Vol. 21/2013 No. 1

MORAVIAN GEOGRAPHICAL REPORTS

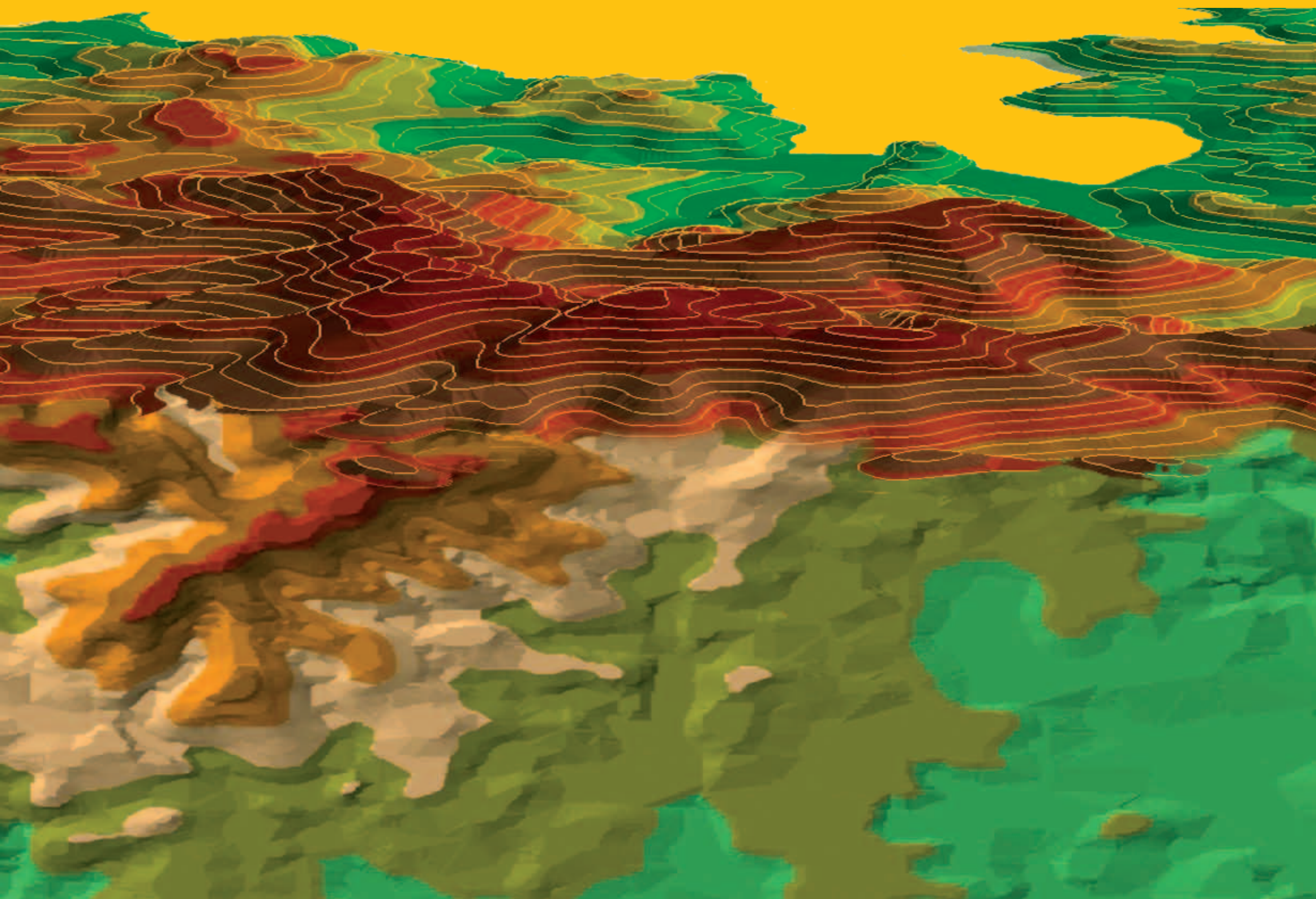

Fig. 1: Trails destined to both hikers and bike tourists are routed through the landscape of flat valleys; former settlement Nový Brunst in the Šumava Mountain (Photo: J. Navrátilová)

Fig. 2: Mountainous borderland areas of the South Bohemia have become the rouge for the close to nature biotopes. Those biotopes constitute the basis of the preconditions for the development of the tourism oriented to the stay in an „intact" nature; settlement Pohoří na Šumavě (Photo: J. Navrátilová)

Illustrations related to the paper by J. Navrátil et al.

MORAVIAN GEOGRAPHICAL REPORTS

PRICE

280 CZK (excluding VAT) per copy plus the postage
800 CZK (excluding VAT) per volume (four numbers per year) plus the postage

PUBLISHER

The Academy of Sciences of the Czech Republic
Institute of Geonics, v. v. i.
Identification number: 68145535

MAILING ADDRESS

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

Brno, March 31, 2013

PRINT

NOVPRESS s.r.o., nám. Republiky 15, 614 00 Brno

ISSN 1210-8812

Articles:

URBAN SHRINKAGE AS A CHALLENGE TO LOCAL DEVELOPMENT PLANNING IN SLOVAKIA

Ján BUČEK, Branislav BLEHA

Abstract

The demographic characteristics of "shrinking" processes in large Slovak cities, as well as the awareness of such shrinkage processes in local development planning, is the subject of this article. Population loss, together with other demographic indicators, clearly documents such a trajectory in urban development. In spite of this reality, there is only limited reflection of the "shrinking" in planning documents of cities approved by town councils. Some reasons for this decreased sensitivity to the complex problem of shrinking cities include missing relevant information (e.g. demographic prognoses), the milder forms of "shrinking" in Slovakia, the absence of political acceptance of the process by local elites, and the dominant-growth oriented planning practices.

Shrnutí

Zmenšování měst jako výzva plánování rozvoje na místní úrovni na Slovensku

Příspěvek je zaměřen na demografické charakteristiky a míru zohlednění procesů „shrinking“ v plánování lokálního rozvoje ve velkých slovenských městech. Snižování počtu obyvatel spolu s dalšími demografickými ukazateli jasně indikují přítomnost této trajektorie vývoje. Přes realitu zmíněného vývoje nacházíme jen malý odraz „shrinkage“ v plánovacích dokumentech měst, které schvalují městská zastupitelstva. Mezi důvody, které vysvětlují tuto sníženou citlivost na komplexní problém zmenšování měst, můžeme uvést nedostatek relevantních informací (např. demografických prognóz), mírnější podoby „shrinking“ na Slovensku, absenci akceptování tohoto procesu v místních elitách i převládající praxi růstově orientovaného plánování rozvoje měst.

Keywords: *shrinkage, large cities, local development, planning, demography, Slovakia*

1. Introduction

Cities are not only growing but also stagnating or declining. One of the frequently-used conceptual terms related to processes of depopulation, economic and social restructuring and physical environment degradation in urban areas, is shrinking. Urban shrinkage, or the “shrinking city”, is usually referred to as an urban area featuring population loss, economic decline and restructuring, increasing unemployment or various kinds of social problems (Rienietz, 2009; Martinez-Fernandez et al., 2012). It is a multidimensional process with manifold effects, accompanied by simultaneous quantitative and qualitative changes. We can observe its demographic, economic, geographical, social and physical environment dimensions. It is a result of multiple parallel processes having global, national, regional and local dimensions and differences.

The main aim of this contribution is to outline the basic features of the shrinking of Slovak cities, as well as awareness of and responses to these phenomena. At first, we focus on demographic processes occurring in a selected group of cities during the period from 1996 – 2010. Demographic development is usually accepted and used as one of the crucial indicators of shrinkage (e.g. Bleha, 2011; Martinez-Fernandez, Weyman, 2012). We also subscribe to views that demographic development and urban shrinking do not depend exclusively on economic development (e.g. Grossmann et al., 2008). Due to the lack of actual direct data at a city level, we avoid far-sighted conclusions concerning economic restructuring, housing stock or infrastructure adaptation aspects of shrinking. Besides the necessary analyses of demographic development in cities, we focus on the reflections of population processes indicating shrinking in the main development planning documents elaborated at a local level in Slovakia. This planning response is among the growing fields of interest within the “shrinking” debate (Pallagst, 2010). It reflects awareness as well as preparedness to respond actively with needed measures and decisions. As Wiechmann (2008) appropriately documented in the case of Dresden, planning documents and related policies do not reflect the existing urban development trends immediately but with a certain delay.

In order to provide realistic knowledge, we focused on three major types of development - related documents (programmes and plans for territorial planning, strategic development and social services). As the official documents adopted by the City Council, they serve as the major guidelines for local self-government decision making. They also provide a regulatory and activity framework for many other actors within the cities. Each of these documents contains analytical sections in which we search for the identification of 'shrinking' in the city as a building block for the awareness of 'shrinkage' formation. These plans also contain more implementation and executive based sections, in which we look for shrinking-linked priorities or measures (focusing on the usual fields of shrinking). Our principal attention is paid to strategic development planning documents known in Slovakia as the Programmes of Economic and Social Development. We would like to know if local elites and the public are aware of such development and respond properly, or if they are still under the influence of the growth-oriented stereotypes in approaching their cities' development, underestimating the shrinking of their cities' face. Our main attention concentrated on 11 Programmes of Economic and Social Development (covering each studied city) and 9 Community Plans of Social Services that had already been adopted. In addition, we also evaluated 6 Master Plans that had been adopted or revised within the last decade (up to 2011).

We formed a sample of Slovak cities suitable for our research purposes with the intention of including Slovak "secondary cities" (i.e. not only Bratislava and Košice). Such cities are mentioned as those "out-of-sight" but facing serious changes (Grossmann et al., 2008). Cities exceeding the limits of one or two hundred thousand inhabitants are frequently used in international analyses (e.g. Turok, Mykhnenko, 2007). In Slovak geography we can find a frequently-used size limit of 50 thousand inhabitants (e.g. Slavík, Kožuch and Bačík, 2005; Buček, 2005), which determines a group of the largest Slovak cities (among which the two largest cities of Bratislava and Košice have a specific position). They represent nodes of the largest urban functional regions and form altogether (with mutual linkages) the main settlement "skeleton" of the country. Within this group of 11 cities, we find eight cities serving as the seats of regional self-governments (including the capital city of Bratislava, with the exception of Martin, Poprad and Prievidza). One should keep in mind that among nearly 2,900 local self-governments in Slovakia, there are 138 cities. The share of the urban population is slightly below 55% of the total population (2010). A large group of cities has less than 10 thousand inhabitants and some of them even less than 5 thousand inhabitants (resulting from the definition of statutory cities in Slovakia).

The suitable time-span for data in considering urban shrinkage is subject to much discussion. We assume that a longer period with certain internal time space consistency is indispensable. Following this criterion, we primarily focus on the period from 1996 – 2010. The period is long enough and offers an opportunity to discuss the issue within the latest possible time scale. During this period, no major changes occurred in the composition of this group of cities (one city exceeded the lower size limit in this period – in 2010). As an important feature, we consider also the fact that most administrative changes within the city borders had been completed earlier. This makes it possible to eliminate misleading considerations based on the different spatial delimitation of the cities. Due to the forced integration of neighbouring villages during the socialist period, the cities regained their autonomous position mostly during the first years after 1989. This was of course accompanied by significant changes in population numbers in most of the cities in our sample (except for Bratislava and Košice).

2. The context of shrinking in Slovakia

Cities in Central and Eastern Europe (CEE) are often considered as typical cases of urban shrinkage. As revealed in many studies (e.g. Turok and Mykhnenko, 2007; Steinführer and Haase, 2007; Grossmann et al., 2008), population decline in cities is a common phenomenon in this region. It is influenced by a range of processes accompanying the post-socialist transformation and globalisation. Nevertheless, more detailed information on shrinking in various Central Eastern European countries is often missing. More attention is paid to developments in Poland and the Czech Republic (e.g. Steinführer et al., 2010; Rumpel and Slach, 2012), while Slovakia belongs to a group of less systematically covered countries.

Among the few Slovak authors dealing with urban shrinking, Finka and Petríková (2006) have provided some introductory knowledge within the CEE context. Slavík, Kožuch and Bačík (2005) mentioned the shrinkage indirectly in their evaluation of population development and suburbanization in cities since 1990. Bleha and Buček (2010) focused on selected local population and social policy features of shrinking with the example of Bratislava that represents a very suitable observational unit for such an analysis. Bleha (2011) analyzed local population policy and shrinkage perception among mayors in Slovakia – likely the first information on local decision-makers' perceptions of the current demographic changes and their implications. Finally, Buček and Bleha (2012) outlined shrinkage in urban planning in an introductory essay. It is worth mentioning that urban shrinkage provides an additional perspective for various more detailed analyses.

The Slovak urban system had experienced decades of permanent growth (in population, as well as in spatial and physical terms), which culminated during the 1970s and 1980s. Due to the combination of socialist industrialization and urbanization, the decades of growth were followed by population decrease in Slovak cities after 1989. At the beginning of the transition period, a sudden population decrease related to changes in administrative borders of some cities. Consequences of the post-socialist transformation accompanied by radical economic and social reforms represented other general reasons. Economic downturn and social uncertainty influenced population processes, including family and migration behaviours. The collapse of many industrial enterprises led to wide-scale deindustrialization. Together with the collapse of new housing construction, it stopped immigration to cities for years. The new service-based economy in cities was growing slowly and only in some of them. Delayed a few years, suburbanization started to be influential in the largest cities.

In the 1990s, a wide debate related to population development in cities was still missing, despite the availability of indicators revealing changes in population development. This can be explained by common expectations that after the temporary post-socialist social and economic decline, the dynamics of growth would be re-established and the cities would grow further. The population decrease in the cities was considered as temporary and the phenomenon was denoted as a stagnation of their size. However, the processes of population decrease remained a dominant feature of development in most large cities for a longer period. Some newly-emerged cities lost more than 10% of their population within 15 years after 1996 (mostly smaller cities dependent on an industrial tradition). Now, having the possibility of evaluating more than twenty years of post-socialist urban development, we can observe no significant return to growth in the cities. The attention to the processes of shrinking in Slovakia is under such circumstances a great challenge. A cardinal issue is, however, whether the local elites and the policy makers are aware of such a development and to what extent they have adapted their approaches to development in this respect.

It is important to mention that there has not been any explicit national urban policy (or a specific policy focusing on the problems of shrinking cities) in Slovakia. We can only find specifically-oriented measures adopted by the state (including allocated resources) in which cities play decisive implementation roles (see e.g. Buček, 2005). The most important aspect is that the central state has formulated a programming and planning framework within which the issue of shrinking can be addressed. State ministries have also managed to elaborate nationwide development planning documents and strategies (e.g. in regional development, territorial planning, environmental planning, population forecasts). However, most of the nation-wide planning and forecasting documents are of older date (adopted at the beginning of the previous decade) and need to be revised (we can expect such revisions within the forthcoming years). They do not pay much attention to the issue of shrinking (although the indices of population development in cities are mentioned). Slovak central state spatially-oriented policies are more focused on regional development policy and the mitigation of regional disparities. Also, the wide-scale decentralization in the last decade resulted in urban problems being perceived primarily as problems of individual local self-governments.

3. Demographic identification of shrinking in Slovak cities

The demographic data document what we can observe as a crucial turn in the natural increase and migration flows of population in Slovakia after 1989. In this section, we demonstrate to what extent this applies to the largest Slovak cities. We compare the population development among them, compared to rural settlements, as well as within the framework of total population development in Slovakia. Our main intention is to identify to what extent we can consider changes in the population development in cities as relevant cases of urban shrinkage. After arguments confirming such a development, we present the main features and factors related to this development. Table 1 provides a list of the studied cities ordered by their population sizes. Because a problem exists with data reliability before 1996 (due to the above-mentioned disintegration processes that cities experienced in that period, see e.g. Slavík, 1998), we used indicators of population change and age structure in the period since 1996.

The decrease of reproduction dynamics is linked to the decline of the total fertility rate after 1989. It was recorded very soon and at first especially in the largest cities. The trend is based on the phenomenon

City	Population number (as of Dec. 31st 1996)	Population number (as of Dec. 31st 2010)	Relative change (in %)
Bratislava	452,288	432,801	– 4.5
Košice	241,606	233,886	– 3.3
Prešov	93,147	91,193	– 2.1
Žilina	86,811	85,129	– 2.0
Nitra	87,569	83,444	– 4.9
Banská Bystrica	85,052	79,819	– 6.6
Trnava	70,202	67,368	– 4.2
Martin	60,917	57,987	– 5.1
Trenčín	59,039	56,403	– 4.7
Poprad	55,303	54,271	– 1.9
Prievidza	57,395	49,994	– 14.8
Slovakia	**5,378,932**	**5,435,273**	**1.0**

Tab. 1: Population size of the largest Slovak cities
Source: Statistical Office of the Slovak Republic (1996–2010)

of postponed fertility, which is extensively debated in post-socialist transition countries. The total fertility rate in the largest Slovak cities is well below 1.3 now. This indicates that it is below the level considered as the lowest low fertility value – the term first introduced by Kohler et al. (2002). Its values for Bratislava and Nitra were 1.15 and 1.0 respectively in 2007. A few years ago, this value had been less than 1 in a number of cities. Although we can see a gradual recuperation of births (primarily in Bratislava), this extremely low fertility results in the low number of births regardless of the numerous reproductive cohorts of the 1970s. At the same time, despite growing life expectancy, the natural increase is close to zero – although some signs of growth are evident for the years 2008 – 2009 (see Fig. 1). However, the changes in fertility and age composition are leading factors of changes in natural decrease and the weight of mortality is expected to increase in the coming years.

Development in the capital city of Bratislava was less positive. However, since the year 2006 we can observe the expansion of postponed births there. The dynamics of crude birth rate and crude mortality rate are also influenced by the so-called age-structure momentum – the age structure of cities is considerably unbalanced as a result of unstable and intervening socialist migration. The natural increase either diminished or turned into decrease later from higher levels in the smaller cities of Poprad and Prešov, located in the traditionally more conservative eastern Slovakia. We can summarise that the natural movement of population is not a principal cause of urban shrinkage in the monitored group of the largest Slovak cities. This is true despite the varying values, their changes and the heterogeneity of this sample of cities, especially during the first half of the observed period. These cities gained 1–4 inhabitants annually (calculated per one thousand inhabitants), due to a birth rate that was higher than the mortality rate. Mortality will increase in the future in relation to the increasing number of elderly people, despite the growing quality of life and the above-average life expectancy in these cities. According to Šprocha (2008), life expectancy of men in Bratislava was 73.07 years (2004–2007). In the centres of regional self-government it was 72.76 years, while for all cities in Slovakia it was 71.45 years (for Slovakia it was 70.35 years). Similar differences are also recorded for the female population. Such a demographic paradox will also affect the birth rate. Although an increased total fertility rate is expected, the cohorts of women at reproduction age will be significantly diminishing, resulting in a decrease of births. Not-surprisingly, such a trajectory is expected in most Slovak regions according to the authors of the sub-national population development forecast (Bleha and Vaňo, 2008).

A different view is offered in Fig. 2, which represents net migration. Almost all cities showed a population loss as a result of higher out-migration during the analyzed period. The population losses were increasing each year after 2000, although in some cities the figures improved around the year 2005 due to a better economic cycle period. The main reason for such a development in most of the cities is residential suburbanization. While the suburbanization before the year 2000 had been limited, it expanded later, reflecting the improved social and economic situation and partly also the increased prices of housing in the cities. Negative annual rates exceeded ten per one thousand inhabitants in some years (e.g. for the city of Prievidza).

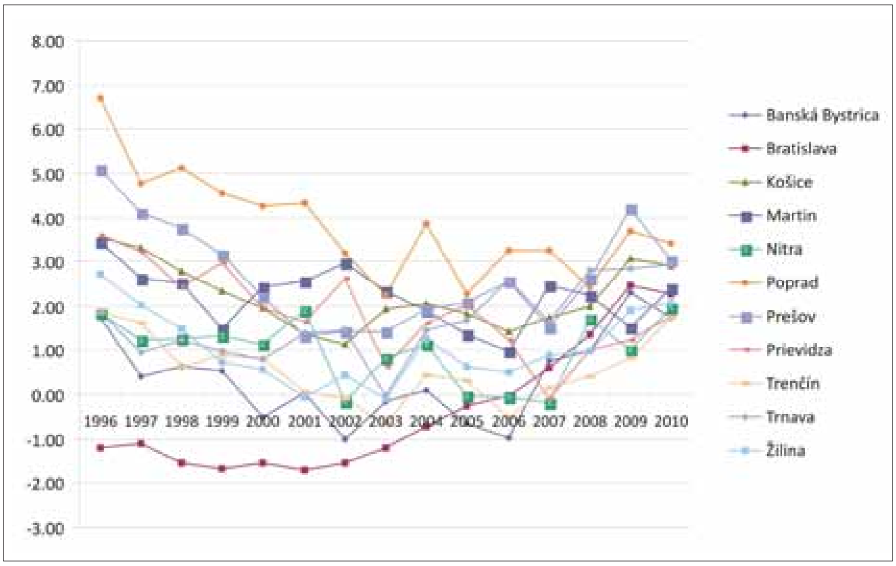

Fig. 1: Natural increase/decrease (per thousand inhabitants)

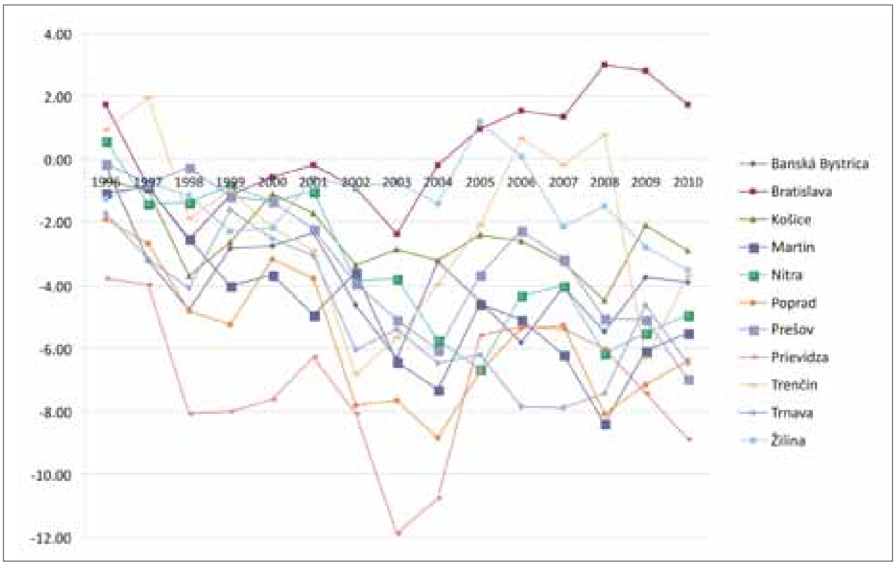

Fig. 2: Net migration (per thousand inhabitants)

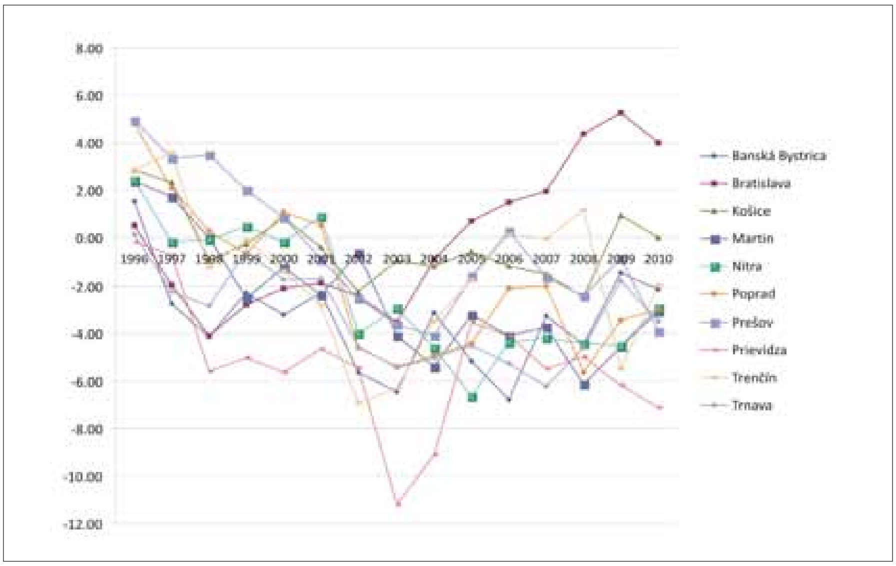

Fig. 3: Annual population increase/decrease (per thousand inhabitants)

The waning of suburbanisation and its lower intensity appeared at first in Bratislava. A turn back to positive numbers was in this case connected with new immigration tendencies, decisions to live closer to the place of work and with the expansion of new housing development in the city (at the end of the decade, the new housing development balanced out-migration also in other cities). The labour market in Bratislava was the biggest and the least saturated in Slovakia. The analysis published by Jurčová et al. (2006) shows that while the communities below 5,000 inhabitants were losing population and the cities with more than 20 thousand inhabitants were gaining most until the year 1993, the situation reversed after this year totally (as documented in Fig. 2). A deeper evaluation of the migration data shows that inhabitants of these cities move especially to communities in their close hinterland. Understandably, the largest belt of such communities is in the Bratislava surroundings. Only in a few cases of the observed cities, is this out-migration linked to worse social and economic situations.

The overall situation is presented in Fig. 3, focusing on total population change. It is clear that the annual total decrease of population is caused by a negative migration balance, although moderated by natural increase. Population development is more different in the case of Bratislava, thanks to the positive population development in migration and natural increase since 2006.

The development shows a population decrease presented in Fig. 4. All large cities lost between 1.9 to 12.9 % of their populations in the period from 1996 – 2010. Prievidza as the smallest city in the sample, faced the most negative population change. However, in this case, important factors besides the population development are industrial restructuring (the city and the surrounding region used to be a traditional centre of mining, energy production and heavy chemistry) and less favourable transport position (outside the main motorway and railway lines). In general, we can conclude that these population losses are quite significant. A similar situation is evident in the whole group of Slovak cities in comparison to rural settlements. While the cities have a positive natural increase, rural settlements have a negative natural increase. In terms of migration, the situation is reversed.

Besides the population dynamics it is important to analyze the age structure in cities (Fig. 5). An increase in mean age is recorded in all eleven cities in the period 1998 – 2010. The greatest increase is recorded in Poprad and namely in Prievidza, in which the mean age increased by about 19%. The ageing index in this city increased more than 2.5 times – from 50 to 133 inhabitants 65 years and older per 100 inhabitants aged 0–14 years. In Bratislava, this index increased by more than three quarters, while Slovakia as a whole exhibited growth by 60 per cent. The mean age is higher in the observed cities comparing to the Slovak average, with the exception of the cities of Poprad and Prešov in Eastern Slovakia. The population in all Slovak cities is ageing substantially faster than the rural population.

