
Strážnice na Moravě	176	48° 46‘ 24“ N, 17° 20‘ 17“ E

2.2. Air temperature as determinative factor for vine growing

This chapter describes elementary air temperature characteristics in the decade 1993–2002 (active temperatures sums, average air temperature IV – IX, average monthly temperature in June, July and September).

If we count up all average daily temperatures higher than 10 °C (from the beginning of vine growing season to its end), we shall get the active temperatures sum (SAT). It is one of the main factors affecting vine growing. In our geographical location, SAT is around 2200 °C (for earliest cultivars) and about 3000 °C (for very late cultivars). However, in southern vine regions SAT is often much higher, e.g. in the Republic of South Africa 6000 °C, in the Crimea 4100 °C. In northern vine regions (including the Czech Republic) the growing season is made shorter by using early and semi-early cultivars, so under identical conditions the quality of wine is better.

Table 2.2.1. Wine cultivar classification according to the mature period (Valachovič 1990)

Groups of wine cultivars	Necessary SAT (°C)	Examples of wine cultivars
early	2 200	Čabianska perla
middle – early	2 500	Irsai Oliver, Muškát moravský
middle	2 700	Veltínské červ. rané, Műller Thurgau, Rulandské šedé
middle – late	2 800	Pálava, Neuburské, Sauvignon, Sylvánske zel., Rulandské bílé, Rulandské modré, André, Tramín červený, Chardonnay, Modrý Portugal,Zweigeltrebe
late	2 900	Ryzlink rýnsky, Ryzlink vlašský, Veltlínské zel., Svatovavřinecké, Frankovka
very late	over 2 900	Ezerjó, Furmint

Table 2.2.2. Active temperatures sums (°C) in selected stations
in South Moravia in the decade 1993–2002

Station / Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	1993-2002
Velké Pavlovice	2845.1	3068.3	2843	2714.7	2785.5	3022.4	3104.4	3149.2	2784.3	2993.7	2931.06
Brno - Tuřany	2806.3	2995.3	2776.9	2541.7	2667.8	2885.6	3014.5	3078.7	2712.7	2936.3	2841.58
Strážnice	2795.7	2922.2	2719.8	2554.7	2571.9	2910.2	2898.2	2936.4	2657.1	2847.2	2781.34
Kuchařovice	2694.5	2870.1	2641.3	2351	2539.9	2720.8	2793.4	2900.7	2592.9	2847.7	2695.23
Dyjákovice	2881.8	3021.8	2869.1	2652.7	2756.1	2976.5	3019.4	3112.2	2830.9	2999.1	2911.96
average	2804.68	2975.54	2770.02	2562.96	2664.24	2903.1	2965.98	3035.44	2715.58	2924.8	2832.234

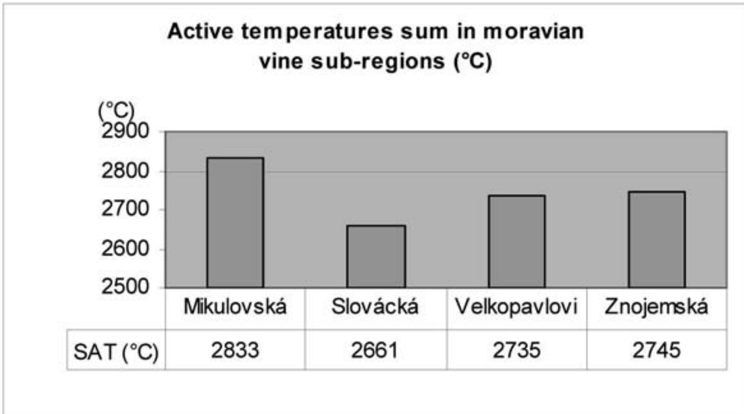


Fig. 2.2.1. Long-term SAT (°C) in moravian vine sub-regions (by Litschmann 2005)

From a long-term perspective, Moravian Slovakia (Slovácko) is the coldest sub-region (but it includes also the former vine region named „Podluží“, which is classified as the warmest locality in the Czech Republic). In this paper, Strážnice is the sample meteorological station for the vine sub-region of Moravian Slovakia. In the decade in question, the highest temperatures were measured in 1994 (in that year temperatures were so high because of an extremely long hot wave – cf. Kyselý 2003) and in 2000. The average SAT figure – 2781,34 (in the decade 1993–2002) corresponds to the wine cultivars with middle period of mature and also certainly to earlier wine cultivars.

The Znojmo vine sub-region has a really good net of meteorological stations, which cover the whole territory. Each of the stations (Kuchařovice, Dyjákovice and in northern part also Brno - Tuřany) observe quite different values. The Dyjákovice station observed the highest values (which were as high as over 3000 °C – in 1994, 1999, 2000). On the other hand, Kuchařovice was the coldest meteorological station in the decade. In the coldest year of the decade (1996), SAT was only 2351 °C.

In a long-term perspective, the sub-region of Velké Pavlovice is the warmest in Moravia. This fact was confirmed in the decade researched, too (2931.06 °C on average in the decade, Table 2.2.2.). The values over 3000 °C occurred four times. In the coldest year of the decade (1996) SAT was still over 2700 °C.

Another factor affecting vine growing is average temperature during the growing season (Apr – Sept) or average monthly temperature in June, July and September.

In Table 2.2.3. we can see that the highest average air temperatures were observed in two stations – Velké Pavlovice and Dyjákovice. The lowest values were reached in the Kuchařovice station. As for long-term values, Moravian Slovakia is the coldest sub-region. The average air temperature in the growing season is only an orientational characteristic and in vine growing regions it ought not to drop under 14 °C. In the decade in question, this limit was achieved in all stations.

The average temperature of the warmest month (i.e. July – this has been proved by the research) ought not to drop under 17 °C in all vine growing regions. It is apparent that this limit was achieved in all stations in the decade in question. With some cultivars, it is possible to reach high quality wine at the temperature of 19 °C (Hubáček, Kraus 1982), if over 19 °C, the quality is excellent. In this perspective, the Dyjákovice and Velké Pavlovice stations have the best conditions.

Table 2.2.3. Average temperature (°C) during the growing season, average monthly temperature in June, July and September in the decade 1993–2002 in selected stations of South Moravia

Station	t IV–IX	t VI	t VII	t IX
Brno - Tuřany	16.3	18.0	19.9	14.3
Dyjákovice	16.6	18.4	20.2	14.5
Kuchařovice	15.6	17.2	19.3	13.8
Velké Pavlovice	16.7	18.5	20.2	14.7
Strážnice	16.0	17.7	19.4	14.2

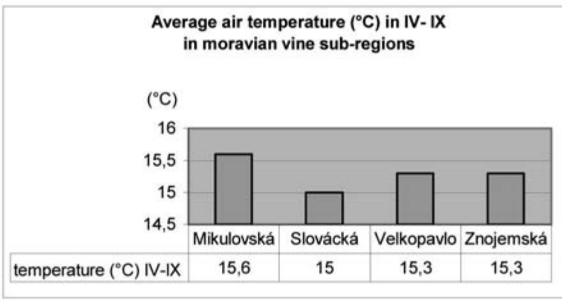


Fig. 2.2.2. Long-term average air temperature (°C) from April to September in Moravian vine sub-regions (Litschmann 2005)

2.3. Precipitation

Precipitation amount belongs among other agro-climatic characteristics for vine growing. Results for the season from April to September in the decade 1993–2002 are shown in Table 2.3.1.

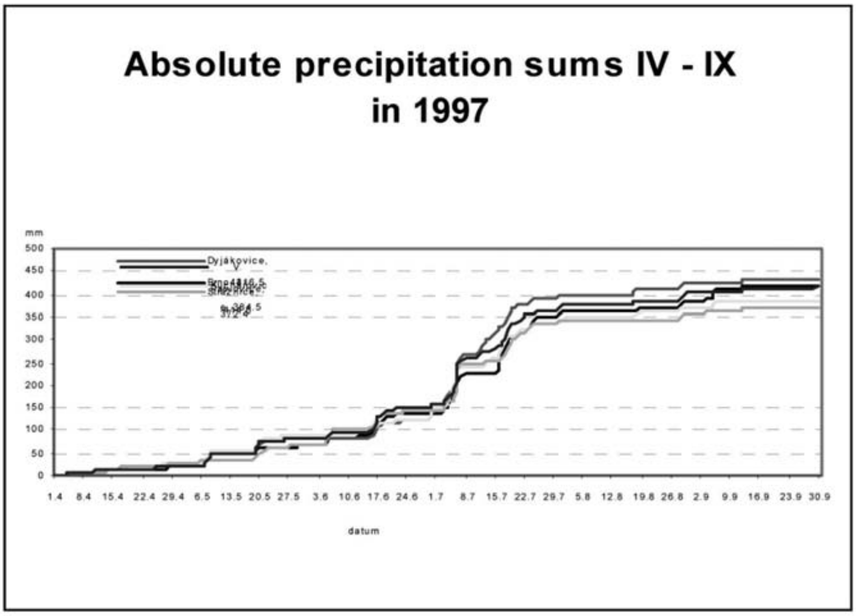
Table 2.3.1. Absolute precipitation sums (mm) in selected stations in the season Apr – Sept in 1993–2002

Station / Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	1993-2002
Velké Pavlovice	285.9	265.4	466.8	361.3	414.5	374.0	334.2	283.5	389.3	360.6	**353.6**
Brno - Tuřany	290.0	310.1	365.2	354.6	416.5	383.1	306.8	245.6	408.5	344.5	**342.5**
Strážnice	244.1	343.1	344.0	378.9	372.4	350.9	327.9	283.4	353.6	301.9	**330.0**
Kuchařovice	295.4	252.4	429.6	411.4	384.5	320.8	356.4	297.2	314.5	471.9	**353.4**
Dyjákovice	312.3	235.4	434.7	363.8	431.0	302.1	364.0	250.2	333.5	392.7	**342.0**
average	**285.5**	**281.3**	**408.1**	**374.0**	**403.8**	**346.2**	**337.9**	**272.0**	**359.9**	**374.3**	**344.3**

In the decade in question we may notice the untypical year 1997. From the Fig. 2.3.1. it is evident that the precipitation sums were evenly placed until June and did not reach extremes. However, after that (from the first decade in July on) it rained a lot during a very short period of time. These precipitation sums were essential in terms of water supplies for flora/vegetation in that year. The raining period was short and lasted only around 14

days. It influenced the crop per hectare in that year (on average only 3.2 t/ha for the districts Brno, Brno – the town, Břeclav, Hodonín, Uherské Hradiště, Znojmo, Vyškov and Kroměříž).

On the other hand, the year 1996 was typical for even course of precipitation during the whole growing season (Fig. 2.3.1.) The crop per hectare in 1996 was the highest (6.2 t/ha) of the decade in question.



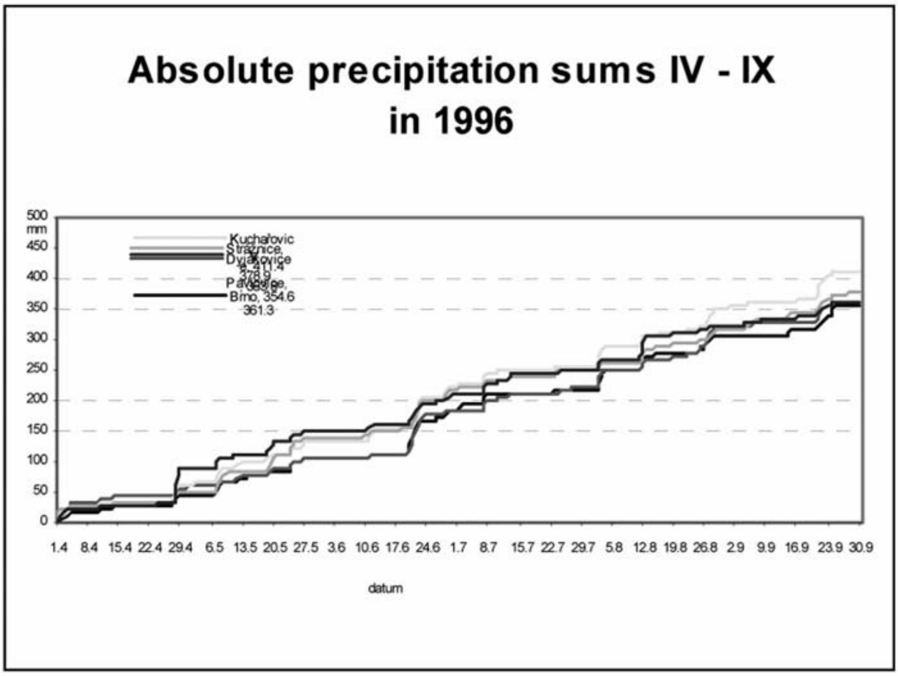


Fig. 2.3.2. Absolute precipitation sums (mm) Apr – Sept in 1997 and 1996
in selected stations of South Moravia

2.4. Local air currents

This chapter describes the most typical air-currents in the area of South Moravia affecting vine-growing. This information about air-currents were taken from Blaha (1940).

In South Moravia, georelief and its active surface affect vine growing in an essential way. There are two basic air-currents in South Moravia: retarding (a negative actuator for vine growing) and accelerating (a positive actuator).

The retarding air-currents have an impact on vine during the whole growing season. They make the air very cold, which may strain the sensitive organism of vine in a significant way. However their influence on vine is unstable. Among the cold air currents, the north ones prevail in South Moravia. These come through depressions to the south (mainly through the Lower Moravian Lowlands). Their impact is often a critical factor for vine growing particularly in the spring months. In South Moravia we can observe three basic cold winds: Židlochovice – Drnholec (N – S), Šakvice – Břeclav (NW – SE), Kyjov – Mutěnice – Lanžhot (along the Kyjovka and Morava/March rivers) and Polešovice – Blatnice pod Sv. Antonínkem – Strážnice – Hodonín.

The next possible negative factor may be inversion. Inversion develop mainly in the Znojmo sub-region (along the Dyje/Thaya River). Another area where inversion takes often place is around Lednice (in the spring) and Svatobořice – Mistřín (in the spring as well).

There are two basic accelerating air-currents in South Moravia: cold and dry currents, "boreal" as Blaha called them, and relatively warm currents, labelled (not precisely) as "föhn". Boreal currents occur in the Znojmo sub-region (north and north-west course), in the areas of Podmolí – Znojmo, Suchohrdly – Tasovice, Znojmo – Konice – Popice – Havraníky – Hnanice. The "fohn" currents are typical for the area of the White Carpathians, having an impact on vine-growing in Moravian Slovakia, blowing from the south, south-east or east. As e.g. Prošek (1998) claims, those are not typical fohn because there are no conditions for their formation due to the morphology (shape) of the main ridge. The most distinct impact of fohn on vine takes place at the period of maturation. There are three basic areas in the region of South Moravia where these currents blow:
on the southern slopes of Ždánické vrchy (the Ždánice Hills), the southern foothills of Chřiby and the Bzenec Region, in the foothills of the White Carpathians (Strážnice – Blatnice) and the Hills of Dunajovice (Valtice – Sedlec – Novosedly).

3. CONCLUSIONS

When elaborating this paper, author has placed greatest emphasis on the behaviour of the two most important meteorological factors related to vine-growing – temperature and precipitation. The results from the decade 1993–2002 (compared with long-term values) have been crucial for evaluation and answering the question which cultivars are fit for vine-growing in the area of South Moravia. The characteristics of temperature are very different in each of the Moravian wine sub-regions. The warmest locality is Velké Pavlovice where SAT did not drop under 2700 °C in the decade reseached. The lowest values were measured in the Kuchařovice station (average SAT was 2695.23 °C in the decade). Apart from the meteorological characteristics researched herein, there are other ecological factors for vine-growing but those were not subject of this research. Therefore, the chapter called "Local air currents" is an important part of this paper. It describes the most typical air-currents in South Moravia affecting vine-growing. That information, published over 60 years ago (see Blaha J. – Mrkos J. 1940), has been very precious for the present research. The resultant air temperature characteristics values show (compared with long-term values) that there were several very warm years (1994, 1999, 2000, 2002) in the decade 1993–2002 (Table 2.2.2., Table 2.2.3.)

The results may arouse a question whether cultivar structure of our vineyards should be changed towards later cultivars, or whether the vine growing region boundaries should be pushed further to the north. This is, however, a cue for another detailed research which could prove the current trend of climatic changes in South Moravia and thus show the way for new vine planting.

4. SOUHRN

Zhodnocení průběhu meteorologických prvků v dekádě 1993–2002 ve vztahu k pěstování révy vinné na jižní Moravě

Hlavní pozornost byla věnována především dvěma zásadním klimatickým charakteristikám ve vztahu k pěstování révy vinné, teplotě vzduchu ve vegetačním období a úhrnu srážek. Získané výsledky z dekády 1993–2002 v porovnání s dlouhodobými údaji sloužily k posouzení vhodnosti pěstovaných odrůd révy vinné na jižní Moravě. Teplotní poměry jednotlivých podoblastí moravské vinařské oblasti jsou velmi rozdílné. Jako nejteplejší se ukázala lokalita Velké Pavlovice, pro kterou SAT neklesla ve zvolené dekádě pod 2700 °C. Nejnižší hodnoty vykazovala pak lokalita Kuchařovice s průměrnou hodnotou SAT 2695.23 °C ve zvolené dekádě. Naznačená analýza vhodnosti pěstování jednotlivých odrůd révy má zcela určitě význam, a to i přesto, že výběr pěstovaných odrůd závisí samozřejmě na více ekologických faktorech. Proto je vhodným doplněním uvedeného příspěvku kapitola Místní proudění vzduchu shrnující hlavní poznatky o klimatických poměrech jihomoravských vinařských oblastí. Tyto poznatky, byť publikované před více než 60 lety (viz Blaha J – Mrkos, J. 1940), jsou jistě i pro dnešní výzkum velmi cenné. Výsledné hodnoty teplotních charakteristik v dekádě 1993–2002 naznačují v porovnání s dlouhodobými údaji, že v této dekádě se vyskytlo několik velmi teplých roků (1994, 1999, 2000, 2002) a to jak podle SAT, tak dalších teplotních ukazatelů. Vzhledem k pěstování révy vinné se logicky nabízí otázka možnosti změny odrůdové skladby našich vinic směrem k pozdnějším odrůdám, resp. celkový posun hranice pěstování révy na sever. To je však již otázka k podrobnějšímu výzkumu, který by prokázal v prostoru jižní Moravy trend dlouhodobého oteplování a tím naznačil cestu pro nové uskutečňované výsadby.

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EVALUATION OF ATTENDANCE IN SELECTED HYPERMARKETS AND SHOPPING STORES IN THE TOWNS OF PREŠOV AND KOŠICE

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Abstrakt

This article points out the current development of retail trade, intensive integration and concentration of business activities in Slovak market. It is indicated by permeate of big supranational companies.

Development of the retail network took place in two completely different stages. The first introductory stage at the beginning of the 1990s was marked by a dynamic development of the retail network. The second stage began at the end of the last decade and was characterized by the concentration of organisations, spatial arrangement of the retail network and by globalisation mechanisms.

The objective of article is evaluation of attendance in selected hypermarkets and retail stores in the towns of Prešov and Košice. We carried out the research during 10th – 16th october 2005 from 8,00 am to 8,00 pm. Intensity and accessibility area of attendance was recorded by number of cars entered to parking lot of hypermarket.

KEY WORDS: retail, hypermarket, retail store, intensity of attendance, and accessibility area of attendance

1. INTRODUCTION

In the last years trade belongs to such branches of science, which have noticed the most significant changes. A fundamental turn occurred in the sphere of trade enterprise. It had been mainly caused by the trade liberalisation, costs deregulations and privatisation. The structure of all sale forms is changing as well as the demand and shopping behaviour of consumer. Recently, there has been an increase in faxour of large shopping centres and malls, either by consumers or by investors. Shopping centres and hypermarkets are located mostly in the city outskitrs, which offer enough space for their construction and where they are more accessible. Thus evently, the evaluation of attendance in selected hypermarkets and retail stores is the basic goal of this contribution.

2. THE TERM BEHAVIOUR AND BEHAVIOURAL GEOGRAPHY

The analysis of behaviour is having been studied by the whole complex of scientific disciplines. We can mention history, sociology, psychology, pedagogy, geography, ethnology, cultural antropology, and also informatics (Pražská – Jindra et al., 1998). English – Englishová stress out the use of experimental methods and observation,, which are being also used in other exact sciences. The term behaviour is, according to them, being used to emphasize the study of objectively observed answers, opposite to those methodological approaches, which emphasize the study of subjective processes. The notion of behavioural science was created in USA in the 1930s (In: Pražská – Jindra et al., 1998).

Among the first works dealing with geographical perception belongs the study of the American geographer J. K. Wright from 1925. The most numerous perception studies in geography emerged at the University in Chicago as a response to the demand of solving problems concerning natural risks (Saarinen, 1976).

The traditional research area of perception primarily used to be the urban environment, later on there started to appear perception studies from other spheres – e.g. transport infrastructure, cultural environment, places of housing etc. (Bartnicka, 1989). In Slovak geographical literature there is just a minor attention paid to problem of behaviour. Behavioural approach has been mostly applied in the research of cities. From Slovak and Czech geography we can choose people who were dealing with this problems:

V. Ira, (1984, 1992, 2003); P. Radváni, (1983); A. Hynek – J. Hynková, (1980); J. Ševčík – J. Benda – J. Bendová, (1978); Z. Ryšavý (1990), R. Matlovič (1992); D. Kollár (1992); V. Slavík, – M. Sedlák (1997). The inhabitants' preferences from the housing aspect were studied by D. Drbohlav (1990a, 1990b, 1990c, 1991); T. Siwek (1988) and M. Hrdlička (1983), and from the philosophical-methodological background of behavioural approach there were works by J. Paulov (1986).

3. SHOPPING BEHAVIOUR

The construction of large-area retail units in Slovakia has consequently changed the shopping behaviour of its inhabitants. They start to prefer the individual car transport and reduce the public or pedestrian one, since the shopping centres concentrate themselves mostly in the city outskirts. People usually do shopping in the afternoon and in the evening. Saturday and Sunday are the most popular days in week for shopping. Thus, we can see that the former models of shopping behaviour are changing and become more identical with those of the western Europe.

Mowen (1987) considers that the discipline of consumer's behaviour is dealing with generation of decisions concerning the processes of acquirement, consumption and use of goods, services, and ideas. The creation of decision is, as he writes, an important basis, whereas it often occurs in groups, families, in firm's management etc. The acquirement process includes the communication, remembering, and considering acquired information (Mowen, 1987).

Behavioural geography, accordind to Walmsley and Lewis (1984), is trying to find a relation between consumers'behaviour and spatial structure of retail trade environment. It used to be supposed that a man prefers the minimal mobility towards shopping and behaves in favour of economic nature. Later studies has proved that a part of consumers select the place of shopping not only by the goods offer and services, size, attractiveness and good atmosphere of the shop. Researches have revealed that people do not respect the logic of objectiveness and behave irractionally (Walmsley – Lewis, 1984). It means that if there was built a supermodern shopping centre with perfect services and low prices near the city, not all people from its surroundings would do their shopping there, and on the other hand, many people from more distant areas might do shopping there (Szczyrba, 2002, 2005).

4. METHODOLOGY OF THE RESEARCH

The basic method was the observation and noting down the number of evidential numbers of cars coming into parkings. Since 8,00 a.m. until 20,00 p.m. there were in one hour intervals counted the cars and noticed down in tables, each hour in new table. Our research was carried out during common week (10.–16.10.2005, from 8,00 a.m. till 20,00 p.m.) in front of shopping centres of Cassovia and Optima in Košice, and in front of the hypermarkets of Tesco and Hypernova in Prešov. This way we got exact state of cars'number per each hour in selected 12 hours time-part of a common week.

5. EVALUATION OF ATTENDENCE IN SELECTED SHOPPING CENTRES IN KOŠICE

Shopping center Cassovia generally shows the two maxims, (secondary) in morning hours from 10,00 to 12,00, and second (main) in the afternoon from 15,00 to 20,00 (graph 1). When we evaluate the attendance for ceratain days, we can point out the difference in maxima during workdays and on weekends. During workdays the secondary maximum from 10,00 to 20,00, and the main maximum from 15,00 to 20,00, on Friday from 14,00 to 16,00 and from 19,00 to 20,00. We have also noticed the absolute maximum on Friday, 630 cars from 14,00 to 15,00, what is conditioned by big family shoppings before weekend. Generally, the Friday's number of cars exceedes workday average and also of weekend (table 1). Throughout the weekend, mostly on Sunday, there is higher attendance in the shopping center Cassovia. The curves have quite balanced development, what is caused by the working time off of inhabitants, and thus, by a relatively unlimited leisure time needed for shopping. On Saturday, there are just two weaker maxima from 8,00 to 13,00, and from 17,00 to 18,00; on saturday there is just one weaker maximum from 9,00 to 11,00 a.m.

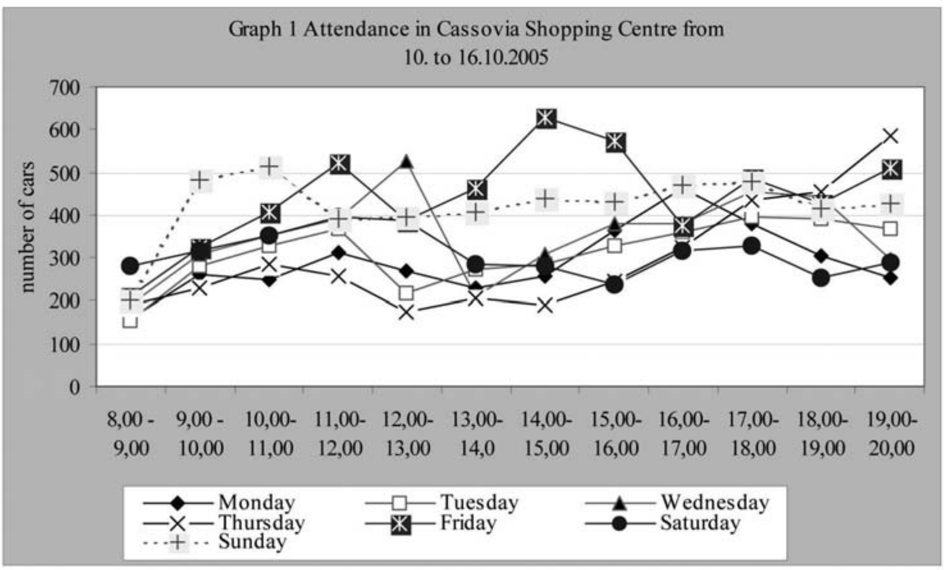
The higher attendance in shopping center Cassovia might be partly conditioned by the neighbouring location of the city flea-market. Shoppings in flea-market are usually connected by shoppings in Cassovia, but there is also a parking area near the market what enables people to get to Cassovia in 5 minutes walk.

If we compare the development of curves of Cassovia and the shopping center Optima, we can state that the graph of attendance in Optima (graph 2) is more balanced. Moreless significant is the main maximum from 17,00 to 19,00. Secondary maximum is not very important (just on Thursday) between 11,00 and 13,00. When we evaluate the attendance in Optima during workdays and weekends separately, the curve development is markedly different on Sunday, during workdays, and on Saturday. On Saturday there are very insignificant divergences, but on Sunday we can observe two marked maxima, from 13,00 to 14,00 and from 15,00 to 16,00. We have noticed also the absolute week maximum – 749 cars between 15,00 and 16,00. If we evaluate the day as a whole, then on Sunday there was noticed the maximum of cars within the week – 4722. Optima has therefore the strong position not only as a shopping centre, but also cultural-entertainment centre, where people come to relax and entertain on Sundays and in the evenings during the whole week.

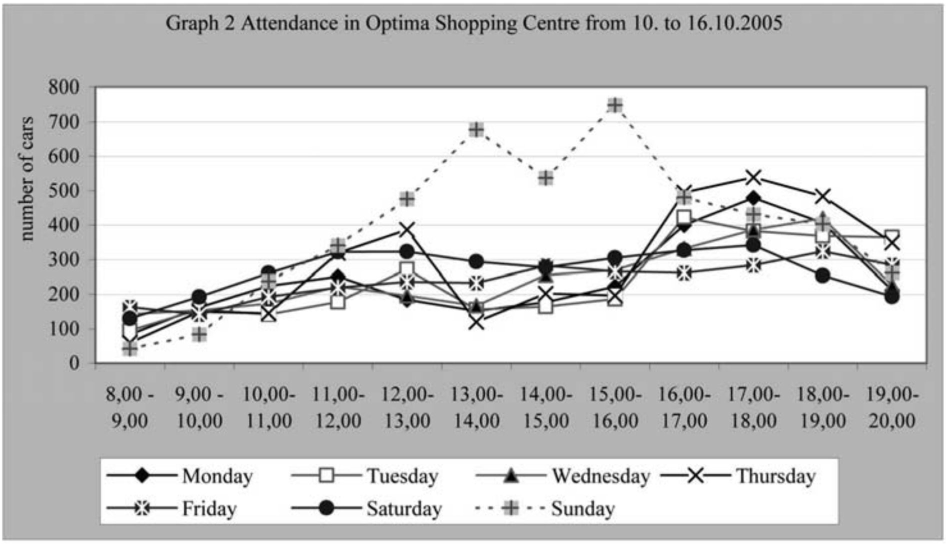
Table 1 Total cars number per day in selected shopping centres by days in common week from 10. to 16.10.2005

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	***Total***
Cassovia	3499	3745	4231	3578	**5322**	3724	5052	***29151***
Optima	2953	2891	2947	3447	2890	3223	**4722**	***23073***
Tesco	3818	3666	2444	2133	3724	**4698**	3739	***24222***
Hypernova	941	1350	1455	1378	1597	**1805**	958	***9484***

Source: own research



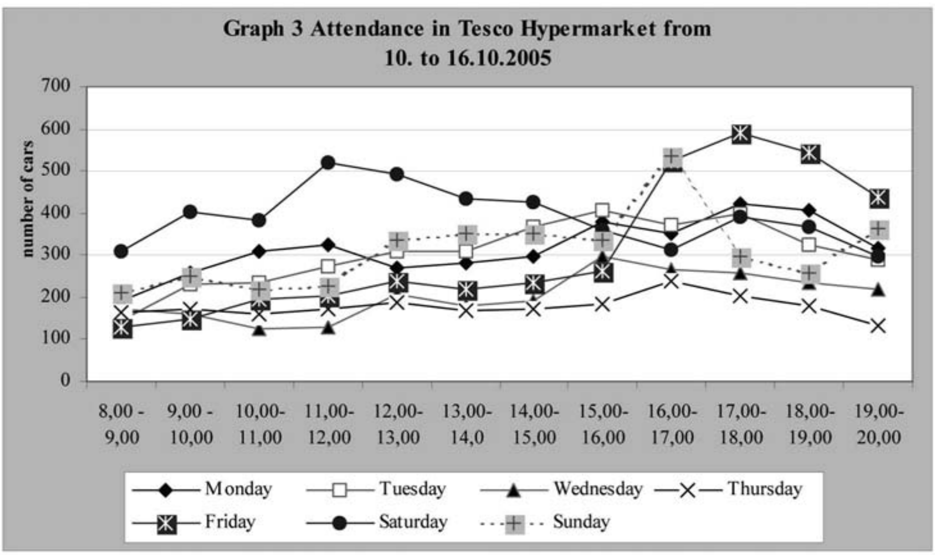
Source: own research



Source: own research

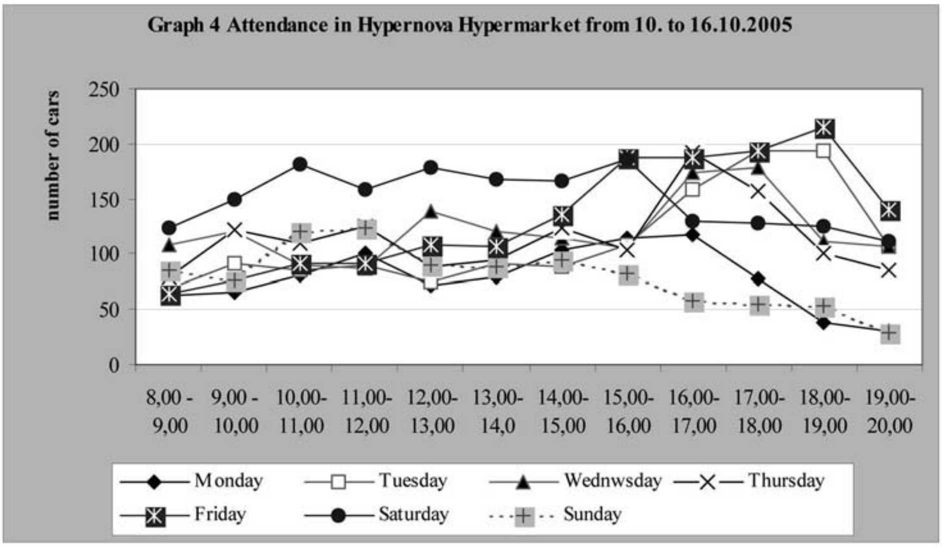
6. EVALUATION OF ATTENDENCE IN SELECTED HYPERMARKETS IN PREŠOV

Hypermarket Tesco like Cassovia shows two maxima – in the morning from 9,00 to 12,00 and the second (main) in the afternoon from 18,00 to 20,00 (graph 3). When evaluating attendance in certain days, we can also state some differences in maxima throughout the workdays and weekend. Throughout workdays there is the secondary maximum from 9,00



Source: own research

to 12,00 and the main from 8,00 to 20,00, on Friday from 17,00 to 20,00. The absolute daily maximum was noticed on Friday from od 17,00 to 18,00. The graph curve shows that the most significant increase in the number of car in the evening was noticed on Friday from 17,00 p.m. At weekend there is generally the higher attendance in hypermarket Tesco. The most significant development of the curve on Saturday can be observed in the morning hours. Secondary maximum can be observed between 17,00 and 19,00 and the main maximum from 12,00 to 15,00. if we look closer at the table 2, there is obvious that the most consumers come to Tesco on Friday - 4698, what is 20% from the whole week number. On Sunday there is only one maximum from 16,00 to 17,00 p.m.



Source: own research

Hypermarket Hypernova generally shows only one significant maximum in the afternoon hours from 16,00 to 19,00 (graph 4). If we evaluate the attendance for cartain days, we can state that there is difference in the development of maxima during workdays and at weekend. Throughout workdays there is the maximum in the afternoon from 16,00 to 19,00. On Friday we noticed the absolute hour maximum from whole week, what was 215 cars from 18,00 to 19,00. This might be mainly conditioned by the shoppings before weekend. On Friday we also noticed the absolute daily maximum, which is 1805 cars. The curves development is different at weekend. There wasn't noticed any significant maximum. The development is rather balanced till afternoon, till 15,00.

7. CONCLUSION

After 1989 there have been rather significant qualitative and spatial changes in retail trade network in Slovakia. The behaviour of trader as well as consumer is changing. Supranational trade networks with their large hypermarkets are penetrating our trade. In last four years the share of hypermarket shopping in Slovakia has increased more than twice, and the share of small shops and counter shops is decreasing despite the fact that they keep the highest average annual shopping frequention. Hypermarkets continuously make a profit of new customers. The market share of hypermarkets on expenses was strengthening in 2003 to 15 % (Fertaľová, 2005).

SÚHRN

Hodnotenie návštevnosti vybraných hypermarketov a nákupných centier v mestách Prešov a Košice

S nástupom veľkých, finančne silných nadnárodných reťazcov, dochádza k rozvoju ich investičných aktivít a stretávame sa s nimi na každom kroku. Rastie nielen počet nových obchodných jednotiek, ale taktiež aj obľúbenosť veľkoplošných obchodných centier a to ako medzi spotrebiteľmi, tak aj medzi investormi. Dochádza taktiež k zmene nákupného správania sa obyvateľstva. Doterajšie modely sa menia a začínajú sa viac podobať nákupnému správaniu sa v západnej Európe.

Výskum prebiehal v bežnom týždni od 10.–16. 10. 2005 v čase od 8,00 do 20,00 hod. V hodinových intervaloch boli spočítané automobily a ich počet zaznamenaný do tabuliek vždy za každú hodinu samostatne.

Nákupné centrá Cassovia a Optima v Košiciach vykazujú vo všeobecnosti dve maximá. Cassovia má podružné maximum v dopoludňajších hodinách od 10,00 do 12,00 hodiny a hlavné popoludní v čase od 15,00 do 20,00 hodiny. V piatok sme zaznamenali aj absolútne maximum v sledovanom týždni a to 630 áut od 14,00 do 15,00 hodiny. V Optime je výrazné viac-menej jedno maximum (hlavné) a to od 17,00 do 19,00 hodiny. Druhé (podružné) maximum je iba málo badateľné (výraznejšie iba vo štvrtok) a to v dopoludňajších hodinách medzi 11,00 a 13,00 hodinou. Medzi 15,00 a 16,00 hodinou sme zaznamenali aj absolútne maximum týždňa a to 749 automobilov.

Hypermarket Tesco v Prešove má podobne ako košické nákupné centrá dve maximá návštevnosti, Hypernova jedno. Tesco má dopoludnia, v čase od 9,00 do 12,00 hodiny podružné a druhé (hlavné) maximum popoludní v čase od 18,00 do 20,00 hodiny. Najviac zákazníkov malo Tesco v piatok a to 4698, čo je 20% z celotýždenného počtu. Hypernova nám vo všeobecnosti vykazuje jedno výraznejšie maximum a to v odpoludňajších hodinách od 16,00 do 19,00 hodiny, dopoludňajšia návštevnosť nie je tak výrazná. V piatok sme zaznamenali aj absolútne hodinové maximum a to 215 áut od 18,00 do 19,00 hodiny, čo podmienené predvíkendovými nákupmi. V piatok taktiež zaznamenávame aj absolútne denné maximum, 1805 áut.

SUMMARY

The entry of big, finantially powerful supranational trade networks is accompanied by the development of their investment activities, and it is possible to find them at every turn. There has been the increase in both, the number of new trade units and also in the faxour of large trade centres by consumers and investors. There is also change in shopping behaviour of people. The former shopping models are changing and are starting to resemble the behaviour in western Europe.

Our research was carried out during common week (10. – 16.10.2005, from 8,00 a.m. to 20,00 p.m.) The cars were counted in one-hour intervals and the numbers were noted down in tables for each hour separately.

Shopping cetres Cassovia and Optima in Košice show generally two maxima. The secondary maximum of Cassovia was identified in the morning from 10,00 to 12,00 and the main from 15,00 to 20,00 in the afternoon. On Friday, we have noticed the absolute maximum whithin the whole week, which is 630 cars from 14,00 to 15,00. In Optima there is only one significant maximum (main) from 17,00 to 19,00. The secondary maximum in the morning from 11,00 to 13,00 is less signifcant (except for Thursday). We have also noticed the absolute week maximum (749 cars) between 15,00 and 16,00.

The Tesco hypermarket, like shopping centres in Košice, shows two maxima, the Hypernova market just one. Tesco shows its secondary maximum from 9,00 to 12,00 in the morning, and the main from 18,00 to 20,00 in the afternoon. The most customers were noticed in Tesco on Friday – 4698, what is 20 % from the whole week attendance. Hypernova generally shows only one more significant maximum from 16,00 to 19,00 in the afternoon, the morning attendance is not so marked. We have also noticed the absolute hour maximum on Friday (215 cars) from 18,00 to 19,00, what might be mostly conditioned by weekend shoppings. On Friday we have also noticed the absolute daily maximum – 1805 cars.

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COMMUNICATING AIR QUALITY TO THE PUBLIC AS A TOOL TO RAISE AWARENESS OF AIR POLLUTION ISSUES

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Abstract

The paper labours reasons for broadening communication of air quality measurements to the general public in the present-day Czech Republic. A more direct reporting of current air pollution records, on both nationwide and local scale, is requisite to draw closer attention to air quality as one of the major clues to maintain sustainable environment.

KEY WORDS: air quality index, public awareness, Czech Republic

1. INTRODUCTION

Air quality in the Czech Republic has undergone major changes in the last fifteen years. Industrial air pollution decreased due to general reduction in the production volumes, closing down of many businesses and sheer modernizing of plants that continue operation. A significant reduction in emissions of sulphur dioxide (SO_2) was faciliated by desulphurising flue gases emitted from brown-coal power plants (programme completed by 1997). Commencing the Temelín nuclear power plant (in 2002) also allowed reducing the dependency of the Czech energy market on burning fossil fuels. Local heating patterns shifted from coal in favour of natural gas and electricity – according to the air pollution report of the Czech Hydrometeorological Institute (2005) solid fuels were used for heating in 19% of flats in the country in 2004 compared to 45% in 1991, while the share of gas fuels raised from 16% to 36% and electricity from 1% to 6% in the same period. The share of district heating remained almost the same (37% in 1991, 38% in 2004). A significant drop in the use of solid fuels in local heating occurred in the 1990s, since then the share remains stable and still comprises a significant group of consumers. The costs of gas and electricity heating have been growing fast in the recent years and there is indication that the widening gap in prices of fuels may persuade part of the consumers to migrate from gas and electricity back to coal and wood. Another indicator describing the rising importance of individuals in air pollution issues is the number of vehicles used in the country. According to yearbooks published by the Czech Statistical Office there were around 2.7 million passenger cars (including vans) in the Czech Republic in 1993 and more than 3.8 million in 2004.

2. AIR QUALITY INDEX AND ITS MODIFICATIONS

Air quality monitoring uses various environmental indicators. Besides air pollution levels for specific airborne pollutants in a given location the so called **air quality index** (AQI) has been defined as a more complex report tool on air pollution.

Numerous modifications of AQI have been derived based on various data sets of air pollution levels, primarily concerning the effect of airborne pollutants on human health.

2.1. AQI in the Czech Republic

In the Czech Republic, air quality index ('index kvality ovzduší' in Czech, abbreviated as IKO) has been proposed for air quality assessment since the beginning of 1980s. The very early version of this indicator was published by the Ministry of Health in 1981, but it faced criticism, did not encounter wider practical use and has finally been abandoned (Hůnová, Janoušková, 2004).

The National Institute of Public Health (Státní zdravotní ústav) has developed an air quality index based on annual, daily and instant concentration values. This IKO has been used in recent years as part of the annual reports on health impacts of air pollution. Any airborne pollutant with a designated national limit may be assessed by this IKO. It is also possible to derive IKO values for any selected group of pollutants. The calculated IKO values are classified into colour-coded, verbally described levels on a scale of one to six (Table 1).

Table 1: Air quality index (IKO) of the Czech National Institute of Public Health

IKO		Description	Colour
value	level		
<0; 1)	1	clean air, health favourable	fresh green
<1; 2)	2	satisfactory air, healthy	dim yellowish green
<2; 3)	3	slightly polluted air, health acceptable	dim yellow
<3; 4)	4	polluted air, endangering health of sensitive persons	dim ochre
<4; 5)	5	heavily polluted air, endangering health of the whole population	dim red
<5; 6)	6	air harmful to health, very heavily polluted	bright crimson

Source: Postup výpočtu indexu kvality ovzduší. Státní zdravotní ústav.

The Czech Hydrometeorological Institute derived a different air quality index and used it to classify the area of the Czech Republic into five categories according to air pollution levels confronted with air pollution limits. Outputs of this assessment were published in the annual reports in 1997–2002 (Hůnová, Janoušková, 2004) but this was abandoned after the adoption of the new air quality legislation.

2.2. Selected examples of AQI from abroad

The **U.S. EPA** uses AQI as a key tool for reporting daily air quality. The original Pollutant Standards Index (PSI), used since 1976 to label local air quality within newspaper reports, was revised and renamed as AQI in 1999. The indicator is defined on a scale from 0 to 500 divided into six intervals, colour-coded for the ease of perception of the health concern (Table 2). An AQI value of 100 corresponds to the national air quality standard for the specific pollutant. EPA calculates the AQI for five major air pollutants regulated by the U.S. Clean Air Act: ground-level ozone, particulate matter, carbon monoxide, sulphur dioxide, and nitrogen dioxide. In large cities (more than 350,000 people), state and local agencies are required to report the AQI to the public daily. When the AQI is above 100, agencies must also report which groups in population may be sensitive to the specific pollutant. Many smaller communities also report the AQI as a public health service. Many cities even provide forecasts for the next day's AQI. Information on AQI is broadcasted within local television and radio weather forecasts, reported in local newspapers and posted on the Internet (http://www.airnow.gov/).

Table 2: US EPA Air Quality Index categories

AQI range	Health Concern	Colour
0 to 50	good	green
51 to 100	moderate	yellow
101 to 150	unhealthy for sensitive groups	orange
151 to 200	unhealthy	red
201 to 300	very unhealthy	purple
301 to 500	hazardous	maroon

Source: Air Quality – A Guide to Air Quality and Your Health. U.S. EPA.

In **Portugal**, an AQI for major urban areas has been developed for daily reports on air quality (Ferreira et al., 2002). The classification is based on the worst daily concentration of particulate matter (PM_{10}), the worst 8-h concentration of carbon monoxide, and the worst hourly concentrations of nitrogen dioxide, sulphur dioxide and ground-level ozone. For each of the five pollutants its worst average is classified on a scale of five AQI categories (very good – good – medium – weak – bad). Information on AQI is published daily at 17.00 h based on data from midnight to 15.00 h. Ferreira (2002) proves this AQI to successfully reflect high pollution levels found according to European legislation and to serve as a useful tool to provide better public information and awareness.

A simple AQI was developed in 1993 for the Helsinki Metropolitan Area, **Finland** in order to inform the public in layman's terms about the current air pollution situation (Hämekoski, 1998). The index was required to be simple to calculate, clear enough for the public to understand, yet still have a sound scientific basis. The pollutants included in the calculation are carbon monoxide (1-h and 8-h concentration), nitrogen dioxide (1-h and 24-h), sulphur dioxide (1-h and 24-h), ground-level ozone (1-h) and particulate matter expressed as PM_{10} (1-h). Subindices are calculated hourly for all pollutants and for the given hour the highest subindex becomes the AQI. Moving averages are used for 8-h and 24-h averages. The AQI calculation is based on a segmented linear function consisting of four breakpoints (AQI of 10, 50, 100, and 150) joined by straight-line segments. The AQI level of 100 corresponds to the pollutants' concentration limits according to the Finnish air quality guidelines (except for O_3, assessed due to lack of the national standard on the basis of WHO recommendation). For easier public understanding the AQI levels are segmented into four colour-coded categories (Table 3). When the air pollution situation changes very fast, the subindices based on 24-h averages can still determine AQI value even though the concentration of the pollutant in question has already dropped. This temporary disagreement of the AQI with real-time air quality lasts only a few hours and the value is correct as far as potential 24-h exposure of city dwellers is concerned. A direction of the change of the AQI may be added to the instant figure in order to control the reverberation phenomenon.

Table 3: AQI categories – Helsinki, Finland

AQI range	Definition	Colour
< 50	Good	Green
51–100	Fair	Yellow
101–150	Passable	Orange
> 150	Poor	Red

Source: Hämekoski, K. (1998).

Many other examples of AQI can be found all around the world, including both developed and developing countries. The prevailing principle is to confront the current air pollution levels of the most common health-affecting airborne pollutants against their national standards and to transform this information into an easily understandable index that can be directly reported to general public on a regular, preferably daily basis.

3. DISCUSSION

At present, the Czech mass media cover air quality issues mainly by individual, irregular reports on local air pollution accidents, summaries of seasonal or annual assessment studies and other similar topics. Although weather forecasts are an integral part of everyday television and radio broadcast on both national and local levels, as well as they are published in newspapers and posted on news websites, air quality reporting is not contained unless warning on high pollution levels or smog regulation is necessary. The public service weather forecast on the Česká televize channel contains regular prediction of the following day's air pollutant dispersion conditions; the TV weather forecasts prepared by Meteopress uses a specific air quality prediction index (scale 1–10). None of these short communications contain a real, current air quality assessment report. In the early 1990s a former Czech public service TV channel OK3 broadcasted real-time air pollution levels from selected areas of the country (northern Bohemia, northern Moravia, Prague etc.) but this practise was abandoned with the transformation of TV broadcasting after the split of Czechoslovakia.

Air pollution monitoring in the Czech Republic uses a relatively dense network of monitoring stations, including automated ones. Data from this network are available in close-to-real time, all the basic airborne pollutants are covered according to the requirements of national legislation which has come into accordance with EU Directives at the process of the Czech Republic joining the European Union. Availability of data on current air pollution levels is therefore comparable to countries where regular air quality reporting has become standard.

While large industrial sources are obliged to follow strict air pollution regulations according to the Czech legislation, individuals do not have to carry out specific emission regulations (apart from proper combustion source installation and vehicle maintenance). The responsibility of individuals for their emissions of airborne pollutants should be supported by proper information in order to raise the awareness of air quality issues. The practice of regular communicating of air quality to general public is technically easy to implement and adopting such service would draw attention of public to air pollution prevention. A simple, easy to report air quality index shall be calculated at least for the larger urban areas in the country to be broadcasted on a daily basis within the weather forecast, as well as newspapers and news websites. Local municipal authorities may also take action in the similar way, offering the local value of AQI to local media (local television channels, regional news broadcast within the national television channels, local and regional radio stations, local and regional press, municipal and regional websites etc.).

4. CONCLUSIONS

Sufficient information on environmental issues is necessary to support public consciousness about pollution prevention. The necessary data are already available from expert institutions nationwide. Regular reporting of a simple air quality index on both national and local levels is likely to raise attention of the small, individual producers of airborne pollutants. The daily basis of the reporting and its nature as a standard part of the news content or weather forecast is the primary concept of making air-quality awareness an integral part of everyday decision making.

5. SOUHRN

Sdělování kvality ovzduší veřejnosti jako nástroj ke zvýšení povědomí o problémech znečištění ovzduší.

Kvalita ovzduší je v České republice legislativně ošetřena v souladu se zvyklostmi vyspělých zemí a požadavky Evropské unie. Síť sledování kvality ovzduší poskytuje dostatečná data pro zpracování jednoduchého a laikům snadno pochopitelného indexu kvality ovzduší, který by se mohl stát nedílnou součástí obsahu zpravodajství či informací o stavu a předpovědi počasí na celostátní i regionální či místní úrovni. Obdobná informační služba je běžná v řadě vyspělých zemí a ani v České republice jejímu zavedení nestojí v cestě závažnější technické překážky. Pravidelné informování široké veřejnosti o aktuálním stavu kvality ovzduší, ať už na celostátní nebo místní úrovni, by pozvedlo povědomí občanů coby soukromých provozovatelů malých a mobilních zdrojů znečišťování ovzduší a obzvlášť s doprovodným upozorněním na účinky na lidské zdraví by se mohla stát jedním z efektivních nástrojů prevence znečišťování atmosféry.

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THE USE OF GIS METHODS IN TSES PLANNING

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Abstract

The aim of the article is to introduce the practical use of GIS methods in the territorial system of ecological stability of landscape (TSES) establishment. One of the goals of this methodology is to eliminate a subjective access at the territorial system of ecological stability of landscape planning and establishment. It has been developed and tested at the local TSES proposal in a part of Bartosovicky stream-basin area in the north-eastern Moravia. One of the important qualities of the landscape is its ecological stability according to Míchal (1992). The need to conserve fundamental landscape capacity, as an important donator of renewable resources, is the widest contemporary conscious process leading to the straightening of the ecological landscape stability. The completion of the TSES is one of its compounds as well.

KEY WORDS: ecological stability, GIS, landscape, TSES

1. INTRODUCTION

An idea of territorial system of ecological stability has emerged from the biogeographic island theory. Human activities result in the fragmentation of the natural environment life of other organisms and in the reduction of natural and nature close ecosystems in the landscape. Only a small part created "islands" - residual nature patches - is large enough and it contents such biodiversity to support possible survival and development of the distinctive species, its populations and societies. Occasionally, a species can extinct at one/more limited patch/es. To ensure this species re-colonisation from other residual patches, it is necessary to conserve a sufficient amount of large "islands" and to ensure the possibility of migration among those "islands". Different species are bound to specific abiotic environments. Therefore, it is important to conserve a wide range of such environments. The objective of the landscape ecological stabilisation is clear, however, the issue is what ways should be used to achieve the stage proposed. The recent methodology is based mainly on the intuition and the relation to the landscape. Nevertheless, the nowadays approaches should be more based on the scientific data (e.g. the landscape and its patterns condition). This attitude is compatible with the landscape synthesis process according to Kolejka et Pokorný in Voženílek (1999). At the same time, it is important to include the geo-informational technologies, which are suitable for the analysis of a big amount of the space data and other synthesis.

2. METHODOLOGY OF TSES PLANNING WITH THE USE OF GIS

2.1 Analysis and visualization

The methodology is based on the technology of the GIS. Tuček characterizes geographic informational systems as an organized system of hardware, software and geographical data to achieve an effective collection, storing, actualizing and visualization of the time-space information. Preparation of digital data is time-consuming stage and means conversion of all printed maps to digital layers (maps) in the environment of system PC ARC/INFO 3.5.2. Alternatively, it is possible to digitize scanned maps in the system ArcView. Analysis and other visualization of results have been done in software ArcView GIS. Data got during the fieldwork was implemented to an attribute table. On the base of an ortophoto were modified outlines and accurate position of a current landscape segment. Area of such modified segments was consequently recount. Final maps were completed in the scale layouts with all the components of a map.

2.2. Theoretical base

Theoretical basis of establishing local TSES using GIS were created on the ground of methodology Kolejka et Pokorný in Voženílek, 1999, with use of same techniques from Metodika vymezování místního ÚSES/Methodology of local TSES identification (Löw et al., 1995).

Main principles of TSES completing:

1. To comply with natural landscape structure and its predisposition for a certain risk processes as a basis for an evaluation of landscape human modification and analysis of the requirements for ecological stabilization.
2. To take the abundance of valuable landscape segments in the landscape matrix into account.
3. To ensure the sufficiency of existing elements of the system.
4. To prefer poly-functionality of all elements of the system.

The most suitable method for the TSES establishment is a process of the landscape synthesis. Therefore, the essential is prior landscape diagnosis. This part involved primary (natural) landscape structures inventory and location of secondary (existing) landscape structure. The evaluation part of the diagnosis consists of the eco-stability function determination of both natural and secondary landscape structure and their integral display into the actual landscape segments condition from the ecological stability viewpoint.

2.3. Identification of the primary landscape structure

Identification of the primary landscape structure is the main starting point for the impact evaluation of human landscape modification and the analysis of the need for ecological stabilization. A prior step for the location of primary landscape structure is to create layer (map) of geobiocen type groups (GTG). A geobiocen type consists of natural geobiocenose and all other transformed geobiocenose derivate and developed from natural geobiocenosis and its development stages. Detection process of natural landscape stage includes a geobiocenosis classification and geobiocen classes specification. Basic application unit of this typification are geobiocen type groups (GTG). Their names are derived from the terms of predominant temperate woody species from original forestal geobiocenose. The geobiocen type groups (GTG) as a frame of specific ecological conditions and therefore potential biocenosis are specified by biocenological code. The first symbol in the code (a number) represents altitudinal vegetation zone, the second symbol (a letter) represents the soil conditions (trophic level) and finally the third letter presents hydric level (Löw at al., 1995). The GTG associates areas with similar lasting ecological conditions without a reference to their existing situation. Nevertheless, these areas have similar conditions for the using in forestry, agriculture, water management and nature conservation.

The GTG for the forest land have been specified by the conversion from STL forest type group derived from the forest typological map. A conversion table has been used for the purpose of a conversion of a HPJ (hlavní půdní jednotka) to the GTG. More options, how to BPEJ data interpret, exist as the reason that in BPEJ (bonitovaná půdně ekologická jednotka) key does not always mention its pedogenic substrate. As a consequence, a final verdict for the soil condition (trophic level) has depended on the soil parent material inferred from the geological map.

The GTG for the agricultural land were specified by the conversion from HPJ derived from BPEJ, where the second and the third position of the five-symbol code has simply defined the soil type, sort and hydrological regime (Kynčl, 1994).

The final result of the process was the GTG digital coverage (map) with the corresponding attribute tables.

2.4. Identification of secondary landscape structure

The current landscape structure condition has been found out by the field environmental mapping in the growing season. The field mapping was completed according to the methodology Mapování krajiny SMS (Vondrušková, 1994). Each uniform landscape segment in structure and function was confined and specified with the ordinal number. In the table, these attributes have been recorded: the ordinal number, corresponding special segment type data code (účelový typ segmentu), actual size, ecological stability level and basal parameters. The basal parameter contents the description of the landscape, vegetation cover, and other notes.

The secondary landscape structure was confronted with the ortophoto map (to achieve the accuracy), digitized and visualized. Special segment type data code, actual size, ecological stability level and basic parameters were added to the attribute table.

2.5. Determination of the natural stability

The natural stability was inferred from the theme of the geobiocen type groups (GTG). The natural stability was determinate for each entity within the frame of GTG, in the case of particular GTG was compounded from a several area separated segments (entities). This technique has prevented an unduly generalization of weighted average effect of inclination and geological substratum. To the each GTG segment were assorted point values representing nature factor influences. The bioclimate, soil conditions (trophic level) and soil humidity (GTG code) are in the frame of GTG uniform. The influence of the inclination and the geological substratum was determinate separately for each GTG segment as point values weighted average inferred from real natural components. The final natural stability level was derived from the summary point valuation acquired as a sum of partial point values of particular nature factors. The essential step to learn a geological substratum impact was the creating of digital geological coverage and attribute tables with point values for particular geological substratum. This theme (coverage) was united together with the primary landscape structure theme (coverage) to simplify a new polygonal theme. Weighted averages were counted in the attribute tables.

The essential step to create the geo-relief inclination theme was a contour line digitalization. Consequently, a fully dimensional digital model was created in the module of the ArcView 3D Analyst. Simultaneously, the slope categories were redefined: 0–3° for flatlands and very gentle slopes, 3–15° for gentle slopes and over 15° for steep slopes. The final 3D digital model was converted to the shapefile polygon coverage. The subsequent union with a primary landscape structure theme was analogical to the process with geological substratum theme.

The final step in this part of process was uniting primary landscape structure theme competed with nature stability values and secondary landscape structure theme. The secondary landscape structure units are for a particular GTG homogenous also in their natural quality.

2.6. Determination of the functional stability

By the uniting primary and secondary landscape, structure themes were creating a theme containing units uniform in their natural character and purpose utilization. The functional stability of individual natural landscape units (entire GTG) was determinate as a weighted average of ecological stability levels of purpose segment types in the frame of the GTG geosystem. Ecological stability levels of purpose segment types were determinate in accordance with the methodology Mapování krajiny SMS (Vondrušková, 1996). The functional stability level was determinated in terms of point values in Tab. 1.

Tab. 1: Determination of natural and functional stability (Kolejka et Pokorný, 1999)

Stability value	Abbreviation	Point values of natural stability	Point values of functional stability
Very high	VH	12–15	4,500–5,000
High	H	9–11	3,500–4,499
Average	A	7–8	2,500–3,499
Low	L	4–6	1,500–2,499
Very low	VL	0–3	0,000–1,499

2.7. Determination of the ecological stability

The ecological stability values of individual GTG were derived using the means of matrix (Tab. 2).

The ecological stability level is an aggregate indicator of real eco-stabilization status or area condition of an entire natural landscape unit (entire GTG) and, therefore, also a condition of purpose segment type within a specific GTG. The condition is impacted by the current land use (functional stability) and by the natural resistance against destabilization processes (natural stability).

Tab. 2: Decision matrix for ecological stability determination (Kolejka et Pokorný, 1999)

		Functional stability				
		VH	H	A	L	VL
Natural stability	VH	5	5	4	3	3
	H	5	4	3	3	2
	A	4	3	3	2	2
	L	3	3	2	2	1
	VL	3	2	2	1	1

2.8. Planning of the landscape ecological stability structure

Realized ecological stability levels are main base for delimitation of ecological stability structure. Ecological stability structure integrates existing ecologically significant landscape segments. Ecologically landscape segments are created by ecosystems with relatively a higher ecological stability with preponderance of these ecosystems (Löw et al., 1995).

The incorporating landscape segment priority rate of particular purpose segment types of GTG into ecological stability structure depends on the confrontation of entire ecological stability of particular GTG with an area condition within the purpose segment type. If an area of a certain GTG was stabile and concurrently the particular purpose segment type within this GTG was stable too, than the importance of the incorporating of this stable landscape segment was relatively low. Reversely, if an area of a certain GTG was instable but the particular purpose segment type within this GTG was stabile, than the priority of incorporating of this stabile landscape segment was maximal. The priority determination of ecologically significant landscape segments incorporation into the ecological stability structure was managed within matrix (Tab. 3).

Tab. 3: Decision matrix for priority determination of significant landscape segments incorporation into ecological stability structure; 5 – max. priority, 1 – min. priority (Kolejka et Pokorný, 1999)

		Ecological stability of purpose segment type in the background of GTG				
		VH	H	A	L	VL
Ecological stability of GTG	VH	4	3	2	1	1
	H	4	3	2	2	1
	A	5	4	3	2	1
	L	5	4	3	3	1
	VL	5	5	4	3	1

2.9. Planning of the local TSES

All the ecologically significant landscape segments are concurrently existing structural segments of the TSES. In the process of TSES planning, these existing segments should be preferred especially. Newly established segments have to be created in the field, these will be fully functional after many years. The reorganization of ecological stability structure is not possible until the TSES are in the full and optimal capacity. According to the prevailing function and parameters are the structural segments distinguished into biocentres, biocorridors and interactive components (Löw et al., 1995).

The priority determination of the existing biocentre from the proposal of other biocentres into the TSES structure was managed with the decision matrix (Tab. 3). The concrete selection from the amounts of equivalent segments was managed through the use of spatial requirements listed in Tab. 5.

The principle of such a selection is to conserve with the minimal spatial equivalent existing GTG in the landscape structure.

The priority determination of new bio-centres localization (will be established in instable areas) was done the opposite way. The determination of a suitable purpose segment type (or a concrete segment type in its area) to form a new bio-centre and was managed through the use of the decision matrix (Tab. 4). The priority rate of a certain purpose segment type incorporating (or a concrete segment in its area) depended on the situation confrontation in a concrete purpose segment type in the frame of a certain GTG with the condition of the whole GTG area. After the confrontation with the primary landscape structure map were separated out ineligible locations impossible or uneconomical to create the new bio-centre (e.g. build-up an area, an urban area)from the segments selected.

Tab. 4: Decision matrix for the priority determination of landscape segments to completion of biocenter; 5 – max. priority, 1 – min. priority (Kolejka et Pokorný, 1999)

		Ecological stability of purpose segment type in the background of GTG				
		VH	H	A	L	VL
Ecological stability of GTG	VH	1	1	2	2	3
	H	1	2	2	3	3
	A	2	2	3	3	4
	L	2	3	3	4	5
	VL	3	3	4	5	5

The final conceptual objective of the TSES planning was the selection of optimal interconnections between bio-centre concepts. The bio-corridors should be created with the minimal migration barriers for keeping its effective function. These barriers are GTG divisions and disturbance corridors (e.g. motorways), which form a barrier for species migration. It is necessary to ensure the sufficient capacity to enable the migration of multitude species. Minimum area requirements for migration corridors are listed in Tab. 5.

Tab. 5: Area parameters of local biocentre and biocorridor parameters (Löw et al., 1999)

canopy type	Min. area of biocentre [ha]	Biocorridor	
		Max. length [m]	Min. widht [m]
Forest canopy	3	2 000	15
Wetland canopy	1	2 000	20
Meadow canopy	3	1 500	20
Steppe canopy	1	2 000	10
Rock canopy	0.5	–	–
Combined canopy	3	2 000	–

It is rational to assume, that a higher variability in conditions of landscape segments (in the frame of GTG) imply a stronger barrier character. Fewer amounts of species will cross this barrier and will migrate along the barrier. Therefore, the best option is to plan the migration corridor along the GTG division. Theoretically, such a corridor can use different species bounded to both environments concerned to bordering the GTG. GTG divisions are the prime option to plan a biocorridor.

The economic efficiency of the biocorridor planning (and constructing) is directly proportional to the quantity of the existing or partially existing functional sections between two preliminary selected biocentres. The real situation in the area of potential biocorridors was located after covering the GTG division network coverage and secondary landscape structure coverage.