We can summarize that from the demographic point of view, we observe urban shrinkage in Slovakia. The number of inhabitants is diminishing in most of the 138 cities. The number of persons living in the cities has decreased by almost 100 thousand. Approximately half of the urban population loss is caused by developments in the eleven largest Slovak cities. However, this group of cities is very heterogeneous in terms of population dynamics. A substantial influence on this decrease is the redistribution of population from cities to rural settlements.

The scale of the population loss in cities cannot be considered as devastating, but it calls for attention. As a certain positive feature, we can consider the fact that most of the emigrants live in the urban functional regions of their respective cities.

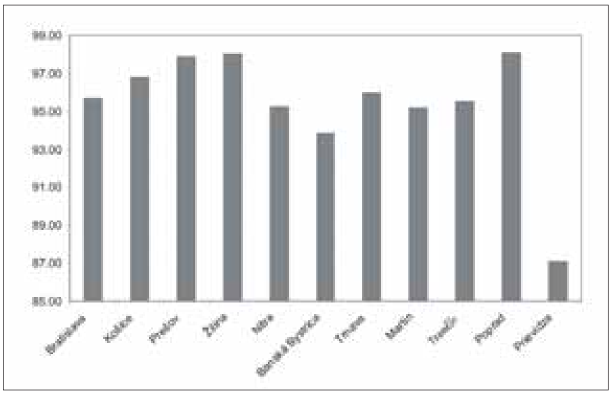

Fig. 4: Index of population growth in the period from 1996 – 2010 (1996 = 100)

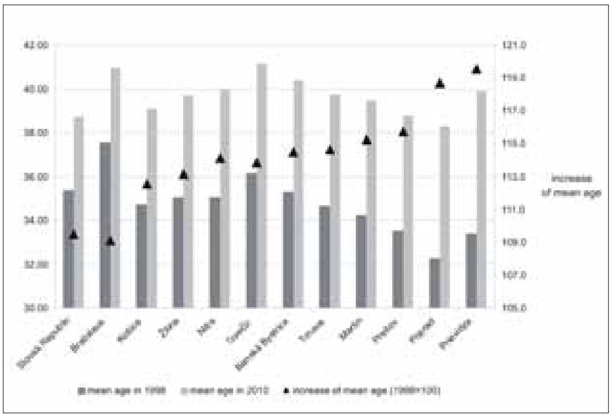

Fig. 5: Mean age of population

Among the most serious issues related to current trends and the scale of shrinking in Slovakia is population ageing. Taking into account predicted doubled numbers of seniors in the Slovak cities within the next two-three decades this really becomes a serious problem. It is an issue that concerns both urban and rural environments. Nevertheless, while the rural population recorded a higher mean age in 1996, the situation turned in 2004 and the urban population became older. This caused a three times faster increase of mean age in urban populations comparing to rural populations during the last 15 years. Although it is more a result of the age structural momentum, i.e. transition of big cohorts to post-productive age and larger decrease of fertility in cities, to a certain extent it is also affected by suburbanization. The mean age in our selected cities is growing much faster comparing to the total Slovak population, with the exception of Bratislava. The most affected city from the viewpoint of shrinkage and ageing is the smallest city in our sample – Prievidza. As already outlined, this city has faced serious economic restructuring, combined with a less favourable transit position and diminishing role as a traditional housing centre for the surrounding region.

4. Reflection of demographic base of shrinking in major urban development documents

Planning at the local level has a long-lasting tradition in Slovakia, but for decades there were mostly only territorial plans adopted (the most important were Master Plans). The role of planning has been strengthened step-by-step in the last two decades. Local self-governments have obtained many new powers and responsibilities, accompanied by pressure upon improving management practices. They are responsible for managing local development, provision of local services, quality of the environment, etc. For these purposes, new kinds of development planning documents and practices have been introduced. Besides the territorial planning-based documents, there are documents prepared in the field of strategic development planning, as well as planning documents addressing particular specific fields of activity. We focus on three selected local development planning documents that provide the main framework for managing city development. We assume that they also should reflect processes of shrinking following their primary demographic identification. The elaboration of these documents is obligatory for each Slovak city, according to legislation, and they have to be adopted by City Councils. While Master Plans are strongly expert-dominated, the other two kinds of local development documents are more participatory and community-based documents. Unfortunately these planning documents in cities do not fulfil satisfactorily the expectation to identify processes of shrinkage as expressed in demographic development. Demographic analyses and projections of some cities' populations are more "wishes" or "imaginations" of their local self-governments than realistic demographic futures. As we document in the following discussion, it is caused predominantly by less elaborated demographic forecasts that suffer from a simplified, schematic approach, a short-term analytical basis, and spatial incompatibility.

Territorial planning has the longest tradition among local planning activities, which leads to the adoption of a Master Plan (in Slovak – Územný Plán – UPN). In its current form it is elaborated according to legislation adopted already in the mid-seventies (Act No. 50/1976), but with many "modernisation" amendments adopted within the last twenty years (see e.g. Slavík and Kožuch, 2003). It represents a crucial local development regulatory document with a strong focus on land use, construction and development limits. Its elaboration is a long-term, procedurally complicated and costly process. Its selected sections are adopted as local by-laws.

The second type of planning at the local level is in line with the growing attention to regional development. Its role is growing since the decentralization of powers and resources for the local level introduced into practice by stages since 2002. This kind of local planning was introduced at the beginning of the previous decade (Act No. 503/2001 on the Support of Regional Development, later amended) and is leading to the elaboration of the Programme of Economic and Social Development (in Slovak – Program hospodárskeho a sociálneho rozvoja – PHSR). It bears typical signs of strategic development planning at the local level (e.g. Buček, 2007). The last type of planning document focuses in more detail on the planning of social services. It was introduced by legislation in 2008 and it is directly related to the transfer of more powers in social services to the local level (Act No. 448/2008). The output is a Community Plan of Social Services (in Slovak – Komunitný plán sociálnych služieb – KPSS). Both of these plans are prepared within a shorter time frame than the Master Plan. They are more implementation-oriented, including concrete measures and financing of selected activities. In order to recognise to what extent these documents identified the demographic base of shrinking, in the following we focus on the "demographic parts" of their analytical sections.

Programmes of Economic and Social Development (PHSR) are prepared for a normal time span from 7 to 15 years. All of the analyzed PHSR were adopted or amended after the year 2005. Currently valid PHSR have worked with time frames up to 2013, 2015 and 2020 (depending on the time of adoption). In each of these programmes we can find two basic sections – analytical and programming, linked together by the vision of future development. The analytical section should contain a demographic development analysis with more details concerning the latest trends. We can conclude that each of the 11 cities programmes contains a demographic analysis, which is in principle at a sufficient quality. It includes an overview of basic indicators of demographic dynamics and structures. However, due to the prospective character of the programmes, a more important part is their population forecast section. From this point of view, we found less satisfactory elaborated outcomes. Within the strategic planning documents of all 11 cities only three had a demographic forecast elaborated at an adequate level, based on the application of the cohort-component method, with a sufficient explanation of introductory assumptions, accompanied by the transparent and logical presentation of results. On the other hand, a positive feature is that the demographic forecast was missing in any form only in one city.

Although most strategic plans are prepared within the time framework up to 2013 – 2015, forecasts are calculated for a longer period, mostly up to 2020–2025. These less elaborated forecasts suffer from simplicity and a schematic approach, not to mention inconsistent assumptions. For example, we can find simple extrapolations of total population size, or attempts to derive a future population number from the official forecast of population number prepared for larger territorial units, mostly districts. An unclear proposal of future age structure on a basis of more or less contradictory assumptions, without a declared calculation method, we consider as the worst case. In some cities, these less elaborated forecasts are too optimistic in forecasting the already existing and future population size development. The population number is substantially higher in forecasts already 4–5 years after their adoption, compared to the known actual population size. The reason for unsatisfactory demographic forecasting in strategic plans is definitely the fact that it is a sophisticated sub-discipline of demography. Authors/participants working on strategic plans usually are not experts primarily in this field. There also are no standards defined in general planning guidelines requiring the application of more reliable forecasting methods. It also is a matter of fact that more qualified planning would be more costly for local budgets financing their elaboration.

Stipulated by legislation, the Community Plan of Social Services requires analyses of social and demographic data with reference to the city territory. Ten of eleven cities in our sample already had adopted KPSS (with the exception of Bratislava). Current legislation does not define precisely the scope of analyses, so it is upon the decision of local self-government bodies and those that directly elaborate this plan. Usually the crucial part of the KPSS is an analysis of social services and needed facilities, as well as their financing. Quite often a survey of citizens' and clients' satisfaction is included. Demographic analyses are in most cases inadequate. We found cases in which the analysis of demographic data works only with one or two year population data (number, mean age, births/deaths, in and out-migration), having only a basic indicative reason. Any longer-term population forecasts are missing in most of them, although the time framework of the plan is about 4–5 years. As a result, only general remarks on ageing and pressures on the traditional family are mentioned, and the expected pressure on local finances is indicated. A more specific calculation of future needs is hardly possible under such state of analysis. Only a few cities have more extensive analyses (longer time series, more indicators), including a demographic "outlook" or a simple population forecast (for example derived from the official forecasts at the district level). Nevertheless, it made it possible to outline a basic trend in the population development. It concerned mostly the rapidly growing share of elderly people and services they will need in the future. In most cases, an explicit formulation of conclusions based on demographic analyses is missing. This section seems to include more KPSSs probably with an ambition to fulfil legal obligations, but it does not serve as a base for planning the provision of efficient future social services.

The analyzed Master Plans (UPN) typically feature good quality demographic analysis. Especially the latest UPNs have a realistic vision of population development that incorporates the stagnation of population size. It results from a more professional approach and longer experience in their elaboration. The principal participants in their elaboration are specialised planning companies which often have their own demographers or invite external specialists for demographic analyses (from universities, research bodies). The good quality of the analysis of demographic processes and structures is, however, usually not combined with a good demographic forecast. In some cases, simple extrapolations and estimation are used with an absence of more variants. As a result, an unrealistic population growth is still expected in most cities. It is already clear (due to the longer time of Master Plans elaboration), that these earlier forecasts are in conflict with the already documented population size of cities.

5. "Shrinkage"– based responses and measures in major urban planning documents

As often mentioned, shrinkage brings new challenges to urban planning. According to the already existing debate on the interaction of shrinking and planning in cities, we can turn attention to a known set of primary issues (Wiechmann, 2008; Hollander et al., 2009). One of the most challenging is the planning of housing and housing stock adaptation (e.g. including demolition) and related housing market tensions (e.g. Bernt, 2009). Longer term shrinking also generates large areas of vacant, derelict, functionally obsolete land, mostly linked to processes of deindustrialisation. It results in a greater attention to the issue of land use in such cities. It is accompanied by manifold environmental aspects and change in the urban landscape. Vacant land and emptying housing estates also can lead to overcapacity in the urban infrastructure (see e.g. Moss, 2008) and problems with the effectiveness of services delivered (water, gas, heating etc.). A similar pressure is experienced by social infrastructure conceived on a wider scale – school networks, cultural centres, health facilities. Shrinking has important consequences for the provision of local social services.

This development places on the agenda a wider issue of infrastructure right-sizing. All these issues acquire a new and complicated dimension when linked to local finances. Any demographic change has its own fiscal implications (see e.g. Wolf and Amirkhanyan, 2010). Decrease of income generated by property taxes, shared taxes, or user fees can substantially undermine standards of local services and the potential of local government. Among emerging questions (Hollander et al., 2009) we can also find how to cope with social equity and urban density issues in a shrinking city. We focus on goals and measures in planning documents from the point of view of their responsiveness to accustomed processes of shrinking in Slovak cities. In our sample of Slovak cities, we searched for an explicit expression of goals reflecting different needs of shrinking cities. We also tried to identify concrete measures that would confirm active adaptation of cities to shrinking in the afore-mentioned fields of land use, housing, infrastructure (social, technical), economic restructuring, fiscal policy and social issues.

One of the most visible linkages to shrinking processes concerns land use in Slovakia. Particular attention is related to deindustrialisation and its consequences. Large areas of former industrial plants are now vacant and not used in cities. While those areas close to the city centre are often already restructured to new functions, large sites of unused and derelict land have remained inside the compact urban environment. Some cities attempt to revitalize them and offer them as brown-field locations. For example, the city of Banská Bystrica intends to provide such land with a specific regime and support, to adapt it quickly into new use. A precise identification of such lands and plans to elaborate specific projects for their future use is declared in many cities. At the same time, new industrial locations (industrial parks) are prepared as 'green field' or land for such use is reserved in UPN. An interest is usually expressed to attract new developers that will generate new jobs. In many cases, a hope in some new investments inflow is ground for calculated future growth, despite the awareness of existing development difficulties. In more cases, we can find intention for more efficient land use within an already built-up area, following the concept of a compact city. Objectives are often formulated of new developments within an already existing area of the city, using available vacant land, with preference given to compact forms, e.g. in housing construction (e.g. Nitra).

Housing is not considered as a challenging issue from the viewpoint of Slovak cities. After the large-scale housing privatisation, most housing is private and the housing issue is considered to be the direct responsibility of citizens. The central state and the local self-government are responsible for a general framework, including various forms of housing development support in general (mortgages, land availability). However, due to extensive housing stock in mass concrete socialist housing estates on their territory, most cities point out a need for their regeneration, modernization or efficiency improvement. They are interested in the humanization of the housing estates living environment to prevent losses and degradation of this housing stock. Humanization (a term close to the meaning of more widely-used regeneration, mostly used in the Central Eastern European context, e.g. in Slovakia, Czech Republic and Poland) emphasizes a need to respect the human dimension and quality of the living environment, not developed during the socialist period (e.g. Gajdoš, 2002). As a result, great efforts have been addressed, for example, in public spaces improvement (pedestrian ways, street lighting, playgrounds, cycling routes, more green spaces) in old housing estates.

All cities must also consider extensive new housing construction, which is also demanded by citizens. These needs are partly explained by the expected pressure for improvement of housing standards and changes in the composition of households (with the increasing number of small households). The risk of this too optimistic perception of development is mitigated by minor direct involvement of local self-governments in housing provision and real estate market supply-demand development. Most cities expressed a need of further activity in the field of social rented housing. An inevitable direct involvement of the public sector will focus mostly on housing for vulnerable groups of citizens. Some cities announced the elaboration of their own Housing Strategy for the future (in rare cases already adopted). Cities can use for their activities in social housing support provided by the central state Housing Support State Fund. It is clear that the development in housing is less dramatic than in certain East German cities. The shortage of housing resources in cities played an important role, namely in the 1990s and in the first half of the next decade, as economic recession limited new housing construction and the absence of housing support tools. Nevertheless, based on the exaggerated population growth forecast, some extensive new housing construction locations may be reconsidered.

The most typical powers for which local self-governments are responsible is pre-school and school education network management. Also in the field of school facilities, the construction of new schools is envisaged, these being planned in newly developing areas. No details are specified about what will happen to the already existing schools. In the city of Prešov, a need has been already suggested to close some school facilities, e.g. in the city centre, and to change the function of these buildings in response to the changing composition of households. The need to close some schools is clearly possible. One of the typical cases of functional conversion is a transfer of some primary and secondary schools to expanding universities, or their transformation into old people's homes.

For technical infrastructure a 'growth-based' approach is still in evidence. Plans are focused mostly on infrastructure needs in areas of new development, replacement of older infrastructure and completion of missing environmental infrastructure (sewage system, water treatment). No attention is paid to overcapacity, although it already exists. Growth-based thinking expresses its perception as reserves (for further development) and good future potential. Nevertheless, some cities have declared the effort for efficient infrastructure management, e.g. in water and sewage system. There are Master Plans that formulate future needs according to the forecasted higher number of population. For example, the need of water infrastructure capacity for the city of Trenčín is calculated for an unrealistic 75,000 inhabitants in 2015 (a contradiction to the later adopted PHSR, which indicates more realistic 59 thousand inhabitants only).

Programmes of Economic and Social Development usually contain analyses of local self-government finance (such analyses are not in the other two plans), in some cases combined with analyses into availability of other resources for development. The important source of local finance is personal income tax as shared tax (about 70 per cent of its total yield is distributed to local self-governments in Slovakia). It is distributed namely on the basis of the number of permanently registered local residents (official number being provided every year by the Statistical Office of the Slovak Republic). Changes in population numbers are immediately reflected in the size of funds transferred from this tax to local budgets. Similar negative financial effects have the changed population numbers in the individual groups of inhabitants, for example, in the number of pupils in local schools. The transfer of resources from the state budget for education is calculated predominantly on a per pupil base, so the decreasing number of pupils means less resources for the local education network. This may cause a financial pressure in the network of existing school facilities. Each decrease in the population number means a financial loss for the local self-government and a threat to the public services it provides. A smaller number of citizens means reduced resources provided by fewer citizens as fees for the provision of local services (e.g. waste collection and disposal). It influences the effectiveness of service provision. On the other hand, the PHSR as well as the KPSS should contain measures including their financing scheme. From this point of view some cities indicated a lack of resources to cope with certain urban shrinkage-based issues, such as the regeneration of old industrial land or investments into social services, e.g. for old people. Despite certain logical links, explicit references to shrinkage are missing in the local finance sections of PHSR.

Even a well-elaborated demographic forecast included into the analytical sections of development plans is self-oriented if it does not link with the implementation-oriented part of the strategy and if it is not transformed into the hierarchy of goals, policies and tools. This is true even though various features in population development (ageing, migration loss) are mentioned as weaknesses or threats (e.g. Prievidza) within their SWOT analyses. This aspect represents unfortunately a weak point of the analyzed strategic plans. Cities have not explicitly defined any strategy reflecting population development trends. Besides direct interventions into the population development (for example steps in attracting new, young inhabitants, efforts to stop out-migration), the agenda of adaptation measures is very important. Proposals that could be helpful from this point of view are mostly missing. It would be useful to have forecasts for the number of elderly people to plan measures in social care affairs. The forecasted number of children is very practical for planning future school network policy. Strategic plans (PHSR) prefer orientation on more extensively conceived human and social capital, workforce resources. General statements are often presented that are not directly linked to actual or predicted demographic developments. Thus, the problem has to do with the quality of analyses and forecasts, as well as with the understanding of possible direct and logical links to programming/implementation sections of development programmes. Nevertheless, we can find some positive exemptions that link a good demographic analysis and forecast with adopted measures.

Due to its orientation on social services we concentrated on this set of issues as they were addressed primarily within the Community Plans of Social Services. We recognise both ends of the age structure as relevant to the processes of shrinking. This is why we searched in KPSS for responses focusing on development concerning these two target groups – the elderly population and activities towards families with children (or families in crisis, as pointed out in some KPSS). Within the KPSSs, much more attention has been paid to the elderly population as an immediate challenge for the local self-government responsible for their care in much larger numbers than before. Cities often claimed insufficient capacities and the lack of diversity in providing services for the elderly population. Many of them mentioned unfavourable demographic development as a threat to local social services. All cities reflected an immediate need to increase capacities. To reduce waiting lists to various facilities serving elderly citizens in their cities is cited as an immediate need. Mid-term perspective appeared only in a few cities. They proposed an increase of capacities in certain facilities by about 10–20 per cent within two to three years (e.g. Poprad). Despite the unclear demographic analyses, they also attempted to declare needs concerning their facilities (especially in old people's homes) at a perspective of 4–5 years, mostly as estimates. We can find conversion plans – from facilities serving children to facilities serving elderly citizens (e.g. Martin). Needs were mentioned to invest into the construction of new facilities for old people (e.g. Trenčín, Martin, Košice). Most of the plans avoided outlining of longer-term needs. Nevertheless, the city of Banská Bystrica declared, for example, the need to increase the capacity for elderly care in their households during 2008–2015 by 50 per cent. As a part of the future solution to meet the growing requirements of care for old people, Košice and Prešov plan to develop their own "City of the Third Age". In rare cases, cities defined also the housing needs according to more precisely identified target groups, including elderly citizens.

We were also interested if there were any signs of the pro-active family policy that could potentially improve development by means of children and family-oriented measures. However, they were mostly oriented to the prevention of family crises, on helping families with handicapped children, etc. Shrinking cities usually face an age imbalance typically by insufficient capacities for old people, and they face less obstacles with the declining number of children (not mentioning overcapacity in some facilities).

6. Conclusions

The basic demographic analysis has confirmed shrinking in Slovak cities. However, in their planning documents, this development is less precisely and rarely perceived. Low attention to shrinking in Slovakia has more reasons (besides missing a suitable direct translation of the term "shrinkage" into the Slovak language). Its scale is smaller and it has a less complex character (for example, compared to Eastern Germany). Larger cities do not face deep troubles. Extreme cases of shrinking that would attract the attention of experts, media, politicians and public are missing. The debate on shrinking has also been weakened by strongly dominant transitional and transformation research theorizing during the last two decades. This widely applied framework is weakening in Slovak social sciences only in recent years. It slowly opens space for new concepts in urban development. Shrinking has a potential to be one of the influential emerging approaches linked to the post-transformation period.

There is a contradiction between the general tendency of population stagnation (and population decrease forecasted for the next years) at the national level (see Bleha and Vaňo, 2007) and the locally-expected growth in individual cities. Surprisingly, in their development plans, cities take into account neither the known population development in Slovakia in general (debated extensively, for example, also by the media) nor their own known basic local population trends (the latest population development data are easily available). We can conclude that the missing awareness of shrinkage in Slovakia results from the less precise perception of population development at the local level and its link to nationwide population development. The absence of well-elaborated demographic analyses and especially demographic forecasts influences the less developed public responses to urban shrinkage. It is also caused by the absence of longer-term and deep analyses of urban system development in Slovakia within the last twenty years. Although the urban problems are paid considerable attention (well documented, for example, in Matlovič et al., 2009), any concentration on the various partial processes leave to one side deeper urban system development analysis.

Despite the absence of an explicit shrinkage debate, we identified several measures addressing processes linked to shrinking in Slovakia. Cities are particularly aware of industrial restructuring and land use changes, socialist housing estates adaptations, new needs in social service provision, school network revision, not to mention financial problems. Responding to shrinking processes has been unintentional, without any reference to this concept. It also means partial solutions, adopted only in a few cities. The existence of cities that are conscious of these issues can support rising and more complex awareness of these issues in a larger number of cities in the future. In practice, the most typical shrinking-induced decisions are adopted within the framework of so-called "optimization of schools network". For example, in 2004 – 2005 four schools were cancelled in the city of Prešov and in 2010 there was expected overcapacity of about 1,500 places in these schools. It means again a challenge to close two or three of the currently existing schools. The city of Košice cancelled four schools in 2008, Banská Bystrica two schools in 2012. After the transfer of competences, the cities carefully considered the correct size of their facilities. The latest pressure for adaptation initiated a financial and economic crisis, accompanied with lower resources available in local budgets.

The adopted decisions addressing 'shrinkage' are mostly outside of the main planning documents conclusions. They are the results of current developments, especially the operative evaluations/audits and financial pressures. It means that plans do not serve all real needs and their sense remains unfulfilled to a certain extent. They are "development" plans, which do not address extensively the situation of no-development or shrinking. One possible explanation points to the political nature of the local planning and programming documents. The Programmes of Social and Economic Development as well as the Master Plans are sensitive documents adopted by City Councils. There is an understandable effort to manifest positive expectations and to underemphasize partial less positive local development processes. The local elites seem less anxious to present to the public negative variants of the future or to include less popular future measures. There is a need to strengthen a more expert and professional base of plans against the political pressures. The plans should be more realistic and should provide a more balanced perception of the future.

In general, the Slovak planning system offers an acceptable framework to address the processes of shrinkage. Sufficient reflection in practice has not been attained because of a varied quality of the elaboration of local plans (at least in their specific sections). We can observe an introductory period of neglecting the shrinkage, which is accompanied by its less systematic reflection in local planning documents. Such a delay is in line with the similar development in some other countries (e.g. in Germany, Wiechmann, 2008). The quality of analytical works has substantially influenced the formulation of adequate measures. We can only hardly expect more attention to shrinking if it is not sufficiently identified. One might ask whether even well-identified shrinking processes would lead to reasonable planning-based responses. Perhaps the quality of local planning could improve better developed linkages among these plans (e.g. good population forecasts could improve quality of all plans). Shrinkage is considered as a serious challenge for urban planning all around the world (e.g. Rieniets, 2009; Pallagst, 2010; Wiechmann and Pallagst, 2012) and this is also true for planning practices in Slovakia.

The situation of planning social services that was introduced only a few years ago is quite specific. The good intentions of the legislation have not yet been sufficiently met. We assumed that this plan should reflect a strong influence of demographic processes typical for shrinking, as well as measures to cope successfully with them. Our insight into the already available KPSS indicated less attention to population development. Until now, they are primarily oriented to analyses of the existing situation and identification of immediate shortcomings in the provision of local social services. With rare exceptions, they are not elaborated extensively as documents formulating measures in the mid- and long-term perspective. It is evident that they are the first experiences with planning in the field of social services for local self-governments. They serve particularly for "understanding and mapping" the situation, identification of the scope of short-term tasks and mobilisation of local capacities in this field. They were elaborated during the first years after national legislation had been adopted, without any previous practice. The composition of the quite large teams that worked in this area needs some adjustment. Staff was composed from various institutions dealing with social services provision, but without specialist expertise in demography, urban development and planning. We can hope that the "next" generation of these plans will address issues of shrinking better.

Acknowledgement

This contribution had been supported by VEGA Grant No. 1/0709/11 „Adaptability of spatial systems during the post-transformation period".

References:

Act No. 50/1976 Zb. on Territorial Planning and Building Order (as amended) – in Slovak

Act No. 503/2001 Coll. on Support of Regional Development (as amended by Act No. 539/2008 Coll.) – in Slovak.

Act No. 448/2008 Coll. on Social Services – in Slovak.

BERNT, M. (2009): Partnerships for Demolition: The Governance of Urban Renewal in East Germany's Shrinking Cities. International Journal of Urban and Regional Research, Vol. 33, No. 3, p. 754–769.

BLEHA, B. (2011): Lokálny demografický vývoj na Slovensku: percepcia, spoločenské implikácie a interdisciplinárne výzvy. Sociológia, Vol. 43, No. 4, p. 362–390.

BLEHA, B., BUČEK, J. (2010): Theoretical issues of local population and social policy in 'shrinking' cities – some findings from Bratislava. In: Kovács, Z. [ed]: Challenges of Ageing in Villages and Cities: The Central European Experience. Szeged, Department of Economic and Social Geography, University of Szeged, p. 110–131.

BLEHA, B., VAŇO, B. (2008): Demografická budúcnosť okresov Slovenska: približovanie či divergencia. Bratislava, Infostat, 82 pp.

BUČEK, J. (2005): Slovakia. In: Van Kempen, R., Vermeulen, M. and Baan, A. [eds]: Urban Issues and Urban Policies in the New EU Countries. Aldershot, Ashgate, p. 79–108.

BUČEK, J. (2007): Current strategic economic development planning in cities and its application in Slovakia. Quaestiones Geographicae, 26B, p. 15–25.