2.10. Selecting and proposition of the TSES components

Basic TSES components are biocorridors, biocentres and interactive components. These components can be divided according to the functionality into the existing (functional), semi-functional (partially functional) and absent (non-functional) biocentres and biocorridors.

The existing biocentres should be selected from the sum of equivalent ecologically significant landscape segments according to their area parameters. The evaluation of landscape segment ecological stability on the background of the GTG has required a high fragmentation to ensure the character homogeneity of the each segment. A certain amount of such segments was not in compliance with the requirements to the minimal local (or regional) bio-centre size. Therefore, the final existing biocenter selection was in some cases affected by a sequential synthesis of neighboring segments with similar phytocoenose, eventually the synthesis of segments with different vegetation cover, but it belonged to the same or affinitive GTG. All the times, their area parameters were verified. In the case the requirements were not fulfilled, such biocentres were classified as a semi-existing (semi-functional) bio-centre. Absent areas usually on arable land were recommended for tree species planting (tree species must correspond to the potential nature biocoenose). All the recommendations together with other attributes (characteristic of current condition, area parameters, GTG code and segment sequence number) were written into the tables. The biocentres with sufficient area parameters (however, their vegetation cover does not correspond to potential nature biocoenose – artificially modified natural species composition with preponderance of allochtonous species) were also included into the semi-functional bio-centre category. Such areas were recommended for a gradual replacement from the allochtonous species to the autochtonous. The existing biocentres are devised to conserve its biocoenose.

In the process of a non-existing bio-centre determination were found many large segments suitable for the stabilization. The final selection was done in the consideration of greatest distance admissible for the bio-corridor connecting different biocentres. Therefore, a new biocentre was selected on the biocorridors usually on the crossings of biocorridors.

The existing functional biocorridors formed a full connection between biocentres and met all the area parameter requirements (length, width, disconnections) and are compounded from the species corresponding to the potential nature biocoenose. The main function of the corridor is the interfered biological information flow in the landscape.

Semi-functional biocorridors represent usually a non-interrupted connection of two biocentres, however, some of these segments do not meet area parameter requirements and in addition, the vegetation cover is composed of rellativelly instable biocoenose. These segments are recommended to be extended and species should be changed in the sense of potential natural ecocoenose. The last sort of semi-functional biocorridors are those with non-functional segments on an arable land.

Non–functional absent bio-corridors or their parts are recommended for plantion in the strip attached to both sides of the GTG borders. The recommended tree-species should be adequate to both GTG – the objective ecocoenose is supposed to represent a transition zone.

The interactive components are remaining landscape segments, which were not included in the TSES for the reason of substandard area parameters or unsuitable position, however, they are important for conserving and increasing of the eco-stability and biodiversity of the landscape. Other typical segments classified as interactive components are significant lineal canopies, which are not eligible for the biocentre tracking.

SUMMARY

Although the territorial system of ecological stability of landscape theory is sometimes criticized, currently represent the best practical system of landscape conservation. The methodology introduced in this article is based on the methodology Kolejka et Pokorný (1999) and its main goal is eliminate a subjective access at the territorial system of the TSES planning and establishment as an most criticized point of the TSES theory. The GIS technology afforded multifunctional analysis and synthesis of natural or human-influenced components of the landscape.

SOUHRN

Využití metod GIS v územním plánování

Územní systém ekologické stability (ÚSES) krajiny představuje v současnosti hlavní nástroj ochrany přírodních a přírodě blízkých segmentů krajiny a celkové krajinné struktury. Využití geografických informačních systémů umožňuje eliminovat subjektivní přístupy při stanovování ÚSES. Popsaná metodika vycházející z metodiky Kolejka et Pokorný (1999) byla vyvinuta a ověřena při vytyčení lokálního a (částečně) regionálního ÚSES v severní části Bartošovického potoka na severovýchodní Moravě.

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SELECTED CHANGES IN EXPLOITATION AND MINING OF MINERAL RESOURCES IN THE CZECH REPUBLIC IN THE PERIOD 1993–2005

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Abstract

In the last few years, structure changes in the Czech economy, especially in industry, have influenced both the role and the importance of branches of extracting and processing minerals and materials of mineral origin. Index of mineral production share of the GDP reflects the changes, as it has decreased from 3.7% in 1993 to 1.3% in 2005. Mining industry has to a large extent negative impact on the environment. That is why production restrictions in many deposits have a positive effect on landscape and nature and on other factors with environmental impacts. Very important is decrease of mineral production in protected landscape areas. Mining in these areas has reached the half level in 2005 compared to 1993. However, there still exist protected landscape areas where restrictions have not been materialized and even when an extent of mining has increased.

KEY WORDS: mining spaces, mineral resources, building minerals, limestones

1. INTRODUCTION

In the last few years, structure changes in the Czech economy, especially in industry, have influenced both the role and the importance of branches of extracting and processing minerals and materials of mineral origin. Market economy caused a restriction or even termination of mining of non-economic deposits, where mining continued with the help of state subventions in the past. All mining was stopped in the deposits of ores, the mining of coal has been limited significantly in many regions. The mining of uranium ores was strictly limited.

2. MINING SPACES IN THE CZECH REPUBLIC

At present, (as of 31st December 2005), in the Czech Republic, there are 1004 mining spaces (claim) with a total area of 1 480 km^2 (2 % of the state territory). The delimitation of the mining space is only the beginning of a procedure which will end with permission granted for mining entailing the beginning of the anthropogenic transformation of the relief. The mineral sources in the Czech Republic are owned by the state. They consist of deposits of selected minerals ("exclusive deposits"). Additionally, the protected deposit area is established for exclusive deposits of mineral resources (in accordance with the Mining Law – see below), where construction activities unrelated to the extraction of the exclusive deposit are limited. When considering the fact that nearly 90 % of the mineral resources in the Czech Republic are extracted from opencast mines, the extent of anthropogenic influence on the landscape is obvious. The extraction itself is controlled by the applicable Bureau of Mines.

At present, the importance of extraction of mineral resources has been shifted from the area of public interest to the focus of interest of private mining companies which are attempting to gain economic profit from the mineral resources of the territory. This also results in a range of conflicts of interest between municipalities along with citizen-action associations and the mining companies. Nevertheless, the "mining lobby" plays an important role in regional development. In areas with underdeveloped economies in particular the presence of mining companies is approached mostly positively. They represent an important source of income for the municipal budget and often contribute to off-budgetary incomes despite the landscape risks and environmental impacts resulting from the extraction activities. The municipalities where the extractions are carried out benefit from the income in the form of remunerations set by the mining law as settlement for the allotments and compensations from the extracted minerals in accordance with the § 32a of the Law no. 44/1988 Coll., within the meaning of the Law of ČNR no. 541/1991 Coll. The accounts on which the remuneration's are paid are kept by the applicable Bureau of Mines which then distribute this money to the authorised beneficiaries, i.e. to the municipalities and the state budget. The annual payment of an mining space larger than 2 hectares is CZK 10,000 and it is multiplied with each extra km^2. The annual payment for mining spaces smaller than 2 hectares is CZK 2,000.

According to the Mining Law, the annual compensation for the extracted minerals is calculated as a percentile share of the total receipts for the extracted mineral at the actual market price (the maximum share is 10 %). 25 % of the amount paid to the Bureau of Mines is transferred to the state budget of the Czech Republic. This money is used for reparation of damages to the environment caused by the extraction of exclusive and non-exclusive deposits. The remaining 75 % is transferred to the budget of the municipality. Remuneration is paid in accordance with the kind of extracted mineral. The actual rate depends on the kind of mineral resource and is set by Decree no. 617/1992 Coll of the Ministry of Economics, with, for example, 5% for oil and natural gas, 0.5% for underground mined coal, 1.5 % for opencast mined coal, 8 % for kaolin (China clay), 10 % for high-percentage limestones, 3 % for other types of limestone and other cement mineral resources, etc.

Table 1: Mining spaces in the Czech Republic (1993 and 2005 compared)

mineral	**Number of mining spaces**			**Total area of mining spaces**		
	1993	2005	Index 2005/1993 (%)	1993	2005	Index 2005/1993 (%)
Hard coal	38	27	71,1	524,4	374,5	71,4
Brown coal and lignite	54	36	66,7	458,4	305,8	66,7
Crude oil and natural gas	27	93	344,4	253,9	432,7	170,4
Ores	18	5	27,8	29,6	5,6	18,9
Radioactive raw materials	16	11	68,7	99,7	65,6	65,8
Kaolin	25	27	108	9,6	11,1	115,6
Building stone	351	385	109,7	60,5	66,2	109,4
Gravel sand, sands	165	173	104,8	109,2	114,8	105,1
Limestones and dolomites	63	50	79,4	28,6	26,2	91,6
Brick raw materials	175	109	62,3	36,7	25,1	68,4
Other minerals	184	88	47,8	77,1	52,1	67,6
Total	1091	1004	92	1678,1	1479,7	88,2

Source: Makarius, R. ed. (1993, 1995, 2005); Kavina P. ed.(2004); database Bureau of Mines

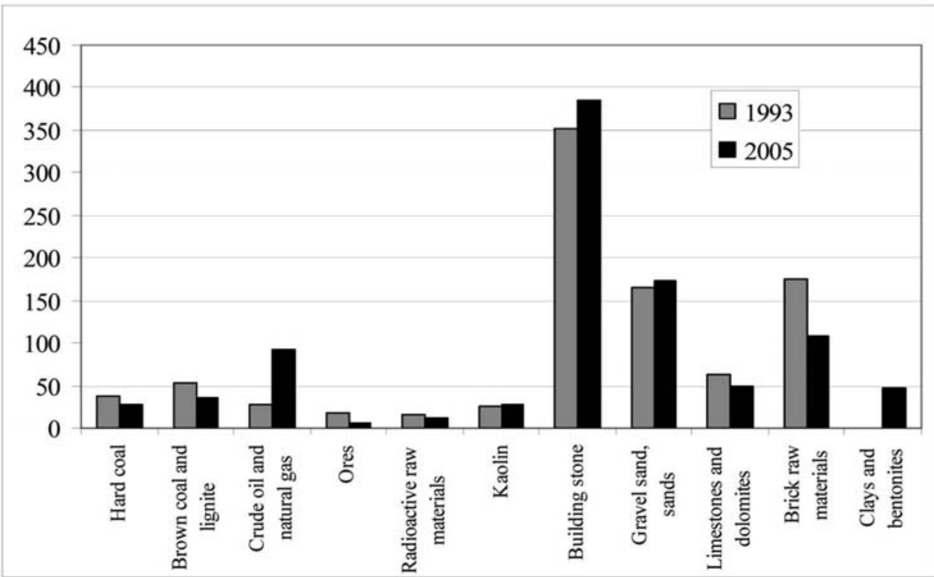


Figure 1: Number of mining spaces in the Czech Republic in the year 1993 and 2005 (comparision)
*Source: Makarius, R. ed. (1993, 1995, 2005); database Bureau of Mine*s

3. EXTRACTION OF MINERAL RESOURCES IN THE CZECH REPUBLIC

Although in modern history the Czech Republic and the previous state formations within its present area did not rank among leading mining countries, the utilisation of domestic raw deposits was high in the past. Over the course of each individual historical period, priorities in terms of extraction of minerals changed, and this was reflected in the varied intensity of extraction with a number of consequences including noticeable changes in the relief. Ore extraction has, for example, a particularly old tradition with the oldest archeological evidence of gold panning dating back to the 9^{th} century B.C. In the Middle Ages, Bohemia was the centre for European mining of gold and silver. The last boom in mining was after 1948, during the period of socialist industrialisation when ore deposits were extensively extracted, even at the cost of substantial financial losses. Particularly common was that after long-term historical deep mining which damaged the environment to a relatively limited extent, i.e. without substantial anthropogenic transformations of the relief with a maximum attempt at effectiveness, the mining in the 1950s and 1960s broadly affected vast areas with a number of accompanying adverse effects. Vast opencast mining resulted in the destruction and liquidation of numerous underground mines, but especially the emergence of new anthropogenic shapes on the surface. The extraction was often accompanied by vast regulations of waterways and the emergence of new accumulated waste heap formations. After 1989, ore extraction was cut back considerably and later the mining of base metal deposit (+ Au) in Zlaté Hory was terminated. In 1994, ore extraction was definitively brought to an end in the Czech Republic. At present, the areas affected by extraction have been redeveloped and rehabilitated.

A somewhat different trend can be observed in the mining of deposits for energy producing raw materials. Coal has been mined from the beginning of the industrial revolution and the mining of uranium ore began after World War II. The extraction of energy producing raw materials reached its height in the second half of the 1980s. After 1989, a state reduction programme was launched, and the previous extensive mining was reduced considerably. Additionally, volume and territorial limits were set for coal mining. The extraction of uranium ore has also been substantially reduced and is limited to the Rožná deposit, where the uranium ore is mined by the traditional deep-mining method. In North Bohemia, however, uranium is attained through the leaching of in sit within the arms of the liquidation program at the deposit in Stráž pod Ralskem.

In contrast, the extraction of oil has been dynamically developing oflate in South Moravia in the area around Hodonín and Břeclav. There is also new interest in the extraction of oil and natural gas in the Beskydy Mountains in the Trojanovice region where vast deposits of black coal have been found. The Trojanovice allotment was designed for the purposes of extensive stone-coal extraction back in 1989, and with its area of 63 km^2 is the largest allotment in the Czech Republic. At present, coal mining is concentrated in two areas: Podkrušnohoří (brown coal) and the Ostrava basin (black coal).

Table 2: Extraction of mineral resources in the Czech Republic (1993 and 2005 compared)

Mineral	Extraction (103)		Index number 2005/1993
	1993	**2005**	**(%)**
metallic ores out of uranium ore)	131	0	0
uranium ore (t)	437	124	28,4
hard coal (t)	18 296	13 252	72,4
brown coal (t)	63 335	44 619	70,4
crude oil (t)	111	301	271,2
natural gas (m^3)	244	221	90,6
kaolin (t)	2 326	3 884	167,0
building stone (m^3)	9 677	13 684	141,4
gravel sand, sands (t)	12 305	15 921	129,4
limestones (t)	10 071	9 778	97,1
brick raw materials (m^3)	1 354	1 939	143,2

*Source: Makarius, R. ed. (1993, 1995, 2005); database Bureau of Mine*s

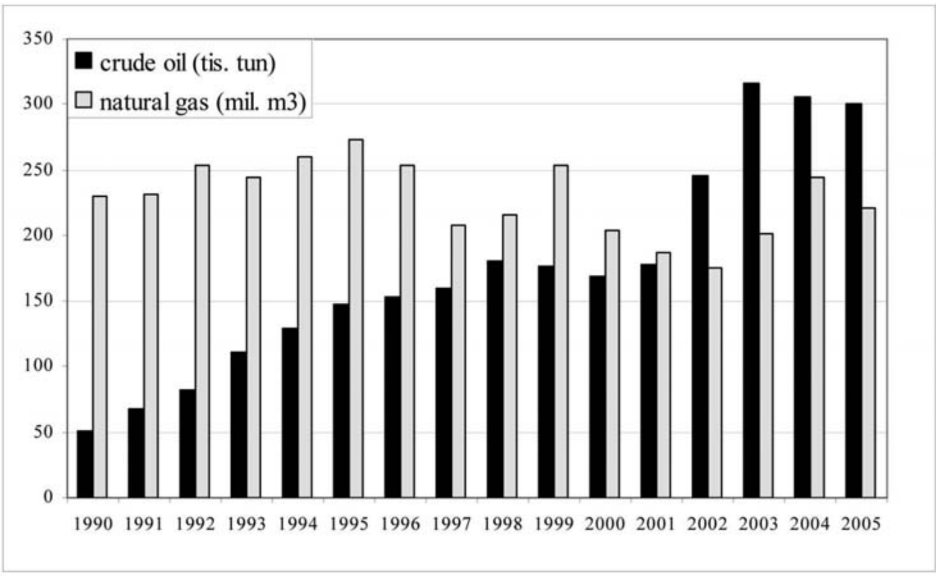


Figure 2: Extraction of crude oil and natural gas in Czech Republik in the period 1990–2005.

Coal mining in Podkrušnohoří, consisting of the largest destruction to the environment, in terms of volume, in the Czech Republic, began at the end of the 18th century in locales with outcrops of coal seams and in shallow opencast mines. Since the second half of the 19th century, the mining has become more intensive and the North Bohemia coal district has become the most important coal district in Central Europe. Deep mining methods predominated at all of the basins (Chebská, Sokolovská, Severočeská) at that time. From the beginning of the 20th century, the amount of opencast mining has been increasing, resulting in vast devastation to the landscape. While the number of opencast mining was about 25% of the total volume of mined coal at the end of the 1930s, in the 1950s, it had reached an absolute majority. The first reduction in extraction occurred in the southwest area of Podkrušnohoří in 1833, where mineral water resources protection zones were established for spa purposes. Consequently, the highest volume of extraction was concentrated in the Severočeská hnědouhelná pánev (SHP, North Bohemia Brown-Coal Basin) where 3,5 mld. tons of coal have been extracted so far, of which 2,6 mld. tons (74,2 %) in opencast mines. In the Sokolov basin, more than 1 mld. tons of coal have been mined.

3.1. Building minerals

In addition to minerals fuels, industrial minerals represent the most important group of raw materials in the territory of the Czech Republic. In this group the largest reserves are of limestones, kaolin, clays, bentonite and natural (glass and foundry) sand. Other industrial minerals represent smaller nevertheless important raw material potential of the national economy. Kaolin, quartz sand, limestone, clays, feldspar and dimension stone are also important export commodities. There are very high geological reserves of construction materials – building stone, sand and gravel and brick clays – in the Czech Republic.

The landscape contains giant opencast mines, originating due to large volumes of extracted mineral resources, with noise and dust disturbing the surrounding environment and the natural system of groundwater often disturbed. Among the non-ore raw mineral resources, the extraction of limestone has a special position. The largest opencast mines include Mokrá u Brna in Moravský kras, Čertovy schody and Mořina in Český kras, Kotouč near Štramberk, Hranice in Central Moravia and Prachovice in Železné hory mountains. Opencast extraction of limestone often results in disturbances to the hydrogeological environment.

According to use, the limestones in the Czech Republic are classified into the following grades: limestones with very high percentage of $CaCO_3$ (containing at least 96% of carbonate component), other limestones (with carbonate content at least 80%), clayey limestones (with $CaCO_3$ content over 70% and higher content of SiO_2 a Al_2O_3) and carbonates for use in agriculture.

Karst regions in the Czech Republic represent a group of isolated areas with special landscape values. They were frequently infracted by small-scale quarrying in the past and today the abandoned quarries usually represent remarkable landscape features. On the other hand, large-scale quarrying started to intensify in the 1960s and has introduced significant disturbances into the landscape. Although the overall amount of limestone extracted in the Czech Republic has decreased recently, more than one third of its production continues to be quarried from specially protected areas.

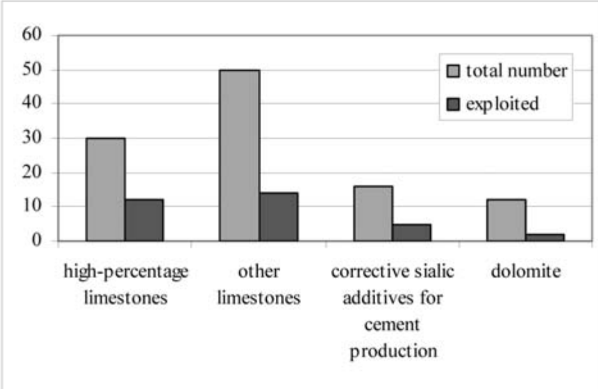


Figure 3: Registered deposits limestones and dolomite (as of 01.01.2005)

*Source: Makarius, R. ed. (1993, 1995, 2005); database Bureau of Mine*s*; Kavina P. ed.(2004)*

Table 3: The largest extracted mining areas (MA) of limestone (as of 01.01.2005)

mining area	**total area (ha)**	**year of assesment MA**	**mining companies**	**conflicts of interests[3)]**
Skoupý	336,6	1961	Agir s.r.o.	–
Suchomasty I	310,2	1975	Velkolom Čertovy schody a.s.	PLA[4)] Český kras (Bohemian Karst)
Mokrá	265,9	1959	Českomoravský cement a.s.[2)]	close vicinity of PLA[4)] Moravský kras (Moravian Karst)
Chotěšov[1)]	220,1	2002	Lafarge Cement a.s.	accumulation area of underground waters
Úpohlavy	167,2	1967	Lafarge Cement a.s.	accumulation area of underground waters
Mořina	151,6	1961	Lomy Mořina s.r.o.	PLA[4)] Český kras (Bohemian Karst)
Štramberk I	118,2	1964	Kotouč Štramberk s.r.o.	valuable archaeological location (cave Šipka)
Prachovice	111,1	1971	Holcim (Česko) a.s.	close vicinity of PLA[4)] Železné hory
Koněprusy	85,7	1963	Velkolom Čertovy schody a.s.	PLA[4)] Český kras (Bohemian Karst)
Zadní Kopanina I	58,1	1959	Českomoravský cement a.s. [2)]	PLA Český kras[4)] (Bohemian Karst)
Dolní Lipová	56,9	1967	OMYA a.s.	balneology (spa Lipová, spa Jeseník)
Úpohlavy I	54,0	1991	Lafarge Cement a.s.	accumulation area of underground waters

*Source: Makarius, R. ed. (2005); database Bureau of Mine*s

Comments:MA = mining area; 1) mining area under survey and development;
2) part of HeidelbergCement;
3) conflicts of interests – localization of mining areas in connection to the protected localities
4) PLA = protected landscape area

Table. 4: The largest mining companies of limestone and dolomite (as of 01. 01. 2006)

Mining companies	**extraction (thousand t)**	**mining area**
Lomy Mořina a.s.	1 623	Mořina, Holý vrch, Tetín
Velkolom Čertovy schody a.s.[2)]	1 570	Koněprusy, Suchomasty
Lafarge Cement a.s.	1 190	Chotěšov, Úpohlavy
Českomoravský cement a.s.[1)]	1 111	Mokrá, Hvížďalka, Špička, Loděnice
Holcim (Česko) a.s. Prachovice	961	Prachovice
Cement Hranice a.s.[3)]	841	Hranice, Černotín
Vápenka Vitošov	756	Vitošov
Kotouč Štramberk s.r.o.	613	Štramberk
OMYA a.s.[5)]	334	Dolní Lipová
Hasit Šumavské vápenice a omítkárny a.s.[4)]	288	Hejná – V. Hydčice

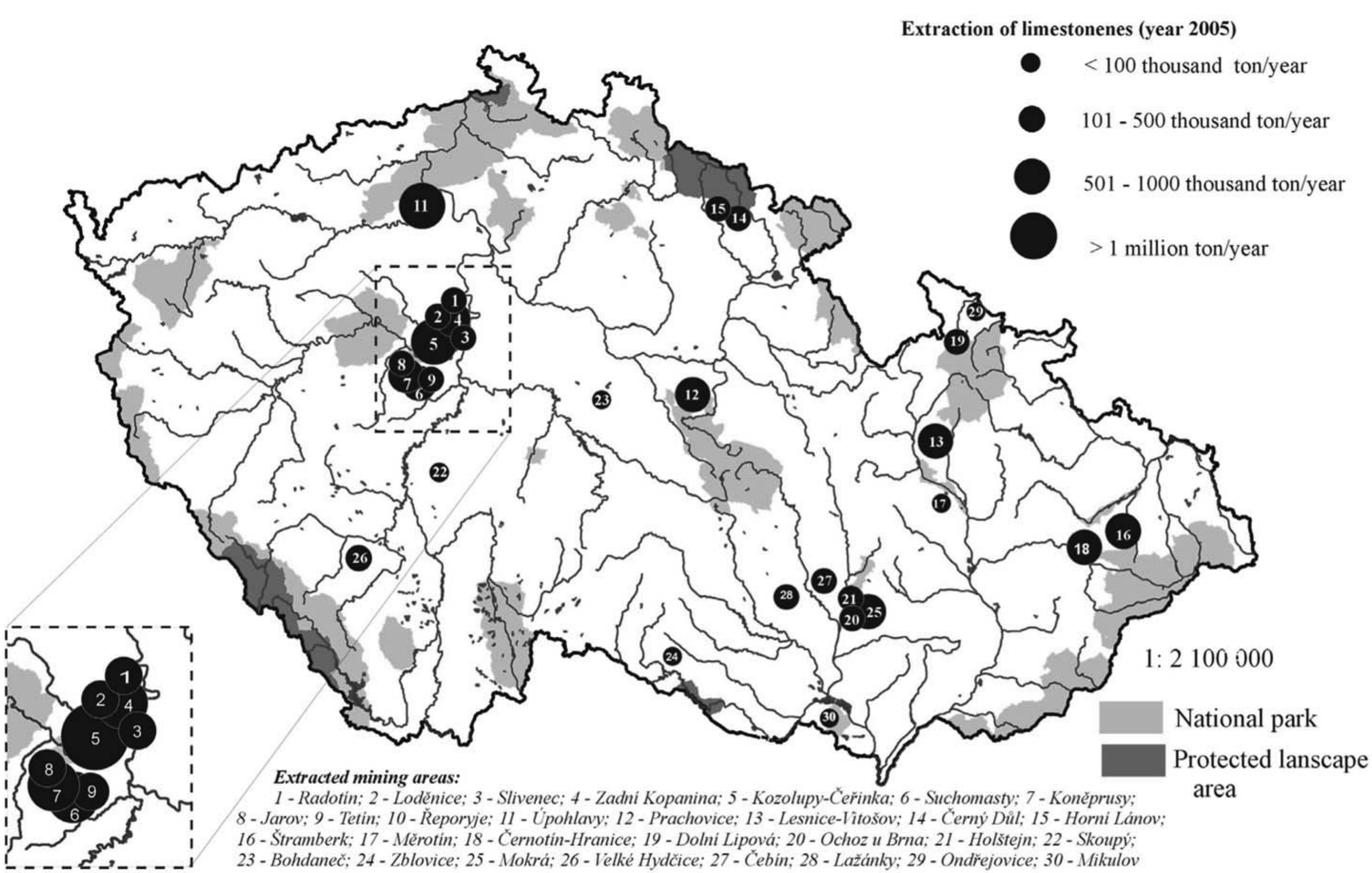
*Source: Makarius, R. ed. (1993, 1995, 2005); database Bureau of Mine*s*; annual reports*

Poznámky: 1) part of HeidelbergCement; 2) part of Lhoist; 3) majority shareholder since 1997of concern Dyckerhoff; 4) part Hasit Group; 5) part of concern OMYA A.G.

Picture 1: Extraction of limestone a: locality (mining area) Měrotín, b: locality (mining area) Vitošov; (author: I. Smolová, 2006)

4. ENVIRONMENTAL CONSEQUENCES OF EXTRACTION OF SELECTED MINERAL RESOURCES IN THE CZECH REPUBLIC

Extraction of mineral resources on the territory of the Czech Republic operates on the Law on Protection and Utilization of Mineral Wealth (No. 44/1988), which, among others, newly established the status of Protected Deposit Territory (PDT). Within PDT, for the sake of protection of mineral wealth, it is forbidden to establish constructions and equipment not related to the extraction of the deposit. For the sake of protection of nature and landscape there are further limitations determined for the extraction of mineral resources, especially those resulting from the Law on Protection of Nature and



Picture 2: The largest extracted mining areas of limestone (as of 1. 1. 2006)

Landscape (No. 114/1992, as amended by the Act of Parliament No. 218/2004), which states that on the whole territory of National Parks (NP) it is forbidden to extract minerals, rock and humolites, except for building stone for buildings on the territory of NP, and that on the territory of Protected Landscape Areas (PLA) it is forbidden to "transform the preserved natural environment". However, explicit restriction of extraction applies to the 1st PLA zones only. Moreover, there are further restrictions in the protective zones of water resources, protected areas of accumulation of underground and surface waters, in the protected area of spas, etc. As of 1992 new intentions to extract raw materials were subject to consideration of their impact on the environment by application of Law No. 244/1992 Coll. In 2002, in line with the laws of European Communities, a new Law came into force - the Law on Consideration of Environmental Impact (Law No. 100/2001 Coll., lat amendment in 2004 (Law No. 93/2004)). The consideration of environmental impact by the procedure EIA (Environmental Impact Assessment) in this law applies to determined intentions and concepts, the realization of which should have significant impact on the environment. The intentions and concepts are listed in two categories. One comprises intentions subject to consideration at all times (e.g. establishment of a new mining area or modification of an existing one, underground mining of coal exceeding 100 thousand ton/year, increase of open-cast mining exceeding 1 million ton/year, or extraction of mineral resources between 10 thousand and 1 million ton/year). The other category comprises intentions requiring declaratory proceedings. This is required for example for underground mining exceeding 100 thousand ton/year, extraction of other raw materials exceeding 10 thousand ton/year, or increase of existing extraction to 1 million ton/year.

The most extensive conflicts of interests are caused in the cases of extraction of limestone and other carbonates. With respect to exceptional nature of karst areas most karst localities are protected by law and extraction on their territory must be permitted by exception given by the Ministry of Environment. In the last few years the extraction of limestone in specially protected areas is of opposite trend than in the cases of other raw materials. Despite the fact that the total volume of materials extracted in specially protected areas has decreased within the period from 1990 until present (see Diagram 1), in case of limestone the volume of its extraction has increased in the last few years after a decrease in the early 1990's. Whereas in 1995 the extraction of limestone in protected landscape areas was 2 327 thousand ton, i.e. 21.6 % of their total extracted volume in CR, then in 2003 this figure increased to 3 381 thousand ton, which is over a third of the total extraction of limestone in CR. Therefore the rate of the growth index for the period of 1995–2003 reached 145 %. Moreover, there are several other mining areas localized in close vicinity of specially protected areas. Right behind the boundary of PLA Železné hory Mountains there is extraction in progress with the volume exceeding 1 million tons/year in MA Prachovice (Holcim (Česko) a.s. Prachovice) as well as in close vicinity of PLA Moravian Karst in MA Mokrá (HeidelbergCement).

The extraction of limestone seriously loads the PLA areas, which can be documented by the volume of extraction averaged to 1 km^2. Among all PLA in CR, extreme loading is in PLA Bohemian Karst, where the load exceeds 26 thousand ton of produced raw

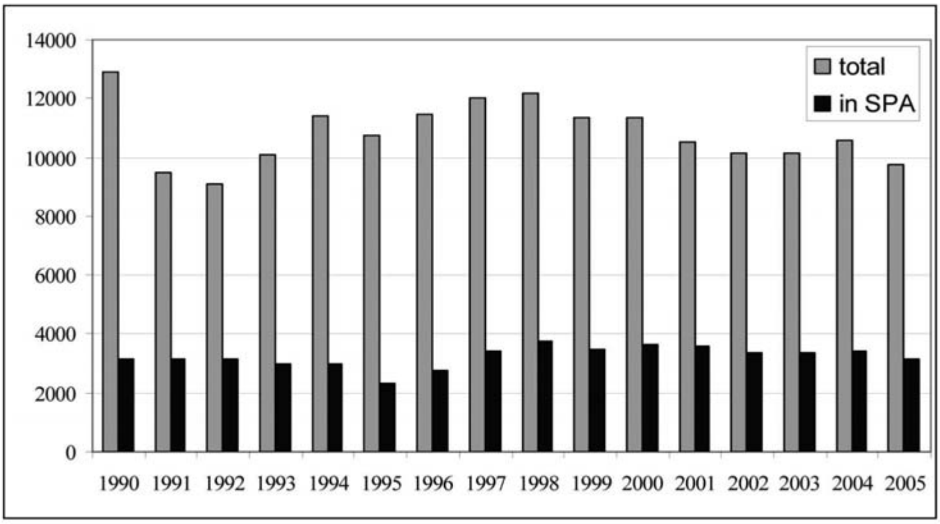


Figure 4: Extraction of limestone in the Czech Republik in the period 1990–2005 (extraction in thous. tons).

Note: SPA = Specially protected areas
Source: Makarius, R. ed. (1995, 2005); Kavina P. ed.(2004); database Bureau of Mines;

material from 1 km^2 and in the last few years this trend continues (Diagram 2), while it is considered that high loading is loading exceeding 10 thousand ton from 1 km^2. High loading by the extraction of limestone is also in PLA Moravian Karst (2 thousand ton of produced raw material from 1 km^2) or in PLA Pálava Hills, which is one of the six UNESCO biospherical reserves in CR (0.8 thousand ton of produced raw material from 1 km^2). Despite the effort of, primarily, ecological associations to reduce extraction in specially protected areas, it is very hard to reduce the extraction in most localities, the only outcome is that construction of new cement works was not realized (e.g. Tmáň in Bohemian Karst). A unique project, for the time being, is "Extraction of Limestone - Example of Involvement of the Public into the EIA Process", which was supported by the Ministry of Environment and which brought, for example, preclusion of further expansion of mine Čertovy schody in Bohemian Karst. Apart from that, also new areas for extraction are approved, which is always subject of consideration. Since 2001, the following limestone extraction areas were approved: MA Chotěšov near Litoměřice (in 2002) and MA DP Líšeň II in Brno. MA Hvozdečko near Olomouc, with expected extraction of 40 thousand ton/year, is being approved currently.

4.1. Antropogenic landscape features created by mining

Following the termination of mining activities, anthropogenic landscape features like quarries, sand pits, gravel pits, mullock tips, and spoil banks, may transform into valuable localities, favourably enhancing ecological stability in the area by advancing its landscape diversity. Exposed quarry walls and bottoms as well as newly formed water bodies often represent suitable habitat conditions for various plant or animal species. Favourable conditions arise especially in mining areas fully left to natural succession. Botanical and zoological surveys often record even critically endangered species in localities of this type. It is possible to utilize abandoned mining areas by their integration into the natural environment in the form of landscape parks, botanical gardens or arboreta. As an example of this approach, environmental restoration of a former lime pit in the town of Štramberk (northern Moravia) is mentioned. A botanical garden and an arboretum have been developed there since 1996, covering approximately 10 hectares of the abandoned mining area and its close surroundings.

4.2. Water bodies created by the extraction of raw materials

Water bodies are important landscape elements. They may also occur as a result of extraction activities. Water bodies are created as a consequence of activities in some pit quarries, sand quarries, gravel quarries or clayfields. Most commonly they are created by extraction of gravel-sands in flood plains where the mining area gets submerged during the extraction itself and the extraction then proceeds from the bottom of the water body (anthropogenic lakes). Water infilling the mined depression is of alluvial water type, which penetrates through the permeable fluvial sediments. In case of extraction of building raw materials (granite, kaolin, coal, lignite, limestone, etc.) the quarries may get submerged after completion of extraction activities by meteoric water of irruption of underground water in case of insufficient drainage or within recultivation (so-called hydrologic recultivation).

After completion of extraction activities the water bodies offer in particular recreation utilization, some of them also become important biocenters and are then protected by law. Important biocenters are in particular abandoned sand quarries in flood plains. As an example, we may take specially protected areas in the flood plains of River Morava. For example, in PLA Litovelské Pomoraví it is *NM Bázler's Sand Quarry* (0.28 ha, 1993) serving as an important refuge of amphibians in the midst of agricultural landscape, *NR Chomoutov Lake* (106.2 ha, 1993) protecting a shallow lake with several islets, important for nesting and migration of water fowl, or *NR Moravičany Lake* (92.2 ha, 1994) protecting one of the three large water bodies created by the extraction of gravel-sand in the Mohelnice Furrow. Extraction of some raw materials causes the creation of specific water environment in the immersed area (with extreme pH, increased content of minerals, etc.), to which some exceptional species of fauna and flora are united, like the *Chomutov ("Alum") Lake* in the northwestern outskirts of Chomutov. Also water in the *Hromnice (Red) Lake* north of Pilsen is of extraordinary composition; the lake was created by accumulation of aggressive sulphurous water in a 60-meter deep quarry for the extraction of ampelite. Even today the meteoric water outwashes sulphates from the surrounding refuse piles and the sulphates keep accumulating in the quarry. The water is so acidic (pH 2.6–2.8) that it is virtually lifeless, apart from algae.

Picture 3: Water bodies created by the extraction: a) locality Nová Ves – Litovel b) locality Žermanice – natural monument Žermanický lom (author: I. Smolová, 2005)

Besides small water bodies with high biodiversity, there are also other water bodies planned to be created in the *Krušné hory Mountains area* within the hydric recultivation, which will rank among the largest in area in our country. After termination of lignite mining, large part of open pits is to be submerged in water. An example of already submerged quarry is the former quarry Barbora near Teplice, on the shores of which a luxurious residential area is being built. The planned lake Libouš is to have an area of more than 500 ha and maximum depth of 56 meters. The water resource should be the River Ohře. The projected lake Bílina (with an area of 1,145 ha) and maximum depth up to 170 meters should also be watered from the River Ohře. If this northern Bohemian project is realized, the largest anthropogenic lakes in CR will be created.

5. CONCLUSION

Although in modern history the Czech Republic and the previous state formations within its present area did not rank among leading mining countries, the utilisation of domestic raw deposits was high in the past. Over the course of each individual historical period, priorities in terms of extraction of minerals changed, and this was reflected in the varied intensity of extraction with a number of consequences including noticeable changes in the relief. At present in the Czech Republic, there are 1004 mining spaces with a total area of 1 480 km^2. In 2005, 540 deposits were in operation in the Czech Republic, out of which 132 million tons of mineral resources were extracted. At present, the importance of extraction of mineral resources has been shifted from the area of public interest to the focus of interest of private mining companies which are attempting to gain economic profit from the mineral resources of the territory. In the last few years, structure changes in the Czech economy, especially in industry, have influenced both the role and the importance of branches of extracting and processing minerals and materials of mineral origin. Index of mineral production share of the GDP reflects the changes, as it has decreased from 3.7% in 1993 to 1.3% in 2005. There was a small decrease from 7 % in 1993 to 2.8% in 2005.

Market economy caused a restriction or even termination of mining of non-economic deposits, where mining continued with the help of state subventions in the past. All mining was stopped in the deposits of ores, the mining of coal has been limited significantly in many regions. The mining of uranium ores was strictly limited.

The strictest rules on the extraction of mineral resources are in areas established by the Nature and Landscape Protection Law no. 114/1992 Coll. In accordance with this law, it is forbidden to extract mineral resources in National Parks (with the exception of extraction of building blocks and sand for construction within the area of the National Park), in the first zone of Protected Landscape Areas (SPA) and in Nature Reserves.

Although extraction in the second and third zones of the Protected Nature Areas is not explicitly forbidden by Law, it is quite difficult to obtain a permit for extraction. Although the overall extraction of mineral resources in the protected areas has decreased after 1989, the amount of extraction in some of them has actually increased. With some mineral resources, e.g. limestone, feldspar or precious stones, the extraction in the protected areas constitutes a substantial share of the total amount of extraction of a particular mineral. The landscape contains giant opencast mines, originating due to large volumes of extracted mineral resources, with noise and dust disturbing the surrounding environment and the natural system of groundwater often disturbed. Among the non-ore raw mineral resources, the extraction of limestone has a special position. The largest opencast mines include Mokrá u Brna, Čertovy schody, Mořina in Český kras, Kotouč near Štramberk, Hranice in Central Moravia and Prachovice in Železné hory. Opencast extraction of limestone often results in disturbances to the hydro-geological environment.

6. SOUHRN

Vybrané změny v těžbě a dobývání nerostných surovin v České republice v letech 1993–2005

Těžební činnosti probíhá na území ČR ve stanovených dobývacích prostorech, které se podílí necelými 2 % na celkové rozloze státního území. Po roce 1989 došlo k výraznému poklesu objemu těžby surovin, kdy v případě rud (vyjma uranu) byla těžba ukončena zcela, u černého a hnědého klesla téměř na polovinu a u nerudních surovin se snížila o třetinu. V průběhu devadesátých let a zejména po roce 2001 výrazněji narůstá díky objevům nových perspektivních ložisek těžba velmi kvalitní ropy na jižní Moravě, která se však podílí necelými 2 % na celkové spotřebě ropy v ČR. V rámci útlumových programů jsou investovány desítky miliard do sanací a rekultivací území v minulosti vážně narušených těžbou surovin. Negativním rysem je probíhající a v některých případech i rostoucí těžba v územích, která mají ze zákona stanoven ochranný režim (např. v CHKO Český kras, Třeboňsko nebo Blanský les). V zájmu ochrany přírody a krajiny jsou pro těžbu nerostných surovin stanovena omezení, zejména vyplývající ze zákona O ochraně přírody a krajiny, ve kterém je na celém území NP je zakázáno těžit nerosty, horniny a humolity kromě stavebního kamene pro stavby na území NP a na území celé CHKO zákaz „měnit dochované přírodní prostředí“. Výslovně je však těžba zakázána pouze v 1. zóně CHKO.

Mimo to jsou další omezení v ochranných pásmech vodních zdrojů, chráněných oblastech akumulace podzemních a povrchových vod (CHOPAV), v ochranném pásmu lázní apod. Počínaje rokem 1992 podléhaly nové záměry těžby surovin posuzování jejich vlivu na životní prostředí uplatněním zákona č. 244/1992 Sb. V roce 2002 vstoupil v platnost v souladu s právem Evropských společenství nový zákon o posuzování vlivu na životní prostředí (zákon č. 100/2001 Sb. naposledy novelizovaný v roce 2004 (zákon č. 93/2004)). K nejčetnějším střetům zájmů dochází v případě těžby vápenců a ostatních karbonátů. Mezi všemi CHKO v ČR je extrémně vysoce zatížena CHKO Český kras, kde zatížení dosahuje více než 26 tisíc tun vytěžené suroviny z 1 km^2 a v posledních letech trend zvyšování pokračuje. Vysoké zatížení těžbou vápenců je i v CHKO Moravský kras (2 tisíce tun vytěžené suroviny z 1 km^2) nebo CHKO Pálava. I přes snahy zejména ekologických sdružení o omezení těžby ve zvláště chráněných územích, se těžbu na většině lokalit nedaří snížit.

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ENVIRONMENTAL MIGRATION IN CHINA

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Abstract

Environmental degradation and resource depletion play a contributing role in affecting population movement. The work explores the subject of environmental refugees as a significant group of migrants, includes definition of the term and explanation main reasons for fleeing the people from their habitats. The special view is aimed at the analysis of environmental migration in China and the resettlement problems due to construction of development projects, natural disasters and environmental changes or lack of natural resources with security consequences.

The paper consists of essential environmental characterization of the Yangtze River basin, especially water utilization and environmental changes in the upper reaches of the Yangtze River. The state of environment in the region is very important for sustainable development of the whole China because it provides strategic supplies of water here. This work discusses the theory of solution the environmental problems and establishing sustainable development by the environmental migration in the area. The authors of the work are afraid for that solution of environmental degradation by displacement of people does not deals with causes of the degradation, but looks for reasons for displacement of the people from the development projects area.

The main purpose of this paper is to explain the resettlement issue of the Three Gorges Dam area, especially the resettlement program of Chinese government and the problems connected with its implementation. Final part of the paper deals with the analysis of the actual condition of the environmental refugees from the area and their social and economic situation. The work is partly founded on the field survey in the region and the analysis of selected research works and documents interested in the issue.

KEY WORDS: environmental migration, environmental refugees, China, natural resources, the Three Gorges Dam,.

1. INTRODUCTION

Global processes creating the vision of the "time-space compression", as well as shifts in political and economic map of the world underlie current unprecedented qualitative and quantitative changes of the phenomenon known as international migration (Graham, 2000; Zlotnik, 1999). In this way, Zlotnik (1999) accentuates not only growing number of international migrants but also increasing number of countries actively participating in the exchange of people. Demographic trends, increasing number of ethnical, religious, and political conflicts, increasing level of poverty and ever-spreading environmental degradation create large, but far from exhaustive, set of potential migration motives. Thus, research on this topic is becoming more and more important to better understand the complex nature of the phenomenon.

Environmental degradation and resource depletion play a contributing role in affecting population movement, often filtered through contexts of poverty, food deficiency, conflicts and social inequity. In this way, Myers (1993, 1994, 2001b), Brown (2004) and others declare the rapidly increasing number of incidents that force people to leave their houses and fields due to environmental problems. Moreover, the same authors regard environmental migration as an emerging issue of global importance, especially in the light of analysis of climate change conducted by the Intergovernmental Panel on Climate Change (McLeman, Smit, 2004, 5).

Who are environmental refugees? They are people who were forced to leave their traditional habitat, temporarily or permanently, because of lack of natural resources and/or environmental disruption that had jeopardized their existence and seriously affected the quality of their life. Thus, home-region was not able to ensure them safe livelihood. By 'environmental disruption' is meant any physical, chemical and/or biological changes in ecosystem (or the resources base) rendering it temporarily or permanently in the way, which is unsuitable to support human life. Environmental disruption, often triggered by population pressures and poverty, can be caused by natural and/or human activity. Not all of the refugees flee their country, many of them being labeled as 'internally displaced people' (compare with LiSER, 2004; Myers 1994, 2001b; Leiderman, 2002, 5).

The international refugee legislation, the Treaty of Geneva approved in 1951 (further Treaty), defines refugees "as persons forced to flee across an international border because of a well-founded fear of persecution based on race, religion, nationality, political opinion or membership of particular social group" (UNHCR, 2005; UNHCR, 2002). Institutionally, the issue of refugees falls under responsibility of United Nations Commissioner for Refugees (UNHCR). Both, Treaty and UNHCR, were established more than fifty years ago as a reaction to the huge number of displacement people after World War II. Nowadays, many critics argue that conditions have changed during the last few decades and revision of the concept should be considered. The revision ought to clarify current legal vacuum of two important groups of migrants, in particular "internally displaced people" and "environmental refugees", which international law does not recognize as refugees and thus these groups of migrants can not draw any material or juridical support of institutions like the UNHCR or government agencies (compare with Black, 2001; LiSER, 2004; UNHCR, 2002).

2. RESEARCH METHODOLOGY AND GOALS

The domain of research is the phenomenon of environmental migration and environmental refugees as an emerging research topic of global importance. The main goals of the paper are to explain situation of environmental refugees in the selected region and create environment for solution of their situation. Very important question is how to avoid these kinds of projects producing big hazards, possibly how to precede them. The territory of interest is People's Republic of China (including occupied territories) with Special attention given to Upper Reaches of the Yangtze River, especially Three Gorges Dam area.

To address the complexity of the research topic the following issues has to be considered:

A. The environmental factors including natural conditions and ecological factors of the regions, the frequency of natural hazards in the region, the recent and possible changes of climate in the future, possible changes of environment, environment pollution and human influences.

B. The social, economic and political factors including international law in the framework of international migration, environmental migration processes in the region, human conditions for living and principal human rights, economic and social development of the regions, population pressure and poverty.

C. The relations between environment and security including food and water security, conflicts due to natural resources and the possible threats to future in the context of China's increasing consumption of natural sources.

D. The migration potential in China, especially for last three decades.

E. The possibilities of predicting the phenomenon of environmental migration in the region.

The range of the paper does not allow authors to cover all the issues, mentioned above. Some of them we can only remark.

Methodologically, the paper is based on analysis of relevant information sources including research studies and documents, scholar journals and information from specialized websites. The information synthesized from the information sources are supplemented with findings of field research conducted in the interest region in October 2004 by one of the authors. The research was carried out in the study area of counties Fengdu, Wushan, Zigui and surroundings of Shibao Tower and was oriented on the social and economic situation of the refugees in the context of environmental issues. The field research tried to verify the conclusions formulated on the basis of information source analysis, using methods of observation and interviews with some displaced people. The document pictures from the areas were taken as well.

3. THE TYPOLOGY OF ENVIRONMENTAL REASONS OF DISPLACEMENT IN CHINA

There are three, most frequent cited, reasons why the people have to force their habitats because of environmental degradation or lack of natural resources in China, in particular construction of development project, natural disasters and environmental changes, and lack of natural resources.

3.1. Development projects

Involuntary resettlement in China firstly results from construction of water reservoirs, transport infrastructure, and urban construction (Cernea, McDowell, 2000, 129–130):

- *Reservoir development* was the leading cause of resettlement in past, now displaces no more than 10 percent of the people resettled each year. Reservoir resettlement impacts are much greater and more difficult to deal with than any other type of projects. Entire villages, even townships, are overtaken by reservoirs. These populations must frequently be placed on land already used by others, often in a new political jurisdiction. This can result in host-resettler tensions, and all incomes may decline. Rich fertile land is lost and replacement options depend on fragile soil and less dependable water supplies. New cropping patterns have to be mastered, and land scarcity may force people to look for non-agricultural employment (see below).
- *Transport infrastructure investments* displace primarily rural people located in transport corridors and at the sites of airports, bridge abutment, and so forth. This displacement is therefore limited in scale and may vary from as few as a handful of families to hundreds or thousands, depending on circumstances. Transportation displacements also take place in the urban areas. In the 1980s about 12 percent of overall involuntary resettlement was caused by the construction or upgrading of railroads and roads. In these cases, villages rarely lose all the village land and are able to redistribute the remaining lands to ensure more equity of land use. In more extreme cases they may be given an urban passport and resettled in the nearest town.
- *Urban resettlement* now accounts for the majority of all Chinese resettlement. All urban land is owned by the state and therefore only usufruct rights rather than ownership rights are lost. Any resettlement project must compensate individuals for lost use rights by providing substitute housing of equal or higher standards, and by providing alternative places for doing business and the means to replace lost assets.

The World Commission on Dams published in 2000 report (WCD, 2000), in which impacts of construction of the large dams in the second part of 20th century were evaluated. The displacement is reported from 68 of the 123 big dams (56 per cent), especially in Asia, Africa and Latin America, where large river dams are one of the forms of forced displacement. 40–80 million people have left their livelihoods and homes including 10,2 million people form China between 1950 and 1990 according to official statistics. “But independent sources estimate that the actual number of dam-displaced people in

China is much higher than the official figure" (WCD, 2000, 102–104; compare with Cernea, McDowell, 2000, 128). It was estimated that only the Three Gorges Dam project displaced or will force to display nearly 2 million persons probably, according to independent sources. Official government statistics still quote 1.2 million people. During the second part of the 20th century China constructed more than 84,800 reservoirs together with a total capacity of 485.3 billion cubic meters (Wang, Ren, Ouyang, 2000, 63).

The World Commission on Dams declared, that generally "resettlement programmes have predominantly focused on the process of physical relocation rather than the economic and social development of the displaced and other negatively affected people. The result has been the impoverishment of a majority of resettlers" (WCD, 2000, 103). The forced resettlements due to construction of the Three Gorges Dam are in the similar situation (see below in detail).

3.2. Natural disasters and environmental changes

Every year natural disasters, such as floods, drought, storms, hails, earthquakes, landslides and mud-rock flows destroy millions houses and hectares of crops in China and millions people have to be relocated. For example in the period between January 1 and July 20 in 2004 natural hazards „have damaged about 18 million hectares of crops. About 1.6 million hectares of arable land yielded no harvest. An estimated 388,000 houses collapsed and 2.4 million were destroyed, forcing the relocation of nearly 1.3 million people", killing 659 people and causing losses of about 39.26 billion yuan (4.75 billion USD). Floods accounted for more than half of the deaths and affected 45.7 million people in the same period. „The hardest hit provinces and regions were Yunnan, Guizhou, Sichuan and Chongqing in the southwest, Hubei, Hunan and Henan in central China and Guangxi in the south" (Lim, 2004). During the first half of the year 2005 floods in southern and eastern China, have killed 567 people, left 165 missing, forced the emergency relocation of 2.46 million people and caused direct economic losses of 22.9 billion yuan (2.77 billion USD) (Reuters, 2005).

The Gobi Desert in China is growing by 10,400 square kilometers a year and the refugee stream is swelling. Asian Development Bank preliminary assessment of desertification in Gansu province identified 4,000 villages, which faced abandonment (Brown, 2004). Desert expansion has accelerated with each successive decade since 1950. China's Environmental Protection Agency reports that the Gobi Desert expanded by 52,400 square kilometers from 1994 to 1999. The Chinese population of 1.3 billion and a livestock population of just over 400 million have huge impact on the land. "Huge flocks of sheep and goats in the northwest are stripping the land of its protective vegetation, creating a dust bowl on a scale not seen before. Northwestern China is on the verge of a massive ecological meltdown" (Brown, 2003).

The area of the land, affected by drought, was estimated at 195.92 million hectares (approximately 2 million square kilometers) in the period 1949–1990 and the area of the land, degraded by drought, at 7,689 million hectares by year (approximately 77,000 square kilometers). The average loss of cereal production was 11.0 million tons. But in 1988 the cereal loss was 31,2 million tons and 28,4 million tons in 1989 (Wang, Ren, Ouyang, 2000, 34). "Major natural factors that cause droughts in China are a huge population and very low water resource occupation rate, very uneven and imbalanced distribution of water and land resources, and a great variation of precipitation and runoff within and from year to year." (Wang, Ren, Ouyang, 2000, 33)

Myers estimates that "due to largely to sea-level rise and flooding of coastal-zone communities, but also as a result of increased droughts and disruptions of rainfall regimes such as monsoonal systems, global warming could put large numbers of people at risk of displacement by the middle of next century if not before." (Myers, 1997, 171) Preliminary estimates indicate that the total amount of people at risk of sea-level rise in China is 73 million. (Myers, 1997, 171; Myers, 2001b, 611; compare with Myers, 2001a)

3.3. Lack of natural resources

China feeds 21 per cent of the world's population (in 1997) with 7 per cent of the world's cultivated lands. Simultaneously, China makes an important contribution to the world food supply (Wang, Ren, Ouyang, 2000, 63) and world's prices of foodstuffs. In February 2005 Lester Brown, director of the Earth Policy Institute, published comparative report on two biggest consumers of natural resources – United States and China. "Among the five basic food, energy, and industrial commodities-grain and meat, oil and coal, and steel-consumption in China has already eclipsed that of the United States in all but oil. China has opened a wide lead with grain: 382 million tons to 278 million tons for the United States last year. Among the big three grains, the world's most populous country leads in the consumption of both wheat and rice, and trails the United States only in corn use" (Brown, 2005). The production consumes huge amount of water.

"China's urban population is expected to almost double to a total of more than 600 million. This will engender greatly increased demand for water for household use, to the detriment of the country's agriculture which currently takes 87 percent of all water consumed in order to maintain food production" (Myers, 1997, 171). The worsening of sustainable access to safe drinking water in Chinese cities can trigger human migration in future. While coverage increased in rural areas, access to improved sources decreased in urban areas. This contrasting trend in the region reflects what happened in China over the decade (1990–2002), with coverage in urban areas decreasing from 100 to 92 percent. In rural areas, coverage improved in the same period from 60 to 68 per cent. But in the country there are still almost 300 million people without the access to safe drinking water (UNSD 2004). Migration from rural areas plays an important role in this regard, however, increasing water consumption for industry production concentrated in Beijing and around urban areas on coast is the most crucial factor in this way.

While China consumed around 562.3 billion cubic meters of water in 1997, in 2010 total water supply is expected to increase at 646 billion cubic meters, and for the year 2025 at 720 billion cubic meters. China predominantly depends on surface sources of water

(Wang, Ren, Ouyang, 2000, 63). Considering current lack of water in cities and some parts of China, we can expect some tensions between states sharing the same water resources together with China. As long as China wants to increase the consumption of water from rivers as Brahmaputra or Mekong for irrigation of fields or industrial production, this step will affect the needs of the neighboring countries India, Bangladesh, Laos, Cambodia and Vietnam, which are likely to protest.

Compound water security is becoming a critical issue in China. This issue includes (compare with Wang, Ren, Ouyang, 2000, 169–170):

- food security (food sufficiency and accessibility, malnutrition, famine);
- human (individual) security (adequate safe water access,);
- environmental security (deforestation, soil erosion, desertification, biodiversity conservation, environmental pollution, frequency of disasters);
- social security (state of economy, employment, refugees issue, etc.)

4. CONTEMPORARY AND PROSPECTIVE "HOT SPOTS" OF ENVIRONMENTAL MIGRATION IN CHINA

Upper reaches of the Yangtze River and Yellow River (especially in areas affected by construction of dams and soil degradation), Southeast coast regions (annually hit by tropical hurricanes and floods) and North and Northwest regions in China (threatened by desertification and drought) belong to source areas of contemporary environmental migration. The contemporary aimed areas for people from the environmental devastated regions are coast areas (especially cities), Beijing and other big cities, and Tibet (e.g. for displace people from Three Gorges Dam area). Some of the migrants cross the border to neighboring countries, primarily to Russia, Kazakhstan and other Central Asia states or to USA, Australia, Europe (see Table 1).

Table 1: Contemporary environmental "hot spots"

Contemporary threatened area	**Contemporary aimed areas**
Upper reaches of the Yangtze River and Yellow River	Sea coast areas (cities), Beijing, Tibet
South-East China (sea coast area, river banks)	Cities near the coast sea; Europe, Australia, USA
North and North-West China (Gobi desert, Turkestan)	Cities, Beijing, Tibet, Central Asia, Russia, Europe

New potentially threatened regions in China with a prospective growth of number of environmental refugees are low situated coast areas in Southeast and East China (primarily because of prospective sea level rise and raised intensity and number of hurricanes due to predicted global or regional climate change), the reaches of the Yangtze River and Yellow River (especially in areas affected by floods, construction of dams and soil degradation), North and Northwestern China (affected by desertification, drought and lack of sustainable sources of safe water). New potential aimed areas for displaced people in China will be cities in central and western parts of China, the capital Beijing or occupied Tibet. Some of the refugees will cross the border to Central Asia countries, Russia (especially to Siberia), South-East Asia states with a greater Chinese minority (e.g. Indonesia), USA, Australia, Europe (see Table 2).

Table 2: Prospective environmental "hot spots"

Prospective threatened area	**Prospective aimed area**
Reaches of the Yangtze River and Yellow River	Cities in central and western parts of China, Beijing, Tibet
South-East, East China (low situated sea coast)	Central parts of China, USA, Australia, South-East Asia, Central and Western Europe
North and North-West China	Russia (e.g. Siberia), Central Asia, Beijing, Tibet, Europe

Absolute majority of contemporary and prospective environmental refugees are/will be internal displaced peoples, who do/will not leave China. Considering the present lack of cultivated soil or grassland, sustainable sources of safe water and other natural resources, together with difficult living conditions of the refugees, can undermine social stability in aimed areas and elicit crises or conflicts.

5. DISPLACEMENT IN THE THREE GORGES DAM AREA

5.1. Essential environmental characterization of upper reaches of the Yangtze River

The upper reaches of the Yangtze River covers an area of 1.056 million square kilometers, equivalent of 58.9 percent of the whole Yangtze River basin. It encompasses a region from the sources of the Yangtze to Yichang city (Hubei Province). The landscape consists of mountains (50 per cent), plateaus (30 per cent), hills (18 per cent) and small plains (2 per cent). The population of the region amounts to around 180 million (in 2001), making up 14 per cent of the whole population in China. (Yan, Qian, 2004, 613–614).

Most parts of the upper reaches of the Yangtze River are more than 3000 m above sea level and sloping land forms 45.9 per cent of the total cultivated land (40,700 square kilometers). Soil erosion counts among the most severe environmental problem in the region. The present area, suffering from soil erosion in the upper reaches of the Yangtze, amount between 350,000–393,000 square kilometers, more than one third of the total area upper reaches of the Yangtze. In the 1950s soil area covered 299,500 square kilometers of land (Yan, Qian, 2004, 620–621; Wang, Ren, Ouyang, 2000, 39). The eroded soil in the upper Yangtze reaches 1,568 billion tons, an equivalent of 3,870 square kilometers of soil, depth of 30 centimeters worn away annually. Some authors quoted annually amount of eroded materials 6.8 billion tons (Wang, Ren, Ouyang, 2000, 39). In the limestone areas in Guizhou province about 1,800 square kilometers of land is being petridesertified and about 76 square kilometers of arable land is lost each year. "Farmers in some villages had to move out of their original locations and resettle to other places due to losses of their farmland" (Yan, Qian, 2004, 621).

Flood periods in some basins in the upper reaches of the Yangtze are four months (Wang, Ren, Ouyang, 2000, 32). Deforestation has increased frequency and size of floods. During the rainy season, floods, mud-rock flows and landslides in deep valleys occur frequently. While serious floods, occurring on the Yangtze in 1998, were mainly caused by abnormal climate and concentrated precipitation, to a great extent they can also be attributed to soil erosion that has reduced the flood discharging and storage capacity of rivers, lakes and reservoirs (Yan, Qian, 2004, 621). In Sichuan, a province located at the upper reaches of the Yangtze River, there are more than 50 counties with forest coverage of only 3–5 per cent (Wang, Ren, Ouyang, 2000, 39).

Environmental destruction causes changes in the climate and land desertification. Climate change in the upper Yangtze River is one of the main factors resulting in the loss of vegetation, degradation of wetlands, etc. Due to regional reduction of rainfall and overgrazing, a vast extent of grassland has been changed to semiarid area. (Yan, Qian, 2004, 622; compare with Wang, Ren, Ouyang, 2000, 43)

Although the region of upper reaches of Yangtze River is very important for sustainable development of the whole China, the environment has deteriorated due to deforestation, reduction of vegetation, soil erosion and pollution of water. These conditions affected the livelihoods of the people in the region. Construction of the Three Gorges Dam worsened environment and forced to displace nearly 2.0 million people from the area. Official authority still contends that number of migrants ranges between 1.1–1.2 million, but it does not only refer to different data between Chinese authority and "independent sources"outside China (see Ming 1999, Adams, Ryder 1998).

5.2. Fundamental characteristics of the Three Gorges Dam

The Three Gorges Dam is located in west China, in Chongqing and Hubei provinces and it is the largest hydropower project in China. Construction of the Three Gorges project started in 1993 and used 13.7 billion USD (113.1 billion yuan) investments by the end of April 2005. The total investment will be controlled with 21.8 billion USD (RMB 180 billion yuan) by 2009, when the whole project is completed despite the hikes of building materials prices in recent years. „Considering the factors of inflation and loan interests, the total investment in the project was initially estimated to reach 26.7 billion USD (RMB 203.9 billion yuan), according to the China Yangtze Three Gorges Project Development Corp (TGP, 2005a). According to some „independent knowledgeable Chinese banker“ the real investments are about 77 billion USD (Adams, Ryder, 1998).

The reservoir is about 600 kilometers long, and the dam is 2,309 meters wide and it is going to be 181 meters high. The area of the reservoir is 1,084 square kilometers (Libra, 2004). Since the year 2003 the level of Yangtze River at the reservoir has risen 135 meters and will continue to rise close to the level of 175–180 meters. Since the year 2003 about 1,500 towns and villages were flooded due to filling the reservoir.

5.3. Resettlement program of Chinese government and its realization

China's tragic experiences with Danjiangkou and Sanmenxia Dam displacements in the 1960s and 1970s have led to the adoption of new resettlement policy (Cernea, McDowell, 2000, 25). Based on the influence of personal observation in the place, authors of the paper believe that tools, proposed for implementation, are not adequate in the case of Three Gorges Dam area.

According to the official figures, more than 1.2 million people have been resettled because of construction of the Three Gorges Dam. More than 40 percent are rural people, engaged in agricultural production. "The rural resettlement has involved three main methods, in particular settling people in nearby areas, moving them to distant locations in groups, and encouraging migrants to relocate on their own initiative, perhaps by going to live with relatives or friends" (CAS, 2002, compare with Jing, 2000, 26). In fact most rural migrants are still being resettled in the vicinity of the reservoir area (see previous, compare with CAS, 2002). Since June 2005 some 813,000 people in the Chongqing Municipality have been relocated due to the Three Gorges Dam (TGP, 2005b).

Yan and Qian claim that environmental migration in the upper Yangtze is closely related to poverty alleviation and environmental regeneration (Yan, Qian 2004, 615). But the experience of the author of this paper is quite different – the poverty of the displaced people is deeper and the press on environment is much stronger. This analysis is in accord with conclusions of the reports prepared by Wu Ming for International Rivers Network (Ming 1999) and researchers from the Chinese Academy of Science (CAS 2002).