BUČEK, J., BLEHA, B. (2012): Planning responses of shrinkage in the Slovak Republic's largest cities. In: Martinez-Fernandez, C., Kubo, N., Noya, A., Weyman, T. [eds.]: Demographic Change and Local Development: Shrinkage, Regeneration and Social Dynamics, OECD Working Papers, Paris, OECD/LEED, p.141–147.

Community Plans of Social Service (2008–2010) as adopted in cities: Banská Bystrica, Košice, Martin, Nitra, Poprad, Prešov, Prievidza, Trenčín, Trnava, Žilina.

FINKA, M., PETRÍKOVÁ D. (2006): Shrinking cities in Central and Eastern Europe. Paper presented at International Symposium – Coping with City Shrinkage and Demographic Change – Lessons from around the Globe, Dresden 30–31.03.2006, Germany.

GAJDOŠ, P. (2002): Človek, spoločnosť, prostredie – vybrané problémy priestorovej sociológie. Bratislava, Sociologický Ústav SAV, 374 pp.

GROSSMANN, K., HAASE, A., RINK, D., STEINFÜHRER, A. (2008): Urban shrinkage in East Central Europe? Benefits and limits of a cross-national transfer of research approaches. In: Nowak, M. and Nowosielski, M., [eds.]: Declining cities/ Developing cities: Polish and German perspectives. Poznan, Instytut Zachodni, p. 77–99.

HOLLANDER, J. B., PALLAGST, K. M., SCHWARZ, T., POPPER, F. J. (2009): Planning shrinking cities. Progress in Planning, Vol. 72, No. 4, p. 223–232.

JURČOVÁ, D. et al. (2006): Populačný vývoj v okresoch Slovenskej republiky 2005. Bratislava, Infostat, 118 pp.

KOHLER, H. P., BILLARI, F. C., ORTEGA, J. A. (2002): The emergence of lowest-low fertility in Europe during the 1990s. Population and Development Review, Vol. 28, No. 4, p. 641–680.

MARTINEZ-FERNANDEZ, C. AUDIRAC, I., FOL S., CUNNINGHAM-SABOT, E. (2012): Shrinking Cities: Urban Challenges of Globalization. International Journal of Urban and Regional Research, Vol. 36, No. 2, p. 213–25.

MARTINEZ-FERNANDEZ, C., WEYMAN, T. (2012): The crossroads of demographic change and local development. In: Martinez-Fernandez, C., Kubo, N., Noya, A., Weyman, T. [eds.]: Demographic Change and Local Development: Shrinkage, Regeneration and Social Dynamics. OECD Working Papers, Paris, OECD/LEED, p. 15–37.

MASTER PLANS (2002–2011) as adopted in cities: Bratislava, Nitra, Prešov, Prievidza, Trenčín, Banská Bystrica (proposal).

MATLOVIČ, R., IRA, V., KOREC, P., ONDOŠ, S. (2009): Urban structures and their transformation (the contribution of Slovak geography). Geographia Slovaca, Vol. 26, p.71–100.

MLÁDEK, J. et al. (2006): Population Atlas of Slovakia. Bratislava, Comenius University, 168 pp.

MOSS, T. (2008): „Cold spots“ of urban infrastructure: „Shrinking“ process in Eastern Germany and the modern infrastructure ideal. International Journal of Urban and Regional Research, Vol. 32, No. 2, p. 436–451.

PALLAGST, K. (2010): The planning research agenda: shrinking cities – a challenge for planning cultures. The Town Planning Review, Vol. 81, No. 5, I–VI.

PROGRAMMES OF ECONOMIC AND SOCIAL DEVELOPMENT (2005–2011) as adopted in cities: Banská Bystrica, Bratislava, Košice, Martin, Nitra, Poprad, Prešov, Prievidza, Trenčín, Trnava, Žilina.

RIENIETS, T. (2009): Shrinking cities: causes and effects of urban population losses in the twentieth century. Nature and Culture, Vol. 4, No. 3, p. 231–254.

RUMPEL, P., SLACH, O. (2012). Je Ostrava „smršťujícím se městem"? Sociologický časopis, Vol. 48, No. 5, p. 859–878.

SLAVÍK, V. (1998). Územné zmeny obcí v Slovenskej republike v etape transformácie (1990 – 1998). Acta Facultatis Rerum Naturalium Universitatis Comenianae, No. 41, p. 137–154.

SLAVÍK, V., KOŽUCH, M. (2003): Land use plans – a document of the city in the transformation period. Acta Universitatis Carolinae - Geographica, Vol. 38, No. 1, p. 387–402.

SLAVÍK, V., KOŽUCH, M., BAČÍK, M. (2005): Big cities development in Slovakia: Development, planning, contemporary transformation. European Spatial Research and Policy, Vol. 12, No. 2, p. 47–69.

STATISTICAL OFFICE OF THE SLOVAK REPUBLIC (1996 – 2010): Population movement statistics. Available at www.statistics.sk.

STEINFÜHRER, A., HAASE, A. (2007): Demographic Change as a Future Challenge for Cities in East Central Europe. Geografiska Annaller, Vol. 89 B, No. 2, p. 183–195.

STEINFÜHRER, A., BIERZYNSKI, A., GROSSMANN, K., HAASE, A., KABISCH, S., KLUSÁČEK, P. (2010): Population Decline in Polish and Czech Cities during Post-socialism? Looking Behind the Official Statistics. Urban Studies, Vol. 47, No. 11, p. 2325–2346.

ŠPROCHA, B. (2008): Reprodukčné správanie mestského a vidieckeho obyvateľstva na Slovensku. Bratislava, Infostat, 73 pp.

TUROK, I., MYKHNENKO, V. (2007): The trajectories of European cities, 1960 – 2005. Cities, Vol. 24, No. 3, p. 165–182.

VEREŠÍK, J. (1974): Mestá. In: Plesník, P. et al.: Slovensko: Ľud (I. časť). Bratislava, Obzor, p. 522–578.

WIECHMANN, T. (2008): Errors Expected – Aligning Urban Strategy with Demographic Uncertainty in Shrinking Cities. International Planning Studies, Vol. 13, No. 4, p. 431–446.

WIECHMANN, T., PALLAGST, K. (2012): Urban shrinkage in Germany and the USA: A Comparison of Transformation Patterns and Local Strategies. International Journal of Urban and Regional Research, Vol. 36, No. 2, p. 261–80.

WOLF, D. A., AMIRKHANYAN, A. A. (2010): Demographic change and its public sector consequences. Public Administration Review, Vol. 70, Special Issue, p. 512–523.

Authors´ addresses:

Assoc. Prof. Ján BUČEK, e-mail: *bucek@fns.uniba.sk*
Assoc. Prof. Branislav BLEHA, e-mail: *bleha@fns.uniba.sk*
Department of Human Geography and Demography, Faculty of Natural Sciences
Comenius University, 84 215 Bratislava, Slovakia

Initial submission 30 June 2012, **final acceptance** 10 March, 2013

Please cite this article as:

BUČEK, J., BLEHA, B. (2013): Urban Shrinkage as a Challenge to Local Development Planning in Slovakia. Moravian Geographical Reports, Vol. 21, No. 1, p. 2–15.

INTERNET AVAILABILITY AS AN INDICATOR OF PERIPHERALITY IN SLOVAKIA

Konštantín ROSINA, Pavol HURBÁNEK

Abstract

A method employing different data sources in the construction of indices that quantify internet availability is developed in this article, and it is applied at municipality and regional levels in Slovakia. The indices are subsequently correlated with other indicators commonly used to delineate peripheral areas, in order to evaluate factors which might influence (or be influenced by) the spatial distribution of internet availability. The results show that the information-communication technology side of spatial polarization generates similar patterns as the other more traditional aspects

Shrnutí

Dostupnost internetu jako indikátor perifernosti na Slovensku

Příspěvek popisuje metodu, která využívá různé zdroje údajů pro tvorbu indexů kvantifikujících dostupnost internetu a aplikuje tuto metodu na úrovni obcí a regionů na Slovensku. Tyto indexy jsou následně podrobené korelační analýze ve vztahu k jiným indexům obvykle používaných pro vymezení periferních území za účelem nalezení faktorů, které by potenciálně mohly ovlivnit (nebo být ovlivňované) prostorovým rozložením dostupnosti internetu. Výsledky ukazují, že informačně-komunikační a technologický aspekt prostorové polarizace vytváří podobnou prostorovou strukturu jako jiné tradičně zkoumané aspekty.

Keywords: *periphery, internet, broadband, information-communication technology, Slovakia*

1. Introduction

1.1 Approaches to delimitation of peripheries

Landscape is an extremely complex, heterogeneous and dynamic system. The socio-economic sphere, in particular, with its typical nodal organization of space, is the source of heterogeneity at various spatial scales. This heterogeneity, often described as spatial polarization, is a fascinating and frequent object of research in many scientific disciplines.

Peripheries and cores are evident at multiple scales. Even one place can be a core at one scale and a periphery at another scale. Also, the same place can be seen as a periphery from one aspect (e.g. economic) and as a core from another aspect (e.g. ecological). The term peripheral is ambiguous as well. Some authors suggest that the terms peripheral and marginal are identical; others suggest that marginality is worse than peripherality (Andreoli, 2004). It is impossible to define a periphery universally; it can be done using only a certain approach or multiple approaches to the topic, but definitely not all of them. Leimgruber (1994) suggests four basic approaches to the delimitation of peripheries: (1) geometrical, which considers peripheries as areas on the geometrical periphery of a territory; (2) ecological, which can be understood either as a natural potential for human existence or as environmental quality; (3) economic, defining marginality on the bases of production potential, accessibility, infrastructure and attractiveness in terms of the spatial economy; and (4) social, focused on minorities and marginal social groups.

Some approaches employ various factors to delimitate specific types of peripheries. Havlíček et al. (2005) emphasize, that these factors and their intensity are changeable over time. Marada (2001) notes that physical-geographical factors (elevation, localization of natural resources) were primary factors influencing the distribution of core and peripheral regions; however, gradually social and economic factors gained on importance. While some authors focus on the influence of the former, most often georelief (e.g. Olah et al., 2006; Štych, 2011), others concentrate on the examination of the latter. Usually, only a few selected socio-economic factors are examined in a single study, most frequently transport accessibility alone (e.g. Horňák, 2006) by itself or in combination with settlement exposedness (e.g. Kabrda, 2004). A more synthesizing approach to the delineation of peripheral areas is less common. An example is the review by Halás (2008), taking into account a wide range of indicators divided into four groups: human resources, economic potential, personal amenities, and access to centres.

In fact, a whole set of peripherality attributes can be found, but they usually do not occur in their native forms, rather as results of complex inherent relations and influences. Usually, the following aspects can be recognized: a) physical-geographical (complexity of terrain, climate, elevation, etc.); b) geometric (distance from centre, location, etc.); c) economic (GDP per capita, unemployment, income, etc.); d) socio-demographic (education, age, gender, etc.); e) ecological (contamination, emissions, damage to forests, loss of biodiversity, etc.); f) cultural (ethnicity, local customs, etc.); g) religious; and h) political (degree of autonomy, administrative division, etc.) (Havlíček et al., 2005).

1.2 Information-communication technology (ICT) and peripheries

Geographic or human geographic disciplines often attempt to take a complex point of view on the topic and look for synthesizing indicators to delimitate the polarization of space. The development of a mobile telephone operator's coverage can be considered as an example of such an indicator. The operator takes into consideration a range of objective, but also subjective factors when deciding when and where to expand its network coverage (Havlíček and Chromý, 2001).

Linder et al. (2005) explicitly take the ICT perspective in the delimitation of peripheries in EU-15 countries. They use five groups of indicators in their analyses – ICT, business networks, governance, social capital and tourism. The ICT group contains 22 indicators, e.g. cable modem/DSL connections, internet access prices, households with internet access, on-ine buyers, etc.

By analogy, we assume that the spread of internet infrastructure is spatially polarized, i.e. it is an innovation with spatial diffusion occurring over time. There is a lot of evidence about this in the research literature, for example, many American authors mention the rural-urban digital divide phenomenon, although we understand the development of ICT in the United States as being at least five years ahead of that in Slovakia).

Grubesic (2003) suggests that issues regarding the provision of residential broadband services are of great importance and that rural areas are currently lagging far behind urban areas in broadband availability in the United States. An example can be found in the state of Ohio where 46% of all counties have broadband digital subscriber line (DSL) service available in one or more locations. Of those counties classified as urban, 100% have DSL service. For those counties considered rural, however, only 34% are equipped with DSL infrastructure. In addition, Grubesic examines characteristics of market demand that are driving cable and DSL infrastructure investment through the use of statistical models and a geographic information system. Results suggest that income, education, age, location, and competition from alternative broadband platforms influence DSL infrastructure investment.

The ICT revolution was associated with great expectations of positive consequences for the development of peripheries. The internet was supposed to become a powerful tool of decentralization, to compensate for the disadvantage of remote location, to enhance the quality of life, to enable the sustainable development of peripheries in a globalizing world, to slow down rural depopulation, etc. Even the term "death of distance" was coined (Cairncross, 1997) to describe the ability of the internet to substitute for transportation in some fields, e.g. e-commerce, e-learning, e-government, e-health and e-work. These expectations turned out to be exaggerated. Technological boom is a demand-driven process and the demand for new technologies is typically associated with densely populated urban areas usually with higher GDP per capita and younger and more educated populations than with peripheral areas having mostly the opposite characteristics.

While the peripheral rural areas, by their nature, have always suffered from serious infrastructural disadvantages, in terms of telecommunications infrastructure they have benefitted considerably in the past through cross-subsidization, resulting from the application of a universal service obligation by national telecommunications providers. With the liberalization of telecommunication markets in Europe and elsewhere in recent years, this is no longer the case, and with the shift towards more expensive broadband infrastructure being associated with a reliance on market forces, there is a real danger that the peripheral rural areas will become increasingly disconnected from the opportunities presented by the new digital economy (Grimes, 2003). This explains the difference between the narrowband access on the one hand, based on regular telephone lines that were provided as a "universal service" and therefore wide-spread in all areas, and the broadband access on the other hand, developing after liberalization of markets and therefore spreading only in areas where the laws of demand and supply applied. Although this does not mean that peripheries are completely disconnected, they are still lagging behind, with technologies at least one generation older than in central regions or with higher prices for comparable services.

Some countries, however, have achieved remarkable success in spreading broadband into rural regions, especially the Scandinavian and Benelux countries. The reasons for the high level of broadband penetration in countries like Finland, even in their relatively remote rural regions, include the proactive involvement of their governments and the significance of the information technology in their economies (Henten and Kristensen, 2000). There are still quite large differences among the EU member states, though, especially between those mentioned above and those that joined the EU in this millennium (Fig. 1). Slovakia and Poland are the most lagging countries, especially in rural DSL coverage.

Involvement of the state seems to be the way to help the peripheral regions in the broadband take-up. EU institutions are aware of this and have approved action plans and initiatives focused on the problem. Apart from the Lisbon Strategy, which is a key document regarding the conception of an information society, a series of action plans (eEurope, eEurope 2002, eEurope+, eEurope 2005, i2010) has been approved.

The European Commission plan for the economic recovery of the EU includes a proposal to channel part of the unspent EU budget on broadband investment and announces the development of the EU broadband strategy in cooperation with member states and other relevant players. On 19–20 March 2009, the European Council approved the proposal for investment in broadband and a common agricultural policy health check (€1.02 billion). A conference on the topic of the EU spending on broadband within the context of the recovery plan and the sharing of broadband good practices between rural and regional development authorities was held in Turin on 2–3 April 2009 (Regione Piemonte, 2009).

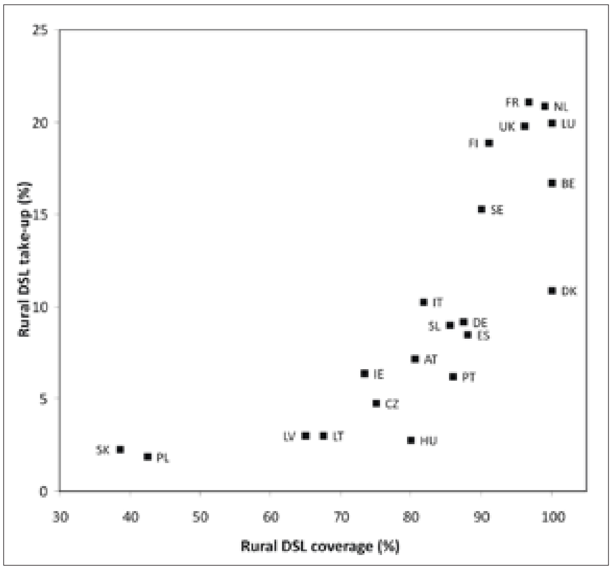

Fig. 1: DSL coverage in rural areas and share of population having a DSL internet subscription in rural areas in the EU countries, as of December 2007 (%)
Note: Data for Bulgaria, Cyprus, Estonia, Greece, Malta and Romania are not available
Source: Directorate-General for Agriculture and Rural Development, 2008

The United Kingdom is one of the EU countries with the best broadband availability in rural areas, more specifically with more than 90% DSL coverage as of December 2007 (Fig. 1). In April 2009, the UK government signalled its commitment to ensuring everyone in the country has access to broadband speeds of two megabits per second by 2012 (BBC, 2009). In other words, the 2 Mbps access should become a universal service.

2. Methodology

2.1 Objectives

The objectives of this paper are as follows: (1) to describe the method of collection, evaluation and quantification of data about availability of the internet, with a focus on residential broadband services; (2) to examine the spatial distribution of the phenomenon in Slovakia and to visualize it cartographically; and (3) to measure its correlation to other human- and physical-geographical characteristics, which already have been used as criteria for the delimitation of peripheries.

2.2 Availability versus penetration

The "internetization" of society can be regarded from several points of view: as growth in the number of internet users, the number of subscribed households, the number of people covered by internet services, internet usage in public administration, the importance of on-line services, etc. Usually, two indicators (based on two of the above-mentioned aspects) are used to evaluate and compare the level of internetization:

1. The share of households or population that subscribe(s) to an internet service provider (ISP) and also use(s) its service is often referred to as the penetration (or simply take-up) of the internet. This indicator designates real customers of internet services and therefore it is more immediate or direct in nature (as opposed to the next one that could be regarded as less immediate or indirect) and thus – in a sense – is also more objective. However, its disadvantage is the availability of statistical data. In Slovakia, for example, these data are available only for the NUTS 3 regions and thus are not suitable for the assessment of spatial distributions assessment at a finer scale of resolution.
2. The availability of internet can be defined as a share of population/households being covered by

ISP services, i.e. coverage. It is also adequate to consider differences in the quality or number of available services.

Values of both mentioned indicators (considering only DSL services) for EU countries are displayed in Fig. 1. As the availability of a service is a primary premise to a customer's decision to subscribe to it, it is not a surprise that these two indicators are positively related. The other factors that influence the decision include for example the ownership of a computer or another connectable device, computer literacy, knowledge of the advantages of the internet, ability and willingness to bear the costs of subscription, etc. The survey of 4,500 households conducted in Slovakia in the second quarter of 2007 identified the following reasons for not subscribing to an internet service connection: "We do not want or do not need the internet" (48%); "We have access to the internet elsewhere" (31%); "The installation of the internet is too expensive" (27%); "The use of the internet is too expensive" (31%); and "I can not work with the internet" (19%) (Statistical Office of the Slovak Republic, 2007).

2.3 Study area

The entire territory of Slovakia was examined using two systems of spatial units representing two different hierarchical levels or spatial resolution scales: Firstly, 2,928 LAU 2 units, which include 2,889 municipalities, 17 parts of the Bratislava City, and 22 parts of the Košice City, hereinafter referred to as municipalities, were determined. A second set of 49 quasi-functional urban regions (QFURs) was created by the aggregation of 79 existing districts (LAU 1 units), which is a frequently-used approximation to real functional urban regions called "System FMR 91-A" developed by Bezák (2000) that gives the possibility of using statistical data available for districts.

2.4 Data collection

The variety and nature of internet availability means is a limiting factor with respect to data collection. There is a great number of providers of internet access including the local and regional ones (several hundred ISPs), and therefore there is no unified data source. It is almost impossible to evaluate all of them, as many of the local ISPs do not provide information about the spatial availability of their networks. Another issue concerns the variability of the attributes of connection technologies – bandwidth, price, mobility, data transfer limits, etc. It is obvious that the problem has to be handled with some degree of generalization.

Using a method developed by Rosina (2008), eight of the most significant broadband technologies of connection (as they were available in the first half of 2008) were taken into account. With the internet coverage considered as an innovation spatially diffusing in time, the choice of and the focus on broadband technologies and their availability level at the given moment in time was crucial with respect to its application as a synthesizing indicator of peripherality. Four of the eight technologies were fixed wired (ADSL, ADSL2+, CaTV, FTTH), two were fixed wireless (WiFi, WiMax) and two were mobile wireless (HSPA, FLASH-OFDM). Basically, two types of data sources regarding availability were used – [a] on-line maps of coverage (HSPA, FLASH-OFDM, WiMax) or [b] a simple listing of municipalities, where services are available (the five other technologies). The rate of availability of each of the technologies was identified in each of the municipalities. A value of the variable ra_t (rate of availability of technology t) was determined in two different ways. The variables rab_t, the rates of availability of technologies with data source [b], were set to binary values, 0 if the technology is not and 1 if it is available. The variables raa_t, the rates of availability of technologies with data source [a], were set to values from the interval $\langle 0, 1 \rangle$ bounded and closed from both sides, representing the share of built-up areas of a municipality covered by the technology and – if making the assumption of anevenly distributed population in the built-up area – also the share of population of a municipality covered by the technology.

Although this is an unrealistic assumption, it is much more realistic than what is often being done when trying to derive covered population size by overlaying service coverage maps with traditional population density choropleth maps or population count proportional symbol thematic maps (see e.g. Kusendová and Bačík, 2009 for more details on advantages and disadvantages of different types of thematic maps). Before overlaying the coverage areas of the individual technologies with the layer of built-up areas (ÚGKK SR, 2005) based on 1:50000 map, this layer had to be modified (as illustrated in Fig. 2) in order to reduce some spatially exaggerated objects on the original map, e.g. roads (see also Hurbánek, 2008).

3. Results

3.1 Construction of synthesizing indicators

Two pairs of slightly different synthesizing indicators of the internet availability (one simple and one weighted for both municipalities as well as QFURs) were constructed by combining eight ra_t values derived in the previous step. The first pair of indicators is based on a simple arithmetic mean of the ra_t values. The second pair of indicators is based on a weighted mean of the ra_t values, where the weights are calculated as a bandwidth-to-price ratio of each technology (Fig. 3).

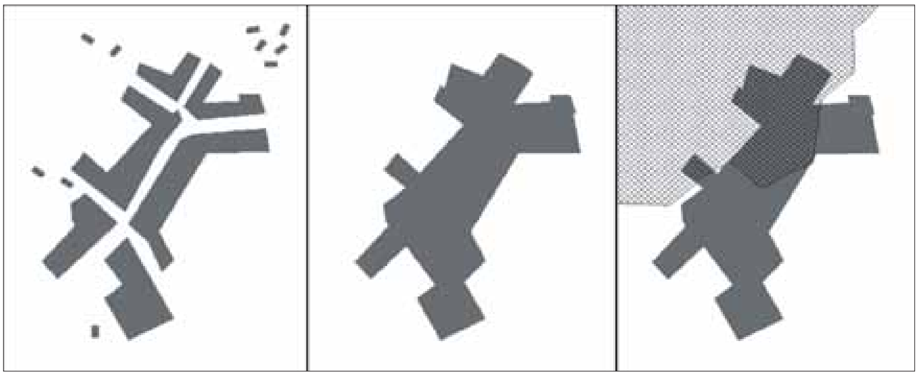

Fig. 2: Modification of built-up areas layer

$$AS_m = \frac{\sum_{t=1}^{8} ra_{tm}}{8} \quad AW_m = \frac{\sum_{t=1}^{8} (ra_{tm} w_t)}{\sum_{t=1}^{8} w_t} \quad AS_q = \frac{\sum_{m=1}^{n} (AS_m P_m)}{\sum_{m=1}^{n} P_m} \quad AW_q = \frac{\sum_{m=1}^{n} (AW_m P_m)}{\sum_{m=1}^{n} P_m}$$

Fig. 3: Internet availability indicators (AS_m – internet availability rate in municipality m (simple); AW_m – internet availability rate in municipality m (weighted); AS_q – internet availability rate in QFUR q (simple); AW_q – internet availability rate in QFUR q (weighted); rat_m – rate of availability of technology t in municipality m; w_t – weight of technology t; P_m – population of municipality m; n – number of municipalities in QFUR)

By calculating a mean of eight ra_t values of two types of variables according to the scale of measurement (binary rab_t values and ratio raa_t values) the resulting AS_m value from the interval ⟨0, 1⟩ bounded and closed from both sides is essentially a weighted mean of two proportions: (1) the proportion of the technologies available in a given municipality from all the studied type-[b] technologies (with weight = 5), and (2) the average proportion of the built-up area (and also of the population, if the built-up area is assumed to be homogenous with respect to population density) in a given municipality covered by the type-[a] technologies (with weight = 3).

Fig. 4 shows the spatial distribution of the AS_m values. Fig. 5 shows the spatial distribution of the SUMD 300 values, which is an indicator that represents the sum of direct distances (beelines) from the given municipality to the closest of the 1, 2, 3, ... 300 largest (in terms of population) municipalities (Džupinová et al., 2008). The patterns formed by these two indicators representing two different aspects of peripherality are notably similar.

3.2 Correlation analysis

The four synthesizing indicators were analysed together with a set of other peripherality indicators. When selecting the latter indicators, a wider range of them was preferred, so that as many of potential significant relations as possible could be revealed. All basic approaches to the delimitation of peripheries were considered in the selection of indicators (geometric, ecological, economic and social). Finally, a set of 31 indicators was used in the analysis for QFURs and 12 variables for municipalities, using Pearson's, Kendall's and Spearman's correlation coefficients.

The analysis revealed statistically significant correlations (at $\alpha = 0.01$) between the synthesizing indicators and some of the other peripherality indicators. While in some cases it is the *AS* indicator that yields stronger correlations, in others it is the *AW* indicator. At the municipality level, six indicators correlated with the AS_m or AW_m indicator obtained Pearson's *r* values between (+ or –) 0.70 and 0.43 (in descending order):

- The above-mentioned SUMD 300 indicator;
- Share of households with the internet connection according to the 2001 census;
- Mean number of schooling years (SCHOOL) assuming the following numbers of years spent attending school by inhabitants at different highest achieved levels of education according to the 2001 census: primary 8.5, secondary without final exam 11.5, secondary with final exam 12.5, "higher" 14.5, Bachelor level 15.5, Master level 17.5, Ph.D. level 20.5;
- Population size as of 31 December 2006;
- Population density per 1 km^2 of built-up area as of 31 December 2006; and
- Population density per 1 km^2 as of 31 December 2006 (DENSITY).

As the scatter plots revealed some nonlinear relationships, it is worth noting that after simple mathematical transformations of some of the variables

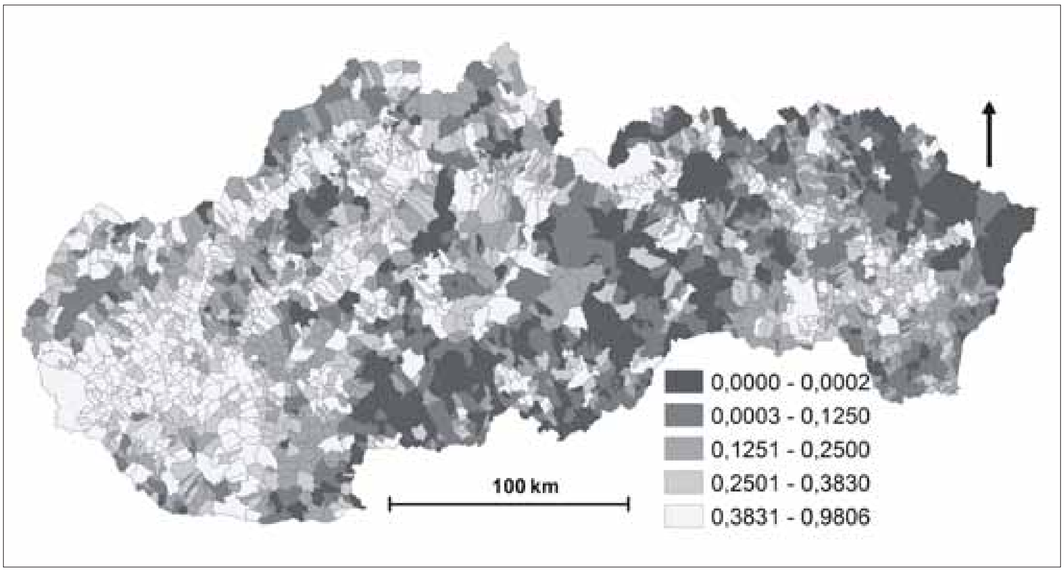

Fig. 4: Internet availability rate in municipalities ASm (proportions) in Slovakia classified into quintiles
Note: the inverse colour scheme enhancing the comparability with Fig. 5

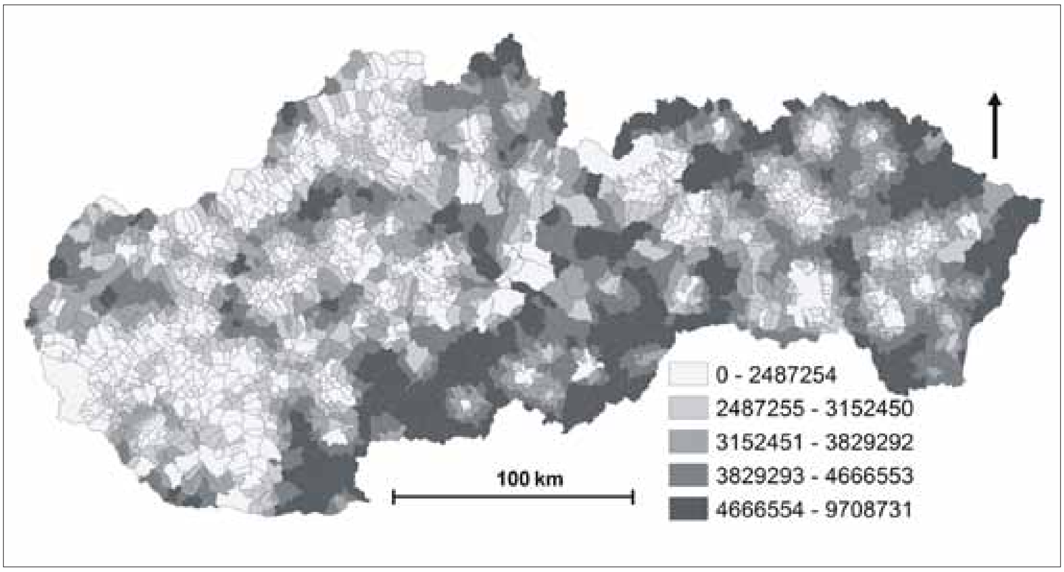

Fig. 5: Sum of the distances in municipalities SUMD 300 (metres) in Slovakia classified into quintiles

even greater absolute values of the respective Pearson's correlation coefficients are found. This is in accordance with the fact that the top four most correlated variables with either AS_m or AW_m indicator – when measured by Kendall's and Spearman's correlation coefficients – are slightly different (in descending order):

- The above-mentioned SUMD 300 indicator;
- Population density per 1 km^2 as of 31 December 2006 (DENSITY);
- Population size as of 31 December 2006; and
- Mean number of schooling years (SCHOOL).

Obviously, the correlations at the QFUR level turned out to be generally stronger than those at the municipality level. At the QFUR level, 17 indicators correlated with the AS_q or AW_q indicator reached Pearson's r values between (+ or –) 0.86 and 0.55. Seven of them showed the highest correlation with r values between (+ or –) 0.86 and 0.77 (in descending order):

- The mean value (weighted by municipality population) of the above-mentioned SUMD 300 indicator within given QFUR;
- Population density per 1 km^2 as of 31 December 2006 (DENSITY);
- Share of households with the internet connection according to the 2001 census;
- Mean number of schooling years (SCHOOL);
- Economic aggregate (mean monthly income multiplied by the number of employed persons) per capita in 2006;
- The mean of the shares of households with water, gas and sewage systems connections, each of them representing a different stage of innovation

diffusion in time in Slovakia with the shares of 95.1%, 74.5% and 56.5% in the given order according to the 2001 census; and

- Mean monthly income of an employee in organisations with more than 20 employees in 2006 (INCOME).

Figure 6 shows some example scatter plots for some of these relations (see also Rosina, 2008; Džupinová et al., 2008).

4. Conclusion

The construction of indicators made it possible to visualize and explore the spatial distribution of internet availability in Slovakia and to evaluate related and potentially influencing and/or influenced spatial, ecological, economic and social factors by means of correlation analysis. This helped to identify a whole range of areas from those with an excellent service to those with a very poor one. Results of the correlation analysis show the relation of the specific attributes of space, society and economy to spatial variations in internet availability, and they also suggest that the internet availability might be used as an appropriate synthesizing indicator of peripherality, at least in the conditions of Slovakia in the middle of the current decade. Because strong relationships have been found between internet availability on the one hand and most of the geometric and some economic and socio-demographic periphery indicators on the other hand, it is clear that the internet availability has not brought about the "death of distance" yet, but rather has followed and accentuated the existing polarized socio-economic spatial structure.

Obviously, there are many different ways, in which this research work could be further developed, for example by collecting new data on the ever-expanding internet coverage; by analysing the dynamics of the diffusion process; or by employing more sophisticated multivariate analyses to achieve a better understanding of the mutual relationships amongst all the considered peripherality indicators. Nevertheless, since one of the objectives of this paper was to point out the importance of accounting for the share of the municipality built-up area instead of the share of the municipality total area covered by the service in focus, a logical next step – from

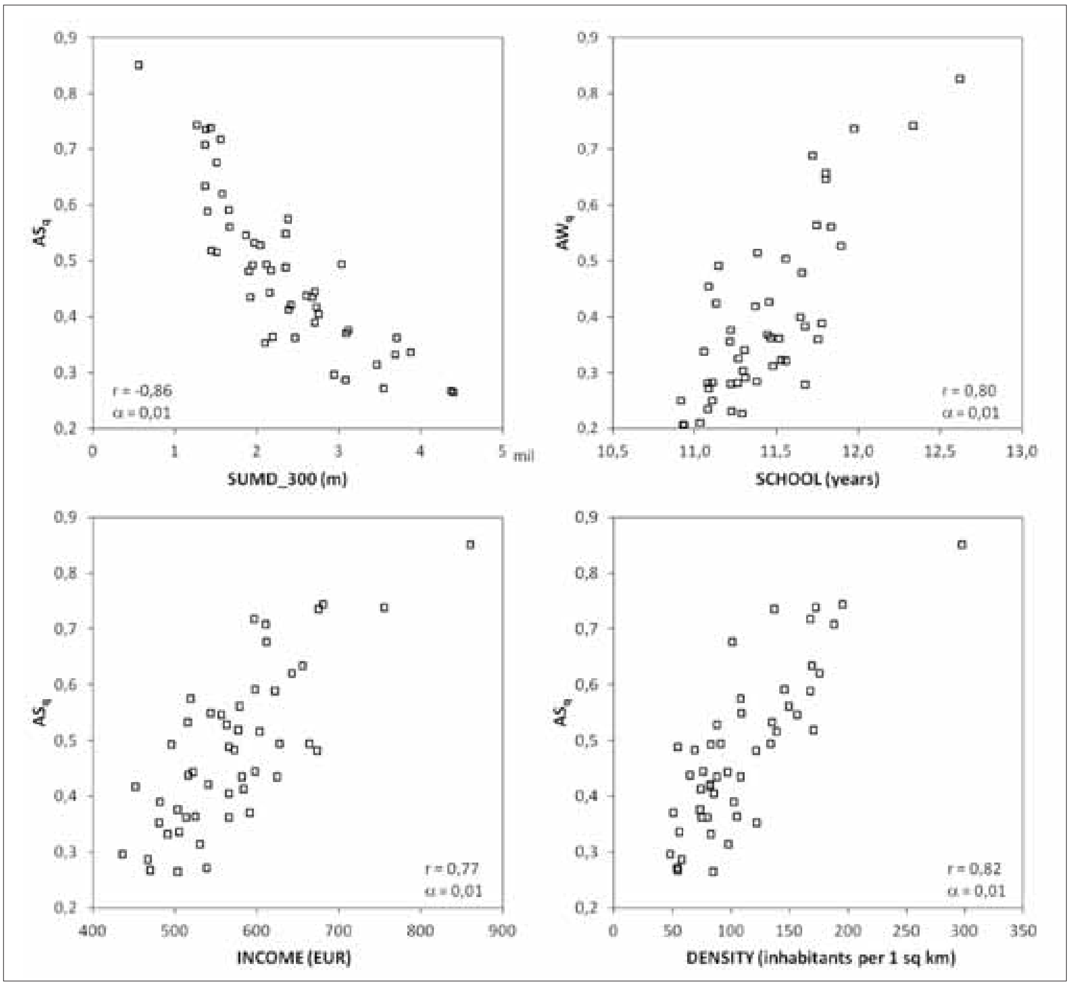

Fig. 6: Part of the results for QFUR

the geographical research point of view - is rejection of the assumption that the built-up area in the given municipality is populated at homogenous density. This or similar assumptions have been implicitly present in and thus hindering the geographical research for ages. However, with the development of geoinformation technology and new data sources emerging on the horizon, the datasets such as high resolution population rasters for whole countries and continents are becoming increasingly available. What seems to be an obvious thing to do next step is to use these datasets and turn them into instruments that would take the geographical research over the hindrance of this unrealistic assumption to the next level.

Acknowledgement

This research was supported by the Slovak Scientific Grant Agency VEGA project No. 1/0275/13 "Production, verification and application of population and settlement spatial models based on European land monitoring services".

References:

ANDREOLI, M. (1994): Development and marginalization in Liguria region. In: Chang-Yi, D. Ch., Sue Ching, J., Yin-Yuh, L. [eds.]: Marginality and development issues in marginal regions, Proceedings, 1–7 August 1993. Taiwan, National Taiwan University and International Geographic Union, p. 41–61.

BBC (2009): Government backs 2Mbps broadband. [online]. BBC News [cit. 7.10.2012]. Available at: URL: <http://news.bbc.co.uk/2/hi/technology/8012848.stm>.

BEZÁK, A. (2000): Funkčné mestské regióny na Slovensku. Geographia Slovaca, Vol. 15, p. 1–90.

CAIRNCROSS, F. (1997): The Death of Distance: How the Communications Revolution Will Change Our Lives. Boston, Harvard Business School, 303 pp.

DIRECTORATE-GENERAL FOR AGRICULTURE AND RURAL DEVELOPMENT (2008): Rural Development in the European Union. Statistical and Economic Information – Report 2008. [online]. EU DG AGRI [cit. 7.10.2012]. Available at: URL: <http://ec.europa.eu/agriculture/agrista/rurdev2008/RD_Report_2008.pdf>.

DŽUPINOVÁ, E., HALÁS, M., HORŇÁK, M., HURBÁNEK, P., KÁČEROVÁ, M., MICHNIAK, D., ONDOŠ, S., ROCHOVSKÁ, A. (2008): Periférnosť a priestorová polarizácia na území Slovenska. Bratislava, Geo-grafika, 186 pp.

GRIMES, S. (2003): The digital economy challenge facing peripheral rural areas. Progress in Human Geography, Vol. 27, No. 2, p. 174–193.

GRUBESIC, T. H. (2003): Inequities in the broadband revolution. The Annals of Regional Science, Vol. 37, No. 2, p. 263–289.

HALÁS, M. (2008): Priestorová polarizácia spoločnosti s detailným pohľadom na periférne regióny Slovenska. Sociologický časopis, Vol. 44, No. 2, p. 349–369.

HAVLÍČEK, T., CHROMÝ, P. (2001): Příspěvek k teorii plarizovaného vývoje území se zaměřením na periferní oblasti. Geografie – sborník České geograické společnosti, Vol. 106, No. 1, p. 1–11.

HAVLÍČEK, T., CHROMÝ, P., JANČÁK, V., MARADA, M. (2005): Vybrané teoreticko-metodologické aspekty a trendy geografického výzkumu periferních oblastí. In: Novotná, M. [ed.]: Problémy periferních oblastí. Praha, Univerzita Karlova v Praze, Přírodovědecká fakulta, Katedra sociální geografie a regionálního rozvoje, p. 6–24.

HENTEN, A., KRISTENSEN, T. M. (2000): Information society visions in the Nordic countries. Telematics and Informatics, Vol. 17, p. 77–103.

HURBÁNEK, P. (2008): Recent developments in definitions of rurality/urbanity: Focus on spatial aspect and land cover composition and configuration. In: Europa XXI, Vol. 17, Warszawa, Polish Academy of Sciences, Stanisław Leszczycki Institute of Geography and Spatial Organization, p. 9–27.

HORŇÁK, M. (2006): Identification of regions of transport marginality in Slovakia. Europa XXI, Vol. 15, Warszawa, Polish Academy of Sciences, Stanisław Leszczycki Institute of Geography and Spatial Organization, p. 35–41.

KABRDA. J. (2004): Vliv polohové exponovanosti na rozložení využití ploch v kraji Vysočina. Geografie – sborník České geograické společnosti, Vol. 109, No. 3, p. 223–235.

KUSENDOVÁ, D., BAČÍK, V. (2009): Počítačová tvorba tematických máp - Cvičenia v MapInfo Professional (2. rozšírené vydanie). Bratislava, Geo-grafika, 160 pp.

LEIMGRUBER, W. (1994): Marginality and marginal regions: problems of definition. In: Chang-Yi, D. C., Sue Ching, J., Yin-Yuh, L. [eds.]: Marginality and development issues in marginal regions, Proceedings, 1–7 August 1993. Taiwan, National Taiwan University and International Geographic Union, p. 1–18.

LINDNER, Ch. et al. (2005): A spatial Peripherality in Europe. Cartographic and statistical analyses. Dortmund, Universität Dortmund, Institut für Raumplanung, 86 pp.

MARADA, M. (2001): Vymezení periferních oblastí Česka a studium jejich znaků pomocí statistické analýzy. Geografie – sborník České geograické společnosti, Vol. 106, No. 1, p. 12–25.

OLAH, B., BOLTIŽIAR, M., PETROVIČ, F. (2006): Land use changes' relation to georelief and distance in the East Carpathians Biosphere Reserve. Ekológia Bratislava, Vol. 25, No. 1, p. 68–81.

REGIONE PIEMONTE (2009): European Regions for better ICT connections, Conference Turin 2–3.4.2009. [online]. Direzione Regionale 21 – Innovazione, Ricerca, Università e Sviluppo Energetico Sostenibile [cit. 7.10.2012]. Available at: URL: http://www.regione.piemonte.it/innovazione/regions4ict.html.

ROSINA, K. (2008): Dostupnosť internetu v SR a jej vzťah k periférnosti územia. Bakalárska práca. Bratislava, Univerzita Komenského v Bratislave, Prírodovedecká fakulta, Katedra regionálnej geografie, ochrany a plánovania krajiny, 50 pp.

STATISTICAL OFFICE OF THE SLOVAK REPUBLIC (2007): Informácia o výsledkoch zisťovania o využívaní IKT v domácnostiach. [online]. ŠÚ SR [cit. 4.7.2008]. Available at: URL: http://portal.statistics.sk/showdoc.do?docid=8874.

ŠTYCH, P. (2011): Comparative analysis of the impact of slope inclination and altitude on long-term land use changes in Czechia. Acta Universitatis Carolinae, Geographica, Vol. 46, No. 1, p. 71–76.

ÚGKK SR (2005): Continuous Vector Map SVM 50 (084/051108-AG). Bratislava, Institute of Geodesy, Cartography and Cadastre of the Slovak Republic.

Authors addresses:

Mgr. Konštantín ROSINA
Slovak Academy of Sciences, Institute of Geography
Štefánikova 49, 814 73 Bratislava, Slovakia
e mail: *konstantin.rosina@gmail.com*

Mgr. Pavol HURBÁNEK, Ph.D.
Catholic University in Ružomberok, Faculty of Education, Geography Department
Hrabovská cesta 1, 034 01 Ružomberok, Slovakia
e mail: *pavolhurbanek@gmail.com*

Initial submission 23 October 2012, **final acceptance** 15 March, 2013

Please cite this article as:

ROSINA, K., HURBÁNEK, P. (2013): Internet Availability as an Indicator of Peripherality in Slovakia. Moravian Geographical Reports, Vol. 21, No. 1, p. 16–24.

A MODEL FOR THE IDENTIFICATION OF AREAS FAVOURABLE FOR THE DEVELOPMENT OF TOURISM: A CASE STUDY OF THE ŠUMAVA MTS. AND SOUTH BOHEMIA TOURIST REGIONS (CZECH REPUBLIC)

Josef NAVRÁTIL, Kamil PÍCHA, Stanislav MARTINÁT, Jaroslav KNOTEK, Tomáš KUČERA, Zuzana BALOUNOVÁ, Vivian L. WHITE BARAVALLE GILLIAM, Roman ŠVEC, Josef RAJCHARD

Abstract

A basis for the identification of potential tourist development areas was defined as a combined use of the model of area load by visitors, the territorially-located database of tourist attractions, and the perception of their attractiveness by visitors. A distinctive inequality was identified in the area load and the distribution of tourist attractions. The areas of development were determined on the basis of a difference between the relative attendance and the relative attractiveness of the partial territorial units of a regular hexagonal network, sized approximately 3 km^2, with a concurrent requirement of above-average total attractiveness.

Shrnutí

Model identifikace rozvojových oblastí cestovního ruchu: Turistické regony Šumava a Jižní Čechy (Česká republika)

Základem pro identifikaci potenciálních rozvojových oblastí se stalo kombinované využití modelu zatíženosti oblasti návštěvností, územně lokalizované databáze atraktivit cestovního ruchu a percepce míry jejich atraktivnosti návštěvníky oblasti. Identifikována byla výrazná nerovnoměrnost v zatížení oblasti cestovním ruchem a nerovnoměrnosti v rozmístění atraktivit cestovního ruchu. Rozvojové oblasti byly určeny na základě rozdílu relativní návštěvnosti a relativní atraktivity v dílčích územních jednotkách pravidelné šestiúhelníkové sítě, jejichž přibližná rozloha je 3 km^2, a při současně splněném požadavku na nadprůměrnou hodnotu celkové atraktivnosti.

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

1. Introduction

Regional development policies are anchored in paradigms of particular economic and geographical theories, which are expressed in the diversified scale of regional development theories (Dawkins, 2003) and whose application should achieve the objectives of regional (or local) competitiveness (Kitson, Martin and Tyler, 2004). Support for the activities of tourism are important elements of regional development policies in the long term. Those policies dwell on the parallel evolution of both development and tourism theories since World War II (Telfer, 2002a). The realization of tourist activities manifests itself in the economic benefits for the visited area (Dwyer, Forsyth and Dwyer, 2010) through the transfer of income and investments from wealthier and more developed territories to the poorer and less developed ones (Sharpley, 2002). The main benefits come from the visitors' expenses in the tourist destinations, as well as investment in tourism infrastructure by businesses coming from the areas that generate tourists.

There are, however, both positive and negative impacts (Williams, 1998). As an important sector of the economy (Dwyer et al., 2010), tourism influences a wide spectrum of development issues in the destination regions. Such issues are, among others, the economy (Mihalič, 2002), as well as socio-cultural matters (Hashimoto, 2002) or community matters (Timothy, 2002). For these reasons, tourism is one of the important elements of regional development policies in various contexts, be it sustainable life in rural areas, the revitalization of towns, or support to generally poorer areas or island economies (Telfer, 2002b). The assertion that tourist activities could be 'friendly' to their environments came quite recently (particularly in the context of physical impacts of tourism on the environment: Hall and Lew, 2009). Overall, the purpose is to let the losses due to the existence of tourism not exceed the generated benefits (Christofakis, 2010).

Although regional development studies often place emphasis on the economic aspects of the topic (Ray, 2008), this subject has also many other approaches that are based primarily in geography, psychology, sociology, environmental studies and the like. These problems of tourism have a highly multidisciplinary character (Williams, 1998). Although it is usually not mentioned in regional development studies, the visitor is a key element of the development. The visitor is the one who realizes the expenses in those destination areas and for whom the tourism infrastructure is built (Goeldner and Ritchie, 2009). Hence, attendance in an area (its quantity and quality) is fundamental for the realization of the development potential of tourism within the destination area. All of the above-mentioned factors led the authors to opt for the identification of tourism development areas (in its spatial meaning) as the aim of this paper.

The chosen objective is certainly not new in research on the problems of the spatial and development aspects of tourism (Benthien, 1997). It is one of the key problems to be resolved by tourism geography (Williams, 1998), and it is currently further developed in this context (Hall and Page, 2009) and thus constitutes a part of the main paradigm (Gibson, 2008).

This paper is based on a combination of varied approaches to the assessment of attractiveness of core resources (Ritchie and Crouch, 2003). Unlike similar studies that emanate from our cultural environment, the core of selected methods is not concerned with the typological-spatial analysis (e.g. Vystoupil et al., 2006) but rather in the analysis of the visitor's relationship to those resources. Even the analysis we have chosen is not exceptional (e.g. Pompurová, 2011), but other research is usually not directly linked with concrete spatial elements. They are commonly related to products supplied by enterprises or otherwise reset from expert estimations (Bína, 2002; Vepřek, 2002; Švec et al., 2012). The purpose of the present study is to extend the above-mentioned current knowledge and research experience.

2. Methods

Potential areas of development were identified within the model territory of the tourist regions of South Bohemia and the Šumava Mountains (Cetkovský, Klusáček, Martinát and Zapletalová, 2007). The model of attendance was employed to serve as an initial model of the load of the area (Navrátil, Švec, Pícha, and Doležalová, 2012: for details about the methods, see p. 52–53). For further calculations in this paper, we used the layers of GIS with the data on total model attendance of partial spatial units of the regular hexagonal network, according to input data for the year 2010.

The model of the attractiveness of an area proceeds from the spatially located database of potential attractions that were identified in literature devoted to the issues of tourism geography (Kušen, 2010; Mariot, 1983; Navrátil and Navrátilová, 2011; Ritchie and Crouch, 2003; Vystoupil et al., 2006). The database comprises potential attractions, which are parts of permanent structures, i.e. those which cannot be moved or newly built, according to the up-to-date demand of tourists (Gunn, 1997). In particular, elements of physiognomy, culture and history (in the meaning of Ritchie and Crouch, 2003) are considered: in total, 69 types of attractions.

The following elements were used from the category of "physiognomy":

- land use: the polygonal layer for the whole surveyed territory, divided according to land use types (Löw and Novák, 2008) – agricultural, forest-agricultural, forest, pond and urbanized landscape;
- landscape types: the polygonal layer of the whole surveyed territory, divided according to the type of relief (Löw and Novák, 2008) – landscapes of hilly areas and uplands of Hercynicum, landscapes of flatlands, landscape of broad floodplain meadows (Fig. 1 – see cover p. 2), landscape without differentiated relief – towns; landscapes of highlands, landscape of highly situated plateaus, karst landscapes, landscapes of distinctive hillsides and rocky mountain ridges, landscape of cirques, landscape of carved valleys and landscapes of volcanic mounds and cones;
- attractions of living nature – the polygonal layer; a subject of protection was identified within the bounds of small-area protected territories (AOPK ČR, 2011) and it was encoded to the three types of attractiveness that are included in the object of protection (Fig. 2 – see cover p. 2) – forest, peat-bog, meadow, plant and animal. With regard to the source of data, the rocks were supplemented; and
- attractions of inanimate nature: the point layer with points of attractions: caves located on the basis of the open-access database of the United Evidence of the Speleological Objects of the Agency for Nature Conservation and Landscape Protection of the Czech Republic (AOPK ČR, 2012), springs and sources were localized on the basis of the tourist map of the service www.mapy.cz (SHOCart, 2012),

mineral water springs were located based on the sources of literature (Kříž, 1985), and waterfalls were located according to the tourist maps of the Czech Tourist Club 1:50 000.

The following elements were used from the category of "culture and history":

- historical and cultural attractions: the point layer with points located primarily according to the tourist maps of the Czech Tourist Club 1:50 000; the following elements were recorded into the database – church, monastery, chapel, Jewish monument (only those attractions that were mentioned in the text part of the tourist maps), tower house (Fig. 3 – see cover p. 4), castle, remains of fortresses and fortified settlements, ruins of castle or other monuments, memorial of an important person, memorial of an important event, Calvary chapel, Calvary cross, conciliation cross, historically important cemetery, museum, open-air museum, gallery, point of an important historical event, place where an important historic person was living and/or creating, important (usually geographically or historically) border stone, theatre, observation and viewpoint;
- historical and cultural attractions: the polygonal layer including abandoned and dilapidated villages (Fig. 4 – see cover p. 4), located on the basis of the map from the second military mapping; monuments of popular architecture localized using the data of the National Heritage Institute (NPÚ, 2012) – the border of village monument reservations, borders of the village monument zones and proposals of the village monument zones within their residential area were used; the database was also supplemented (under the notion "town monument reservation"; according to the same materials) town monument reservations and zones within those borders as they were declared or within the border of the historical core of the town (in the case where there is only a proposal of such declaration); and
- technical monuments: the point layer created according to the information stated in the edition of technical monuments of the publishing house Libri and supplemented with information according to the tourist maps of the Czech Tourist Club 1:50 000 – historical factories, historical mines and panning sites, rural workrooms and storehouses, water mills and iron-mills, historical transport equipment, water tanks and waterworks towers (usually from the second half of the 19th century or the first half of 20th century) and water dams. The line layer of the line fortification of the Czechoslovak Republic was further created based on information from the server ropiky.net (WWW.ROPIKY.NET, 1999–2012) that were validated by information originating from the tourist maps of the Czech Tourist Club 1:50 000.