Researchers from the Chinese Academy of Science (CAS, 2002), who asked the migrants and the hosts in the resettlement site of Changling town, in the Wuqiao district of Wanxian city in 2000 confirmed that the migrants had more farmland per capita (0.08 ha) in their place of origin, Tailong town, than in the new location (see Table 3). They could take advantage of the diversity of land resources in Tailong and pursue a variety of livelihoods, such as growing oranges in the orchards and fishing on the Yangtze River, two extremely important sources of income. Even though the amount of cultivated land in Changling town was two times more than in Tailong, due to host population, the migrants were experienced a sudden decline in farmland per capita - 0.04 ha, just half the original amount. They also suffered a great loss of cash income, which had largely been earned by growing oranges, animal husbandry and other farming-related activities in their native town. Though Changling town was less than 20 km away from their place of origin, there were no orange orchards available in the new resettlement site. Some migrant households were further frustrated by the fact that they lost another important part of their livelihood – fishing – because the resettlement site is not situated by the river (CAS, 2000).

Table 3: A comparison of land use in the place of origin and resettlement site (in per cent hectares/person)

	Cultivated land	Garden plot	Forest land	Settlement, industrial land	Roads	Water area	Unused land	Land per capita
Original site (Tailong town)	34.97	22.10	4.13	5.49	3.70	6.35	23.26	0.08
Resettlement site (Changling town)	74.90	0	0	7.34	4.41	0	13.35	0.04

Source: CAS (2002)

Compensation rates vary widely across the area, as well as between locations classified as urban and rural, and there has been no indication whether compensation will be adjusted to reflect inflation. The value of the farmers' property, the cost of moving and the price of construction materials to build new houses were calculated in 1992 (Ming, 1999).

Villagers in Gaoyang Township, Yunyang County, have repeatedly appealed to the central government for more resettlement funds. "Their appeal has to do, in part, with the regional discrepancies in the amount of compensation that resettlers can get after part of the resettlement investment is used to build community infrastructures such as roads, irrigation systems, schools, and medical clinics. The following figures are the varying rates of per capita compensation for distribution among individuals" (Jing, 2000, 26–27):

- Fengjie County: 9,458 yuan (1,144 USD)
- Zhongxian County: 7,611 yuan (920 USD)
- Kaixian County: 7,306 yuan (883 USD)
- Wushan County: 7,197 yuan (870 USD)
- Yunyang County: 6,773 yuan (819 USD)

Among the five counties listed above, Yunyang has more cultivated fields to be submerged and a greater number of villagers to be resettled. But it has the smallest amount of compensation funds to be distributed among the local resettlers.

More significantly the migrants experienced a sharp drop in per capita income after displacement. The average per capita income in the 11 households surveyed in Changling town, in the Wuqiao district of Wanxian city decreased from 3,431 yuan RMB (415 USD) in 1999 to 2,450 yuan RMB (296 USD) in 2000, a decline of 29 per cent, with variations according to the work undertaken by the households (CAS, 2002).

Closer analysis of each laborer's working day in different sectors between migrants in Changling town shows an apparent shift from agricultural to non-agricultural sectors. This clearly reflects the fact that there is much less farmland available and more business opportunities in the new resettlement site. The statistics indicate that laborers involved in traditional farming spent 67 percent of their working day on average on these activities before displacement, and that this percentage fell to less than 40 percent after resettlement. This marked change reflects the sharp drop in farmland per capita. As a result, rural migrants have slipped into a state of underemployment after resettlement, leading to a greater surplus of laborers in the resettlement site. Before resettlement, each laborer worked an annual average of 227.4 days, but this figure declined to 165.7 days a year in the new location. Assuming that a laborer employed full-time works 300 days a year, the current employment rate after resettlement is 55 per cent. Before resettlement, the equivalent employment rate was 76 percent. Resettlement appears to have a disproportionate impact on women. Before resettlement, women laborers worked an annual average of 240.8 days, but after resettlement the figure declined to 157 days. If each woman worked 300 days a year, the current employment rate would be only 52 percent, compared with 82 percent before resettlement (CAS, 2002).

5.4. Primary groups of problems and prevent practical aspects of any resettlement programme

The researchers from Chinese Academy of Science focused on the rural migrants resettled in the peri-urban area around Wanxian city. They identified four groups of problems (CAS 2002):

1. *Development project, natural disasters and environmental changes, and lack of natural resources, serious shortage of farmland.* It is somewhat surprising to note that local farmers suffer more from the resettlement and urbanization than the migrants do. One reason for this appears to be that the state resettlement policy guaranteed migrants a per capita average of 0.04 ha of farmland, while the host population was persuaded, sometimes forcibly, to hand over part of their land to the migrants. As a result, local farmers had an average of 0.02 ha per capita left for themselves, just half the size of the migrants' land-holdings.
2. *Continuous decline in household income.* A substantial decline in income from traditional agriculture can be seen in both migrants and locals. The poverty-stricken reservoir area seems to have suffered more from this trend because of the weak local economic foundations, a limited labor market and growing competition from other regions in developing non-farm industries and products. Apart from households with members working in the construction industry, both migrants and locals engaged in all other production categories are experiencing a steady decline in household income.
3. *Unemployment and underemployment.* The employment rate among migrants was 76 percent before displacement, but the rate dropped to just 55per cent after their resettlement. For the host population, the employment rate was 86per cent in 1997 but only 65per cent in 2000. It can be anticipated that, inevitably, a large jobless army is likely to harm the local economy and trigger social unrest in the Three Gorges area.
4. *A low level of education and technical skill* among both the migrant and host populations will have a negative impact on future sustainable development in the reservoir area. The migrants had an average of 6.52 years of schooling in 2000, while the host population had an average of 5.95 years. Workers in factories, the construction in-

dustry and in commerce and services had more education than agricultural laborers, who had 5.47 years of schooling (migrants) and 4.36 years (host population). These figures give an indication of why both migrant and local laborers are experiencing a great deal of difficulty in shifting from farm work to non-agricultural sectors.

Authors of this paper suppose that implementation of any resettlement program should cover the following practical aspects (compare with Yan, Qian, 2004, 629–632):

- adequate preparation
  - clear and transparent criteria for relocation,
  - social impact assessment,
  - environmental impact assessment,
  - suitable and fertile fields for farmers,
  - suitable and sustainable employment opportunities for workers,
  - new suitable houses (mainly for villager) or flats (mainly for inhabitants of towns and cities)
  - suitable policies for relocation,

- willingness and participation of migrants
  - long-term explanation campaign,
  - comply to human rights,
  - psychological assistance,

- willingness and participation of hosted population
  - allow preserving standards of livelihood,
  - improve the infrastructure situation in target areas,

- adequate funds for
  - compensation, rehabilitation and social programmes,
  - construction of new villages, towns, cities or houses, flats,
  - construction of new factories or other employment opportunities,
  - modern environmental technologies and equipment (access to safe water, sewerage, etc.)
  - purchase and adaptation of target areas;
  - relocation,
  - usable instruments and capacity for moving (vehicles, buses, etc.),

- social integration
  - allow preserving standards of livelihood,
  - long-term process of integration to new environment, culture, society, etc.

6. CONCLUSION

Nowadays, environmental migration is emerging as a new phenomenon with an unpredictable potential. China with its scarce resources, overpopulation and economic development projects represents a country, which can be seriously hit in this regard. The case of Three Gorges Dam region clearly illustrates the relevance of this assertion. Some authors claim that environmental migration from the region is an inevitable and only solution to local environmental and social problems. "Implementation of environmental migration to relieve population pressure and bring about sustainability of development between environment, population, economy, and society in this region has been proposed in recent years" (Yan, Qian, 2004, 615). "Emigration from overloaded water – carrying capacity and ecologically fragile regions is necessary, but needs careful human ecological planning and management" (Wang, Ren, Ouyang, 2000, 171; compare with Jing, 2000, 26). Yan and Qian claim that some areas do not possess the basic condition for human subsistence. "An important cause is the excessive growth of the population and the continually increasing population densities. Increased population pressure then ensues in over-cultivation, over-grazing, and haphazard logging, leading to reduction in vegetation and exacerbated desertification" (Yan, Qian, 2004, 614–615). Through environmental migration, the people will be moved out of areas with seriously degraded environment or unlivable natural environment that essentially do not posses the condition for human subsistence and they will rebuild their resettlements in other locations.

However, it remains the question: "Is environmental migration from the region in accord with the fundamental principles of sustainable development?" According to the authors of this paper the answer is rather straightforward. The solution of environmental degradation using the strategy based on the displacement of people does not solve the primary causes. Instead of searching a more acceptable solution for all actors (e.g. construction of smaller dams, implementation of environment friendly technologies) the problem is transferred elsewhere with blurred impacts on both, original and host areas. In China, the problem is complicated by the absolute lack of natural resources including land. Thus, the construction of the Three Gorges Dam contributed to environmental pressures and social problems of displaced people. Economic benefits are controversial as well.

Research reports from the field and personal experiences of one of the authors of the paper argue that environmental migration generally cannot solve environmental problems or poverty of people in the Three Gorges area or in the whole China. The solution of the issue consists of change of access to environment and nature generally, prevention of wastage of natural resources and prevention of water contamination (compare with Wang, Ren, Ouyang, 2000, 44). Agriculture in the area needs to use modern environmentally friendly technologies together with best knowledge (e.g. measures against the soil erosion mainly), which allows producing sustainable food and social security in the region. The experience from study areas (e.g. county Zigui) gives evidence that local people do not use the basic measures against soil erosion in their fields.

The construction of the Three Gorges Dam can contribute to economic growth in some areas of the region, but it will not surely help to nearly two million displaced people, who had to leave their habitats, houses and fields. Even though the promises of the central government or local authorities, enhance of living standards have not become, but reversely, the environmental refugees from the area have became poorer. Authors of the paper can confirm that many of them came back to their original sites in spite of strict prohibition, where they try to live and grow farming products to the last moment. They live in temporary homes (that are frequently built from papers, or plastic foils) and "wait" for reservoir level rise. For this reason their future fate remains unsure. We can expect their illegal migration to some Chinese cities with all negative consequences of their decision.

SHRNUTÍ

Environmentální migrace v Číně

Studie se zabývá problematikou environmentální migrace v Číně, jejími příčinami vzniku a konkrétními dopady na vystěhované obyvatelstvo, především v oblasti výstavby přehradní nádrže „Tři soutěsky". Dále jsou zmíněny odhady současné i budoucí environmentální migrace v regionu a provedena diskuse týkající se problematiky teoretického východiska environmentální migrace ve smyslu řešení environmentálních problémů oblasti. Největší prostor je věnován analýze sociálního, ekonomického a environmentálního prostředí environmentálních uprchlíků pocházejících původně z oblasti zmíněné přehradní nádrže.

Práce je založena na analýze a následné kompilaci materiálů zabývajících se environmentální, sociální, ekonomickou a migrační problematikou a pozorování v oblasti výstavby přehradní nádrže „Tři soutěsky" z října 2004 prováděné jedním z autorů. Během tohoto výzkumu došlo k pořízení mnoha obrazových i písemných záznamů dokumentujících reálnou situaci uprchlíků v okolí přehrady a ověření některých závěrů citovaných výzkumných zpráv.

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SIGNIFICANT FEATURES OF TRANSFORMATION OF THE SERVICES SECTOR IN AN AREA – A CASE STUDY FOR THE MICRO-REGION OF OLOMOUCKO (CONTRIBUTION TO RESEARCH ON THE ISSUE)

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Abstract

After the year 1989, almost all sectors of the Czech economy were reshaped by a dynamic transformation. Pronounced organisational and spatially-functional changes occurred namely in the services sector which had not been counted among the preferred economic fields before the transformation period. This paper represents a microregional probe surveying the changes within the services sector in the city of Olomouc and its rural vicinity after 1989.

KEY WORDS: services sector, transformation, spatial variability, micro-region

1. INTRODUCTION

Extensive changes in the services sector appertain to the significant features of the transformation process in the Czech Republic. On one hand they constitute a sound shift from the generally low quality of community facilities in the period before 1989. On the other hand they respond to the dynamic transformation of economic conditions induced by a wide range of tertiary activities developed by both domestic and foreign economic entities. As to spatial organisation, dramatic changes in the parameters of civic amenities in Czech settlements are considered. It is not only the number and forms of service entities that have transformed; spatial mobility of population in relation to services has altered as well. The former socialist services pattern based on central planning rather than on the principles of free market has been consistently removed by these changes.

2. GEOGRAPHICAL ASPECTS OF TERTIARISATION IN THE POST-COMMUNIST COUNTRIES

Relatively close attention has been paid to the phenomenon of tertiarisation of the Czech society after 1989 in national scientific literature, yet mostly in publications focused on sociology or economy (Večerník, 1998a, 1998b, and other). Basic geographical research covers this issue in minor extent. Among geographers, tertiarisation of the Czech society in broader context has been studied on a long-term basis by the team of researchers at the Department of Social Geography and Regional Development at the Faculty of Science, Charles University in Prague (Hampl et al., 1996, 2001), or for example by J. Maryáš who deals with issues on regional differentiation of small and medium-sized businesses in the Czech Republic (1999, 2000). Likewise, recent Polish literature contains works critically assessing transformation of the services sector in the context of all-society changes, including selected spatial aspects (Jakubowicz, 2000, Wilk, 2001), whereas considerable accent is given to the transformation of retail as an exemplary sector (Powęska, 1995, Taylor, 2000, Pokorska a Kasprzak, 2002, Wilk, 2005, and others). Increased frequency of topics related to spatial aspects of transformation of retail is evident in both Czech (e.g. Szczyrba, 2000, 2004, 2005) and Slovak geographical literature (Pulpitlová, 2002, Fertaľová, 2005). Transformation of the services sector in the rural vicinity of the Slovak capital city after 1989 was studied by V. Lauko (2003) who explicitly quantified the extent of transformation changes in an almost full spectrum of service facilities for the years 1989, 1995, and 2001. The published outputs of his study allow deriving two basic findings; first, the increasing extent of commercial services for the resident population (retail, restaurants, etc.), second, the stagnation or slight reduction in public services in the rural area. Similarly to sociological or economic literature, authors of geographical studies work preferably on rather general features of tertiarisation, i.e. mostly on inter-sector exchange of labour force and goods, their causal and implicational relations, regional differentiation and variability and the like (Nowosielska, 1994). Only few authors focus on issues on the level of facilities in an area during economic transformation. For example, J. Kubeš (2000) studies the transformation issues and the current level of service facilities on a broader spatial scale; his monograph entitled *Issues on stabilisation of rural settlement in the Czech Republic* (*Problémy stabilizace venkovského osídlení ČR*) examines the current level of facilities in the Czech rural areas. Kubeš considers the question of public service and indirectly points to the fact that a disturbance in the stability of a given part of the settlement area by reducing the facilities serving to residential population results in a long-term impact in its functional infrastructure. This intensifies the mobility of rural population towards services. Another example of publications dealing with the services sector and its transformation after the year 1989 is a series of research studies entitled *Geography of small towns* (*Geografie malých měst*), published annually by the Institute of Geonics, Science Foundation of the Czech Republic (Vaishar et al., 2005 etc.).

3. BASIC GEOGRAPHICAL CHARACTERISATION OF THE OLOMOUCKO MICRO-REGION

The rural vicinity of the city of Olomouc comprises of 44 municipalities with a total population of 57,681 (as of December 31, 2004), representing more than one third (36.4%) of the population of the Olomouc administrative territory[1]. When sorted according to

[1] A micro-region defined by the Czech Act no. 314/2002 Coll. as an administrative territory of municipality with extended powers.

population size, 19 of the municipalities fall into the category of 1,000–1,999 inhabitants, altogether containing almost one half (45%) of the population in the area. Compared to the previous years, more significant trend towards suburbanisation in the micro-region is noted, resulting in population growth of smaller municipalities in the vicinity of Olomouc (Ptáček, 2004, Sedláková, 2005). On the contrary, the city of Olomouc lost almost 2,000 inhabitants between the years 2001 and 2004 ($index_{2004/2001}$ = 98.2). The city population has therefore decreased close to 100,000.

Another characteristic feature with a substantial impact on the level of service facilities is the volume of commutation to work and schools in terms of centripetal relations. The net commuting migration rate is negative at an overwhelming majority of municipalities, with a total of –12,524 inhabitants, i.e. more than 22 commuters per 100 inhabitants of the micro-region. Only two municipalities in the area record a markedly positive commuting migration rate owing to the presence of local job opportunities in two large machinery companies: *Hlubočky* (4.5 thousand inhabitants, company MORA MORAVIA), and *Lutín* (3.2 thousand inhabitants, SIGMA). Both municipalities underwent pronounced physiognomic changes in the socialist past with the construction of housing estates and associated service facilities for the needs of industry and residents. Nonetheless, both Hlubočky and Lutín remain in the category of rural municipalities, although in terms of functional typology they are classified as industry-service municipalities (type A). The only municipality with a town status is *Velká Bystřice* (2.8 thousand inhabitants) with a general employment-residential function (type B). Other rural municipalities in the micro-region are markedly residential with a negligible manufactural function (type C).

The functional specification of municipalities described above presents significant characteristics in terms of the potential expected level of service facilities, much like the classification of municipalities according to principles of the so-called central settlement pattern, used as the key guideline in designing and consolidating the capacity of facilities in an area before 1989.[2] In the studied micro-region, 13 municipalities were classified as central (called first-order centres), while the city of Olomouc was naturally classified into a higher level within the hierarchy (Fig. 1). From today's perspective, all municipalities with a population of 2,000–2,499 (a total of eight) together with five larger municipalities of type C and a population size of 1,000–1,999 inhabitants fall into the category of first-order centres.

[2] On the other hand, the central settlement pattern was used as a tool for the integration of municipalities (in the 1970s and 1980s). Municipalities were classified into two basic groups as either central or non-central. The service facilities were subsequently designed on a scale proportional to the hierarchy of centres.

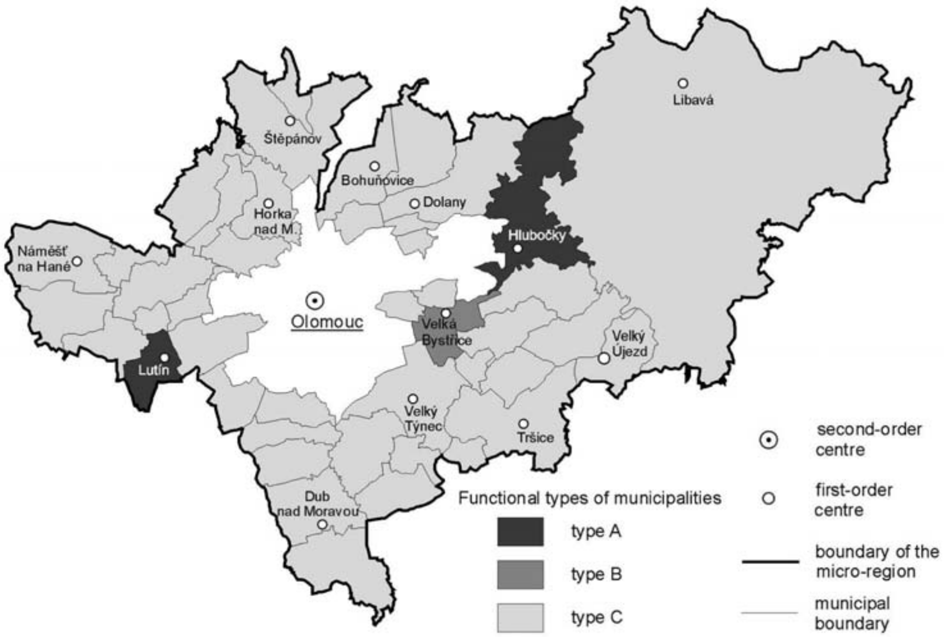

Fig. 1: The Olomoucko micro-region, functional types of municipalities

4. TRANSFORMATION OF THE SERVICES SECTOR IN THE OLOMOUCKO MICRO-REGION

Because spatial data on service facilities in the Czech Republic are not collected generally on any regular statistical basis, it was necessary to carry out field research in 2005 in order to register the level and nature of changes in the studied micro-region. The field research was realised as part of the project no. 402/04/0535 of the Grant Agency of the Czech Republic entitled *"Transformation of the services sector in the Czech Republic"* (*„Transformace sektoru služeb na území ČR"*). The methods used were derived from a research project undertaken by the Federal Statistical Office of Czechoslovakia in the late 1980s. This so-called *Survey on the civic amenities of settlements* (*Šetření občanské vybavenosti sídel*, 1987) was also used as an information source for subsequent comparisons and analyses. The service facilities network was classified into 9 categories (see below).[3]

Data in Table 1 reveal that the intensity of changes within the service sector graduated according to its type. During the observed period of time (1989–2005) *progressive* development of commercial services was recorded before all, encompassing retail, catering establishments, accommodation, and other commercial services for the resident population, i.e. services scanty during the previous socialist period.

[3] The network of banking facilities was intentionally not evaluated, in consideration of the specific development in the financial sector before and after the year 1989.

Progressive transformation was registered also in the network of healthcare and social-service facilities, represented by apothecaries, individual offices of medicine doctors, and new social-work institutes (namely rest homes with day care for seniors). A rather significant change in both qualitative and quantitative manner was recorded at physical training and sports facilities. Certain types of amenities, e.g. aquaparks of golf courses, have been experiencing radical upswing and became the fashionable item within the range of services.

Tab. 1: Transformation changes in the services sector in the Olomoucko micro-region, 1989–2005

Basic classes of service facilities		Number of facilities in year		Nature of change
	Sub-classes	1989	2005	
1	**Schools**	**80**	**82**	±
	1a Kindergartens	46	45	±
	1b Primary schools	33	34	±
	1c Secondary schools	1	3	+
2	**Culture amenities**	**88**	**78**	–
	2a Cinemas	15	5	– –
	2b Culture houses	31	31	±
	2c Libraries	42	42	±
3	**Sports facilities**	**125**	**160**	+
	3a Sports grounds	65	80	+
	3b Gymnasia	43	45	±
	3c Other (swimming pools, shooting ranges etc.)	17	35	+ +
4	**Healthcare and social-service facilities**	**56**	**101**	+ +
	4a Apothecaries	5	13	+ +
	4b Health centres	11	11	±
	4c Individual offices of medicine doctors	34	61	+ +
	4d Specialised healthcare institutions	2	4	+
	4e Social-work institutes	4	12	+ +
5	**Retail facilities**	**93**	**192**	+ +
	5a General merchandise	51	56	+
	5b Shopping centres	12	13	±
	5c Individual shops selling foodstuffs	11	46	+ +
	5d Individual shops selling non-foodstuffs	19	77	+ +
6	**Accommodation facilities**	**8**	**31**	+ +
	6a Guesthouses	1	9	+
	6b Hotels	1	3	+
	6c Other	6	19	+ +
7	**Catering establishments**	**75**	**134**	+ +
	7a Restaurants, pubs	63	103	+ +
	7b Coffee lounges, confectioneries	12	31	+ +
8	**Non-manufacturing service facilities**	**39**	**93**	+ +
	8a Hairdressers	20	46	+ +
	8b Other facilities	19	47	+ +
9	**Manufacturing and repair service facilities**	**52**	**163**	+ +

Explanation: **– –** *sharp decrease* **–** *decrease* **±** *no change* **+** *increase* **+ +** *sharp increase*

On the contrary, a *regressive* trend was typical for cinemas. The decrease in their number in recent years has become one of the most evident transformation changes within the service network. Among the causes of such reduction belongs on one hand the growing availability of audiovisual appliances (VHS or DVD recorders etc.) substituting in part the distribution of movies, on the other hand the recent boom of multiplexes in the Czech cities.[4] Almost no change has entered the network of public services (schools, culture amenities); from the transformation perspective, their situation can be described as *stagnant*.

4.1. Spatial changes

From the perspective of spatial distribution of service facilities, the most widespread in the micro-region are schools, culture amenities, and physical training and sports facilities, present in most of the 44 observed municipalities. Also retail facilities show significant spatial variability, as well as other commercial facilities both manufacturing and non-manufacturing. Only the healthcare ad social-work facilities record spatial concentration into central municipalities (first-order centres) which localize up to three quarters of these facilities (see Table 2).

Data in Table 2 reveal that the services sector underwent development differentiated according to functional types of municipalities. More pronounced changes are highlighted in the table; they allow identifying the settlement-functional changes in services after the year 1989. Among the significant changes belongs the attenuation of centrality of the former central municipalities in terms of health-care facilities, social-work facilities, and catering establishments, partly also in terms of manufacturing and repair services. On the contrary, the range of services has widened in rural municipalities (type C) where a more pronounced change was described at health-care, social-service, and accommodation facilities.

[4] According to the Union of Film Distributors (http://www.ufd.cz/) the share of multiplexes in the total cinema attendance increased from 10% in 1999 to over 70% in 2005. At present there are 17 multiplexes in the Czech Republic. From a total of some 1,300 cinemas at the end of 1989 approximately one half was closed down (Ondráčková, 2004).

Tab. 2: Transformation changes in the services sector in the Olomoucko micro-region according to functional types of municipalities (share in total number of facilities expressed as %, 1989 : 2005)

Basic classes of service facilities		Functional types of municipalities		
		A + B	C	First-order centres
1	Schools	12.5 : 12.3	87.5 : 87.8	40.0 : 39.0
2	Culture amenities	9.1 : 7.7	90.9 : 92.3	37.5 : 34.6
3	Sports facilities	16.0 : 15.6	84.0 : 84.4	47.2 : 47.5
4	Healthcare and social-service facilities	46.4 : 35.6	53.6 : 64.4	85.7 : 76.2
5	Retail facilities	14.0 : 14.6	86.0 : 85.4	50.5 : 51.6
6	Accommodation facilities	37.5 : 29.0	62.5 : 71.0	37.5 : 54.8
7	Catering establishments	14.7 : 16.4	85.3 : 83.6	45.3 : 33.6
8	Non-manufacturing service facilities	10.3 : 12.9	89.7 : 87.1	46.2 : 47.3
9	Manufacturing and repair service facilities	17.3 : 14.7	82.7 : 85.3	55.8 : 48.5

Fig. 2: Dolany – new golf links
(Photo: Z. Szczyrba)

5. CONCLUSIONS

The selected set of municipalities was not decisive enough for any generalizing statements on the level of transformation in the service sector and its impact into spatial functions of services in an area. Nevertheless, the partial results of the performed analyses allow hypothesizing on the trend towards deconcetration within the services sector. The changes are directed from larger to smaller municipalities and lead to spatial decentralization of the spatial functions of services, resulting in a larger diffusion of services for the resident population in the area compared to the situation before the year 1989.

The outputs of the quantitative analysis allow identifying three basic types of services during the system transformation under the conditions of transitive economy. Services with regressive development (type I) show a reduction in the network of facilities caused by various reasons. Services with stagnant development (type II) have kept their level and extent of functions from the past until the present. Services with progressive development (type III) indicate dynamic quantitative increase. It is naturally possible to derive subclasses within the basic types as specified above according to the nature of the transformation changes graduated by the second service spectrum.

SUMMARY

During the transformation period, significant changes occurred in the service facilities network in the Olomoucko micro-region, both on quantitative and qualitative basis. The changes that occurred between the years 1989 and 2005 varied in terms of the types of service facilities as well as in terms of their spatial setup.

The changes identified within the span of the transformation period are significant results of both organisational and spatial deconcentration. This process is directed in terms of the settlement-size pattern form the larger to the smaller municipalities, and also towards spatial decentralization in terms of the spatial functions of services. As a result, larger diffusion of services for the resident population in the area is recorded compared to the situation before the year 1989.

It is also possible to derive three basic types of services during the system transformation under the conditions of transitive economy. Services with regressive development (type I) show a reduction in the network of facilities, caused by various reasons. Services with stagnant development (type II) have kept their level and extent of functions from the past until the present. Services with progressive development (type III) indicate dynamic quantitative increase. It is naturally possible to derive subclasses within the basic types as specified above according to the nature of the transformation changes graduated by the second service spectrum.

SOUHRN

Signifikantní znaky transformace sektoru služeb v území – na přikladu mikroregionu Olomoucko (příspěvek ke studiu problematiky)

V průběhu transformačního období došlo na území zájmového mikroregionu Olomoucko k výrazné změně v sítí zařízení služeb, a to jak po stránce kvantity, tak i kvality nabízených služeb. Změny, ke kterým došlo v období 1989–2005 byly diferencovány, a to jak po stránce druhové skladby sítě obslužných zařízení, tak i prostorové organizace.

Změny, ke kterým došlo během transformačního období a které byly identifikovány, jsou prokazatelně výsledkem probíhajícího procesu organizační i prostorové dekoncentrace. Ta probíhá jednak ve směru sídelně velikostní struktury od větších k menším obcím, jednak směrem k prostorové decentralizaci na úrovni územně-obslužných funkcí. Výsledkem je větší rozptyl služeb pro bydlící obyvatelstvo v území, než tomu bylo před rokem 1989.

Dále je možno vymezit tři základní typy služeb pro období systémové transformace v podmínkách tranzitní ekonomiky. První typem jsou služby s regresivním vývojem (typ I), u nichž dochází vlivem různých vlivů k redukci obslužné sítě. Druhým typem jsou služby se stagnujícím vývojem (typ II), které jak v minulosti, tak i v současnosti si udržují své zastoupení v síti obslužných zařízení. Ke třetímu typu řadíme služby s progresivním vývojem (typ III), které vykazují známky dynamických kvantitativních přírůstků. V rámci jednotlivých typů mohou existovat subtypy v závislosti na charakteru transformačních změn, odstupňované podle druhého spektra služeb.

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INFLUENCE OF LABOUR COMMUTING ON HINTERLANDS OF THE CZECH AGGLOMERATIONS: CONTEMPORARY TRENDS

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Abstract

The article is aimed at the analysis of changes in labour commuting to Prague, Brno and Plzeň during the 1990s. The author delimits with the help of the 1991 and 2001 censuses commuting hinterland of the Czech cities and evidences an increase in number of commuting flows from longer distances, which is related to weakened employment function of a number of microregional centres, district towns included. In the period there was a significant expansion of commuting hinterland of the cities, but simultaneously there was a decrease in labour commuting intensity from municipalities located in the immediate hinterland of Prague, Brno and Plzeň. In this part of hinterland a number of new labour positions were created and they were largely occupied by local population – persons, who as late as in the early 1990s commuted to the cities. In connection with the process of suburbanisation not only residential function but also labour function is strengthened.

KEY WORDS: cities, labour commuting, commuting flows, commuting hinterland

1. INTRODUCTION

Labour commuting is a significant component of spatial mobility of population. It is conditioned by an uneven spatial distribution of economically active population on one hand, and of labour opportunities on the other. It is a significant regional process, which plays a significant part in forming of spatial relations in a settlement system, and which is very intensive in the Czech Republic. For regional sciences this process is extremely valuable since it has an unambiguous meaning (one starting and one target point for each flow), relatively high portion of the population takes part in it, and during last decades it is relatively well and in detail statistically registered.

Labour commuting is generally understood as the movement of the population to labour, which crosses an administrative boundary of a place of permanent residence. Studies concerned with the labour communing in the Czech Republic were until the beginning of the 1960s based entirely on the questionnaire surveys, which were carried out by regional planning institutions, e. g. B. Šilhan (1947), J. Mrkos (1948) or M. Macka (1962). Labour commuting data were surveyed for the first time in 1961 as a part of the population census. Since that year the labour commuting data are regular part of censuses and are widely used in regional works concerned with the core-hinterland relationship. Their main task is particularly a delimitation of catchment areas of commuting centres and an intensity of relation between centre and its hinterland. More complex studies take into account also for instance a typology of centres, their hierarchy or position in a settlement system. The most valuable works deal with the whole area of the republic, e. g. M. Macka (1969), M. Hampl, J. Ježek, K. Kühnl (1983), S. Řehák (1987), J. Müller (1994), M. Hampl (2004 and 2005) or V. Polášek (2004).

This contribution has somewhat different aim, partly due to limited space. It is aimed at the intensity changes and spatial distribution of labour commuting in the largest Czech one-core agglomerations after 1989. The changes in the core-hinterland relations are studied in the Prague, Brno and Plzeň agglomerations with regard to an increasing importance of their cores.

2. CHANGES IN LABOUR COMMUTING IN THE CZECH REPUBLIC IN 1991–2001

The 1991 and 2001 censuses data on the numbers of labour commuters are not entirely comparable. Apart from methodical changes regarding persons[1] for which the data were collected, the number of commuters is influenced also by the changes in the organization of the settlement structure. We mean both the level of integration or independence of spatial units into municipalities and the changes of district or region delimitation. In 1991 there were 5 768 municipalities by the census date and in 2001 there were 6 258 of them. Integrations and disintegrations cause that flow between particular spatial units is or is not included into flows outside a municipality.

In 2001 1 727 thousand persons were commuting outside a municipality, it is by 30 thousand less than in 1991. If we exclude from 2001 origin trips the cases of "new-born" origin trips as a mere consequence of municipality disintegration (in 1991 these trips took part within one municipality), the number would drop by 27 thousand, which would make up 57 thousand of commuters as compared to the preceding census.

Considering the lower number of employed in 2001 (there were 486,9 thousand unemployed, 10 years earlier only 122,8 thousand) the portion of labour commuters increased from 33,2 % to 36,5 %. In the 1990s there was a significant increase of destination trips from longer distances. In 1991 the intra-district commuting made up 69,1% of the commuting total, commuting to other districts of a region 19,5 %, commuting to other regions 10,6 %, and commuting abroad (including Slovakia) 0,8 %. Relative figures for 2001[2] were

[1] In 2001 census foreigners with long term stay are included in the total population (in accord with international recommendation). In 1991 census women on so called further maternity leave (until 3 years of a child's age) are included to the economically active population, as well as persons drawing parental benefit, if their employment lasted; in 2001 only women on maternity leave lasting 28 or 37 weeks. Others (women on further maternity leave and persons drawing parental benefit were considered in 2001 as economically non-active.

[2] In administrative boundaries valid in 1991

as follows: 61,2 %, 20,7 %, 16,6 %, and 1,5 %. There was a decrease of commuters from the place of permanent residence to municipalities in the same district, on the contrary there was an increase of the portion of commuters to other districts of the region, but mainly to municipalities in other regions. Increased labour movements across regional borders were recorded in all "old" regions, there are however significant differences. While the Central Bohemia region experienced an increase by more than three fourths, former North Moravia region had the same number of commuters in both years (only by 0,1 % higher). An important factor was how regions succeeded in the economy transformation process (increase/decrease of labour opportunities) and geographical location, quality of transport connections to other regions (possibility to commute to other regions, to become a commuting centre respectively). The highest relative increase was recorded in the commuting abroad, which almost doubled, which is a consequence of political changes connected with the fall of the iron curtain. Absolute figures for commuting abroad reach, however, only 25 thousand (almost all scholars consider this number as underrated).

3. Changes in labour commuting to Prague, Brno and Plzeň

The numbers of commuters to Prague, Brno and Plzeň in 1991 and 2001 are given in the table 1. For the sake of comparability the commuters from Slovakia are not taken into account in 1991. As the table shows the highest increase in commuting in the 1990s was recorded in Prague. In Brno it was almost 10 % and in Plzeň it did not exceed 1 %.

Tab. 1: Labour commuting to Prague, Brno and Plzeň in 1991 and 2001

City	Number of labour commuters		index 2001/1991
	1991	2001	
Prague	105 006	163 108	**155,3**
Brno	59 419	65 127	**109,6**
Plzeň	27 153	27 362	**100,8**

Source: Sčítání lidu, domů a bytů (SLDB) 1991. Dojížďka a vyjížďka do zaměstnání a škol. Federální statistický úřad (FSÚ), 1992. SLDB 2001. Dojížďka do zaměstnání a škol. Český statistický úřad (ČSÚ), 2003.

The number of labour commuters increased in 2001 as compared to 1991 in all regional capitals. The exception was Ostrava, Karlovy Vary and Zlín. The largest decrease was experienced in Ostrava, where in 10 years the number of commuters decreased by 14 thousand persons from 59 358 to 45 359. Apart from Prague, high increase of commuters was recorded also in the regional capitals of Liberec, Jihlava, České Budějovice and Olomouc. Out of other cities the highest increase was recorded in Mladá Boleslav (in accord with increased automobile production), where the number of commuters more than doubled. Mladá Boleslav belongs to the cities with more than 20 thousand commuters in 2001. Apart from it and the three analysed cities only Ostrava, Oloumouc and České Budějovice belong to that category.

The increase of commuting to selected agglomerations is confirmed by three following tables. However, Prague differs from Brno and Plzeň in the fact that the slight increase was recorded even in the case of the so called "country" districts (the Praha-východ and Praha-západ districts). The increase of commuting from other districts of the Central Bohemia region is high as well in the case of Prague (by 72,6 %); corresponding figures for Brno and Plzeň do not exceed 20 %. There is an interesting fact that the development of commuting to Brno and Plzeň according to analysed areas (neighbouring districts, other districts of the region and other regions of the Czech Republic) is very similar in the 1990s.

Tab. 2: Regional structure of labour commuting to Prague in 1991 and 2001

year	**Number of labour commuters**		
	from Praha-východ and Praha-západ districts	From other districts of the Central Bohemia region	From other regions of the CR
1991	36 951	33 469	34 586
2001	38 168	57 766	67 174
index 2001/1991	**103,3**	**172,6**	**194,2**

Source: SLDB 1991. Dojížďka a vyjížďka do zaměstnání a škol. Hlavní město Praha. FSÚ, 1992. SLDB 2001. Dojížďka do zaměstnání a škol. Hlavní město Praha. ČSÚ, 2003.

Tab. 3: Regional structure of labour commuting to Brno in 1991 and 2001

year	**Number of labour commuters**		
	from Brno-venkov district	From other districts of the South Moravia region	From other regions of the CR
1991	31 603	19 358	8 278
2001	29 213	22 614	13 300
index 2001/1991	**92,4**	**116,8**	**160,7**

Source: SLDB 1991. Dojížďka a vyjížďka do zaměstnání a škol. Okres Brno-město. FSÚ, 1992. SLDB 2001. Dojížďka do zaměstnání a škol. Jihomoravský kraj. ČSÚ, 2003.

Tab. 4: Regional structure of labour commuting to Plzeň in 1991 and 2001

year	Number of labour commuters		
	from Plzeň-jih and Plzeň-sever districts	Form other districts of the Plzeňský region	From other regions of the CR
1991	21 635	3 886	1 632
2001	20 270	4 419	2 673
index 2001/1991	**93,7**	**113,7**	**163,8**

Source: SLDB 1991. Dojížďka a vyjížďka do zaměstnání a škol. Okres Plzeň-město. FSÚ, 1992. SLDB 2001. Dojížďka do zaměstnání a škol. Plzeňský kraj. ČSÚ, 2003.

Changes in commuting to Prague, Brno and Plzeň are assessed not only by intensity but also by importance of commuting flows from individual municipalities to the agglomerations. The intensity of a flow is given by the number of commuters. The following tables give 10 highest commuting flows both in 1991 and 2001 for all three cities. A special attention is paid to flows with more than 500 commuters and to so-called significant flows. A significant flow is considered to represent at least 10 % portion commuting to Prague etc. out of the total number of the economically active in a municipality.

3.1. Commuting to Prague

The capital city of Prague is an important source of labour force as the largest city in the Czech Republic, but at the same time the largest centre of labour opportunities. Prague as the capital, centre of social and cultural life with high concentration of educational and health institutions together with other specific condition for activities in tertiary sphere of the economy offers a large number of labour opportunities not only for its inhabitants but also for inhabitants from the nearest hinterland, to lesser extent for inhabitants from the rest of the republic. The number of commuters from other regions of the Czech Republic increased in 1991 to 2001 by more than 30 thousand, which is not a negligible figure.

High intercensual increase of labour commuters to Prague meant the increase of their portion in occupied labour positions during ten years from 14,5 % to 22,5 %. If we took into account commuting from abroad (the Ministry of labour and social affairs of the Czech Republic claimed by the end of 2000 that the number of working foreigners in Prague reached 49 960 persons at that time) it is obvious that at least each fourth person employed in Prague had a permanent residence outside Prague by the 2001 census.

The increase of commuters to Prague in the 1990s was reflected in most cases by strengthened commuting flows. In 1991 thirty six commuting municipal flows headed for Prague with more than 500 commuters, out of which in 9 cases this figure exceeded 1 000 persons. The largest numbers commuted to Prague from Kladno (4,2 thousand). Slump in some industrial branches, mainly metallurgy, was the main cause of the decrease of labour positions in this district and meant the increase in commuting to Prague. By the 2001 census more than 8,3 thousand persons commuted from the city of Kladno to Prague and this flow became the most important in the Czech Republic (the commuting flow from Havířov to Ostrava dropped to the second position). The number of commuters to Prague from the Kladno district increase from 8,4 to 15,6 thousand persons, which was in 2001 only by little less than commuting from the Praha-západ (19,8 thousand) and Praha-východ (18,3 thousand) districts.

Tab. 5: Ten largest commuting flows to Prague in 1991 and 2001

Commuters in 1991			Commuters in 2001		
Rank	**Municipality**	**Number**	**Rank**	**Municipality**	**Number**
1.	Kladno	4 213	1.	Kladno	8 345
2.	Říčany	2 220	2.	Brandýs n. L. – St. Boleslav	2 079
3.	Brandýs n. L.– St. Boleslav	2 074	3.	Říčany	2 079
4.	Roztoky	1 585	4.	Neratovice	1 956
5.	Černošice	1 398	5.	Brno	1 925
6.	Úvaly	1 375	6.	Ostrava	1 656
7.	Hostivice	1 222	7.	Beroun	1 597
8.	Čelákovice	1 158	8.	Slaný	1 555
9.	Kralupy nad Vltavou	1 044	9.	Příbram	1 519
10.	Neratovice	991	10.	Plzeň	1 502

Source: SLDB 1991. Dojížďka a vyjížďka do zaměstnání a škol. Hlavní město Praha. FSÚ, 1992. Dojížďka do zaměstnání a škol. Hlavní město Praha. ČSÚ, 2003 SLDB 2001.

The number of commuting flows to Prague with more than 500 commuters increased from 36 to 57 (in 22 cases they represented more than 1 000 commuters). Only four flows to Prague weakened during the decade, from Říčany, Roztoky, Černošice and Úvaly. In all cases they were municipalities in the immediate hinterland of the capital, where the labour function was significantly strengthened after 1989. The creation of new labour positions was mostly a result of employers with foreign capital. Among ten largest commuting flows to Prague there were in 2001 three flows from other regions – Brno (an increase from 820 to 1925 commuters), Ostrava (from 715 to 1656) and Plzeň (from 8521 to 1502). These are the largest cities of the Czech Republic. More than 1 thousand commuters to Prague were recorded also in Pardubice and Hradec Králové.

A crucial factor for delimitation of commuting regions or commuting hinterland is typically the intensity of labour commuting. As municipalities closely connected to a regional core are often considered those from at least one tenth of the economically active population (or working population) living in a municipality commutes to a regional core. This criterion of significant flows was used in this contribution as well for a delimitation of commuting hinterland of the Czech agglomeration. The hinterland of Prague (Brno and Plzeň respectively) was divided into four zones according to the intensity of labour commuting. The first zone of Prague's hinterland is formed by the municipalities from which more than 50 % of the employed commuted to Prague, the second zone municipalities with this portion between 33,4–44,9 %, the third zone the municipalities between 20–33,3 % and the fourth zone the municipalities between 10–19,9 %.

In 1991 the ten per cent criterion was fulfilled by 322 municipalities, ten years later it was already 565 municipalities. Commuting hinterland of Prague in 2001 extends to all districts of the Central Bohemia region. A part of hinterland is the whole area of the Praha-východ and Praha-západ districts. Almost the whole Kladno district (82 out of 100 municipalities belongs to the Prague's hinterland and the Beroun, Mělník and Kolín districts have more than 50 % of municipalities belonging to the Prague's hinterland. On the contrary the least municipalities belonging to Prague's hinterland are in the Mladá Boleslav district (10 municipalities).

Tab. 6: Commuting hinterland of Prague in 2001

Municipalities where % of commuters out of employed is	Number of municipalities	Number of commuters to Prague	Employed	Average portion of commuters to Prague out of employed (%)
50,0 and more (zone 1)	65	15 955	28 625	55,7
33,4 – 49,9 (zone 2)	121	21 229	52 411	40,5
20,0 – 33,3 (zone 3)	128	27 318	108 441	25,2
10,0 – 19,9 (zone 4)	251	17 043	119 102	14,3
Total	**565**	**81 545**	**308 579**	**26,4**

Source: SLDB 2001. Dojížďka do zaměstnání a škol – Středočeský kraj. ČSÚ Praha, 2004.

Eighty-one and half thousand persons commuted to Prague from its hinterland, which is almost exact half of all commuters to Prague. The number of commuters from the first zone increased only slightly, but the importance of this zone for the total commuting during decade significantly decreased, from 15 % to 9,8 %. Absolute increase of commuters but relative decrease is registered also in the second zone of commuting hinterland. Only in the third and mainly in the fourth zone experienced both absolute and relative increase of the portion in the total commuting to Prague. In the fourth zone the number of commuters increased almost by 85 % (see Tab. 7).

Tab. 7: Changes in commuting to Prague in 1991–2001 according to the zones of the commuting hinterland in 2001

Zones	Number of commuters of Prague in 1991	Portion of zones in commuters to Prague in 1991 (%)	Number of commuters to Prague in 2001	Portion of zones in commuters to Prague in 2001 (%)	Index 2001/ 1991
Zone 1	15 747	15,0	15 955	9,8	101,3
Zone 2	19 795	18,9	21 229	13,0	107,2
Zone 3	16 965	16,2	27 318	16,7	161,0
Zone 4	9 231	8,8	17 043	10,4	184,6
Total	**61 738**	**58,8**	**81 545**	**50,0**	**132,1**

Source: Sčítání lidu, domů a bytů k 3. 3. 1991. Vyjížďka a dojížďka do zaměstnání, škol a učení – Středočeský kraj. KSS ČSÚ Praha, 1993; Sčítání lidu, domů a bytů k 1. 3. 2001. Dojížďka do zaměstnání a škol – Středočeský kraj. ČSÚ Praha, 2004.

3.2 Brno

The influence of labour commuting on the situation at the labour market in Brno was dealt with in detail by T. Krejčí and V. Toušek (2004). The numbers of commuters included also foreign employees registered by the Labour Office Brno-město. Thus, the number of commuters increased in 2001 by more than 12 thousand as compared to 1991.

Tab. 8: The strongest municipal labour commuting flows to Brno in 1991 and 2001

Commuters in 1991			Commuters in 2001		
Rank	**Municipality**	**Number**	**Rank**	**Municipality**	**Number**
1.	Šlapanice	2 341	1.	Šlapanice	1 876
2.	Kuřim	1 272	2.	Kuřim	1 462
3.	Rosice*	1 031	3.	Blansko	1 033
4.	Modřice	928	4.	Vyškov	982
5.	Tišnov	878	5.	Tišnov	968
6.	Rajhrad	811	6.	Modřice	890
7.	Střelice	769	7.	Rosice	783
8.	Mokrá-Horákov	697	8.	Ivančice	746
9.	Vyškov	672	9.	Bílovice nad Svitavou	718
10.	Ořechov	651	10.	Slavkov u Brna	711

* Rosice including Zastávka, in 2001 from Rosice and Zastávka commuted to Brno 1036 persons

Source: SLDB 1991. Dojížďka a vyjížďka do zaměstnání a škol. Okres Brno-město. FSÚ, 1992. SLDB 2001. Dojížďka do zaměstnání a škol. Jihomoravský kraj. ČSÚ, 2003.

Out of 10 largest commuting flows to Brno in 1991 in five cases there was a decrease of their importance given by the lower number of commuters. These were the flows from the municipalities in the immediate hinterland of Brno: Šlapanice, Modřice, Rajhrad, Střelice and Mokrá-Horákov (see the preceding table). In the case of Modřice even greater importance was recorded with an inverse commuting flow. Eight hundred and thirty persons commuted to Brno, while from Brno to Modřice it was 1 314 persons. It is obvious that in present (after completion of the Modřice industrial zone) this flow is even more important. The increase of commuters from Kuřim to Brno was significantly influenced by intensive housing development in Kuřim. However, Tyco Electronics Czech plant was built on the "green field" in Kuřim, which is presently the largest industrial employer in the South Moravia region, that is why the labour commuting from Brno to Kuřim increased as well. The Brno labour market is significantly related to labour markets in nearby Modřice and Kuřim.

During 1991–2001 the labour function of the South Moravian district town considerably weakened. This weakening was reflected in the increase of labour commuting from these towns to Brno. The increase of commuters was the most important in the case of Blansko and Vyškov, where it was more than 300 persons. In 1991 three hundred and twenty seven persons commuted to Brno from Adamov, in 2001 it was already 549 persons. It was caused by the significant slump in industrial production in this town in the 1990s.

The list of municipalities from which at least one tenth of employed local population commuted to Brno was considerably extended in 2001 as compared to 1991 (from 252 to 339 municipalities). Presently the commuting hinterland of Brno reaches not only all districts of the South Moravia region but also to the districts of Třebíč (12 municipalties) and Žďár nad Sázavou (27 municipalities), which are part of the Vysočina region. The most municipalities of hinterland is in the Brno-venkov district (136; from this district only Zálesná Zhoř is not a part of Brno commuting hinterland), followed by the Vyškov (50), Blansko (42), Břeclav (35) and Znojmo (32) districts. The district with the weakest commuting link to Brno is Hodonín, from which only 5 municipalities were a part of Brno commuting hinterland.

By reorganization of spatial administration by January 1st, 2005 twenty five municipalities of the Vysočina region joined the South Moravia region. Out of these municipalities 24 were originally a part of the Žďár nad Sázavou district and one a part of the Třebíč district. All these municipalities were attached to the Brno-venkov district. Nineteen of these municipalities were in 2001 a part of Brno commuting hinterland (out of which 5 belonged to the third zone). This fact confirms the correctness of the change of regional affiliation in favour of the South Moravia region for these are unequivocally a part of Brno labour region.

Delimitation of the Brno commuting hinterland and importance of its zones is presented in the tables 9 and 10. Unlike Prague the Brno zones 1 and 2 experienced in 1991–2001 decrease in the number of commuters, mainly thanks to newly created labour opportunities in a number of municipalities in both zones. This decrease caused that the number of commuters to Brno from its whole hinterland decrease during ten years by more than 1 thousand persons (Prague experienced increase by almost 20 thousand).

Tab. 9: Commuting hinterland of Brno in 2001

Municipalities where % of commuters out of employed is	Number of municipalities	Number of commuters to Brno	Employed	Average portion of commuters to Brno out of employed (%)
50,0 and more (zone 1)	43	11 883	20 573	57,8
33,4 – 49,9 (zone 2)	68	15 055	35 631	42,3
20,0 – 33,3 (zone 3)	92	11 261	43 513	25,9
10,0 – 19,9 (zone 4)	136	7 134	54 928	13,0
Total	**339**	**45 233**	**154 645**	**29,3**

Source: Sčítání lidu, domů a bytů k 1. 3. 2001. Dojížďka do zaměstnání a škol – Jihomoravský kraj. ČSÚ Praha, 2004.

Tab. 10: Changes in commuting to Brno in 1991–2001 according to the zones of the commuting hinterland in 2001

zones	Number of commuters of Brno in 1991	Portion of zones in commuters to Brno in 1991 (%)	Number of commuters to Brno in 2001	Portion of zones in commuters to Brno in 2001 (%)	Index 2001/1991
Zone 1	13 538	21,9	11 883	16,1	87,8
Zone 2	16 197	26,2	15 055	20,3	92,9
Zone 3	11 101	18,0	11 261	15,2	101,4
Zone 4	5 588	9,0	7 134	9,6	127,7
Total	**46 424**	**75,1**	**45 333**	**61,3**	**97,6**

Source: Sčítání lidu, domů a bytů k 3. 3. 1991. Vyjížďka a dojížďka do zaměstnání, škol a učení – Brno-město. KSS ČSÚ Brno, 1993; Sčítání lidu, domů a bytů k 1. 3 .2001. Dojížďka do zaměstnání a škol – Jihomoravský kraj. ČSÚ Praha, 2004.

3.3 Plzeň

In "Top 10" municipalities according to the number of commuters to Plzeň in 2001 there are 9 municipalities, which were in "Top 10" already in 1991. The only change was substitution of Líně by Horní Bříza. As evident from the table 11, the largest commuting flows mostly weakened during the decade, the exception being Dobřany, Přeštice and mainly Rokycany. In this district town the number of labour commuters to Plzeň increased from 705 to 922.

Tab. 11: The ten strongest municipal labour commuting flows to Plzeň in 1991 and 2001

Commuters in 1991			Commuters in 2001		
Rank	**Municipality**	**Number**	**Rank**	**Municipality**	**number**
1.	Třemošná	1 221	1.	Třemošná	1 114
2.	Starý Plzenec	1 067	2.	Starý Plzenec	941
3.	Nýřany	943	3.	Rokycany	922
4.	Dobřany	893	4.	Dobřany	907
5.	Vejprnice	788	5.	Nýřany	884
6.	Zruč-Senec	742	6.	Horní Bříza	714
7.	Rokycany	705	7.	Přeštice	686
8.	Šťáhlavy	637	8.	Vejprnice	638
9.	Přeštice	633	9.	Zruč-Senec	588
10.	Líně	609	10.	Šťáhlavy	533

Source: SLDB 1991. Dojížďka a vyjížďka do zaměstnání a škol. Okres Plzeň-město. FSÚ, 1992. SLDB 2001. Dojížďka do zaměstnání a škol. Plzeňský kraj. ČSÚ, 2003.

During 1991–2001 the number of municipalities forming the Plzeň hinterland increased from 166 to 198. Higher number of municipalities in the commuting hinterland of Plzeň was, as in the case of Brno, accompanied by weakening of commuting intensities in the immediate hinterland. The importance of individual zones of Plzeň commuting hinterland in 2001 is presented in the table 12. While in 1991 there were 33 municipalities in the first zone, in 2001 there were only 28 of them. In both cases they were located in the Plzeň-sever and Plzeň-jih districts. Both these districts had also the largest portion of all municipalities belonging to the Plzeň commuting hinterland. Out of 198 municipalities of the Plzeň commuting hinterland there were 83 in the Plzeň-jih district (83,8 % of the municipalities of the district) and the same number of 83 municipalities in the Plzeň-sever districts (82,2 % of the municipalities of the district). Higher number of commuting flows (belonging to the remaining zones of the hinterland) was recorded from the Rokycany district (23 flows); remaining districts did not play important part in the commuting to Plzeň (Klatovy 5 municipalities, Tachov and Domažlice 0).

Tab. 12: Commuting hinterland of Plzeň in 2001

Municipalities where % of commuters out of employed is	Number of municipalities	Number of commuters to Plzeň	Employed	Average portion of commuters to Plzeň out of employed (%)
50,0 and more (zone 1)	28	4 777	8 698	54,9
33,4 – 49,9 (zone 2)	38	7 022	16 668	42,1
20,0 – 33,3 (zone 3)	53	5 941	23 470	25,3
10,0 – 19,9 (zone 4)	79	3 579	25 179	14,2
Total	**198**	**21 319**	**74 015**	**28,8**

Source: Sčítání lidu, domů a bytů k 1. 3. 2001. Dojížďka do zaměstnání a škol – Plzeňský kraj. ČSÚ Praha, 2004.

Unlike Brno in the case of Plzeň the decrease of the number of commuters was recorded not only in the 1st and 2nd zones but also in the 3rd zone. Whole Plzeň commuting hinterland experienced a decrease, representing almost 1 thousand commuters (see the table 13). The portion of municipalities located in the commuting hinterland in the total labour commuting reached in 2001 more than 70 % which was considerably more than in the case of Brno (61,3 %) and Prague (50 %).

Tab. 13: Changes in commuting to Plzeň in 1991–2001 according to the zones of the commuting hinterland in 2001

zones	Number of commuters of Plzeň in 1991	Portion of zones in commuters to Plzeň in 1991 (%)	Number of commuters to Plzeň in 2001	Portion of zones in commuters to Plzeň in 2001 (%)	Index 2001/1991
Zone 1	5 437	19,7	4 777	16,0	87,9
Zone 2	7 521	27,3	7 022	23,5	93,4
Zone 3	5 969	21,6	5 941	19,9	99,5
Zone 4	3 301	12,0	3 579	12,0	108,4
Total	**22 228**	**80,6**	**21 319**	**71,4**	**95,9**

Source: Sčítání lidu, domů a bytů k 3. 3. 1991. Vyjížďka a dojížďka do zaměstnání, škol a učení – Plzeň-město. KSS ČSÚ Plzeň, 1993; Sčítání lidu, domů a bytů k 1. 3. 2001. Dojížďka do zaměstnání a škol – Plzeňský kraj. ČSÚ Praha, 2004

4. CONCLUSION

The number of commuting flows with more than 500 commuters increased during 1991 and 2001 only in the case of Prague (from 36 to 57), Brno and Plzeň experienced a slight decrease.

Tab. 14: Municipal commuting flows with more than 500 labour commuters to Prague, Brno and Plzeň in 1991 and 2001

City	1991		2001	
	Total	Out of which 1 000 and more	Total	Out of which 1 000 and more
Prague	36	9	57	22
Brno	19	2	18	3
Plzeň	13	2	10	1

Source: SLDB 1991. ČSÚ Praha, 1993; SLDB 2001. ČSÚ Praha, 2004.

A common feature of all three cities is an extension of their commuting hinterland which reflects an increase of commuting from longer distances. The area of commuting hinterland and the number of municipalities is related to the size of the centre. In the case of Prague it is almost 5 thousand km^2, in the case of Brno 3,1 thousand km^2, and in the case of Plzeň almost 2,3 thousand km^2. The same hierarchy is recorded in the number of labour commuters from the hinterland to the centre. The three cities however do not differ much from one another in the portion of commuters from the hinterland to the centre in the employed persons living in the commuting hinterland (Prague 26,4 %, Brno, 29,3 %, and Plzeň 28,8 %).

Tab. 15: Commuting hinterland in 2001

	Number of municipalities	Area (km^2)	Population	Number of employed	Number of commuters to core
Prague	565	4 933,5	634 445	308 579	81 545
Brno	339	3 077,4	346 251	154 600	45 328
Plzeň	198	2 274,6	153 283	74 015	21 319

Source: SLDB 2001. ČSÚ Praha, 2004; own calculations.

In the 1990s there was not only an increase in persons commuting to labour to the Czech cities, but also there was a significant increase of their portion in occupied labour positions in these cities. The only exception out of cities with more than 100 thousand inhabitants is Ostrava, where both indexes decreased, mainly thanks to former one-sided orientation to mining, metallurgy and heavy machinery (branches experienced during the decade deep slump) – M. Baštová, et al. (2005). The total increase of commuters to Prague, Brno and Plzeň was caused not only by commuting from longer distances but also from abroad.

The decrease (with the exception of Prague) of the number of persons commuting to the Czech cities from the immediate surroundings is important information. The immediate surroundings are formed mainly by the first and partly even by the second zone of delimited commuting hinterlands. Municipalities belonging to both zones strengthened in the 1990s not only their housing but also labour function. We can talk about suburbanisation tendencies influencing the development of the settlement structure of the Czech Republic. We can assume that in 5 years the intensity of suburbanisation process is going to weaken. The housing development will be transferred from the surroundings back to the cadastral area of large cities. If the concentration of new labour positions will be transferred as well we cannot say. We can however assume that new labour positions will be created in the tertiary sector and it will be concentrated (but for logistic companies) to the centres of the cities. This fact will probably lead to further increase of the labour commuting intensity both to Prague, Brno and Plzeň. This process could however be influenced significantly by new trends at the labour market, mainly by “home” labour, which will gain greater importance thanks to quickly developing information and communication technologies. The consequence in this case would be a decrease in labour commuting intensity on the contrary.

SOUHRN

Vliv dojížďky za prací na zázemí českých velkoměst: současné trendy

Obsah článku je zaměřen na analýzu změn dojížďky za prací do Prahy, Brna a Plzně během 90. let minulého století. Autor za pomoci dat z censů 1991 a 2001 vymezuje dojížďková zázemí českých velkoměst a prokazuje nárůst počtu obecních dojížďkových proudů do nich z větších vzdáleností, což souvisí s oslabením pracovního významu řady mikroregionálních středisek včetně okresních měst. V hodnoceném období tak došlo k výraznému rozšíření dojížďkového zázemí velkoměst, ale za současného snížení intenzity dojížďky za prací z obcí ležících v nejbližším okolí Prahy, Brna a Plzně. V této části zázemí uvedených měst byla vytvořena řada nových pracovních míst, které byly z velké části obsazeny místním obyvatelstvem, osobami, které ještě na počátku 90. let dojížděly za prací do velkoměst. V souvislosti s probíhajícím suburbanizačním procesem je tímto posilovaná nejen obytná funkce obcí ležících v nejbližším okolí analyzovaných měst, ale také funkce pracovní.

5. REFERENCES

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TOPOCLIMATOLOGICAL RESEARCH IN ÚDOLÍ BYSTŘICE RIVER NATURE PARK (CZECH REPUBLIC): FUNCTIONAL METEOROLOGICAL NETWORK

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Abstract

Topoclimatological research has a long-term tradition at the Department of Geography, Natural Science Faculty, Palacky University of Olomouc. Thanks to the financial support of the Czech Ministry of Education, the latest meteorological instruments and equipment have been acquired and thus the establishing of the meteorological functional network has been made possible. Due to the assumed topoclimate variability, the "Údolí Bystřice River Nature Park" has been selected as an experimental area. This paper deals with the physio-geographic characteristics, instruments and observation methodology of the local climate in the "Údolí Bystřice River Nature Park".

KEY WORDS: The Údolí Bystřice River Nature Park, topoclimate, meteorological functional network, field observation, cross section measure

1. INTRODUCTION

Topoclimatological research has a long-term tradition at the Department of Geography, Natural Science Faculty, Palacky University of Olomouc. It is based on a topoclimatic map construction when the used methodology (e.g. Vysoudil, 1998, 2000,) allows expressing a spatial distribution of supposed topoclimate types and linked climate generating processes in the local scale landscape. In a functional network, field measuring significantly increases the quality of the topoclimatic research. However, this is very demanding especially on the instrument equipment. Without the field measuring, it would be difficult to prove some of the local climatic effects.