The database was completed with recreational attractions that are dependent, first of all, directly on the natural environment:

- public outdoor swimming pools and bathing places: the points were located based on the information published in the Digital Territory Model (DTM) 1:25 000, supplemented with information from the tourist maps of the Czech Tourist Club 1:50 000;
- tennis courts: the points were located based on the information mentioned in the DTM 1:25 000;
- places suitable for paddling: the line created according to the information mentioned in the Atlas of Tourism in the Czech Republic (Vystoupil et al., 2006) and the Atlas for Leisure Time (Economia, 2002);
- horse riding: the points of the location of riding schools were done according to the sources available via the Internet network;
- downhill skiing: the polygons were created according to the information mentioned in the tourist maps of the Czech Tourist Club 1:50 000 and in the DTM 1:25 000;
- golf: the polygons were created according to the information mentioned in the tourist maps of the Czech Tourist Club 1:50 000 and in the DTM 1:25 000 and completed with sources available via the Internet network;
- mountain climbing: the points of location of the registered places were determined according to the sources available via the Internet network;
- sport fishing: the line of the fisheries of the Czech Fishing Union (ČRS, 2003) and private fisheries (Navrátil, 2004);
- spas: the polygons were located according to the information in DTM 1:25 000;
- zoological garden: the polygons were located according to sources available via the Internet network;
- botanical garden and arboretum: the polygons were located according to the publication Botanical Gardens and Arboreta of the Czech Republic (Chytrá, Hanzelka, and Kacerovský, 2010); and
- astronomical observatories and planetariums: the points of location according to the sources available via the Internet network.

First of all, the characteristics of the distribution of the set of identified attractions were assessed. That was carried out using the main tools of frequency assessment of differences and regularities in the distribution. With regard to the large extent of the input data, the set of the attractions was assessed as a whole, not as partial separate types of attractions. Afterwards, regularity in the distribution was established by means of Nearest Neighbour Analysis (Aplin, 1983). Values of the R statistics and Z-scores were computed by means of the software Quantum GIS 1.7.1 (Athan et al., 2011).

The attractiveness of the territory was assessed in identical artificial spatial units, identified as those used previously in the model of attendance of the surveyed territory (Navrátil et al., 2012). The attractiveness of the territory was calculated on the basis of the sum of the attractiveness of the above-mentioned elements in the partially determined territorial units. So, before the proper calculation was made, it was necessary to convert the polygonal and line layers to the points. The polygons and lines were first interlaid by the layer of partial territorial units and subsequently followed a calculation of the centroids of the newly emerged polygons and lines. The occurrence of a point from the original polygon or the line in the polygon of the partial territorial unit, would then require the addition of the attractiveness of the respective type of point to the total attractiveness of the polygon of the concerned partial territorial unit. The exception was represented by the layers of land use and the types of landscape, which cover the whole area of the surveyed territory: here it was necessary to determine the share of particular types on the total area of partial determined territorial units, before both the rate of attractiveness was taken into account and the calculation of centroids was done. Then the attractiveness of the partial sections was fixed as a product of the share of the given land use type on the total area of the partial territorial unit and the rate of attractiveness of the respective type, which was determined by the hereinafter described procedure.

Our previous research on the surveyed territories (Navrátil, Pícha and Hřebcová, 2010; Navrátil, Pícha, Rajchard and Navrátilová, 2011; Navrátil et al., 2013) showed that the usual assessment of the simple spatial distribution cannot be used for the identification of potential development areas. The partial segments of demand differ in attractiveness. For this reason it was necessary to complete the database of the perception of attractiveness by a wider spectrum of visitors. The segments of demand were identified based on the combination of two approaches – interrogating real visitors about the attractions, and interrogating within the model segments. A basis for the identification of the segments became the intensity of running recreational activities during the spending of leisure time by people outside their permanent address (Navrátil et al., 2010). The identical tool was used for testing the influence of the partial segments of demand on the perception of attractiveness (Navrátil et al., 2013).

The respondents were surveyed at 60 attractions in the tourist regions of South Bohemia and the Šumava Mountains in the years 2009–2011. The authors had a database of 3,776 completed questionnaires at their disposal (Navrátil, unpublished data). The selection of the respondents was identical to that published in Navrátil, Pícha, and Navrátilová (2012) and the set of locations was extended (compared to the previously-cited article) with those types of attractions where the attractiveness consisted of elements from culture, history, and recreation. The self-same questionnaire was presented to students selected in compliance with methods used in Navrátil et al. (2013). 396 questionnaires were filled in by those students (return rate of questionnaires was 61%). The students were likewise asked about the rate of attractiveness of partial attractions from the above-mentioned list. The Q-sort Method was used with regard to the number of the observed attractions, as that method allowed the researchers to assess a large number of elements (Doody, Kearney, Barry, Moles, and O'Regan, 2009), where the load on respondents is relatively low, which prevents the negative effect influence of the previous answers (Barry and Proops, 1999), which is, on the contrary, the case of scales or paired comparisons. An eleven-column scheme was used. The assigned task was worded as follows: "Please, classify the following elements of attractiveness of the tourist areas according to the importance you attribute to the particular elements when choosing the place to travel there". The + 5 in this Q-sort corresponds to the statement "It has a crucial importance for my selection of the place to travel to" and the − 5 "It has absolutely no importance for my selection of the place to travel to". The number of attractions for the particular columns was selected to be close to the normal distribution (1-2-4-7-12-17-12-7-4-2-1).

The segments of demand were identified by means of cluster analysis (Ward's method, Euclidean distance) of answers on the scale of the degree of participation in the partial recreational activities in all questionnaires on the level of 50% loss of credibility (Real, Arce, and Sabucedo, 2000). The available hardware did not allow processing of all obtained responses; hence, a randomly selected 2,500 questionnaires were involved in the computation. Besides the proper identification of the segments of demand, the share of particular segments of demand of all visitors in the surveyed tourist regions should be determined.

Those questionnaires filled in by students were further selected from the identified clusters and students' answers concerning the degree of attractiveness were used to calculate the average value of attractiveness of the given attraction for the respective segment of demand. With regard to the methods of data collection, it was necessary to convert the scale of assessing the attractions to positive values and consequently to transform it exponentially before other calculations. The final value of attractiveness for each segment of demand was expressed relatively, as a part of attractiveness of the partial attractions on the maximal value of the achieved attractiveness of the most attractive item. Those values were assigned to the given type of attraction in the database, and this was defined separately for each segment of demand.

The model of the total attractiveness of the territory was created for particular segments of demand (as a sum of attractiveness for a given segment of demand). Based on the attractiveness for the partial segments of demand and their known representation in the demand for tourism in the surveyed territory, it was possible to create a final model of the complex attractiveness of the territory.

All computations and analysis of the questionnaires concerning attractiveness were done using the STATISTICA 10.0 software (StatSoft, 2011). The results were visualized in the environment of ArcView 3.1 For visualization, the quartiles calculated from all values achieved in the set of all types of attractions were used in all cases of models of attractiveness of particular groups of attractions. In the case of the attractiveness of the territory according to particular segments of demand, a scale was similarly created based on quartiles of all the attractiveness values of all segments of demand. The resulting cartograms are quantitatively comparable by visualization.

The assessment of the load of the territory is derived from the comparison of the values of model attendance rate and model attractiveness in each hexagon. The data of both the model of the attendance rate and the model of attractiveness were firstly standardized, and then the differences were investigated. The resulting values were again visualized in ArcView 3.1 using the quartiles. The areas with positive values show a surplus of attractiveness compared to the median of all the surveyed area and then a relatively unutilized attractiveness of tourism development. However, it is not possible to label these areas as "developing". It is possible to define this only in those territories which at the same time show above-average values of total attractiveness.

3. Results and discussion

The model of tourist load in the surveyed area identified three tourism zones (Fig. 5). The largest area is situated in the south-east of the territory and comprises areas from the border of the Třeboň area and the Czech Canada on the north-east, over the central Třeboň area with centre in Třeboň, and in the locations of Staňkovský–Hejtman, Hluboká–České Budějovice and Český Krumlov, up to the Lipno Dam area on the south-west. The second tourism zone is the western Šumava Mountains with centres in the area of Železná Ruda and alongside the Vydra River. The third tourism zone in the surveyed area is the area of Písek with the Orlík Dam Lake and the town of Tábor. There is some manifestation of a border effect in the model. However, its importance is not strong as the above-average visited areas appear in many cases right at the borders of the territory (the Šumava Mountains, the Třeboň area and the Orlík Dam Lake). We can then consider the model to be valid as it shows conformity in the distribution with empirical experience gained directly in the field.

After all adjustments of line and polygonal vector layers of the attractions to the points assignable unambiguously to the particular areas of the regular hexagonal network, the databases include 27,299 items.

Several relationships in the data set are obvious with regard to spatial distribution (Fig. 6). First of all, the spatial accumulation of attractions in specific areas stands out. These are especially the towns, which is not at all surprising. The reason for this is a relatively high number of the types of attractions from the culture-historical category, and the majority of these attractions is linked, above all, with the urbanized areas. Another evident element is the accumulation of attractions along water courses, which is partially caused by their originally line character and also by the fact that several types of the observed attractions are closely related to water: paddling sections and fisheries. However, this should also be linked to the appearance of change of relief type that is usually different from its surroundings along larger watercourses. The last noticeable element is the accumulation of the types of attractions near the edge of mountains, where the character of the relief changes, similar to the case of the watercourses, and where the character of land use often changes as well. So an overall impression is that of the entwining of the types of attractions appertaining to both mountains and lowlands. The Nearest Neighbour Analysis proved the important tendency towards the creation of spatial clusters of attractions, as the R-statistic achieves 0.214 with a value of the Z-score = −248.6.

The degree of attractiveness of the particular surveyed tourist attractions was investigated using the method of interrogating real tourists in the specified territory and the method of the model segments of demand. Before making the proper calculations of both partial and total attractiveness values, it was necessary to identify those

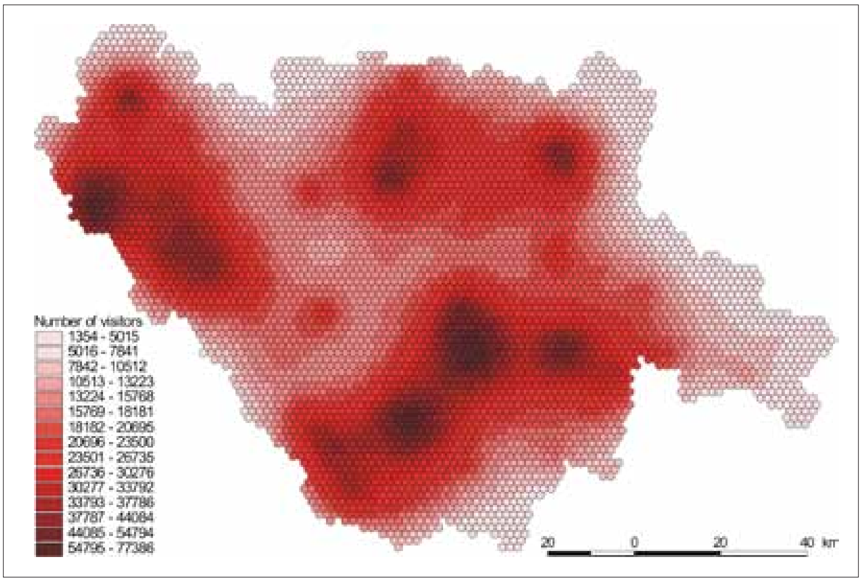

Fig. 5: The model of the number of visitors in particular locations of the tourist regions South Bohemia and the Šumava Mountains

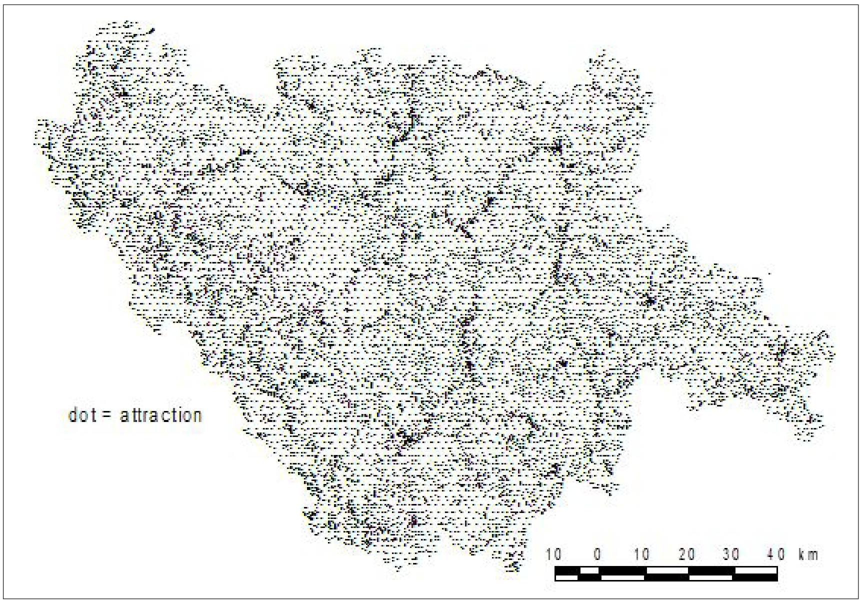

Fig. 6: The distribution of all attractions included in the database, N = 27,299

segments of demand that were determined on the basis of behavioural segmentation criteria (Moutinho, 2000). The cluster analysis of their responses regarding the degree of participation in the partial recreational activities (linked with travelling) helped to identify four main segments of demand (the share of the total number of respondents is indicated in brackets):

- modern outdoor tourism oriented primarily to bicycle touring and entertainment-linked with a visit to the "natural" environment (13.65%);
- traditional tourism oriented to the stay in nature and visit to a historical monument, refusing modern elements represented by bicycle touring (31.46%);
- rather passive and non-engaged tourism with predominant importance consisting of easily accessible destinations (26.44%); and
- hotel-based tourism oriented more towards entertainment and recreational activities (28.45%).

The above-mentioned segments of demand correspond to the structure identified in previous studies (Navrátil, 2008; Navrátil et al., 2010). From the marketing point of view, they could seem to be too rough and simplistically oriented (Kotler and Keller, 2007). However, the objective was not to describe in detail the segments at the micro-level, but to identify major ways of behaving in relation to the attractions from the group of location preconditions for tourism (Mariot, 1983). From that point of view, the classification of four groups is optimal and a huge number of differentiating activities was identified in the spectrum of segmentation questions (Tab. 1).

	Modern outdoor tourism			Traditional outdoor tourism			Non-engaged tourism			Hotel-based tourism		
	average		S.E.	average		S.E.	average		S.E.	average		S.E.
visits to historical sights	3.265	a	0.085	3.794	c	0.097	3.294	ab	0.137	3.750	bc	0.094
visits to museums, galleries, etc.	2.697	a	0.085	3.137	b	0.096	3.000	ab	0.136	3.194	b	0.094
shopping	2.962	ab	0.089	2.618	a	0.101	3.353	b	0.143	4.380	c	0.099
entertainment	3.697	b	0.081	3.186	ab	0.093	3.588	a	0.131	4.519	c	0.090
relaxation	4.023	ab	0.077	3.882	a	0.088	3.137	c	0.124	4.269	b	0.085
watching the nature	4.379	a	0.078	4.176	a	0.089	2.549	b	0.126	3.454	c	0.087
bicycle touring	4.000	c	0.086	1.833	a	0.098	2.216	ab	0.139	2.306	b	0.095
recreational sport activities	3.962	b	0.084	2.725	a	0.095	2.980	a	0.135	3.694	b	0.092
hiking	4.220	a	0.081	4.078	a	0.092	2.608	b	0.131	3.157	c	0.090

Tab. 1: Average values (±mean error, S.E.) of the degree of participation in recreation activities for the respective identified segments of demand. The averages marked with the same letter do not significantly differ (Tukey's multiple range post-hoc test for unequal sample sizes, $p > 0.05$), $N = 393$
Note: the scale of measure employed, where 1 = I don't go for this activity, …. 5 = I do go especially for this activity

The relative attractiveness was determined for the respective attractions within each segment (Tab. 2). Tower houses in the segment "hotel-based tourism oriented to entertainment and recreational activities" were labelled as the absolutely most attractive (Tab. 2). On the contrary, the absolutely least attractive places are identified as golf courses in the segment "traditional tourism oriented to the stay in nature and visit to historical monuments".

A very interesting finding struck us when regarding the attractiveness of the territory as a whole, according to the degree of the attractiveness of this territory for particular segments of demand. It is obvious from the comparison of the map outputs of the analysis that the degree of the perception of territory attractiveness by particular segments of demand has a fundamental spatial dimension. Such a comparison also confirms the necessity of including the visitors' preferences in the models of attractiveness (Bína, 2002), as well as the legitimacy of using the recreational activities for segmentation, which is important for the degree of attractiveness of particular preconditions of tourism development (Navrátil and Navrátilová, 2011).

It is impossible to detect more important differences in the spatial pattern of highly attractive places; they are concentrated in all cases particularly in the area of the Šumava Mountains. However, there is a cardinal difference in the degree of attractiveness of particular locations. For the first segment (Fig. 7), both tourist regions are attractive in a substantial part of their area (quartiles 50–75 and 75–100%). The areas that are perceived as relatively unattractive include namely parts of the České Budějovice Basin, the Klatovy Depression and peripheral parts of the Třeboň Basin; a little bit more attractive is the part of the Písek area. South Bohemia and the Šumava Mountains as a whole are more attractive for the second segment of demand (Fig. 8). On the contrary, the third identified segment (Fig. 9) perceives South Bohemia and the Šumava Mts. area as mainly rather unattractive; the 25–50% quartile prevails in most of the surveyed area. Distinctively attractive areas could be found for this segment only in the mountainous part of the Šumava Mountains, the Lipno Reservoir area, alongside the Lužnice River and then the area of settlement centres. A similar character is seen in the distribution of attractive areas for the fourth segment of demand (Fig. 10), except for the difference that a larger part of both tourist regions belongs to areas of very low attractiveness. Highly attractive locations are for the case of the fourth segment of demand distributed rather regularly across the surveyed area with a light center in the area of the mountainous part of the Šumava Mountains.

From the spatial point of view (Fig. 11), the greatest number of highly attractive areas is concentrated in the area definable as the mountainous part of the Šumava Mountains. Highly attractive or rather attractive areas are concentrated also in the southern part of the territory: the Czech Canada and the Dačice area. However, some highly attractive areas are situated also in other parts of the territory. They are less frequented and are specifically related, above all, to the occurrence of watercourses and settlements. From the perspective of the overall surface, the South Bohemian Basins could be labelled as the less attractive areas (Fig. 11).

	Modern outdoor tourism	Traditional tourism oriented to the stay in nature and visit to historical monuments	Rather passive and non-engaged tourism	Hotel-based tourism oriented to entertainment and recreational activities
landscape mostly covered by forests	0.673	0.697	0.612	0.398
landscape of mosaics of forests, meadows and fields	0.857	0.887	0.831	0.525
landscape with predominant agricultural land	0.079	0.039	0.108	0.049
landscape with frequent appearance of ponds	0.556	0.455	0.431	0.522
landscape of towns	0.188	0.223	0.486	0.489
landscapes of highlands	0.631	0.697	0.394	0.358
landscapes with distinctive hillsides and rocky mountain ridges	0.656	0.647	0.426	0.360
landscape of high elevated plateaus	0.456	0.426	0.257	0.268
landscapes of mountains	0.481	0.434	0.286	0.322
landscapes of cirques	0.497	0.415	0.290	0.320
landscapes of carved valleys	0.458	0.384	0.269	0.292
landscapes of broad floodplains	0.395	0.338	0.257	0.295
karst landscapes	0.668	0.710	0.605	0.506
landscapes of flatlands	0.329	0.282	0.326	0.284
rocks and crags	0.540	0.580	0.452	0.365
peatbogs	0.266	0.331	0.210	0.140
meadow vegetation close to the traditional farming	0.295	0.308	0.257	0.159
rocks, crags	0.540	0.541	0.405	0.324
occurrence of a rare animal	0.429	0.345	0.265	0.305
occurrence of a rare plant	0.295	0.261	0.257	0.198
cave	0.589	0.631	0.677	0.763
spring with potable water	0.404	0.308	0.317	0.251
spring with mineral water	0.369	0.324	0.345	0.318
waterfall	0.817	0.798	0.624	0.849
church	0.211	0.290	0.277	0.272
monastery	0.191	0.295	0.273	0.241
chapel	0.132	0.166	0.202	0.203
Jewish monument	0.167	0.217	0.269	0.232
tower house	0.591	0.831	0.884	1.000
castle	0.558	0.805	0.839	0.985
remains of fortresses and fortified settlements	0.325	0.402	0.350	0.342
ruins of tower houses or other monuments	0.512	0.663	0.624	0.623
memorial of an important person	0.147	0.176	0.202	0.216

Tab. 2: The relative degrees of attractiveness of the surveyed attractions for the respective identified segments

	Modern outdoor tourism	Traditional tourism oriented to the stay in nature and visit to historical monuments	Rather passive and non-engaged tourism	Hotel-based tourism oriented to entertainment and recreational activities
Calvary chapels	0.097	0.092	0.080	0.077
Calvary crosses	0.077	0.061	0.083	0.051
conciliation crosses	0.090	0.066	0.074	0.053
historically important cemetery	0.145	0.186	0.158	0.185
museum	0.351	0.436	0.514	0.536
open-air museum	0.345	0.428	0.436	0.381
dilapidated villages	0.151	0.147	0.136	0.136
gallery	0.155	0.304	0.265	0.316
point of an important historical event	0.247	0.301	0.308	0.292
place where an important historic person was living and/or creating	0.158	0.257	0.217	0.249
important border stone	0.123	0.121	0.151	0.097
monuments of popular architecture	0.334	0.290	0.299	0.320
town historical buildings	0.336	0.407	0.586	0.553
theatre	0.227	0.282	0.360	0.495
observation and viewpoint	0.601	0.605	0.503	0.594
historical factories	0.160	0.113	0.195	0.114
historical mines and panning sites	0.134	0.140	0.116	0.109
rural workrooms and storehouses	0.162	0.163	0.171	0.112
water mills and iron-mills	0.289	0.242	0.202	0.247
historical transport equipment	0.125	0.154	0.124	0.146
water tanks and waterworks towers	0.063	0.067	0.057	0.063
water dams	0.431	0.295	0.410	0.374
line fortification of the Czechoslovak Republic	0.117	0.121	0.133	0.059
offer of horse riding	0.111	0.121	0.065	0.128
public outdoor swimming pools and bathing places	0.519	0.336	0.663	0.790
places suitable for paddling	0.316	0.159	0.277	0.309
pistes	0.322	0.142	0.544	0.386
golf courses	0.018	0.000	0.061	0.125
tennis courts	0.077	0.034	0.095	0.208
spas	0.302	0.322	0.405	0.525
zoological garden	0.499	0.650	0.593	0.871
botanical garden and arboretum	0.295	0.407	0.282	0.360
possibility of climbing	0.170	0.039	0.063	0.078
observatories and planetariums	0.228	0.288	0.142	0.282
possibility of recreational fishing	0.053	0.022	0.028	0.022

Tab. 2: continuing

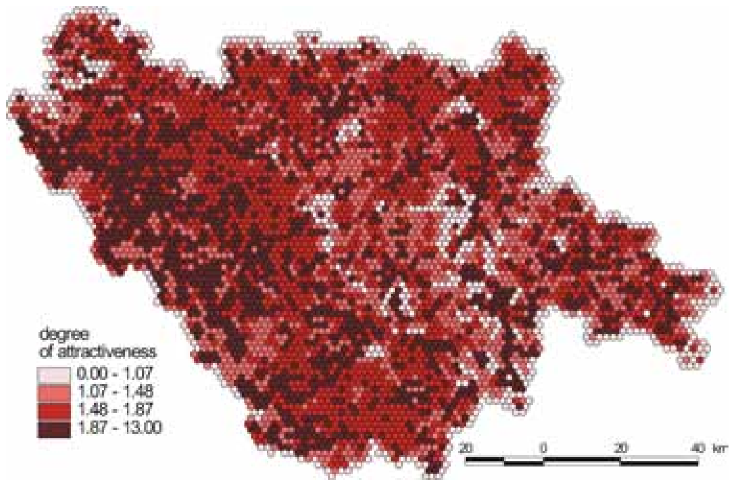

Fig. 7: The degree of attractiveness of the tourist regions of South Bohemia and the Šumava Mountains: the segment of "modern outdoor tourism". The categories used represent the quartiles of the data set of all four identified segments

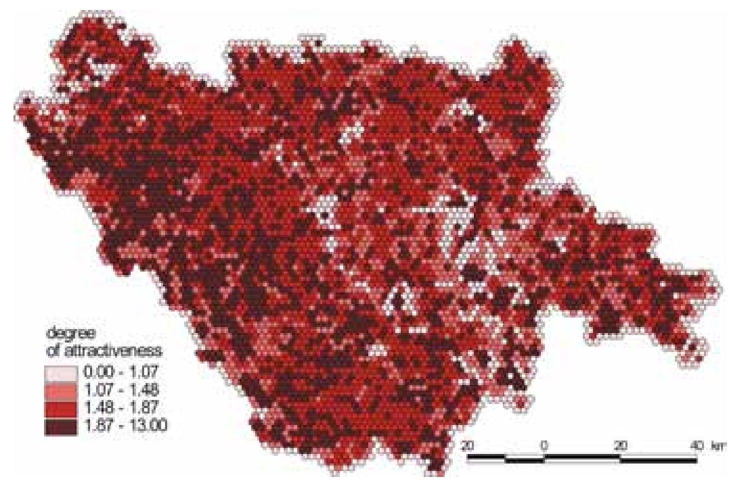

Fig. 8: The degree of attractiveness of the tourist regions of South Bohemia and the Šumava Mountains: the segment of "traditional tourism oriented towards the stay in nature and the visit of historical monuments". The categories used represent the quartiles of the data set of all four identified segments

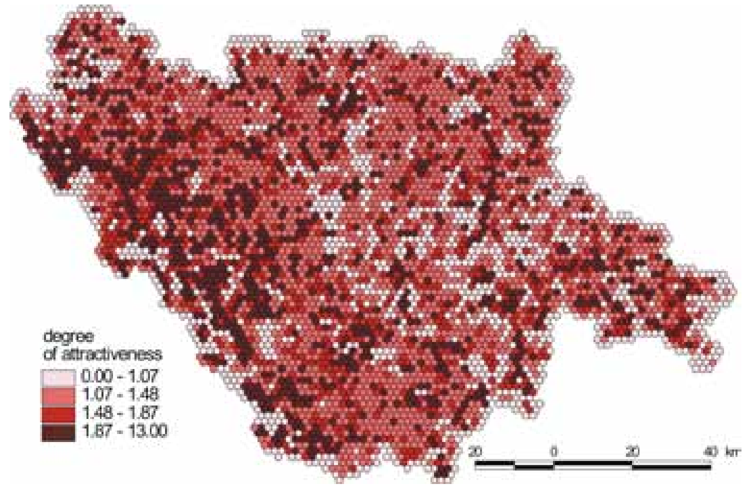

Fig. 9: The degree of attractiveness of the tourist regions of South Bohemia and the Šumava Mountains: the segment of "rather passive and non-engaged tourism with the dominance of importance of easily accessible destinations". The categories used represent the quartiles of the data set of all four identified segments

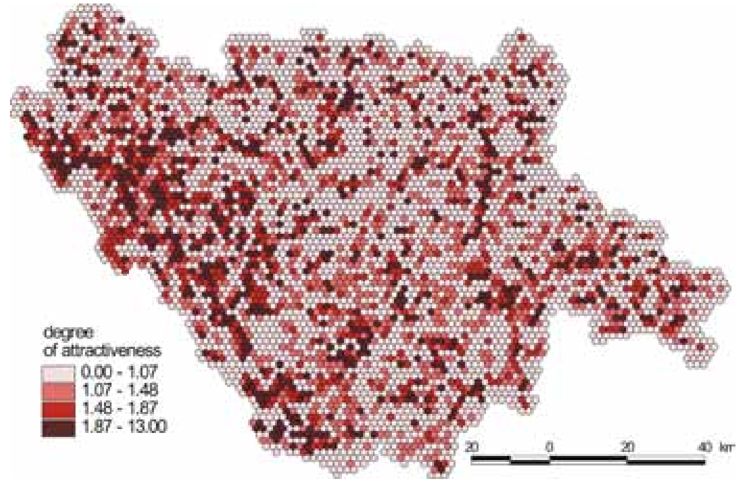

Fig. 10: The degree of attractiveness of the tourist regions in South Bohemia and the Šumava Mountains: the segment of "hotel based tourism oriented towards the entertainment and recreational activities". The categories used represent the quartiles of the data set of all four identified segments

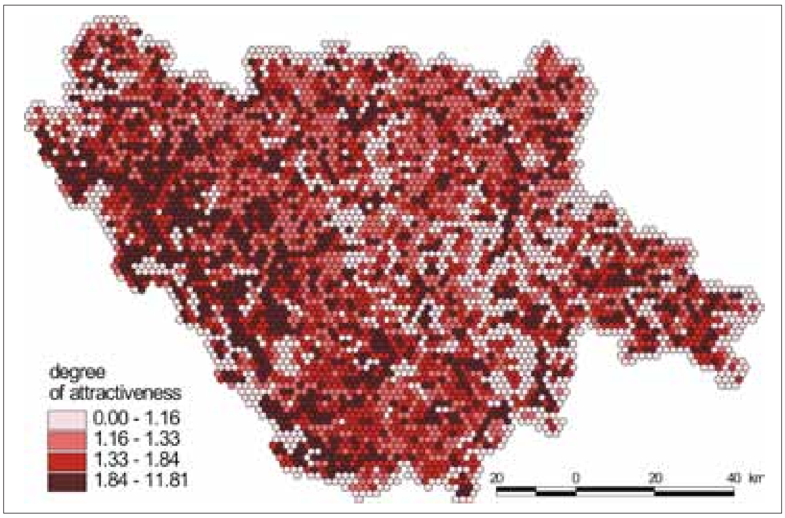

Fig. 11: Degree of total attractiveness of the tourist regions South Bohemia and Šumava Mts.

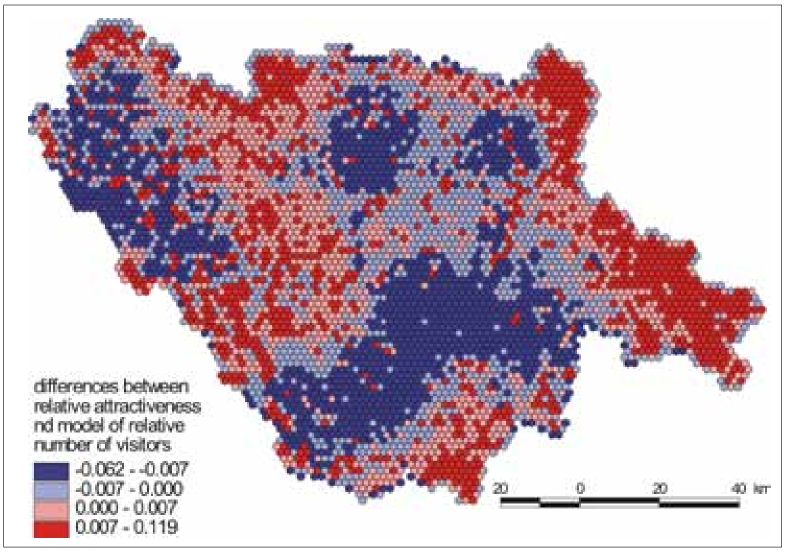

Fig. 12: Spatial identification of the development areas of tourism in the regions of South Bohemia and Šumava Mts., based on differences between the relative attractiveness and the model of relative attendance

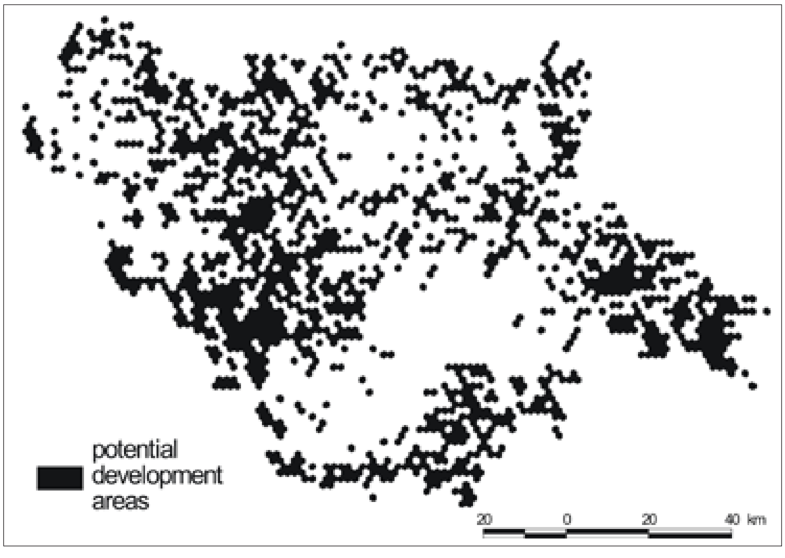

Fig. 13: Spatial identification of the development areas of tourism in the tourist regions of South Bohemia and Šumava Mts. based on the intersection of areas showing positive values of differences between the relative attractiveness and relative model number of visitors and attractive areas

When comparing the attractiveness of the territory with the model number of its visitors, we can identify specific areas, which show a surplus of attractiveness, i.e. those where the relative surplus of attractiveness exists in relation to relative attendance.

Five spatial areas with lower development of tourism in the surveyed area can be identified in the spatial formulation (Fig. 12): those are part of the Šumava Mountains in the surroundings of Prachatice, Novohradské Hory Mts., Jindřichův Hradec and Dačice, the South Bohemian part of the area called the Czech Siberia, and the area of Blatná.

Primarily those parts of the surveyed areas could potentially become developed areas, which are, at the same time, of above-average attractiveness. However, the intersection of the above-average attractive areas with the areas showing a surplus of attractiveness against the model attendance (Fig. 13), identifies the more compact potentially developed areas only in the case of Jindřichův Hradec area, Dačice area and the part of the Šumava Mts. in the surroundings of Prachatice. In the Jindřichův Hradec area, it is primarily the hilly area element, followed in the south by another attractive part of Nová Bystřice and Staré Město, i.e. a substantial part of the area called the "Czech Canada". The developed parts of the Dačice area are the Dačice Depression and the south-east bordering areas of the Brtnice Upland.

The largest area that is attractive and at the same time shows an excess of the relative degree of attractiveness over the relative degree of the model attendance rate, is the southern part of the Prachatice area. Here the river basin of the upper Blanice R. and the valley of the Warm Vltava River, with the surrounding hillsides, represent the most compactly developed area. The area extends to the Boubín Forest in the north and up to the Knížecí Pláně (Fuerstenhut) with the apparent split of the land in the ridge part of the Šumava Mts. in the south. Another closed area of development is constituted by the surroundings of Volyně. This area is determined approximately by the Volyně–Malenice–Čkyně–Čestice quadrangle. A larger number of developmental hexagons, but still not constituting a compact area, is situated in the area of the Šumava Foothills among the towns of Strakonice, Horažďovice and Sušice. Other areas can be detected from Fig. 13: the Blatná area, the Novohradské Hory Mts. and the Pacovská vrchovina Hilly Land to the east of Tábor.

What is also interesting is the comparison of areas with an attendance surplus. While the areas in both the south and the north are almost compact, the area of the "Mountainous Šumava" comprises, despite the high attendance in the entire territory, quite a high number of areas where the relative attractiveness surpasses the relative model attendance rate (Fig. 12, Fig. 13).

4. Conclusions

Theoretical and methodological conclusions

The assessment of the spatial distribution of tourists in the destination regions is problematic due to the lack of empirical data on the number of visitors to many tourist attractions. The proposed model of the spatial distribution of visitors is derived from the assumption that the tourists are accommodated during their stay in the model territory in some of the accommodation facilities. These accommodation facilities can then possibly to be understood as cores from which the visitors spread out to attractive localities in the region (Schoval, McKercher, Ng and Birenboim, 2011). It has already been demonstrated that accommodation facilities in the surveyed area are situated in localities considered in the literature as attractive (Navrátil et al., 2012).

Numerous approaches exist to modelling the attractiveness of a territory for tourism: for example, see the Czech and Slovak research papers recently summarized by Vystoupil, Holešinská, Kunc and Šauer, 2008, and Vystoupil and Kunc, 2009. Considering the fact that the impact of demand segment on the perception of the degree of attractiveness of the attractions is well known, this basic model (derived from the location of preconditions for the development of tourism – Mariot, 1983) was completed with the degree of attractiveness of the observed types of attractions for partial segments of demand. Those segments were determined based on interrogating the visitors in the surveyed tourist regions. The attractiveness of particular areas significantly differs among particular demand segments, thus affecting the total attractiveness of the surveyed territory.

The spatially varied location of the particular attractions made it possible to identify areas showing a surplus of attractiveness over the model demand. The results are related to the mean values of the observed indicators in the surveyed territory. They confirm the assumption of the existence of a territory with above-average attractiveness but with values of a below-average visit rate in the surveyed area.

Practical implications

These conclusions are particularly useful when managing the number of visitors to the attractions and destinations, namely within the management of tourism in vulnerable areas when considering the objectives of regional development (Foret and Foretová, 2001; Foret and Klusáček, 2011; Macháček, 2004; Rumpel et al., 2011).

Obtaining knowledge of the spatial distribution of visitors is important for the management of destinations. That distribution is concentrated in the surveyed area into two main areas: the north-western Šumava Mts. and the arch in the southeastern part of the territory, which is created by the mutually entwining zones of the Lipno Reservoir area, the Český Krumlov area, the České Budějovice area and the northern Třeboň area. The third area is the zone of the north with cores in the Písek–Orlík area and in Tábor. The attractiveness of the territory was assessed as well, based on the perception of attractiveness of all partial observed types of attractions by model respondents. The above-mentioned perception analysis confirmed a distinctive difference in the attractiveness of the territory for different types of visitors, who visit all the respective areas and meet one another at the attractions. The potential areas of development were located by the model in the Jindřichův Hradec area, the Dačice–Slavonice area and the Javornická vysočina Highland. The potential for development was detected especially for a larger part of the Prachatice area in the Šumava Mts.

Limitations in using these research results

The main limitation of the research results consists primarily in their relative foundation. The employed methodology is relative in its core: the results of the partial areas are in this treatise always related to the overall data of the whole area, so their validity is non-transferable in absolute data and not comparable with the outputs of other areas. Nevertheless, it is possible that they can be applied on various levels of the spatial measure. Possibilities of the extension of this study are obvious: enlargement of the surveyed territory to the level of the entire Czech Republic. Another problem of the model is the generalization of the homogeneity of the degree of attractiveness for all attractions of a given type (Bína, 2002). The model presented here is also limited only to the basic elements of the competitiveness of the destinations, which are the core sources and attractions as well as the basic attractions related to the previously-cited elements. The aim was to assess elements that are unambiguously spatially locatable. For that reason, the model of identification of the areas of development does not include other elements that are important for the competitiveness of destinations (Buhalis, 2000; Ritchie and Crouch, 2003).

Acknowledgement

This paper was compiled with the support from the Czech Science Foundation – GACR P404/12/0334 "Factors of visitors' relation to the ambience of attractions in vulnerable areas". The authors also express their gratitude to 19 students as data collection assistants and all those who participated likewise in the questionnaire surveys.

References:

AOPK ČR (2011). Ústřední seznam ochrany přírody. [online]. [cit. 2011-11-15]. Available at: URL: <http://drusop.nature.cz/> .

AOPK ČR (2012). Jednotná evidence speleologických objektů. [online] [cit. 2012-04-01]. Available at: URL: <http://jeso.nature.cz/>.

APLIN, G. (1983): Order-neighbour analysis. Norwich, Geo Books, 38 pp.

ATHAN, T., BLAZEK, R., CONTRERAS, G., DASSAU, O., DOBIAS, M., ERSTS, P. et al. (2011): Quantum GIS user guide, Version 1.7.0 'Wroclaw'. [online] [cit. 2011-10-20]. Available at: URL: http://download.osgeo.org/qgis/doc/manual/qgis-1.7.0_user_guide_en.pdf.

BARRY, J., PROOPS, J. (1999): Seeking sustainability discourses with Q methodology. Ecological Economics, Vol. 28, No 3, p. 337–345.

BENTHIEN, B. (1997): Geographie der Erholung und des Tourismus. Gotha, Justus Perthes Verlag, 192 pp.

BÍNA, J. (2002): Hodnocení potenciálu cestovního ruchu v obcích České republiky. Urbanismus a územní rozvoj, Vol. 5, No. 1, p. 2–11.

BUHALIS, D. (2000): Marketing the competitive destination in the future. Tourism Management, Vol. 21, No. 1, p. 97–116.

CETKOVSKÝ, S., KLUSÁČEK, P., MARTINÁT, S., ZAPLETALOVÁ, J. (2007): Some aspects of cross-border cooperation in Euroregions of the Czech Republic: An example of the Šumava Region. Moravian Geographical Reports, Vol. 15, No. 1, p. 43–55.

ČRS (2003): Statistika úlovků 2002. CD-ROM, Dep.: Výbor územního svazu pro Severní Moravu a Slezsko ČRS, Ostrava.

DAWKINS, C. J. (2003): Regional development theory: Conceptual foundations, classic works, and recent developments. Journal of Planning Literature, Vol. 18, No. 2, p. 131–172.

DOODY, D., KEARNEY, P., BARRY, J., MOLES, R., O'REGAN, B. (2009): Evaluation of the Q-method as a method of public participation in the selection of sustainable development indicators. Ecological Indicators, Vol. 9, No. 6, p. 1129–1137.

DWYER, L., FORSYTH, P., DWYER, W. (2010): Tourism economics and policy. Bristol, Channel View Publications, 776 pp.

ECONOMIA (2002): Atlas pro volný čas. Praha, Economia, 120 pp.

FORET, M., FORETOVÁ, V. (2001): Jak rozvíjet místní cestovní ruch. Praha, Grada, 180 pp.

FORET, M., KLUSÁČEK, P. (2011): The importance of the partnership and cooperation in the regional development exampled on Znojmo region. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, Vol. 59, No. 4, p. 79–85.

GIBSON, C. (2008): Locating geographies of tourism. Progress in Human Geography, Vol. 32, No. 3, p. 407–422.

GOELDNER, C. R., RITCHIE, J. R. B. (2009). Tourism: Principles, practices, philosophies. New York, Wiley, 1092 pp.

GUNN, C. A. (1997): Vacationscape: Developing tourist areas. Washington, Taylor & Francis, 196 pp.

HALL, C. M., LEW, A. A. (2009): Understanding and managing tourism impacts: An integrated approach. Oxon, Routledge, 392 pp.

HALL, C. M., PAGE, S. (2009): Progress in tourism research: From the geography of tourism to geographies of tourism - A review. Tourism Management, Vol. 30, No. 1, p. 3–16.

HASHIMOTO, A. (2002): Tourism and sociocultural development issues. In: Sharpley, R., Talfer, D. J.: Tourism and development. Concepts and issues. Clevedon, Channel View Publications, p. 202–230.

CHRISTOFAKIS, M. (2010): Strategic options for tourism impacts on local sustainability: A conceptual approach. Local Economy, Vol. 25, No. 7, p. 586–598.

CHYTRÁ, M., HANZELKA, P., KACEROVSKÝ, R. [eds.] (2010): Botanické zahrady a arboreta České republiky. Praha, Academia, 408 pp.

KITSON, M., MARTIN, R., TYLER, P. (2004): Regional competitiveness: An elusive yet key concept? Regional Studies, Vol. 38, No. 9, p. 991–999.

KOTLER, P., KELLER, K. L. (2007): Marketing management. Praha, Grada, 787 pp.

KŘÍŽ, H. (1985): Podzemní vody. In: Chábera, S. et al. [eds.]: Jihočeská vlastivěda. Přírodní vědy. Neživá příroda. České Budějovice: Jihočeské nakladatelství, p. 153–166.

KUŠEN, E. (2010): A system of tourism attractions. Tourism – An International Interdisciplinary Journal, Vol. 58, No. 4, p. 409–424.

LÖW, J., NOVÁK, J. (2008). Typologické členění krajin České republiky. Urbanismus a územní rozvoj, Vol. 11, No. 6, p. 19–23.

MACHÁČEK, J. (2004): Koncept místního rozvoje. In: Grospič, J.: Úvod do regionálních věd a veřejné správy. Plzeň, Aleš Čeněk, p. 213–225.

MARIOT, P. (1983): Geografia cestovného ruchu. Bratislava, Akadémia, 252 pp.

MIHALIČ, T. (2002): Tourism and economic development issuues. In: Sharpley, R., Talfer, D. J.: Tourism and development. Concepts and issues. Clevedon, Channel View Publications, p. 81–111.

MOUTINHO, L. [ed.] (2000): Strategic management in tourism. Oxon, CABI Publishing, 349 pp.

NAVRÁTIL, J. (2004): Konflikty rekreačního rybolovu s životním prostředím z pohledu zástupců MO MRS. In: Herber, V. [ed.]: Fyzickogeografický sborník 1, Brno, PřF MU and ČGS, p. 217–220.

NAVRÁTIL, J. (2008): Vodní komponenta krajiny v přírodně orientovaném venkovském cestovním ruchu na příkladu Třeboňska. Acta Universitatis Bohemiae Meridionales, Vol. 11, No. 1, p. 73–82.

NAVRÁTIL, J., PÍCHA, K., HŘEBCOVÁ, J. (2010): The importance of historical monuments for domestic tourists: The case of South-western Bohemia (Czech Republic). Moravian Geographical Reports, Vol. 18, No. 1, p. 45–61.

NAVRÁTIL, J., PÍCHA, K., RAJCHARD, J., NAVRÁTILOVÁ, J. (2011): Impact of visit on visitors‘ perceptions of the environments of nature-based tourism sites. Tourism, Vol. 59, No. 1, p. 7–23.

NAVRÁTIL, J., NAVRÁTILOVÁ, J. (2011): Geografie pro cestovní ruch. České Budějovice, EF JU v ČB, 230 pp.

NAVRÁTIL, J., ŠVEC, R., PÍCHA, K., DOLEŽALOVÁ, H. (2012): The location of tourist accomodation facilities: A case study of the Šumava Mts. and South Bohemia tourist regions (Czech Republic). Moravian Geographical Reports, Vol. 20, No. 3, p. 50–63.

NAVRÁTIL, J., PÍCHA, K., NAVRÁTILOVÁ, J. (2012): Satisfaction with visit to tourism attractions. Tourism, Vol. 60, No. 4, p. 411–430.

NAVRÁTIL, J., PÍCHA, K., KNOTEK, J., KUČERA, T., NAVRÁTILOVÁ, J., RAJCHARD, J., WHITE BARAVALLE GILLIAM, V. L. (2013): The comparison of attractiveness of tourist sites for ecotourism and mass tourism: The case of waters in mountainous protected areas. Tourismos: an International Multidisciplinary Journal of Tourism, Vol. 8, No. 1 (accepted).

NPÚ (2012). WMS/neverejne_sprava_wms (MapServer). [online] [2012-04-10]. Available at: URL: http://mapy.npu.cz/ArcGIS/rest/services/WMS/neverejne_sprava_wms/MapServer.

POMPUROVÁ, K. (2011): Atraktívnosť Slovenska pre vybraný segment návštěvníkov. E+M Ekonomie a Management, Vol. 14, No. 2, p. 137–150.

RAY, D. (2008): Development economics. In: Durlauf, S. N., Blume, L. E. (eds.): The new Palgrave dictionary of economics. Palgrave Macmillan. [online] [cit. 2012-04-21]. Available at: URL: http://www.dictionaryofeconomics.com/article?id=pde2008_D000105.

REAL, E., ARCE, C., SABUCEDO, J. M. (2000): Classification of landscapes using quantitative and categorical data, and prediction of their scenic beauty in north-western Spain. Journal of Environmental Psychology, Vol. 20, No. 4, p. 355–373.

RITCHIE, J. R. B., CROUCH, G. I. (2003): The competitive destination: A sustainable tourism perspective. Oxon, CABI Publishing, 272 pp.

RUMPEL, P., BORUTA, T., SLACH, O., BEDNÁŘ, P., HAVRLANT, J. NOVÁK, D. W., PTÁČEK, P., ŽUFAN, P. (2011): Komplexní regionální marketing periferního rurálního regionu Jesenicko. Plzeň, Aleš Čeněk, 244 pp.

SHARPLEY, R. (2002). Tourism and development - A vehicle for evelopment? In: Sharpley, R., Talfer, D. J.: Tourism and development. Concepts and issues. Clevedon, Channel View Publications, p. 11–34.

SHOCart (2012): Turistická mapa. [online]. [cit. 2012-04-02]. Available at: URL: <http://www.mapy.cz>.

SHOVAL, N., MCKERCHER, B., NG, E., BIRENBOIM, A. (2011): Hotel location and tourist activity in cities. Annals of Tourism Research, Vol. 38, No. 4, p. 1594–1612.

STATSOFT (2011): Electronic statistics textbook. StatSoft, Tulsa. [online]. [cit. 2011-10-12]. Available at: URL: < http://www.statsoft.com/textbook/>.

ŠVEC, R., NAVRÁTIL, J., PÍCHA, K., WHITE BARAVALLE GILLIAM, V.L. (2012): The Perception of the Quality of Accommodation Establishments' Product. DETUROPE. Central European journal of regional development and tourism. Vol. 4, No. 2, p. 4–21.

TELFER, D. J. (2002a): The evolution of tourism and development theory. In: Sharpley, R., Talfer, D. J.: Tourism and development. Concepts and issues. Clevedon, Channel View Publications, p. 35–80.

TELFER, D. J. (2002b): Tourism and regional development issues. In: Sharpley, R., Talfer, D. J.: Tourism and development. Concepts and issues. Clevedon, Channel View Publications, p. 112–148.

TIMOTHY, D. J. (2002): Tourism and community development issues. In: Sharpley, R., Talfer, D. J.: Tourism and development. Concepts and issues. Clevedon, Channel View Publications, p. 149–164.

VEPŘEK, K. (2002): Hodnocení potenciálu cestovního ruchu a jeho využití v územních plánech VÚC. Urbanismus a územní rozvoj, Vol. 5, No. 3, p. 17–28.

VYSTOUPIL, J., HOLEŠINSKÁ, A., KUNC, J., ŠAUER, M. (2008): Teoreticko-metodologické přístupy k tvorbě rajonizace cestovního ruchu v České republice. Ekonomická revue cestovného ruchu, Vol. 41, No. 2, p. 105–117.

VYSTOUPIL, J., KUNC, P. (2009): Geografický výzkum cestovního ruchu v ČR v letech 1950–2008. In: HALÁS, M., KLAPKA, P., SZCZYRBA, Z. [eds.]: Geographia Moravica 1: Sborník prací k šedesátinám doc. RNDr. Václava Touška, CSc. Univerzita Palackého v Olomouci, Olomouc, p. 103–119.

VYSTOUPIL, J., HOLEŠINSKÁ, A., KUNC, J., MARYÁŠ, J., SEIDENGLANZ, D., ŠAUER, M., TONEV, P. et al. (2006): Atlas cestovního ruchu České republiky. Praha, Ministerstvo pro místní rozvoj, 157 pp.

WILLIAMS, S. (1998): Tourism geography. London, Routledge, 212 pp.

WWW.ROPIKY.NET (1999–2012). Mapa Československého opevnění. [online]. [cit. 2012-01-01]. Available at: URL: www.world/tourism.org.

Author´s adresses:

RNDr. Josef NAVRÁTIL, Ph.D.
Department of Economics, Faculty of Economics, University of South Bohemia in České Budějovice
Studentská 13, 370 05 České Budějovice, Czech Republic
e-mail: *josefnav@gmail.com*

Ing. Kamil PÍCHA, Ph.D.
Department of Trade and Tourism, Faculty of Economics, University of South Bohemia in České Budějovice
Studentská 13, 370 05 České Budějovice, Czech Republic
e-mail: *kpicha@ef.jcu.cz*

Mgr. Stanislav MARTINÁT
Department of Environmental Geography, Institute of Geonics, Academy of Sciences,v. v. i.
Drobného 28, 602 00 Brno, Czech Republic
e-mail: *martinat@geonika.cz*

JUDr. et Mgr. Jaroslav KNOTEK, Ph.D.
Department of Applied and Landscape Ecology, Faculty of Agronomy, Mendel University in Brno
Zemědělská 1, 613 00 Brno, Czech Republic.
e-mail: *jarda.knotek@uake.cz*

RNDr. Tomáš KUČERA, Ph.D.
Department of Ecosystem Biology, Faculty of Science, University of South Bohemia in České Budějovice
Branišovská 31, 370 05 České Budějovice, Czech Republic
e-mail: *kucert00@prf.jcu.cz*

RNDr. Zuzana BALOUNOVÁ, Ph.D.
Department of Biological Studies, Faculty of Agriculture, University of South Bohemia in České Budějovice
Studentská 13, 370 05 České Budějovice, Czech Republic
e-mail: *baloun@zf.jcu.cz*

Vivian L. WHITE BARAVALLE GILLIAM (MA)
The Institute of Technology and Business in České Budějovice
Okružní 517/10, 370 01, České Budějovice, Czech Republic
e-mail: *vivian@mail.vstecb.cz*

Ing. Roman ŠVEC
Department of Trade and Tourism, Faculty of Economics, University of South Bohemia in České Budějovice
Studentská 13, 370 05 České Budějovice, Czech Republic
e-mail: *rsvec@ef.jcu.cz*

doc. RNDr. Ing. Josef RAJCHARD, Ph.D.
Department of Biological Studies, Faculty of Agriculture, University of South Bohemia in České Budějovice
Studentská 13, 370 05 České Budějovice, Czech Republic
e-mail: *rajchard@zf.jcu.cz*

Initial submission 20 June 2012, **final acceptance** 15 March, 2013

Please cite this article as:

NAVRÁTIL, J., PÍCHA, K., MARTINÁT, S., KNOTEK, J., KUČERA, T., BALOUNOVÁ, Z., White Baravalle Gilliam, V. L., Švec, R., Rajchard, J. (2013): A Model for the identification of Areas Favourable for the development of Tourism: A Case Study of the Šumava Mts. and South Bohemia Tourist Regions (Czech Republic). Moravian Geographical Reports, Vol. 21, No. 1, p. 25–40.