Thanks to the grants given to the "Educational laboratory for the landscape study", it was possible to buy automatic mobile meteorological stations. Mentioned stations became the basis for the functional topoclimatological network. Obtained test measurements have

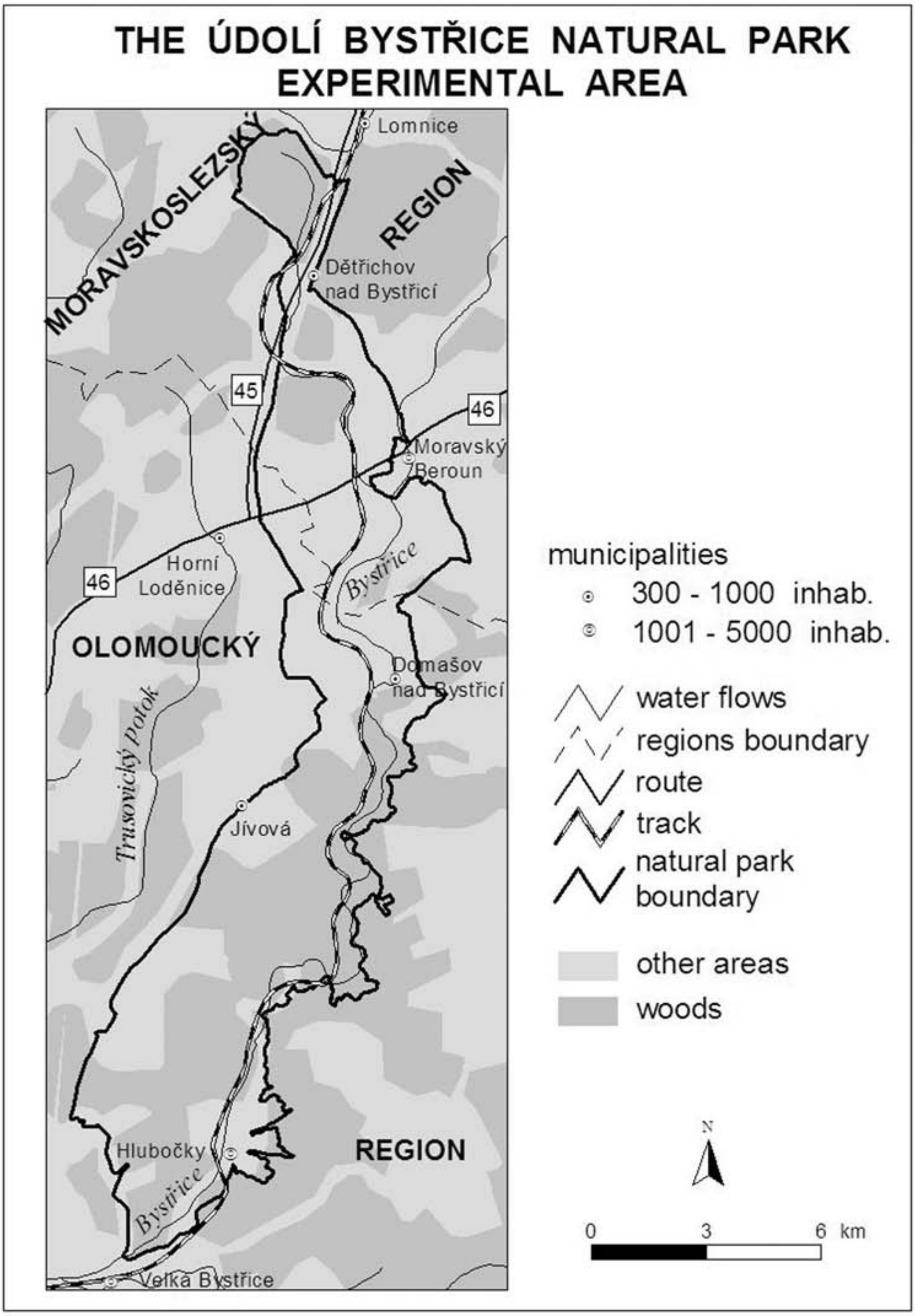


Figure 1: Experimental area

become a part of the next research project "Local climatic effects and their influence on the possibility of pollutants dispersion in the ***"Údolí Bystřice River Nature Park"***.

This contribution, as the first of series dedicated to the topoclimate research in the ***"Údolí Bystřice River Nature Park"***, includes detailed physio-geographic description of the research area, network, instruments and the used topoclimate measure methodology.

2. EXPERIMENTAL AREA PHYSIOGEOGRAPHY CONDITIONS

The experimental area is situated predominantly in the eastern part of the ***'Olomouc'*** region. Only the northernmost part lies within the ***'Moravskoslezský'*** region (fig. 1). The ***"Údolí Bystřice River Nature Park"*** was established in 1995 by the ***'Olomouc'*** and ***'Bruntál'*** district authorities (Šafář, 2003). Its area is 99.3 km^2. The Bystřice River represents the natural axis of the area, even though in the southern half it sporadically forms the area's eastern boundary.

Approximately 50 % of the Nature Park area is covered with woods, mainly beech and spruce. Municipalities are concentrated either along the ***'Bystřice River'*** narrow valley or in the tablelands here. Pastures mainly represent the remaining sections. In some places the slopes of the river valley and the neighbouring valleys are quite steep (fig. 2).

2.1. Geomorphological conditions

From the geomorphological viewpoint, the experimental area is a part of the ***Nízký Jeseník*** geomorphological unit. Four subunits contribute their regions to the experimental area. The ***Domašovská*** Highland lies mainly in the central and the southern section of the nature park, the ***Bruntálská*** Highland is in the northern section, the ***Oderské*** Highland and the ***Tršická*** Upland are in the southeastern area. The highest altitude here, 701m, is at a nameless peak, which lies to the south of the ***Bystřice River*** spring. The lowest elevation of 250 m a. s. l. is at the point where the ***Bystřice*** River leaves the nature park area.

Figure 2: Steep slopes within the Údolí Bystřice River Nature Park (photo M. Vysoudil)

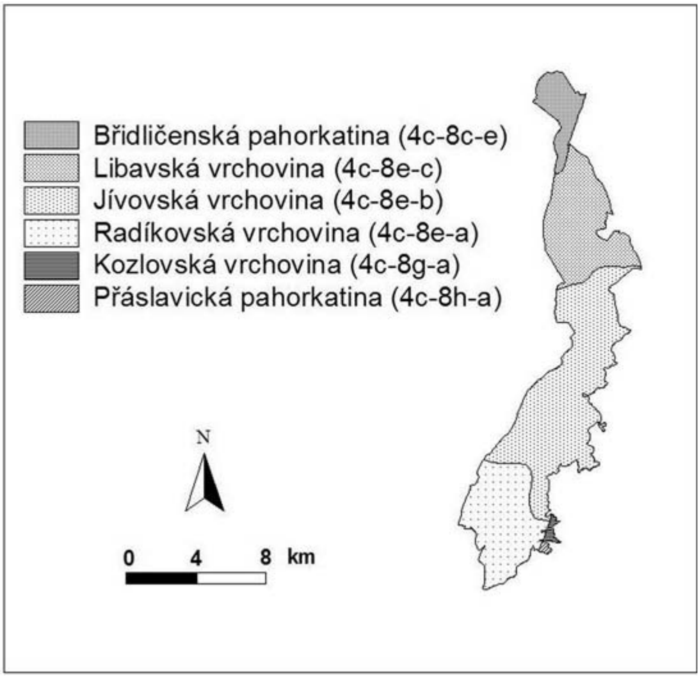


Figure 3: Geomorphological districts (according to Balatka et al., 1987)

The ***Domašovská*** Highland's mean altitude is 548m. Within the natural park area three districts represent this subunit. They are the ***Libavská,*** the ***Jívovská*** and the ***Radíkovská*** Highlands districts (fig. 3). It is a tectonic plate highland formed of mostly sub-Carboniferous slate. The experimental area has a rugged surface cut by young deep valleys (Balatka et al., 1987). This is especially evident in the southern part of the ***Bystřice*** valley. The ***Pštrosí údolí*** and the ***Hluboký Důl*** valleys have a similar landscape. These two valleys join the ***Bystřice*** valley from the right. The valley to peak elevation rise exceeds 200 m in some places, which provides suitable conditions for the topoclimatic research. There are many cryogenic modulations found on the slopes here such as frost riven cliffs and block streams (Janoška, 2003).

The ***Bruntálská*** Highland mean altitude is 567m. Within the Natural Park area this section is characterized by well-rounded ridges and widely spread valleys (Balatka et al., 1987). The ***Břidličenská*** upland district represents the ***Bruntálská*** Highland in the Natural Park (fig. 3). The valley to peak elevation variation is not prominent in this part and does not exceed 100 m. This is where, at 660 m a.s.l., the ***Bystřice*** river springs.

Oderské Highland, which represented by the ***Kozlovská*** Highland district, and the ***Tršická*** Highland, represented by ***Přáslavická*** Upland district, are situated in the southeastern part of the ***Údolí Bystřice*** Natural Park region and their area contributes only marginally to the natural park area.

2.2. Hydrological conditions

The ***Bystřice*** River, springing at 660 m a. s. l., presents a hydrological axis of the nature park area. It empties into the ***Morava*** River near the ***Olomouc*** city's core at 212 m a. s. l.; the catchment area is 267 km^2, the river length is 54 km; an average outflow in the entry slightly exceeds 1 m^3/s (Vlček et al., 1984). The hydrographic system is rather dense with plenty of short and rapid tributaries draining the area into the ***Bystřice*** River. The vast majority of the water in the Nature Park is collected by The ***Bystřice*** River catchment while the ***Trusovický Potok*** catchment only collects water from the westernmost portion in the **Véska** and **Pohořany** municipalities.

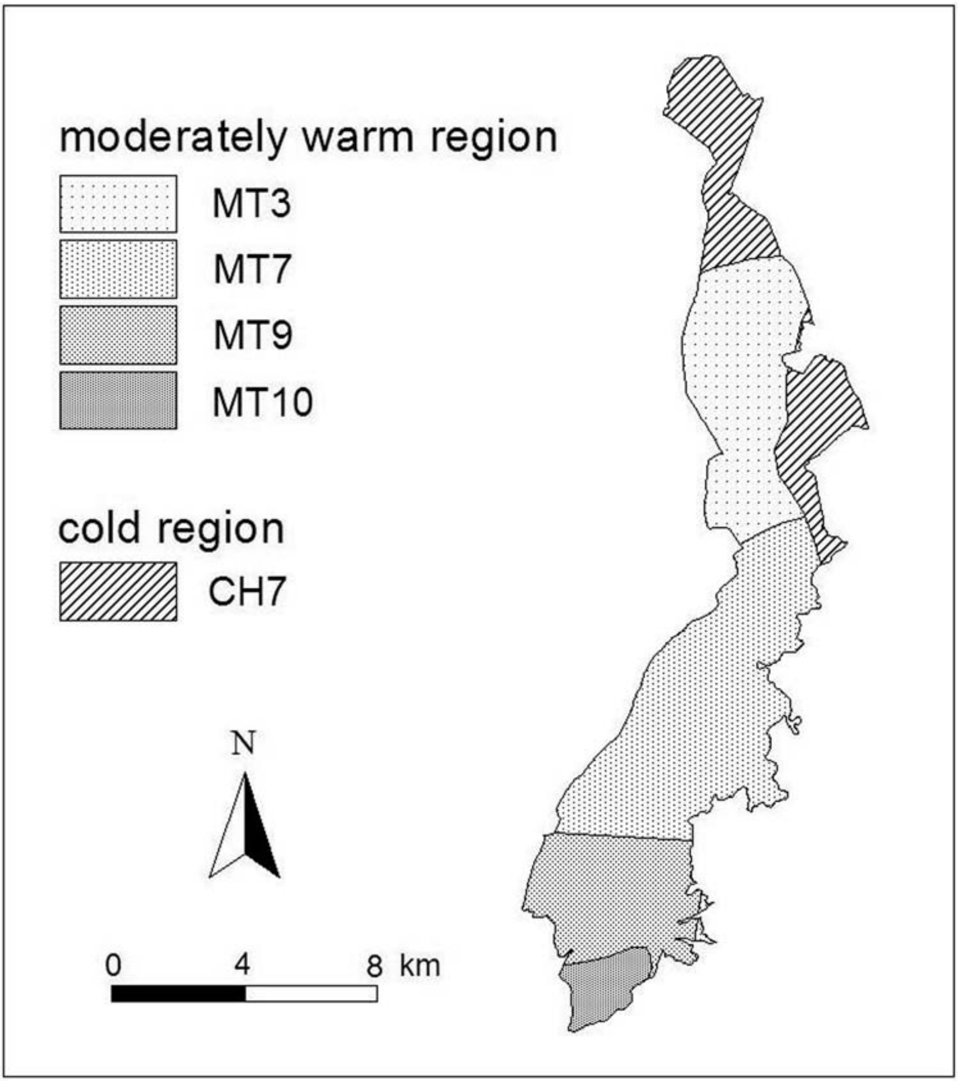


Figure 4: Climatic regions within The Údolí Bystřice River Nature Park (according to Quitt, 1971)

2.3. Climatic conditions

According to Quitt (1971), moderately warm and cold climatic regions play a role in the Nature Park area (fig. 4). The Moderately warm climatic region is represented by four subregions. There are MT10 and MT9 subregions in the southern part; MT7 is in the central part and MT3 is in the north from the center section. Only the northernmost park sector and the segment along the eastern boundary, south of ***Moravský Beroun*** and in the ***Domašov nad Bystřicí*** vicinity, lie within the cold climatic region; subregion CH7. Because the elevation gradually increases heading north, the summer season duration declines in this direction. Therefore, the winter season length and the snow cover period increase correspondingly.

Tab. 1 and fig. 5 present the course of the mean monthly air temperatures at the ***Moravský Beroun*** station (nonexistent nowadays) and at the ***Olomouc*** station during the 1901-1950 period. The ***Moravský Beroun*** station was situated closest to the natural park area at an altitude of 570m, and its geographical location was 49° 48´ north latitude and 17° 27´ east longitude. The ***Olomouc*** meteorological station is situated within the ***Olomouc*** city area. Its altitude is 215 m and the geographical location is 49° 36´ north latitude and 17° 16´ east longitude.

Table 1: Annual course of air temperature [°C] in Olomouc and Moravský Beroun (1901–1950)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	annual mean
Olomouc	–2,7	–1,2	3,4	8,5	13,9	16,6	18,5	17,7	14,0	8,7	3,3	–0,5	8,4
Moravský Beroun	–4,6	–3,3	0,8	5,9	11,6	14,6	16,6	15,4	11,8	6,6	1,3	–2,4	6,2

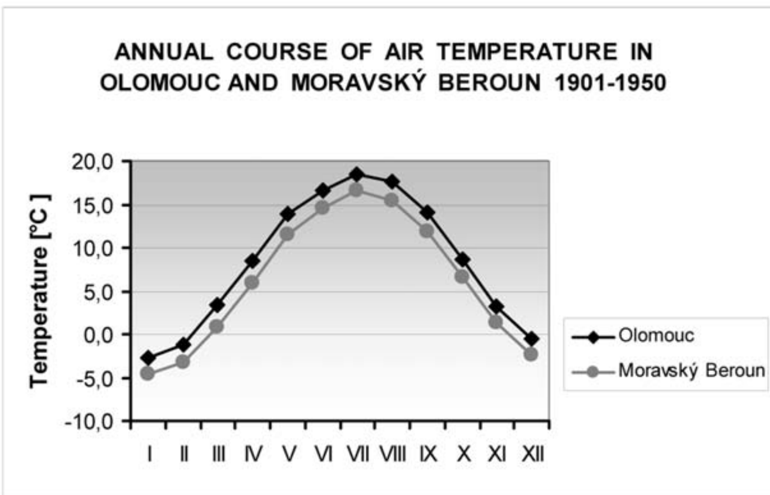


Figure 5: Annual course of air temperature [°C] in Olomouc and Moravský Beroun (1901–1950)

The annual mean air temperature is lower in Moravský Beroun (6.2 °C) than the temperature in Olomouc (8.4 °C); which is explained by the Moravský Beroun's higher altitude.

The annual long vegetation season ($t_d \geq 5.0$ °C) lasts on average 198 days in Moravský Beroun and 218 days in Olomouc. This season begins on 10. IV. and 29. III., respectively, and ends 24. X. and 1. XI, respectively. The annual main vegetation season ($t_d \geq 10.0$ °C) lasts on average 142 days in Moravský Beroun and 160 days in Olomouc; it begins on 7. V. and 27. IV., respectively, ending on 25. IX. and 3. X., respectively.

The highest air temperature ever recorded in ***Olomouc***, 35.5 °C, was measured twice; on 21. and 22. VIII. 1943. The lowest temperature ever recorded, –38.0 °C, was measured on 11. II. 1929 at the same station.

The average number of tropical days per year in Olomouc ($t_{dmax} \geq 30.0$ °C) is 9.5; the average number of summer days (tdmax ≥ 25.0 °C) is 59.1; the frost days ($t_{dmin} \leq -0.1$ °C) 116; and the ice days ($t_{dmax} \leq -0.1$°C) 35.5. The average number of the arctic days in Olomouc ($t_{dmax} \leq -10.0$ °C) is 2.3 days during the 1926–1950 period.

Tab. 2 and fig. 6 present the annual course of precipitation at the ***Olomouc*** and ***Moravský Beroun*** stations.

Table 2: Annual course of precipitation [mm] in Olomouc and Moravský Beroun (1881–1980)

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	annual mean
Olomouc	27	23	28	39	61	75	86	74	47	46	41	30	578
Moravský Beroun	48	40	42	55	74	84	99	93	65	64	57	53	767

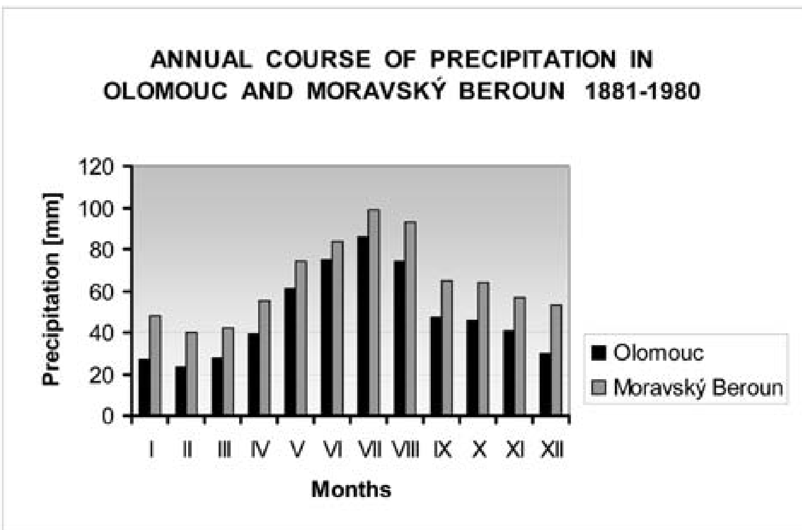


Figure 6: Annual course of precipitation [mm] in Olomouc and Moravský Beroun (1881–1980)

It is evident that higher precipitation amounts, of the two stations, were consistently measured in ***Moravský Beroun***. The lowest monthly precipitation amounts were measured in February in ***Moravský Beroun*** and ***Olomouc***, 40 mm and 23 mm respectively. The highest monthly precipitation amounts, 99 mm and 86 mm respectively, were measured in July at both stations (Vysoudil, 1989).

During the 1920/1921 – 1949/1950 period, 47.7 snow days were recorded in the ***Moravský Beroun*** and 28.2 snow days were recorded in ***Olomou***c. The snow cover duration was on average 96.8 days in ***Moravský Beroun*** and 40.9 in ***Olomouc*** during the same period.

The sunshine duration and the wind direction distribution data are presented for the ***Olomouc*** meteorological station only.

Table 3: Wind direction distribution [%] in Olomouc (1946–1954)

Wind direction	N	NE	E	SE	S	SW	W	NW	calm
Percent occurence	10.1	7.6	4.0	9.0	12.1	6.9	10.2	15.0	25.1

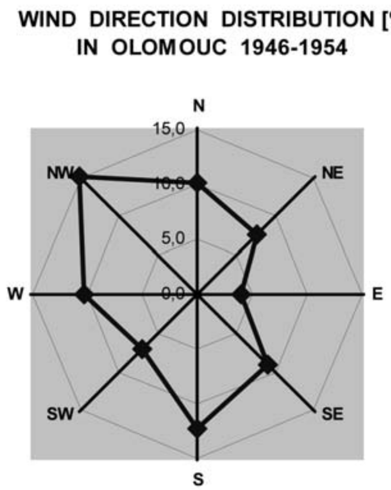


Figure 7: Wind direction distribution [%] in Olomouc (1946–1954)

In ***Olomouc*** the northwesterly winds had the highest percentage occurrence, 15 %; the easterly winds had the lowest percentage occurrence, 4 %. The highest was the calm occurrence percentage, 25, 1 %.

Tab. 4: Sunshine duration (hours) in Olomouc (1946–1955)

It is evident that the sunshine duration in ***Olomouc*** was the longest in July, ranging from 273 to 278 hours, the shortest was in December, ranging from 25 to 26 hours.

The annual mean air relative humidity was 76 % during the 1926–1950 period at the ***Olomouc*** station.

2.4. Biogeographic conditions and nature protection

Mainly spruce and beech participate in the forests species composition within the experimental area. The western and the northern parts of the Nature Park are covered with meadows and pastures. There are some rare plant species that have been preserved in the meadows, Iris Sibirica for instance. Chiroptera often hibernate in quarries and empty adits. Within the Nature Park region, eight Chiroptera species have been discovered (Šafář, 2003); Rhinolophus hipposideros and Myotis myotis can be presented as examples. Salamandra salamandra that hibernates in adits is also one of the rare wild life species worth mentioning.

Within the Nature Park area ***'Kamenné Proudy u Domašova'*** block streams, declared as the Natural Monument in 1974, can be found (Šafář, 2003). Also within the Nature Park is the ***'Hrubovodské Sutě'*** site which was declared the Nature Preserve in 2001.

3. EXPERIMENTAL AREA SOCIOECONOMIC CONDITIONS

Mostly small municipalities are within the experimental area. The largest one is ***Hlubočky*** with a population of 4500, as of 1. March 2001 (Statistický lexikon obcí ČR, 2005). During the second half of the 20th century the population decreased significantly in all municipalities. The biggest settlements are found in the ***Bystřice River*** valley. They are ***Hlubočky, Dětřichov nad Bystřicí, Domašov nad Bystřicí***. The ***Dětřichov nad Bystřicí*** municipality, located in the northernmost part of the Nature Park, lies within the ***Moravskoslezský*** region. The ***Domašov nad Bystřicí***, ***Hraničné Petrovice***, ***Jívová, Hlubočky*** and ***Dolany*** with its parts ***Pohořany*** and ***Véska*** municipalities lie within the ***Olomoucký*** region. ***Moravský Beroun*** is outside the Nature Park area, and only its two urban neighbourhoods, ***Ondrášov*** and ***Sedm Dvorů*** are within the experimental area. ***Radíkov*** and ***Lošov*** are town districts of the **Olomouc** city and have a direct connection with the experimental area by the urban public transportation.

A vital railroad # 310 connecting ***Olomouc*** and ***Opava*** runs through the Nature Park. A major highway connecting ***Olomouc*** and ***Opava*** cuts through the northern part of the park.

There are two major industrial sites within the park area: the Foundeik foundry plant and the Mora producing non-electric devices for private households. They are listed as a category REZZO 2 in terms of the pollution source classification. However, the home furnaces and the increasing automobil traffic present the greatest hazard to the air quality, especially during the temperature inversions.

In the highest locations of the Nature Park, above 600 m a. s. l., with an abundace of meadows and pastures the mountain agricultural production practised dominated by beef raising. In the lower altitudes potatogrowing, grain farming and beef-raising are predominant.

Because of the natural conditions, especially the geomorphological and the climatic ones, an industrial production as well as an agriculture play an isignificant role within the area. Because of the abundance of the leisure time facilities in the park land the area is frequently visited by holidaymakers from ***Olomouc*** and its surrounding areas.

4. NETWORK AND INSTRUMENT DESCRIPTION

At this time, the station network consists of 4-automatic meteorological stations. There are 3-***Fourier system*** stations equipped with a data logger ***MultiProLog*** and 1-***Grant system*** equipped with a data logger ***Squirrel 1209***. Supplementary air temperature and humidity measurements are provided using Forier system miniloggers ***MicroLog EC650.***

4.1. Technical specification

Technical specifications for both systems are described bellow.

a) Fourier Systems Ltd.

<u>Fourier weather station</u>

At present, there are 3-***Fourier*** weather stations located in the experimental area. Their source of energy are solar arrays, which continually charge two batteries. The station allows using two operating modes, the '***Continuous run'*** mode and the ***'Stand-alone Experiment'*** mode. The ***'Continuous run'*** mode saves the data automatically to the computer and requires continuous service software operation. Wireless connection is possible up to 300 meters. The ***'Stand-alone Experiment'*** mode, presently used for technical reasons, saves the data directly to the data logger and requires occasional field trips to download the collected data to a computer.

After setting the stations in leveled position, they were anchored to the surface to withstand even very high winds. The solar panel was set to face south to be optimally exposed to the sun. It is recommended to check the station monthly, to download and to archive the data. The stations' operations were gradually fine-tuned for a practical observation during the summer months, based on the knowledge gained observing their function in the real environment. The first comprehensive time series of meteorological elements from Fourier stations were obtained for the months September – November 2005.

The station Fourier system Ltd. works with Data Logger MultiLogPRO version 8.6WTI, which is equipped with six sensors (tab. 5).

Table 5: Fourier Weather Station sensors specification

Sensor	Range	Sensitivity	Accuracy
Temperature	–15 to 110 °C	0.25 °C	± 2%
Humidity	0 to 100% RH	0.4%	± 2%
Barometric Pressure	800 to 1150 hPa	1 hPa	± 15 Pa
Rain Collector	0 to 204 mm	0.2 mm	± 0.2 mm
Wind Speed	0 to 270 km/h	0.36 km/h	± 0.36 km/h
Wind Direction	0 to 360°	0.46°	± 0.46°

Sampling
Memory capacity 100 000 samples
Sampling Rates from 1 sample per hour to 1 sample per 10 seconds

Power Supply
Solar Panel Max. power 10W
Battery 2 parallel 12V 2.3 Ah rechargeable dealer lead-acid batteries

Software
WeatherLab

MicroLog EC650 Fourier

Device is used for temperature and humidity monitoring support (tab. 6).

Table 6: MicroLog sensors specification

Sensor	Range	Resolution	Accuracy
Temperature	–30 to 50 °C	0.5 °C	± 0.6 °C
Relative Humidity	0 to 100%	0.5%	± 3%

Sampling
Memory capacity 16.000 samples
Sampling Rate from every 10 seconds to 2 hours

Power Supply
Battery 3.6V/1.2 Ah internal lithium battery

Software
MicroLab

b) Squirrel Mini-Met Weather Station, Grant Instruments

At present, there is only one ***'Squirrel Mini-Met Weather Station, Grant Instruments'*** located in the experimental area. The station is powered by lead-acid battery and can supply the station for up to 6 months. During the winter season, with the air temperatures bellow –20 °C, it is necessary to change the battery more frequently. The system stores data directly into the data logger '***Squirrel 1209'*** which requires field trips to download the collected data to a computer.

Used data logger Squirrel 1209 is equipped with six sensors (tab. 7).

Table 7: Mini-Met Weather Station sensors and its specifications

Sensor	Range	Sensitivity	Accuracy
Temperature	–50 to 150 °C	0.1 °C	0.1 °C
Humidity	0–100%	–	2–3%
Rain Collector	–	0.2 mm	0.2 mm
Wind Speed	0–270 km/h	0.3 m/s	2%±0.1m/s
Wind Direction	0 to 360°	0.3 m/s	± 10°
Solar radiation	300–1100 nm	–	–

Sampling
Memory capacity 40.000 samples
Sampling Rates from 1 sample per second

Power Supply
Battery 12V, 7Ah valved regulated lead-acid rechargeable battery

Software
Squirrel View

5. SPATIAL LOCATION OF STATIONS

When chosing the most suitable stations locations, two major chalenges had to be faced. The fisrt one was selecting representative locations that would be suitable for the topoclimatological research. Vertical differences in the experimental area are considerable. In the end, station sites representing the character of their surroundings were found. Two stations have been located at the bottom of ***"Údolí Bystřice River Nature Park"*** in places where the surrounding slopes are steep. Two other stations were situated at the summit part of the terrain. The second chalenge when an appropriate location was protecting the stations from vandalism and theft. All of the selected sites have met both requirements.

Table 8: Weather stations geographical location

Weather station	Latitude	Longitude	Altitude	Terrain location
DD Hlubočky	N 49° 39,6´	E 17° 24,6´	307 m	valley bottom
Domašov nad Bystřicí – líheň	N 49° 43,3´	E 17° 27,0´	458 m	valley bottom
Moravský Beroun	N 49° 47,3´	E 17° 26,4´	545 m	peak site
Radíkov	N 49° 38,5´	E 17° 22,1´	425 m	peak site
Pohořany	N 49° 40,3‘	E 17° 22,6´	561 m	peak site

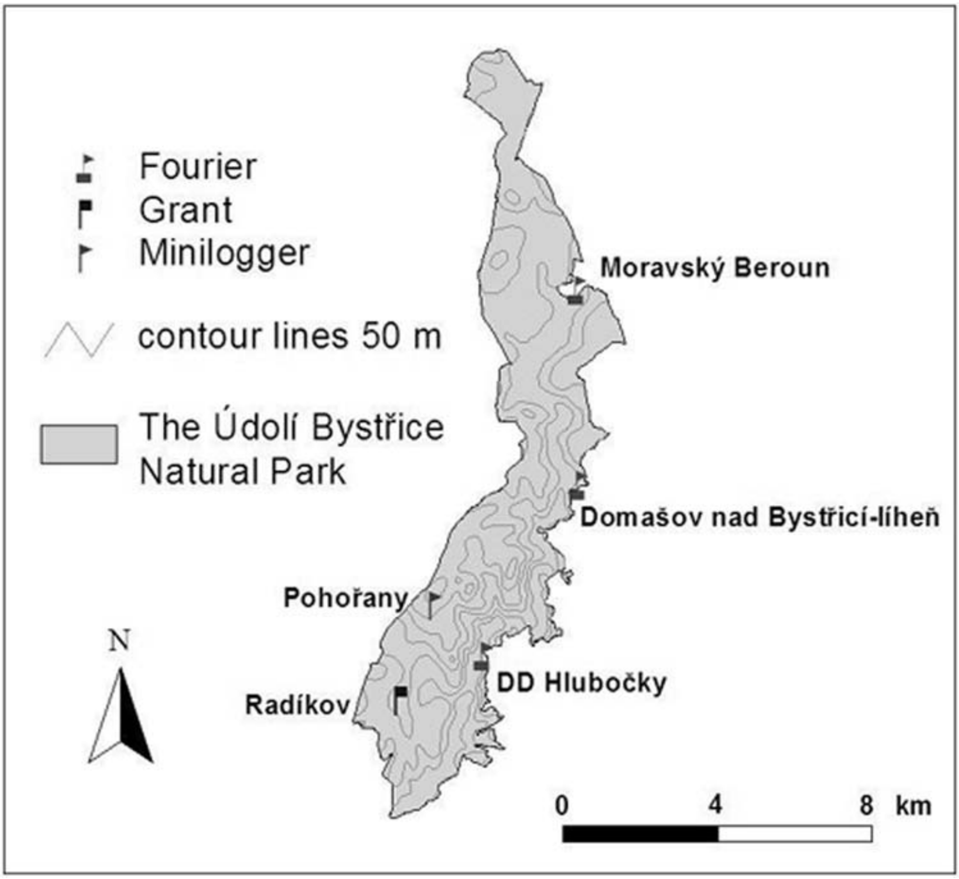


Figure 8: Weather stations geographical location

Geographical positions of the stations have been surveyed by GPS. One Fourier station is located in the Retirement Home garden in the village ***'Hlubočky'*** (bottom of the ***'Bystřice River Valley'***), second one near the Trout Hatchery in ***'Domašov nad Bystřicí'*** cadastral area (bottom of the '***Bystřice Rriver Valley'***), and the third one in a private orchard in '***Moravský Beroun'*** (summit location on the plateau). The station Grant system (summit location) is placed in '***Radíkov'*** in the radiotelecommunication platform area (see tab. 8 and fig. 8).

The highest station elevation is in '***Moravský Beroun'*** (545 m a.s.l.), the lowest one is the station in the Retirement Home in '***Hlubočky'*** (307 m a.s.l.). The elevation difference is 238 metres. Worth mentioning is the fact that the '***Radíkov'*** (summit location) elevation is lower than that of the Trout Hatchery in '***Domašov nad Bystřicí***, located at the bottom of the '***Bystřice River Valley'***.

MicroLog system is placed in the '***Dolany-Pohořany'*** village and represents meteorological conditions in the western part of the Nature Park.

6. STATION AND THEIR SURROUNDING FEATURE

6.1. Stations Fourier system

The '***Moravský Beroun'*** station (Num. 1) is situated on a plateau, at 545 m a.s.l. (Fig. 9), in a private orchard on the southern city border. Houses are scattered in this area and the surface blends into the hilly land. The active surface is represented by a stable and regularly harvested grassland. Low fruit trees in the garden represent the closest terrain barrier. The garden owner's house is approximately 20 meters away.

Figure 9: Moravský Beroun Station (photo M. Vysoudil)

'The Domašov nad Bystřicí'*– Trout Hatchery station (Num. 2)** is also located at the bottom of the 'Bystřice River Valley'*** (Fig. 10) in the Trout Hatchery area close to both, the '***Bystřice River'*** stream and the small hatchery ponds. Active surface is represented by stable and regularly harvested grassland. The valley and the riverbed here are narrower than the one at the ***'Hlubočky'*** Retirement Home station.