LAND-USE CHANGES AND THEIR RELATIONSHIPS TO SELECTED LANDSCAPE PARAMETERS IN THREE CADASTRAL AREAS IN MORAVIA (CZECH REPUBLIC)

Zdeněk OPRŠAL, Bořivoj ŠARAPATKA, Petr KLADIVO

Abstract

The analysis of changes in landscape use and the related significance of some natural factors is examined in this paper, using three municipal cadastral areas in Moravia, Czech Republic. The relationships between changes in the use of the rural landscape and natural conditions were analyzed with the use of GIS tools and methods of canonical correspondence analysis (CCA). The CCA results showed a correlation between the selected natural factors and landscape changes, with the most significant factors being those of slope and altitude. The CCA models exhibited varying reliability in accounting for the extent of landscape changes related to topographical diversity of the territories. Natural conditions were more influential in periods with lower change dynamics and at the same time in areas with higher topographic heterogeneity. Although the results of the statistical analyses confirmed the significance of natural factors, only a part of land use changes could be explained by their influence. Socio-economic factors are apparently the main forces affecting landscape character and change .

Shrnutí

Změny ve využití krajiny a jejich vztah k vybraným přírodním faktorům na příkladu tří katastrálních území na Moravě, Česká republika

Článek se soustřeďuje na analýzu změn využití krajiny a význam vybraných přírodních faktorů na příkladu tří katastrálních území obcí v České republice. Vztah mezi změnami ve využití venkovské krajiny a přírodními podmínkami byl analyzován pomocí nástrojů GIS a metod kanonické korespondenční analýzy (CCA). Výsledky CCA prokázaly korelaci vybraných přírodních faktorů a krajinných změn, přičemž nejvýrazněji se projevovaly faktory sklonu svahu a nadmořské výšky. CCA modely vykazovaly rozdílnou spolehlivost v závislosti na rozsahu krajinných změn a topografické různorodosti území. Přírodní podmínky se ve větší míře uplatňovaly v obdobích s nižší dynamikou změn a zároveň v oblastech s vyšší topografickou heterogenitou krajiny. Ačkoliv výsledky statistických analýz potvrdily význam přírodních faktorů, bylo jimi možné vysvětlit jen část celkových změn využití krajiny. Je zřejmé, že socioekonomické faktory jsou hlavními silami, které mají vliv na charakter krajiny.

Keywords: *Land-use change, rural landscape, environmental factors, Canonical Correspondence Analysis, Moravia, Czech Republic*

---

1. Introduction

Landscape changes are greatly influenced by socio-economic driving forces and by natural conditions. While the socio-economic factors are distinctly diverse and locality-specific, the natural conditions (e.g. slope gradient, altitude, soil quality etc.) are not dependent on changes in political systems or human society. The relationship between landscape changes and environmental factors is a theme which has not been given as much attention in former Eastern Block countries as it has received in Western Europe (e.g. Hietel et al., 2005). The landscape of these countries has undergone dramatic changes in many respects (Bičík and Štěpánek, 1994; Lipský, 1995; Lorincz and Balazs, 2002). Given the existence of unique historical maps of Central Europe (Bender, 2009), these changes in landscape structure were described in a number of local and regional studies. However, landscape-ecology studies usually focus on the description of the chronological and spatial development of the landscape structure at various scales (e.g. Machar and Servus, 2010; Demek et al., 2008; Cebecauerová, 2007), or they may analyze socio-economic factors (as driving forces) (Bičík et al., 2001; Lowicky, 2008). The role of environmental influences on landscape dynamics is generally given less attention. One of the aims of this article is to contribute to the understanding of the importance of specific environmental factors in the dynamics of landscape change in Central Europe using an example of three case studies in Moravia.

This paper focuses on the role of natural factors in rural landscape changes. The areas chosen for research represent various natural conditions typical of the Czech Republic. Two time periods were chosen (1938–1984 and 1984–2009), which encompass periods of significant change in the Czech society and landscape. The first period covers landscape changes following the introduction of socialism in 1948 and the subsequent period of agricultural collectivization. Changes of agricultural management methods were exhibited particularly in a marked waning of grasslands, especially in fertile agricultural areas, and in the distinctly increasing average size of fields (Šarapatka and Štěrba, 1998). The simplification of landscape structure and intensification of farming methods resulted in an overall degradation of the rural landscape. The second, shorter period, represents the transformation from socialist management to a market economy and the return to private forms of land and landscape management after 1989. These recent changes primarily encompass reduction in the acreage of arable land and extensification of farming in highland and upland regions, where the acreage of permanent grassland increased (Bičík et al., 2001).

2. The relationship between landscape development and environmental conditions

Changes in the landscape cover are also determined by a complex set of interactions between environmental and socio-economic factors. Knowledge of the dynamics of change in the landscape can contribute to an understanding of the historical development of land use and serve as a basic guide in predicting future changes in the landscape cover (Veldkamp and Lambin, 2001). This knowledge is important in establishing the sustainable management of the landscape and protection of basic landscape functions.

The dependence of the development of landscape changes on natural conditions has been the focus of several studies. However, their conclusions are not definite and it is difficult to generalize them due to the limited size of the areas studied. For example, the studies by Pan et al., 1999; Chen et al., 2001; Fu et al., 2006, all demonstrated a close relationship between natural factors and land use changes. Other studies, however, (e.g. Schneider and Pontius, 2001; Hietel et al., 2004; Hietel et al., 2005) indicated that land use changes had only a slight correlated dependence on natural conditions. The relationship between natural conditions and changes in land cover is, apart from natural factors, to some varying extent influenced by human activity, which can modify or eliminate the influence of the natural environment.

Research has also shown that the intensity of dependence on natural conditions may also be influenced by the landscape type, or rather by landscape topography. Changes in the spatial structure of landscape in highland regions are, according to del Barrio et al. (1997), significantly more dependent on natural factors than in intensively-farmed agricultural regions. Schneider and Pontius (2001), who studied intensively-used landscapes, indicated lower significance of environmental factors on land use changes use due to lower topographic diversity. On the other hand, according to Simpson et al. (2001), greater geomorphological diversity of landscape has a significant influence on the dynamics of land use change.

Factors such as land gradient, altitude and soil type influence the intensity of agricultural production. In areas characterized by steeper gradients, at higher altitudes and with less fertile soils, agricultural production results in lower yields due to the unfavourable natural conditions. Poor access for agricultural machinery may also play a role. Farming is concentrated in more fertile areas, whereas in agriculturally marginal areas there is a transition to less intensive forms of land use. Changes in land cover also relate to these factors – as confirmed in a study by Hietel et al. (2004) which confirmed a transition from arable land to grassland in areas of higher altitudes, with steeper gradient and worse soil quality. A similar conclusion was published by Fu et al. (2006), explaining the transformation from arable land to forest or grassland occurred especially on low-quality soils typified by steep slopes and damaged by erosion. On the other hand, newly–cultivated land emerged especially on fertile soils and on gently sloping terrains. Chen et al. (2001) confirmed the influence of slope and claimed difficult access as the main reason for gradual extensification of farming in areas with a steeper slope. On the other hand, they suggest that exposure of slope was not a significant factor in land-use changes (Chen et al. (2001). Finally, Simpson et al. (1994) and Pan et al. (1999) also studied geomorphological characteristics of land and pointed to a transition to less intensive forms of land use (from pasture to abandoned land, and from abandoned land to forest) on sites more difficult to work, for example on moraines, or in areas of higher altitudes. This study confirmed the findings of the above-mentioned researchers: namely that gradient, altitude, and soil characteristics proved to be the main determining factors in natural land cover changes, whereas slope aspect had no distinct influence.

Furthermore, this study shows that only a relatively small proportion of changes in landscape cover can be explained by environmental changes, especially in periods of great dynamic changes. The explanation can rely on the exclusion of several other environmental factors, but also on the fundamental influence of socio-economic factors. Subsequent research including selected socio-economic factors (Hietel et al., 2005) confirmed that land use changes result from the combined influence of environmental and socio-economic factors, which are in mutual interaction.

3. Material and methods

3.1 Study area

Three case study areas in the Czech Republic were chosen for the purposes of this study: the rural districts of Archlebov, Branná and Rychtářov (Fig. 1). Case selection criteria reflected an effort to represent the diversity of natural conditions. The chosen locations vary in character, from the most agriculturally fertile district of Archlebov, through the less-favourable upland landscape of Rychtářov, to the upland/highland character of the Branná district.

The Archlebov district has an area of 13.32 km^2 and is located in an old residential area of characteristically fertile intensively-farmed chernozem developed on loess. Arable land dominates in this area, partly situated on agrarian terraces, with no pasture land whatsoever. The northern section of higher elevation has been traditionally used for orchards and vineyards. The altitude range of this area is 200–415 m, with most farmland occurring at altitudes up to 350 m. Average annual temperature is 8–9 °C, average rainfall is 500–550 mm.

Fig. 1: Location of three study areas of Archlebov, Branná and Rychtářov in the Czech Republic
Source: The map was created by the authors with the use of ArcGIS 9.2, 2011

The Rychtářov district has an area of 11.52 km^2. According to historical records it was originally established as a forest plantation but soon acquired the character of farm land. Both arable land and permanent grasslands occur in the district. The landscape is of upland character with altitudes ranging from 309–487 m, the mean annual temperature is 7–8 °C with a mean total precipitation amount is 600–650 mm. The dominant soil types are cambisols and brown earths. The district of Rychtářov was threatened with demise during WWII because the German occupying authorities decided to evict the predominantly Czech inhabitants and turn the area into a military training ground. After the war, some of the residents returned to their devastated homes, but their number has never resumed the pre-war level.

The Branná district in the Jeseník highland region has an area of 14.56 km^2. A significant role in its settlement was played by the mining of precious metals, although in the 19th and 20th centuries the area was predominantly of agricultural character. The region's population underwent a dramatic change after WWII. Branná lies in the former Sudetenland, which was occupied mainly by people of German nationality before WWII. After the war, these inhabitants were displaced from Czechoslovakia and partial re-occupation occured with people of Czech nationality from other parts of the country. Apart from essential economic and social consequences, these changes also affected the use of the landscape. Arable land gradually disappeared from the region and was replaced by pastures, which now dominate the use of agricultural land in this highland region. Natural conditions of the area are of sub-mountainous/mountainous character – altitude 542–905 m, mean annual temperature 6–7 °C, mean annual precipitation amount 800–1000 mm. The landscape features a varied geological composition, with the dominant soil type being cambisols and their modifications.

3.2 Land-use data

For this study, we used a series of historical and contemporary aerial photographs of all three areas of land taken in the years 1937, 1984 and 2009. These years chosen made it possible to observe basic land use changes in two periods: 1938 – 1984 and 1984 – 2009. The first period includes changes in landscape structure and land use after 1948, the second period covers the period of agricultural transformation after 1989. The historical aerial photos from 1938 and 1984 lacked a valid system of coordinates. Therefore, they were orthorectified using the programme Leica Photogrammetry Suite (Leica Geosystems, 2006). The interpretation of the historical aerial photos was based on the analysis of interpretational marks of individual properties (Feranec and Otahel, 2001) with a simultaneous use of archive data and cadastral maps. On the basis of the CORINE Land Cover classification (Bossard et al., 2000), the landscape cover was divided into five basic categories: forest, arable land, grassland, water body and building. Using the ArcGIS 9.2 programme, the map data were manually transformed into digital topographic maps..

3.3 Environmental attribute data

The analysis primarily included environmental variables, representing natural physical attributes of the landscape, and also structural variables expressing the anthropogenic impact on the landscape structure (Hietel et al., 2004). The analyzed environmental factors included gradient, slope aspect, altitude, soil type and form of bedrock. Structural variables were represented by distance of the plot of land from the district centre and by the plot size. A map of gradient and slope orientation was obtained from a digital model of terrain on a scale 1:10 000 with the use of a spatial operation in the programme 3D Analyst ArcGIS 9.3. Average altitude of plots was taken from the contour lines on a scale 1:10 000, provided by the Czech Office for Surveying, Mapping and Cadastre. Raster land maps of the Czech Republic at 1:50 000 were orthorectified and digitized. Categories were maintained according to the national Taxonomic Soil Classification System (Němeček et al., 2011). A total of 8 soil types were defined: chernozems, haplic luvisols, fluvisols, albic luvisols, cambisols, regosols, stagnosols and gleysols.

With regard to the varying natural and geographic conditions, individual soil types usually developed only in certain areas of interest. Geological maps of the Czech Republic 1:50 000 were processed in the same way as the land maps. A total of 10 types of bedrock were identified: fluvial sediment, deluvial sediment, loess, schist, marble, gneiss, phyllite, quartzite, amphibolite and greywacke. In terms of geological bedrock, the individual areas of interest varied, too. The distance of the plots of land from the centre of the village represents accessibility; this variable, however, does not consider topographic conditions and the road network.

3.4 Spatial and multivariate analysis

In order to determine overall landscape changes and to identify the relationship between the main transformation processes in the landscape and natural conditions, a spatial analysis was carried out by overlapping digital layers for the chosen years within the geographic information system. First of all, by combining three digital land-use layers (for 1939, 1984 and 2009), layers were produced to represent the landscape cover transformation in the two observed periods (1939–1984 and 1984–2009). Subsequently, these newly-created layers were combined with the layers of geological and soil conditions. For all polygons representing the individual types of landscape development, calculations were made using a spatial operation of gradient, slope orientation and average altitude values. The variable of distance was set as a distance of the plot centre from the village centre. With regard to changes in the built-up area of individual villages, a distance from the church was used, as the church usually represents the village centre and its location remains unchanged over the years. The results in the form of an attribute table served as the basis for the partial analysis of landscape changes and canonical correspondence analysis.

By combining the layers for land use in various time periods, a combination of individual types emerged. These were the named landscape development types. The development types represented either the transformation from one land use form to another (e.g. arable land – permanent grassland), or the continuation of the same land use (e.g. land which is forested in both time periods). The resulting number of landscape development types was, however, too large. Therefore, it was reduced by combining them into six main types relating to primary processes occurring in the landscape. The processes were identified and described in the context of the European landscapes in the EEA report Land Accounts for Europe 1990–2000, specifically for the region of Central Europe e.g. in a study by Feranec et al., 2000. The following significant processes of landscape change were defined for our study areas:

- Urbanization: increase in the area of urban land use categories (any transformation to urban form);
- Intensification of agricultural production: increase in the acreage of arable land, vineyards and orchards;
- Extensification of agricultural production: shrinking arable land and other categories of intensive agricultural production in favour of extensive production (except for the transformation of agricultural land to forest);
- Forestation: increasing area of forested land categories;
- Deforestation: decreasing area of all forest categories; and
- Construction of water bodies: due to minimum occurrence, this category was omitted from the analysis.

Canonical Correspondence Analysis (CCA) was used to evaluate the relationships between the identified processes and the selected environmental and structural variables. The reliability of the resulting model, e.g. isolated axes and significance of relationships, was tested using the Monte Carlo permutation test.

4. Results

4.1 General trends in land-use changes

The results of the partial analysis indicated that the individual plots of land differed in the nature and intensity of land-use changes (Tab. 1).

In the period 1938 – 1984, the Branná district was by far the most dynamic area (see Fig. 2), which has to do with its historical development (removal of the original German population) and the sub-mountainous/mountainous character of the territory. In this period, as much as 60.4% of the land underwent transformation. In terms of their extent, the most significant processes were extensification (especially the transformation of arable land into grassland: 31.3% of the area) and forestation (28.5% of the area). Both processes concerned areas with a steep gradient (11.5% extensification; 14.0% forestation) and with the relatively high elevation (average 720 m a.s.l. in both cases). Other recorded processes (urbanization, intensification, deforestation) were marginal in extent, while intensification of agricultural production took place mainly on fluvial and deluvial soils at a more favourable altitude (640 m a.s.l.) and near to the village. In the following period 1984 – 2009, the areas were much more stable in terms of landscape changes, with only 12.2% of land being affected by changes. As with the previous time period, the processes of land use extensification (8.6% of land) and forestation (3.1% of land) continued. The other monitored processes showed only low levels of intensity.

In the case of Rychtářov, the period 1938 – 1984 was by contrast the most stable period, as only about 1% of the area (14 ha) underwent transformation, of which 3.5 ha was increased size of water surface and the same area (3.5 ha) was built up. Nearly 3 ha were forested; changes in extensification and intensification were rather insignificant. In the

type of process	Archlebov				Rychtářov				Branná			
	period 1938–1984		period 1984–2009		period 1938–1984		period 1984–2009		period 1938–1984		period 1984–2009	
	area (ha)	share (%)	area (ha)	share (%)	area (ha)	share (%)	area (ha)	share (%)	area (ha)	share (%)	area (ha)	share (%)
no change	1,253.53	94.4	1,287.81	96.7	1,139.09	99.09	1,093.69	94.86	576.89	39.6	1,278.41	87.8
urbanization	18.35	1.4	3.05	0.2	3.41	0.30	3.75	0.33	3.28	0.2	1.99	0.1
intensification	4.17	0.3	10.47	0.8	0.59	0.05	0.72	0.06	1.81	0.1	0.00	0.0
extensification	23.50	1.8	11.96	0.9	2.47	0.21	27.94	2.42	455.27	31.3	126.49	8.7
forestation	27.17	2.0	11.51	0.9	2.83	0.25	26.57	2.30	415.18	28.5	44.58	3.1
deforestation	1.69	0.1	7.20	0.5	1.16	0.10	0.33	0.03	3.56	0.2	4.53	0.3

Tab. 1: Area size (ha) and share (%) of land-use changes in the Archlebov, Rychtářov and Branná study areas
Source: authors

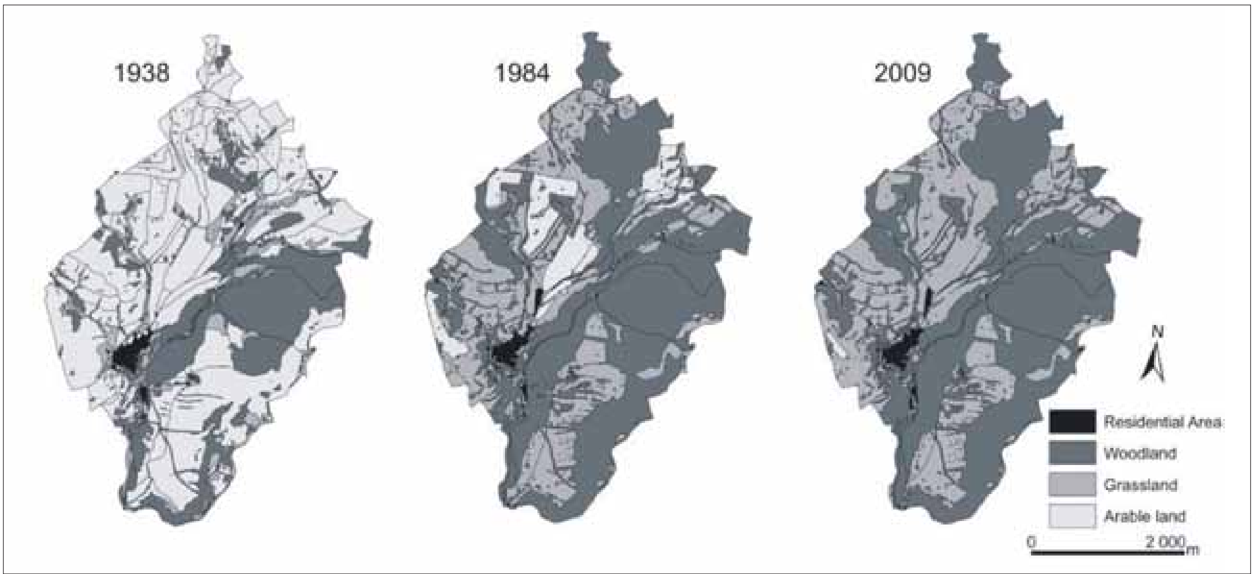

Fig. 2: Land-use patterns of the Branná study area in 1938, 1984 and 2009
Source: Maps were created by the authors with the use of ArcGIS 9.2, 2011

following period 1984 – 2009, landscape transformation intensified (approximately 5% of this area, representing almost 60 ha). Forestation was the most notable process, covering predominantly cambisols on steeper gradients (av. 8%). At the same time, extensification appeared as the conversion of crop fields to pasture land; this process was connected with the occurrence of cambisols and luvisols on greywackes.

The area of Archlebov can be characterized, in terms of land cover transformation and its dynamics, as relatively stable, as this only affected less than 6% of the area in the first time period 1938 – 1984. During that time, the most significant of all the monitored processes were those of extensification and forestation relating to steeper gradient of slopes (7–9%). In contrast to Rychtářov and Branná, the process of urbanisation in Archlebov was relatively significant (1.4% of the area, i.e. 18 ha in total). Intensification was also relatively distinct, occurring on 4.17% of the area. The intensity of transformation processes between 1984 and 2009 was at a similar level as in the previous period. Intensification mainly involved fluvisols while a part of the territory with unfavourable gradients (av. 12.5%) underwent the opposite process of extensification.

4.2 Canonical Correspondence Analysis of relationship between land cover changes and environmental variables

CCA enables the researcher to identify the relationships between land cover changes and environmental variables. Due to varying natural conditions, the analysis was carried out separately for each monitored territory and in two time periods; altogether, six CCA analyses were carried out. The Monte Carlo test provided the significance of the monitored environmental variables. The relationship of individual characteristics to the monitored processes of landscape changes are visualised in ordination graphs. Relationships of extracted axes to selected variables are given in the table of correlation coefficients (Tab. 2), which also shows the significance of individual variables.

The CCA results showed that only a limited proportion of landscape changes were dependent on natural factors. The effectiveness of models differed in this respect – it was lowest in the case of Branná in the first period of 1938 – 1984 when it only explained 3% of the original information. In the second period – 1984 – 2009, this model could explain 11.2% of the variance in the first two canonical variables. The most successful models were those of Rychtářov (15.9% for 1938 – 1984 and 16.7% for 1984 – 2009) and Archlebov (32.6% for 1938 – 1984); these values are within the range found by Hietel et al. (2004).

It is obvious from the level of CCA model success that the dependence of landscape changes on environmental characteristics is to a certain extent determined by the overall dynamics and character of landscape changes. The lowest values in the case of Branná relate to the fundamental transformation of the landscape, which was largely dominated by socio-economic processes (the post-war eviction of German residents and the related attempt to re-populate the area affected the use of the area quite notably) while the environmental characteristics, despite their relatively high diversity, played just a marginal role. The relatively low success of the Archlebov model in 1984 – 2009 probably relates to the character of changes – in this period, the agrarian terraces were built. Environmental variables played a significantly greater role in the monitored landscaping processes in areas with a relatively low overall dynamics of change and also in areas with greater topographical diversity (Rychtářov in both periods and Archlebov in the first period). However, the relatively low success rate of some models does not mean a failure of the CCA analysis but rather points out the limited ability

	Archlebov				Rychtářov				Branná			
	period 1938–1984		period 1984–2009		period 1938–1984		period 1984–2009		period 1938–1984		period 1984–2009	
	Axis I	Axis II	Axis I	Axis II	Axis I	Axis II	Axis I	Axis II	Axis I	Axis II	Axis I	Axis II
area	0.2474	–0.0150	0.2475	–0.0151	0.0878	0.3049	0.0442	–0.2262	0.7739	0.0130	0.6162	0.0669
elevation	–0.8883	0.2686	0.7321	0.4125	–0.6418	–0.0753	0.6433	–0.2219	0.1429	–0.7645	0.3422	–0.4592
slope	–0.4711	0.3103	0.7616	–0.3623	0.0332	–0.5846	–0.3944	0.0378	–0.4134	–0.2884	–0.5960	0.0737
aspect	–0.0347	0.0046	0.1679	–0.0429	0.4375	–0.1837	–0.4594	–0.4529	–0.0748	0.0635	0.2118	–0.4152
distance	0.8422	0.4906	–0.4453	–0.5483	0.3357	0.6507	0.2201	0.4861	–0.1518	0.1906	–0.4962	0.0734

Tab. 2: Intraset correlations between environmental variables and the first and second RDA axes
Source: Statistical evaluation in Canoco for Windows, 2011

of the environmental factors alone to explain changes in the landscape. The dynamics of landscape change undoubtedly depends also on the socio-economic factors. Considering their nature and variability, the inclusion of these factors in the CCA analysis is significantly limited.

The influence of environmental variables on the studied processes of landscape development is documented in ordination graphs from the canonical correspondence analysis (Figs. 3–5). The arrow length indicates the correlation of a given variable with the extracted ordination axis. Points represent the individual soil and rock types and the transformation processes. Their position indicates a relationship to the respective variable. In the case of Branná (1938–1984), the position of points pedo 1 and geo 7 (fluvisol, fluvial sediment) is not surprising in the upper left part of the diagram for the characteristically low altitude, whose vector points in the opposite direction. The relationship between the urbanization process and lower-lying land in the Branná cadaster is also logical. The most numerous instances of land transformation through extensification and forestation characteristically relate to higher altitudes with steeper terrains and larger areas.

The significance of individual environmental variables varies within the studied areas, but we can generally state that, of all explored environmental variables, slope gradient has the greatest effect. This variable is significantly evident in both the transfer to more intensive land use forms (relating to gently sloping terrains) and to extensification (forestation and other extensification processes on steep terrains which are difficult to farm). Altitude is also a notable environmental factor demonstrated in all areas of interest; its significance was particularly greater in territories more diverse in terms of elevation.

Other environmental variables are represented locally. For example the acreage of individual elementary plots is statistically important in Branná where, especially in the first time period studied, larger-size plots were significantly transformed. The influence of slope orientation and distance from the village is less demonstrable. The explanation of the relationship of soil and bedrock environment to landscape changes is rather debatable due to the remarkable difference in the proportion of types represented in the monitored areas. Nevertheless, there is quite a strong relationship between less fertile cambisols and luvisols and the transition to extensive farming.