Figure 10: 'Domašov nad Bystřicí' – Trout Hatchery Station
(photo M. Vysoudil)

The Retirement Home ***'Hlubočky'*** station (Num. 3) is located in the Retirement Home vicinity in the ***'Bystřice river'*** flood plain (Fig. 11). The riverbed is approximately 100m from the station. The Active surface is represented by a stable and regularly harvested grassland. The closest full-grown vegetation is 10 meters away and is approximately 5 meters high. The station is situated in the southern part of the experimental area where the valley is wider than in the northern section.

Figure 11: DD Hlubočky Station (photo M. Vysoudil)

6.2. Station Grant system

Station ***'Radíkov'*** (Num. 4), equipped with Grant system, is placed in ***'Radíkov'*** in the summit in the area near the radiotelecommunication platform. The elevation is 425 m above the sea level. The active surface is represented by a stable and wild growing grassland. The fact that a forest surrounds the station location must be taken into account when processing this station's data. Also, some meteorological characteristics, such as the wind speed and/or wind direction, can be influenced by the proximity of the 35 meters tall radiotelecomunications tower.

Figure 12: Radíkov Station (photo M. Vysoudil)

6.3. MicroLog EC650 Fourier

Station ***Pohořany*** (Num. 5), is equipped with MicroLog EC650 sensor for temperature and humididy recording. It is placed in a private orchard on the southern village border cca 800 meters from peak Jedová (633 m a.s.l.). The elevation is 561 m above the sea level. The active surface is represented by a stable and regularly harvested grassland. Fruit trees in the garden represent the closest terrain barrier.

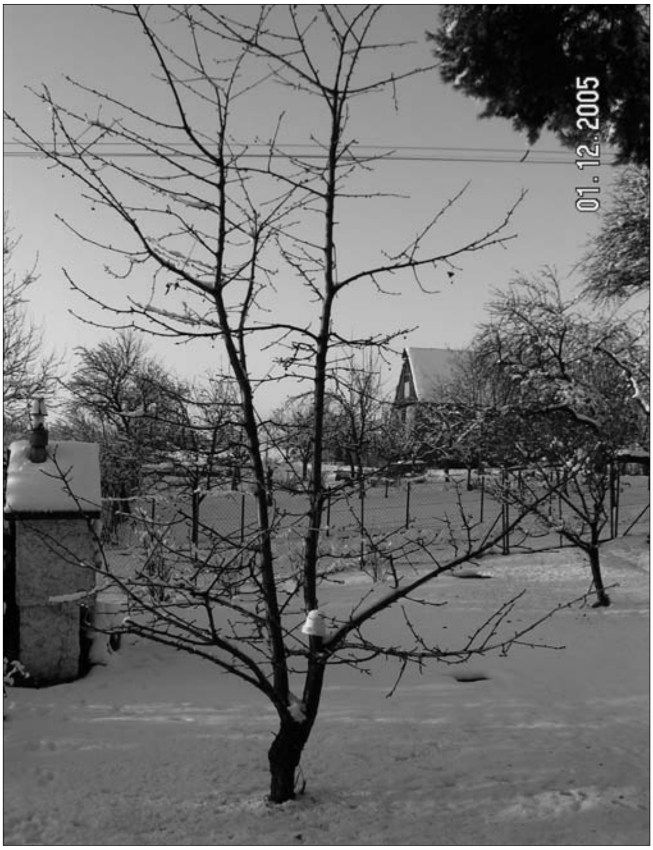


Figure 13: Pohořany Station (photo M. Vysoudil)

7. OBSERVATION METHODS

7.1. Station measurement

Used observation methods are based on general principles for topoclimatic measurement described e.g. by Vysoudil 1981, Obrebska-Starklowa 1995 etc. They involve continual and done in sequence observation lasting several months. The best time for the observations is the warm half of the year.

The influence of the georelief on forming of a stable atmospheric stratification is enormous in deep and narrow valleys (e.g. Colette et al., 2003). Therefore, the spatial distribution of the stations has been done so they can best record the development of the air temperature inversion. The probability of their occurrence in the experimental region is extremely high and the test measurements conducted in 2005 confirmed these presumptions.

For verification of the wind direction modification in deep and narrow, from north to south oriented ***'Bystřice'*** river valley, Mansikkaniemi's (1990) experiences can be applied. He identified relevant changes in the course of these conditions in two dissimilarly oriented valleys (from north to south and from west to east). The results revealed that the prevailing winds are from the north and from the south. The calms also played a significant role. Other registered wind directions were insignificant. On the other hand, the summit station with a low influence of the georelief roughness registered predominantly westerly and southwesterly winds with rare calms. The conducted observations indicate that the deep and narrow valleys greatly modify wind characteristics.

All stations record the air temperature, humidity, wind speed, wind direction, and the precipitation. The ***'Radíkov'*** station (Grant system) is also equipped with a solar radiation registration sensor. Table 9 presents the level of the sensors above the active surface (in cm). The sampling interval for all registered characteristics is 30´, which guarantees detailed overview of their daily courses. Station Fourier, unlike the Grant station and the mini logger, does not allow an automatic start of the recording.

To complete a purpose-built network, a mini logger MicroLog is installed in the ***'Pohořany'*** village to monitor the air temperature and the humidity. Due to the operational and technical restrictions, the measuring at Fourier stations is interrupted during the winter season and the monitoring is partly altered by using mini loggers MicroLog. Only the Grant system station, where the rain collector is disconnected, provides a continuous monitoring.

7.2. Sensors manage

Tab. 9: Location of sensors above ground level (cm)

Station	**air temperature**	**humidity**	**wind speed**	**wind direction**	**solar radiation**	**rain collector**
Fourier	100	100	200	200	×	150
Grant	100	100	250	250	250	150
MicroLog EC650	100	100	×	×	×	×

× – characteristic is not registered

Air temperature and humidity

The air temperature and humidity sensors are mounted 150 cm above the active surface. The 150 cm level is a compromise between the standard 200 cm level and some lower levels used in microclimatological experiments. This height sufficiently reflects the influences of the active surface on the surface atmosphere layer and at the same time eliminates immediate effects of the free atmosphere.

Precipitation

The upper edge of the rain collector is installed 150 cm above the active surface. This height is consistent with the meteorological stations standards.

Wind speed and wind direction

Due to the stations construction, the wind sensor is placed 200 cm (resp. 250 cm station Grant) above the active surface. The influences of the georelif roughness on the wind parameters are significantly expressed at this level which makes for desireable topoclimate study conditions.

Solar radiation

A radiation sensor is only used in the Grant system and is placed 250 cm above the active surface. Some of the Fourier stations will be equipped with these sensors during the year of 2006.

7.2. Cross section measurement

Cross section monitoring, continual stationary as well as sporadic mobile, is considered an important part of the topoclimate study. Quitt's methodology (1972) will be used in the ***'Údolí Bystřice'*** Natural Park experimental area.

Mobile cross section measurement

Mobile cross section measurements provide up to date information about the regime of particular meteorological characteristics, mostly air temperature and humidity. This way of measurement is important where the stationary stations density is insufficient and the need for detailed topoclimate description data is crucial.

Methodology of cross section measurement is relatively standard and in fact offers two choices:

a) reading values and a time at pre-set points from a vehicle moving at a costant speed.
d) reading values at set time intervals from a vehicle moving at a costant speed.

The measurements must be taken either on a closed, circular, route or on a two directional, return, route (there and back). The next step requires a correction of values based on the time difference between the opening measurement and the end measurement.

To satisfy the need for the mobile cross section measuring, three profiles were marked in the Natural Park using GPS. The profiles have a relatively great elevation variation, which is the fundamental requirement for their delineation, and the margin points have maximal, resp. minimal level a.s.l.

Cross section ***'Jívová' – 'Jívová'*** crossroad

The length is 3600 meters and the elevation variation is 137 m (Fig. 14). The highest point (562 m a.s.l.) is in the centre of the ***'Jívová'*** village, the lowest one is the ***'Jívová'*** crossroad (425 m a.s.l.) located cca 100 meters before the ***'Jírovec Brook'*** and the ***'Bystřice River'*** river intersection. The entire cross section follows ***'Jírovec Brook'*** along its flow.

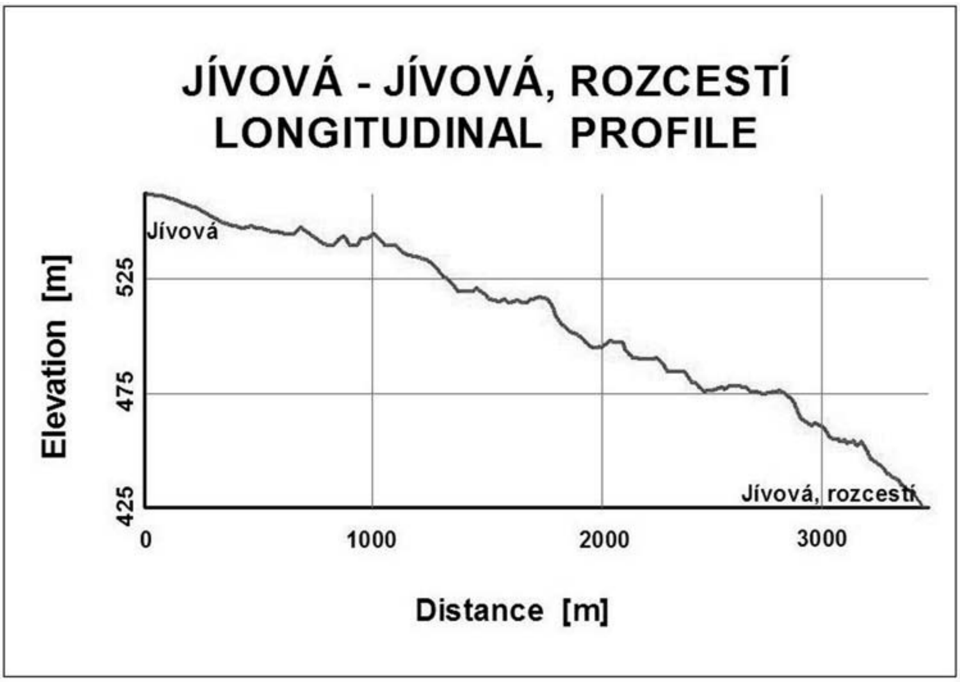


Figure 14: Longitudinal profile ***'Jívová' – 'Jívová'*** crossroad

Cross section ***'Hrubá Voda – Nad Jívovovou'***

This cross section is a little longer (3700 meters). The elevation variation is 225 meters (Fig. 15). The highest point is at ***'Nad Jívovou'*** (554 meters a.s.l.) 1.5 km south from the ***'Jívová'*** village centre. The lowest point is 329 m a.s.l. and is located in the ***'Hrubá Voda'*** village where the ***'Jírovec Brook'*** and the ***'Bystřice River'*** river meet. This cross section almost entirely follows the ***'Pstruží potok'*** brook.

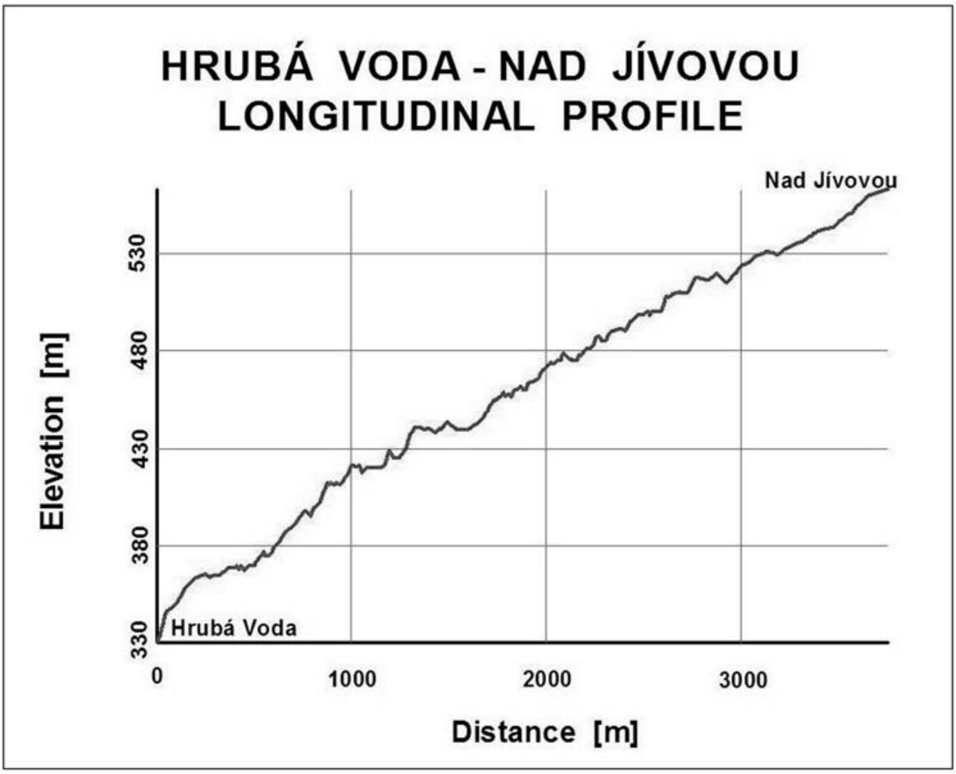


Figure 15: Longitudinal profile ***Hrubá Voda – Nad Jívovovou***

Cross section ***'Dolany – Pohořany'***

This is the longest cross section, 6600 meters, and its 312 m elevation rise is the largest of the three (Fig. 16). The lowest elevation point is 250 meters a.s.l. and is located in the centre of the ***'Dolany'*** village. The highest elevation is 562 meters a.s.l. situated in the ***'Pohořany'*** village. Only the upper part of this cross section is within the experimental area, and its lower part is outside the boundaries.

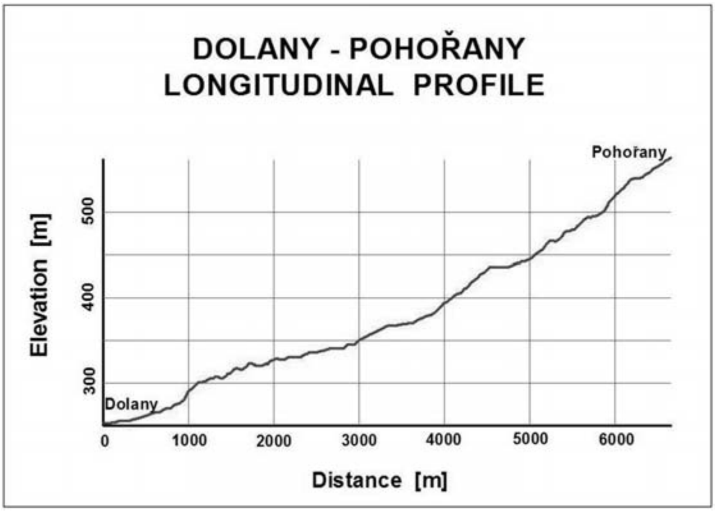


Figure 16: Longitudinal profiles‘***Dolany – Pohořany’***

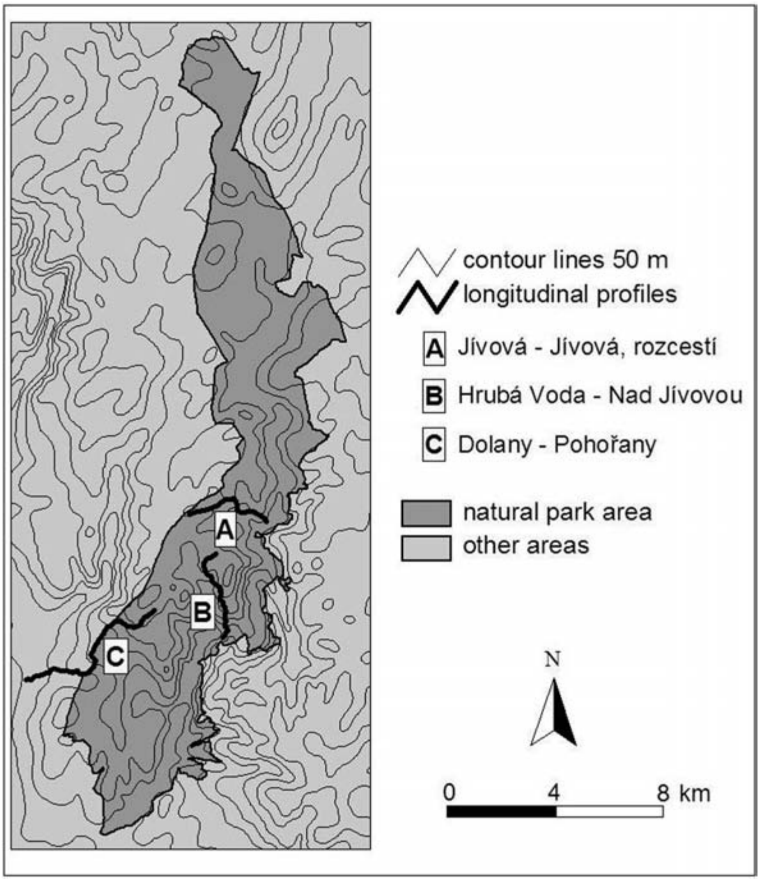
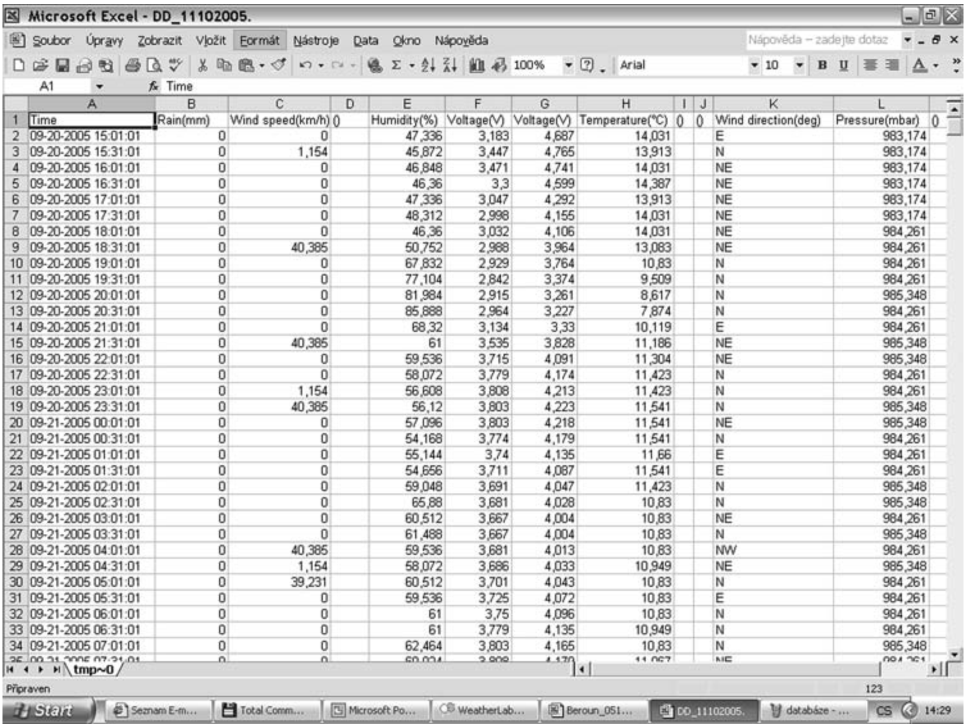


Figure 17: Longitudinal profiles in the ***“Údolí Bystřice River Nature Park”***

9. TIME SERIES AND ITS CHARACTERISATION

Topoclimatic research requires analyzing especially those meteorological data, which are under the direct influence of topography and its active surface. Those data are best received during the anticyclonic weather type especially when the cloud cover is ≤ 2/10 and the wind speed is ≤ 2 m.s^{-1}. To define anticyclonic weather days, the wind characteristics are available from the weather station network and the air temperature daily course curve shape or daily temperature amplitude can be used to determine the cloud cover level. Also, it is possible to use Synoptic Situation Catalogue for the Czech Republic area to identify these days.

To determine a rugged topography influence on the wind direction and the wind speed modification it is possible to use all measured data in a defined period on the local scale.



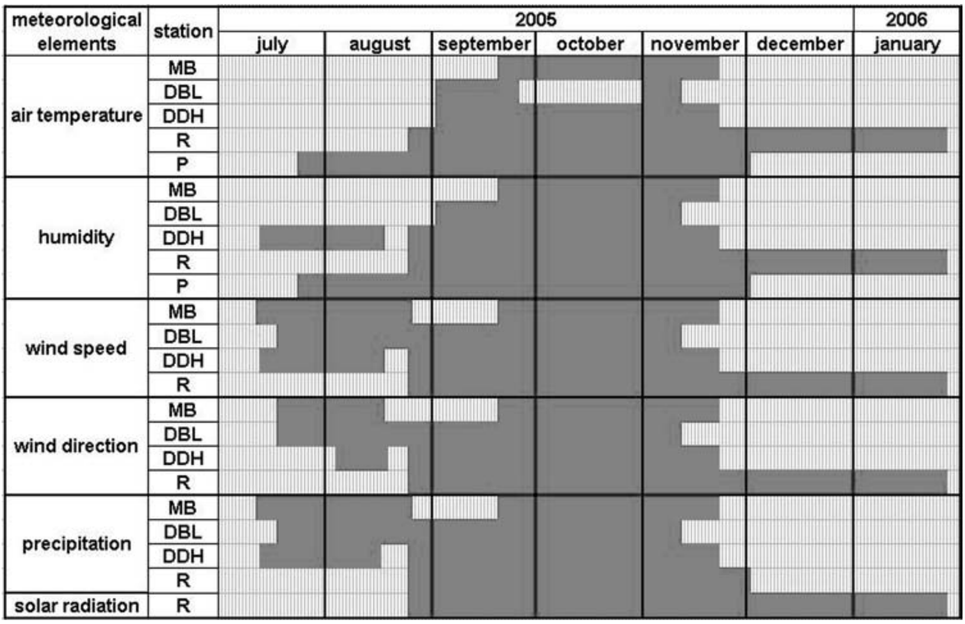
	A	B	C	D	E	F	G	H	I	J	K	L
1	Time	Rain(mm)	Wind speed(km/h)	0	Humidity(%)	Voltage(V)	Voltage(V)	Temperature(°C)	0	0	Wind direction(deg)	Pressure(mbar)
2	09-20-2005 15:01:01	0	0		47,336	3,183	4,687	14,031			E	983,174
3	09-20-2005 15:31:01	0	1,154		45,872	3,447	4,765	13,913			N	983,174
4	09-20-2005 16:01:01	0	0		46,848	3,471	4,741	14,031			NE	983,174
5	09-20-2005 16:31:01	0	0		46,36	3,3	4,599	14,387			NE	983,174
6	09-20-2005 17:01:01	0	0		47,336	3,047	4,292	13,913			NE	983,174
7	09-20-2005 17:31:01	0	0		48,312	2,998	4,155	14,031			NE	983,174
8	09-20-2005 18:01:01	0	0		46,36	3,032	4,106	14,031			NE	984,261
9	09-20-2005 18:31:01	0	40,385		50,752	2,988	3,964	13,083			NE	984,261
10	09-20-2005 19:01:01	0	0		67,832	2,929	3,764	10,83			N	984,261
11	09-20-2005 19:31:01	0	0		77,104	2,842	3,374	9,509			N	984,261
12	09-20-2005 20:01:01	0	0		81,984	2,915	3,261	8,617			N	985,348
13	09-20-2005 20:31:01	0	0		85,888	2,964	3,227	7,874			N	984,261
14	09-20-2005 21:01:01	0	0		68,32	3,134	3,33	10,119			E	984,261
15	09-20-2005 21:31:01	0	40,385		61	3,535	3,828	11,186			NE	985,348
16	09-20-2005 22:01:01	0	0		59,536	3,715	4,091	11,304			NE	985,348
17	09-20-2005 22:31:01	0	0		58,072	3,779	4,174	11,423			N	984,261
18	09-20-2005 23:01:01	0	1,154		56,608	3,808	4,213	11,423			N	984,261
19	09-20-2005 23:31:01	0	40,385		56,12	3,803	4,223	11,541			N	985,348
20	09-21-2005 00:01:01	0	0		57,096	3,803	4,218	11,541			NE	985,348
21	09-21-2005 00:31:01	0	0		54,168	3,774	4,179	11,541			N	984,261
22	09-21-2005 01:01:01	0	0		55,144	3,74	4,135	11,66			E	984,261
23	09-21-2005 01:31:01	0	0		54,656	3,711	4,087	11,541			E	984,261
24	09-21-2005 02:01:01	0	0		59,048	3,691	4,047	11,423			N	985,348
25	09-21-2005 02:31:01	0	0		65,88	3,681	4,028	10,83			N	985,348
26	09-21-2005 03:01:01	0	0		60,512	3,667	4,004	10,83			NE	984,261
27	09-21-2005 03:31:01	0	0		61,488	3,667	4,004	10,83			N	985,348
28	09-21-2005 04:01:01	0	40,385		59,536	3,681	4,013	10,83			NW	984,261
29	09-21-2005 04:31:01	0	1,154		58,072	3,686	4,033	10,949			NE	985,348
30	09-21-2005 05:01:01	0	39,231		60,512	3,701	4,043	10,83			N	984,261
31	09-21-2005 05:31:01	0	0		59,536	3,725	4,072	10,83			E	984,261
32	09-21-2005 06:01:01	0	0		61	3,75	4,096	10,83			N	984,261
33	09-21-2005 06:31:01	0	0		61	3,779	4,135	10,949			N	984,261
34	09-21-2005 07:01:01	0	0		62,464	3,803	4,165	10,83			N	985,348

Figure 18: Measuring data example

Figure 18 presents original data measured at the Fourier automatic station. The data that fail to satisfy the above mentioned parameters would be sorted out. To achieve high data accuracy it is essential to have long time series, ideally yearlong series. That is the reason for conducting the research during consecutive periods. The longest continuous data time series are available from the ***'Radíkov'*** station lasting till 1st February 2006 (see tab. 10). Only the precipitation time series are shorter, because the rain collector was switched off as of 1st December 2005. Shorter continuous temperature and humidity time series are also available from the ***'Pohořany'*** station.

Climatic time series from the other stations are not complete. Nearly complete climatic time series are only available for October 2005. The only measuring failure during this period occured at ***'Domašov nad Bystřicí'***–Hatchery station (temperature time series). Considering that this was a station network test run requiring fine tuning this problem is to be expected.

Table 10: The times series



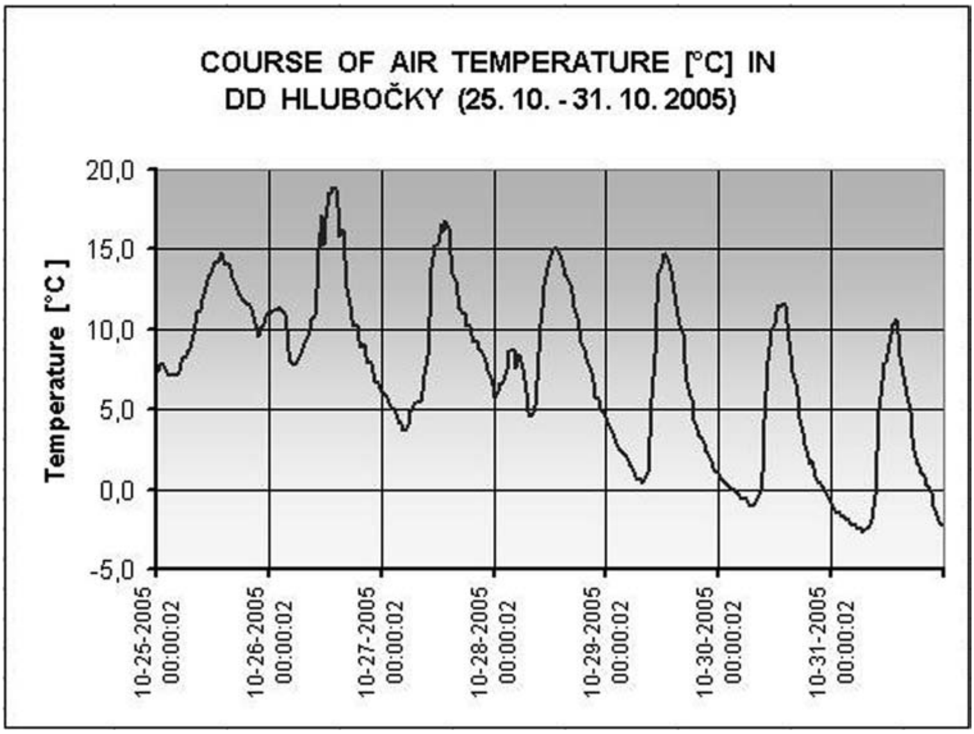


Figure 19: Air temperature course at DD Hlubočky weather station

Fig. 19 presents the weekly course of air temperature at DD ***'Hlubočky'*** station during the anticyclonic weather. The curve run is typical for a clear and cloudless weather, when the differences between the morning and the afternoon temperatures are considerable during the same day.

10. CONCLUSION

The establishment of the trial topoclimatological measurements in the ***"Údolí Bystřice River Nature Park"*** experimental region in 2005 formed a good groundwork for a long-term experiment. It was demonstrated, that obtaining representative series of meteorological data is fundamental for the topoclimate study as well as the local climatic effects study.

It turned out, that to gain adequate long-term and representative time series, the most suitable time for the measurements is mainly the warm half of the year. It also appears necessary to enhance the stationary measuring by performing mobile measuring in selected cross sections.

SOUHRN

Výzkum topoklimatu v Přírodním parku Údolí Bystřice (ČR): Účelová staniční síť

Příspěvek popisuje topoklimatický výzkum organizovaný Katedrou geografie Přírodovědecké fakulty v Olomouci v experimentálním území Přírodní park Údolí Bystřice (Česká rapublika). Území bylo vybráno vzhledem k pestrým fyzickogeografickým poměrům, zejména značné vertikální členitosti terénu. To představuje vhodné podmínky pro studium topoklimatu a místních klimatických efektů. Vzhledem k charakteru georeliéfu a aktivního povrchu se dají předpokládat specifické teplotně vlhkostní poměry, zejména výrazné inverze teploty vzduchu. Také modifikace parametrů proudění a výskyt místních systémů cirkulace jsou pravděpodobné.

Takto organizačně i finančně náročný výzkum bylo možné zahájit díky řešení grantu FRVŠ 3356/2005/A-a „Společná výuková laboratoř pro studium krajiny“. Z jeho prostředků byly zakoupeny automatické meteorologické stanice s příslušenstvím. První testovací měření proběhla take za podpory grantu FRVŠ 2490/2005/G6 „Místní klimatické efekty a jejich vliv na možnost rozptylu znečišťujících látek na území Přírodního parku Údolí Bystřice“.

V experimentálním území byly umístěny 3 automatické meteorologické stanice Fourier System (Moravský Beroun, Domašov nad Bystřicí, Hlubočky) a jedna stanice Grant System (Radíkov) tak, aby svojí polohou pokud možno reprezentovaly výrazné výškové rozdíly a pestrost georeliéfu. Stanice Radíkov má charakter vrcholové stanice, Moravský Beroun zarovnaného povrchu náhorní plošiny a stanice Hlubočky a Domašov nad Bystřicí a jsou typické údolní stanice. Na těchto stanicicíh byla zaznamenávána teplota vzduchu a vlhkost, tlak vzduchu, atmosférické srážky, rychlost a směr větru (na stanici Radíkov též intenzita slunečního záření). V obci Pohořany byl v průběhu testovacích měření umístěn automatický mini data logger MicroLog pro registraci teploty vzduchu a vlhkosti. Byly zaměřeny výškové profily, ve kterých budou v roce 2006 probíhat mobilní měření s cílem získat detailní informace o teplotním zvrstvení přízemní atmosféry.

Během zkušebního provozu v období červenec až listopad 2005 byly postupně odstraňovány především technické problémy. Problémy vykazovaly stanice Fourier System, resp. jejich napájení a softwarová podpora. K dispozici tak jsou více méně neúplné časové řady. V průběhu měření v roce 2006 by se uvedené nedostatky neměly vyskytovat.

První analýzy získaných dat signalizují častý výskyt výrazných teplotních inverzí a také změn v charakteru proudění. Prokázání těchto a dalších specifik místního klimatu bude předmětem výzkumu v roce 2006.

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