The presented models did not consider stable areas where landscape use remained unchanged in consequential time periods; their inclusion would have probably changed the success rate in the individual models. Besides topographic characteristics and intensity of landscape processes, the changing success rate of the models is affected by the selection of individual data entering the CCA (ter Braak and Šmilauer, 2002). The basic environmental variables (altitude, gradient, aspect) set via GIS are included in

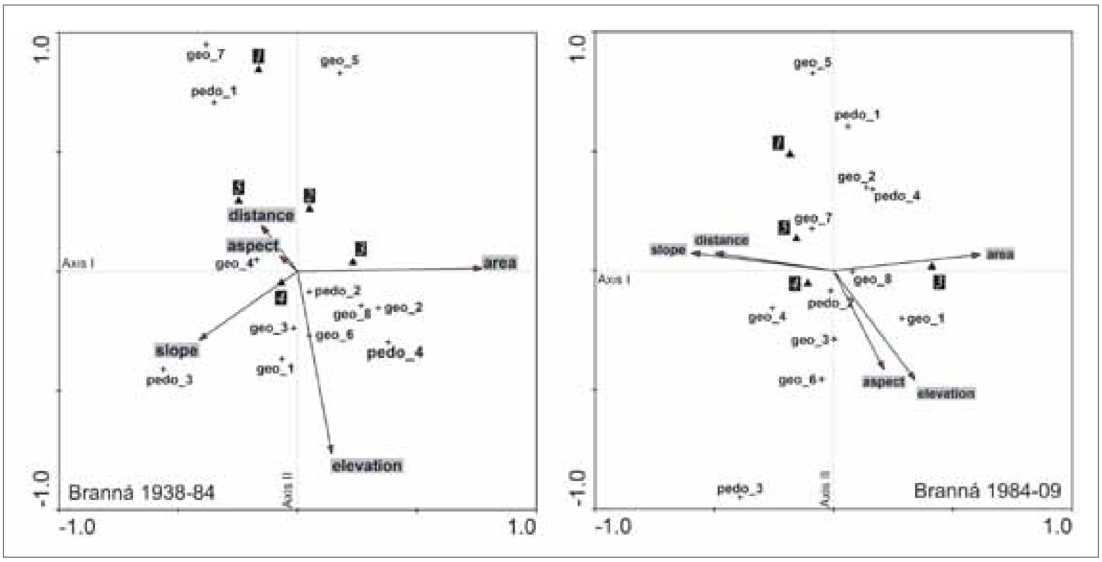

Fig. 3: CCA ordination of land cover transitions in two time periods (1938–1984 and 1984–2009) in the study area of Branná
Codes used in Figs. 3–5: 1 – urbanization, 2 – intensification of agricultural production, 3 – extensification of agricultural production, 4 – forestation, 5 – deforestation; geo_1 – schist, geo_2 – marble, geo_3 – gneiss, geo4 – phyllite, geo_5 – quartzite, geo_6 – amphibolite, geo_7 – fluvial sediments, geo_8 – deluvial sediments, geo_9 – loess, geo_10 – flysch, geo 11 – greywackes; pedo_1 – fluvisol, pedo_2 – cambisol, pedo_3 – stagnosol, pedo_4 – regosol, pedo_5 – chernozem, pedo_6 – haplic? luvisol, pedo_7 – albic luvisol, pedo_8 - gleysol

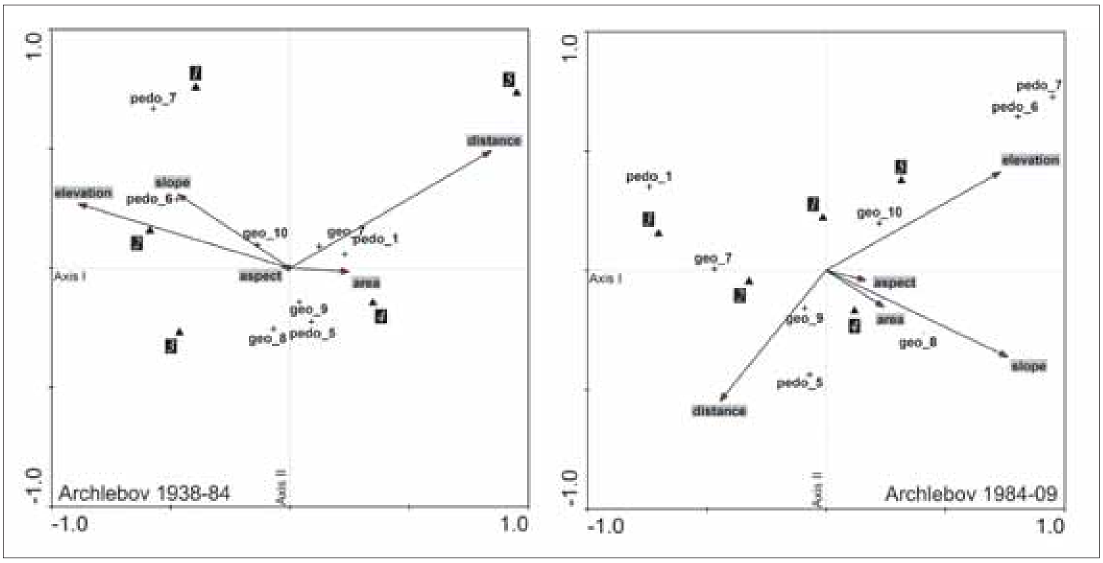

Fig. 4: CCA ordination of land cover transitions in two time periods (1938–1984 and 1984–2009) in the study area of Archlebov (for legend see Fig. 3 above)

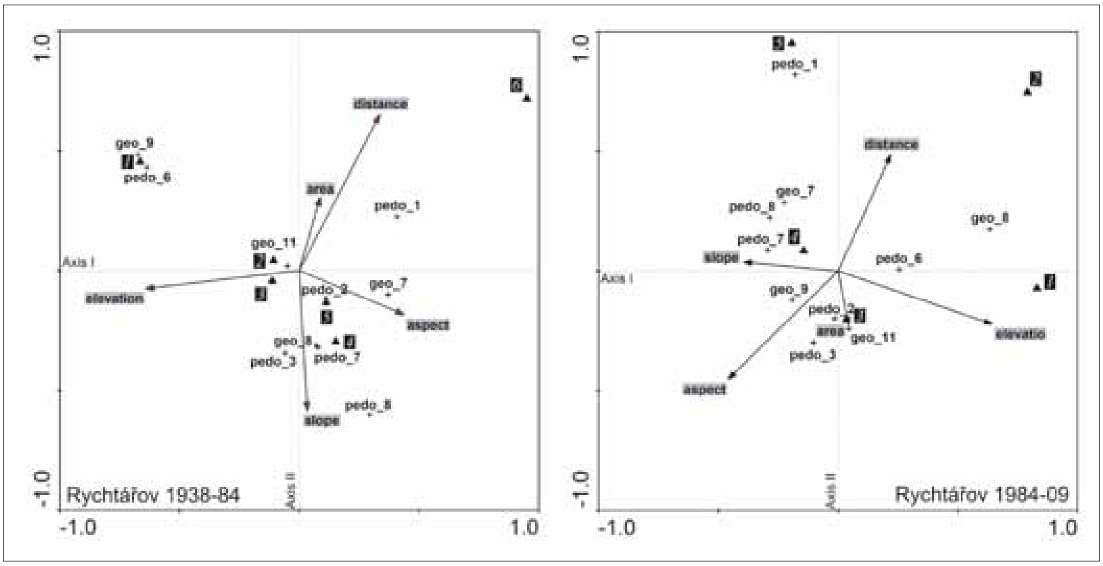

Fig. 5: CCA ordination of land cover transitions in two time periods (1938–1984 and 1984–2009) in the study area of Rychtářov. Source: Statistical evaluation in Canoco for Windows, 2011

the majority of studies on the role of natural factors in the process of landscape changes (e.g Hietel et al, 2004; Huang et al., 2005); but, a certain inconsistency exists in the selection and classification of principal soil parameters (compare Hietel, 2005; Fu et al., 2006).

The use of CCA enables a correlational relationship to be specified between the environmental variables and the landscape changes. However, according to Hersperger (2010), this model cannot simply derive a causal connection from this proven correlation dependence. For a deeper knowledge of the nature of landscape changes the model must involve instigators of the change, too, e.g. local people, various institutions etc. (Burgi et al., 2004). Such an analysis can then allow identification and better understanding of the role of socio-economic factors which, due to their number and diversity, are very difficult for modelling with the use of the CCA analysis (Hietel, 2005).

5. Conclusions

The use of GIS methods combined with CCA enables the researcher to study the landscape change as a function of environmental factors at a local level, and to quantify the importance of natural factors in the process of landscape changes (Hietel et al., 2004). The CCA results showed the correlation of selected natural factors and landscape changes in the studied areas. The influence of slope gradient was the most significant in both intensification and extensification processes; altitude was also of notable influence. Other environmental and structural variables were represented less frequently as their importance varied according to the character of individual areas. Our research has confirmed the varying capacity of natural factors to explain the processes of landscape changes – the model achieved the greatest reliability in the area with the relatively low dynamics of landscape change and, at the same time, relatively high topographic diversity (Rychtářov). Highly dynamic landscape processes induced by significant political and consequential socio-economic changes reduced the role of natural factors in the process of landscape changes (Branná). The importance of environmental variables was also reduced by anthropogenic interventions (construction of agrarian terraces in the Archlebov area).

Although the statistical results of this study confirm physical constraints of land cover changes, only a limited proportion of landscape changes were dependent on natural factors. Therefore, basic driving forces behind land cover changes can be assumed to be socio-economic factors. Many various socio-economic driving forces such as regional planning, land tenure, income, political decisions and other factors can have an influence on land-cover changes in the study areas. However, the inclusion of socio-economic factors and their interaction with natural factors in CCA analysis is hampered by a number of barriers, and therefore remains challenge for a further research.

Acknowledgement

The authors of this article would like to thank for the support for their research, which was carried out with the help of NPV II 2B06101 project entitled "Optimizing Agricultural and River Landscapes in CZ with Emphasis on the Development of Biodiversity" and AS CR Grant Agency KJB300860901 project "Quantitative and Synthesizing Graphic Methods in Approximation, Projection, and Modelling of Geographical Phenomena".

References:

BIČÍK, I., JELEČEK, L., ŠTĚPÁNEK, V. (2001): Land-use changes and their social driving forces in Czechia in the 19th and 20th century. Land Use Policy, Vol. 18, No. 1, p. 65–73.

BIČÍK, I., ŠTĚPÁNEK, V. (1994): Post-war changes of the land-use structure in Bohemia and Moravia: Case study Sudetenland. GeoJournal, Vol. 32, No. 3, p. 253–259.

BENDER, O. (2009): The concept of historic landscape analysis using GIS with a focus on Central Europe. In: Bender, O., Evelpidou, N., Krek, A., Vassilopoulos, A. [eds.]: Geoinformation Technologies for Geocultural Landscapes: European Perspectives. London, Taylor and Francis Group, p. 129–144.

BOSSARD, M., FERANEC, J., OŤAHEL, J. (2000): CORINE land cover technical guide – Addendum 2000. Technical report No. 40. Copenhagen, European Environment Agency, 105 pp.

BÜRGI, M., HERSPERGER, A. M., SCHNEEBERGER, N. (2004): Driving forces of landscape change – current and new directions. Landscape Ecology, Vol. 19, No. 8, p. 857–868.

CEBECAUEROVÁ, M. (2007): Analýza a hodnotenie zmien štruktůry krajiny (na príklade časti Borskej nížiny a Malých Karpát). Geographia Slovaca 24. Bratislava, Geografický ústav Slovenské akadémie vied, 136 pp.

CHEN, L., WANG, J., BOJIE, F., QIU, Y. (2001): Land-use change in a small catchment of northern Loess Plateau, China. Agriculture, Ecosystems and Environment, Vol. 86, No. 2, p. 163–172.

DEL BARRIO, G., ALVERA, B., PUIGDEFABREGAS, J., DIEZ, C. (1997): Response of high mountain landscape to topographic variables: Central Pyrenees. Landscape Ecology, Vol. 12, No. 2, p. 95–115.

DEMEK, J., HAVLÍČEK, M., CHRUDINA, Z., MACKOVČIN, P. (2008): Changes in land-use and the river network of the graben Dyjsko-svratecký úval (Czech Republic) in the last 242 years. Journal of Landscape Ecology, Vol. 1, No. 2, p. 22–51.

HIETEL, E., WALDHARDT, R., OTTE, A. (2005): Linking socio-economic factors, environment and land cover in the German Highlands, 1945 – 1999. Journal of Environmental Management, Vol. 75, No. 2., p. 133–143.

HIETEL, E., WALDHARDT, R., OTTE, A. (2004): Analysing land-cover changes in relation to environmental variables in Hesse, Germany. Landscape Ecology, Vol. 19, No. 5, p. 473–489.

FERANEC, J., OŤAHEL, J. (2001): Land Cover of Slovakia. Bratislava, Veda. 124 pp.

FERANEC, J., ŠÚRI, M., OŤAHEL, J., CEBECAUER, T., KOLÁŘ, J., SOUKUP, T., ZDEŇKOVÁ., D., WASZMUTH, J., VAAJDEA, V., VILDEA, A., NITICA, C. (2000): Inventory of major landscape changes in the Czech Republic, Hungary, Romania and Slovak Republic 1970s–1990s. International Journal of Applied Earth Observation and Geoinformation, Vol. 2, No. 2, p. 129–139.

FU, B. J., ZHANG, Q. J, CHEN, L. D., ZHAO, W. W., GULINCK, H., LIU, G. B., YANG, Q. Y., ZHU, Y. G. (2006): Temporal change in land use and its relationship to slope degrees and soil type in a small catchment on the Loess Plateau of China. Catena, Vol. 65, No. 1, p. 41–48.

HERSPERGER, A. M., GENNAIO, M. P., VERBURG, P. H., BÜRGI, M. (2010): Linking land change with driving forces and actors: four conceptual models. Ecology and Society, Vol. 15, No. 4: [online] Available at: URL: http://www.ecologyandsociety.org/vol15/iss4/art1/.

HUANG, Q. H., CAI, Y. L., PENG, J. (2007): Modeling the spatial pattern of farmland using GIS and multiple logistic regression: a case study of Maotiao River Basin, Guizhou Province, China. Environmental Modelling Assessment, Vol. 12, No. 1, p. 55–61.

LIPSKÝ, Z. (1995): The changing face of the Czech rural landscape. Landscape and Urban Planning, Vol. 31, No. 1–3, p. 39–45.

Leica Geosystems (2006): Leica Photogrammetry Suite Project Manager. Norcross, Leica Geosystems Geospatial Imaging, 414 pp.

LOWICKY, D. (2008): Land use change in Poland during transformation. Case study of Wielkopolska region. Landscape and Urban Planning, Vol. 87, No. 4, p. 279–288.

LORINCZ, R., BALAZS, K. (2003): Historical land use analysis and landscape development investigations for devising sustainable land use structure. In: Mander, Ű., Antrop, M. [eds.]: Multifunctional Landscapes Volume III. Continuity and Change. Southhampton, Boston, WIT Press, pp. 243–261.

MACHAR, I., SERVUS, M. (2010): Linking historical research with restoration ecology in the floodplain landscape. Case study Tovačov Lakes, Czech Republic. Journal of Landscape Ecology, Vol. 3, No. 1, p. 16–41.

NĚMEČEK, J. [ed.] (2001): Taxonomický klasifikační systém půd České republiky. Praha, Česká zemědělská univerzita: Výzkumný ústav meliorací a ochrany půdy, 79 pp.

PAN, D., DOMON, G., DE BLOIS, S., BOUCHARD, A. (1999): Temporal (1958–1993) and spatial patterns of land use changes in Haut-Saint-Laurent (Quebec, Canada) and their relation to landscape physical attributes. Landscape Ecology, Vol. 14, No. 1, p. 35–52.

SCHNEIDER, L. C., PONTIUS, R. G. (2001): Modeling land-use change in the Ipswich watershed, Massachusetts, USA. Agriculture, Ecosystems and Environment, Vol. 85, No. 1, p. 83–94.

SIMPSON, J. W., BOERNER, R. E. J., DEMERS, M. N., BERNS, L. A., ARTIGAS, F. J., SILVA, A. (1994): Forty-eight years of landscape change on two contiguous Ohio landscapes. Landscape Ecology, Vol. 9, No. 4, p. 261–270.

ŠARAPATKA, B., ŠTĚRBA, O. (1998): Optimalization of agriculture in relation to the multifunctional role of the landscape. Landscape and Urban Planning, Vol. 41, No. 2, p. 145–148.

TER BRAAK, C. J. F., ŠMILAUER, P. (2002): CANOCO Reference Manual and CanoDraw for Windows User's Guide: Software for Canonical Community Ordination (version 4.5). 1 ed. Ithaca, Microcomputer Power, 500 pp.

VELDKAMP, A., LAMBIN, E. F. (2001): Predicting land-use change. Agriculture, Ecosystems & Environment, Vol. 85, No. 1–3, p. 1–6.

Author´s adresses:

Mgr. Zdeněk OPRŠAL, Ph.D., e-mail: *zdenek.oprsal@upol.cz*
Palacký University, Olomouc, Faculty of Science, Department of Development Studies
17. listopadu 12, Olomouc 771 46, Czech Republic

Prof. Ing. Dr. Bořivoj ŠARAPATKA, CSc., e-mail: *borivoj.sarapatka@upol.cz*
Palacký University, Olomouc, Faculty of Science, Department of Ecology and Environmental Sciences
tř. Svobody 26, Olomouc 771 46, Czech Republic

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

Initial submission 22 October 2012, **final acceptance** 27 February 2013

Please cite this article as:

OPRŠAL, Z., ŠARAPATKA, B., KLADIVO, P. (2013): Land-use Changes and their Relationships to Selected Landscape Parameters in three Cadastral Areas in Moravia (Czech Republic). Moravian Geographical Reports, Vol. 21, No. 1, p. 41–50.

OPTIMIZATION OF FLOOD PROTECTION BY SEMI-NATURAL MEANS AND RETENTION IN THE CATCHMENT AREA: A CASE STUDY OF LITAVKA RIVER (CZECH REPUBLIC)

Radek ROUB, Tomáš HEJDUK, Pavel NOVÁK

Abstract

Of all natural disasters, floods represent the most serious threat to the territory of the Czech Republic. This is given by the situation of the Czech Republic at the continental as well as the worldwide scale. At present, the design of anti-flood measures is mostly based on technical measures, without considering improvements in the hydromorphological status according to the Framework Directive on Water Management and without considering the natural transformation of flood discharge in the alluvial plains of water courses. This report presents a design for the optimization of anti-flood measures in the pilot catchment of the Litavka River, in which we propose particular measures for the catchment for its entire surface while providing a good hydromorphological status. We also wanted to quantify the proposed measures leading to the increased retention and accumulation capacities of the catchment area.

Shrnutí

Optimalizace protipovodňové ochrany formou přírodě blízkých opatření a retencí v ploše povodí: případová studie Litavky (Česká republika)

Povodňové situace představují na území České republiky největší hrozby přírodních katastrof. Tato skutečnost je dána polohou České republiky v kontinentálním i celosvětovém měřítku. Návrh protipovodňových opatření v současnosti probíhá především formou technických opatření, bez ohledu na zlepšení hydromorfologického stavu vod dle požadavků Rámcové směrnice o vodách a bez ohledu na přirozenou transformaci povodňových průtoků v nivách vodních toků. Příspěvek seznamuje s optimalizačním návrhem protipovodňových opatření v rámci pilotního povodí, kde byla navržena konkrétní opatření řešící komplexně povodí v celé jeho ploše a zároveň zajišťující dosažení dobrého hydromorfologického stavu vod.

Keywords: *retention, GIS, measures, HEC-RAS, floods, HEC-HMS, Litavka River, Czech Republic*

1. Introduction

Water retention in the landscape can be increased by using appropriately designed anti-erosion and anti-flood measures. In practice, these measures are mostly designed as common measures of complex land adaptations (Podrázský and Remeš, 2006). Appropriately designed and quantified anti-erosion measures have multifunctional effects. Along with limiting soil washout they slow down surface runoff and increase water retention in the landscape (Podrázský and Remeš, 2006).

At present, the design of anti-flood measures (AFM) is mostly based on technical measures, without considering improvements of the hydromorphological status according to the Framework Directive on Water Management and without considering the natural transformation of flood discharge in the alluvial plains of water courses. Careless interventions into alluvial plains may cause decreased retention in these inundation territories. Vopálka (2003) reported that without the existence of an elaborated information system and a complex concept of the landscape, no serious solution of flood protection can be found.

The occurrence of a number of disastrous floods in Europe in the last 15 years (affecting Bulgaria and Romania) has led to a significant focus in water management policies on improving anti-flood protection and the implementation of anti-flood measures in order to decrease the flood damage (Munzar et al., 2008). Following these disastrous events, the European Parliament and Council adopted a Directive (2007/60/ES of October 23, 2007) on the evaluation and management of flood risks.

Even in the conditions of the Czech Republic (CR), the issue of floods represents an increasingly pressing problem with regard to the experience from recent years – 1997 floods in Moravia, 2002 and 2006 floods in Bohemia, 2009 rainstorm floods in the region of Nový Jičín and Jesenice, and 2010 rainstorm floods in North Bohemia. For these reasons, great attention is paid to flood prevention measures, which should anticipate these events, eliminate their potential and manage them organizationally. According to their characteristics we classify the anti-flood measures into three different groups - preventive measures, measures in danger of floods or during the floods, and measures after the floods (Act No. 254/2001 of the Collection of Czech Laws).

One of the often cited reasons for the occurrence of runoff extremes in relation to the increased frequency of extreme hydrologic situations that have affected the Czech Republic in several recent years is the decreased retention and accumulation function of the landscape. The reduced retention capacity of a territory is manifested as a consequence of the growing compactness of soil and long-lasting adverse exploitation of the territory, which mostly results from the growing pressure for building in the inundation areas with otherwise standard retardation and accumulation of runoff (Bičík et al., 2008; Trimble, 2003). Analysis of changes in land use development is of interest to a number of authors (Skaloš et al., 2011; Shalaby and Tateishi, 2007). Inundations, retardation and accumulation elements in the landscape together form the ‘retention potential’ of the landscape, which influences the capacity of the territory to transform the causative rainfall into runoff, determines its course and culmination together with further transport of substances released mainly by e.g. erosive processes (Magunda et al., 1997). Retention in a catchment is mostly determined by different involvement and function of retention and accumulation elements during the occurrence of causative rainfall of various types (rainstorm, regional rainfall), depending on the size of the affected area and the current physical or technical status of the retention elements in the course of rainfall occurrence (Mahe et al., 2005).

From the hydrologic point of view, ‘small water circulation’ should be promoted in the landscape. This circulation means water evaporation from the surface and its deposition in the form of rainfall occurring within one territory of the landscape. The significance of this small water circulation mainly lies in water retention, contributing to the microclimate balance (Petříček and Cudlín, 2003).

Petříček and Cudlín (2003) also reported that the retention capacity of a landscape itself is given by the landscape’s capability of retaining water and in this way retarding rainfall runoff from the territory. This term should mean temporary retention of water in the vegetation, objects located in the catchment, water retention in the layer of soil covering the surface, in the soil itself, micro depressions, dry retention reservoirs, and in the ‘runoff-less’ phase of the rainfall-runoff process. Additionally, this landscape function contributes to a more balanced hydrologic cycle (lower occurrence of extreme conditions – floods, droughts) and to lower washout of nutrients.

An important role in the retention capacity of a landscape is played by landscape elements such as forest ecosystems, natural water courses and alluvial plains, meadows, soaking belts, etc. Elimination of these elements from the landscape results in fast water runoff, erosion, the loading of water courses with washed out soil containing high nutrient content, but also in a significant drop in the supply of underground water. An effective form of retaining high water quantities in the landscape is also represented by wetland biotopes, spring areas, peat bogs, pools, pond littorals, river alluvial plains, waterlogged pine woods, etc. (Mauchamp et al., 2002). By their action they contribute to suppression of the flow extremes and to transformation of the flood wave. Wetlands protect the landscape against floods because they create spaces for retaining and accumulating water at the time of flood discharge, when they act as water reservoirs. Studies have reported that 0.4 ha of wetland can retain more than 6,000 m^3 of water (Klementová and Juráková, 2003).

Similarly, grasslands limit the surface runoff by their retention capacity. Besides, non-compacted, humous and structured soils of grasslands possess a high infiltration capacity. This effect plays a role mainly in sloped lands, where permanent grass covers increase the soil retention capacity, particularly during rainstorms and long-lasting rains (Hrabě and Buchgraber, 2004; Hornbeck et al., 1997).

A positive role is also played by forests, which reduce the volume of out-flowing flood water. The transformation effect of woodlands is most visible namely at the beginning of flood events. Runoff formation mainly depends on the structure, thickness, form, degree of looseness and integrity of litter in forest ecosystems. Křovák et al. (2004) described their results from hydrogeologic observation in the Šumava National Park, showing that forest soil is capable of retaining 30 to 50 mm of precipitation. With higher daily values or repeated rainfall in short time intervals, water runoff occurs regardless of the catchment forestation or its species structure. Similar results were obtained by other authors, for example Chlebek and Jařabáč (1988), Tesař et al. (2003), Adamec et al. (2006), Adamec and Unucka (2007), and Jeníček (2009). The retention capacity of forest soils plays significant geomorphologic, hydrologic and environmental roles. The amount of water retained in forest soils represents a key factor in forest fire forecasts, forming a significant water supply for plants, and evaporation from the forest soil contributes to the transport of water and energy in the landscape (Kosugi et al., 2001).

In the conditions of the Czech Republic, the soils are capable of receiving and retaining much higher amounts of water than the volume in all Czech water reservoirs. Soil is an important filtration, retention and transport environment with values of 50–320 $l.m^{-3}$ (Prospective and Situation Report of the Ministry of Agriculture on the Soil from 2006). Water retention capacity reflects the capability of soil to absorb and retain rainfall water before leaving the landscape (Hall et al., 1977).

Retention of soil is positively correlated with the organic mass content in the soil and negatively correlated with the soil volumetric mass, content of particles exceeding 100 μm and with the decreasing thickness of the upper soil layer (Hall et al., 1977).

Based on the above-mentioned facts, we described the possibility of employing an alternative approach to technical anti-flood measures in the form of semi-natural measures and retention in the catchment area. To date, quantification of the retention effect of technical anti-flood measures (AFM) has already been well-elaborated, as reported by Weyskrabová et al. (2010). The aim of our work was therefore to quantify the retention potential of the designed measures in the landscape enabling for example augmentation of water infiltration in the soil, reduction of surface runoff, or definition of the area for directed surface spill (controlled flood areas).

2. Study area

As a pilot area we selected the catchment of the Litavka River (1-11-04), which represents a large area South-West of Prague. The Litavka R. drains water from a large part of the Brdy Uplands, springing between the peaks of Tok (865 m a.s.l.) and Praha (862 m a.s.l.) at 765.66 m of altitude. Litavka is a right-hand affluent of the Berounka River, with its mouth near the town of

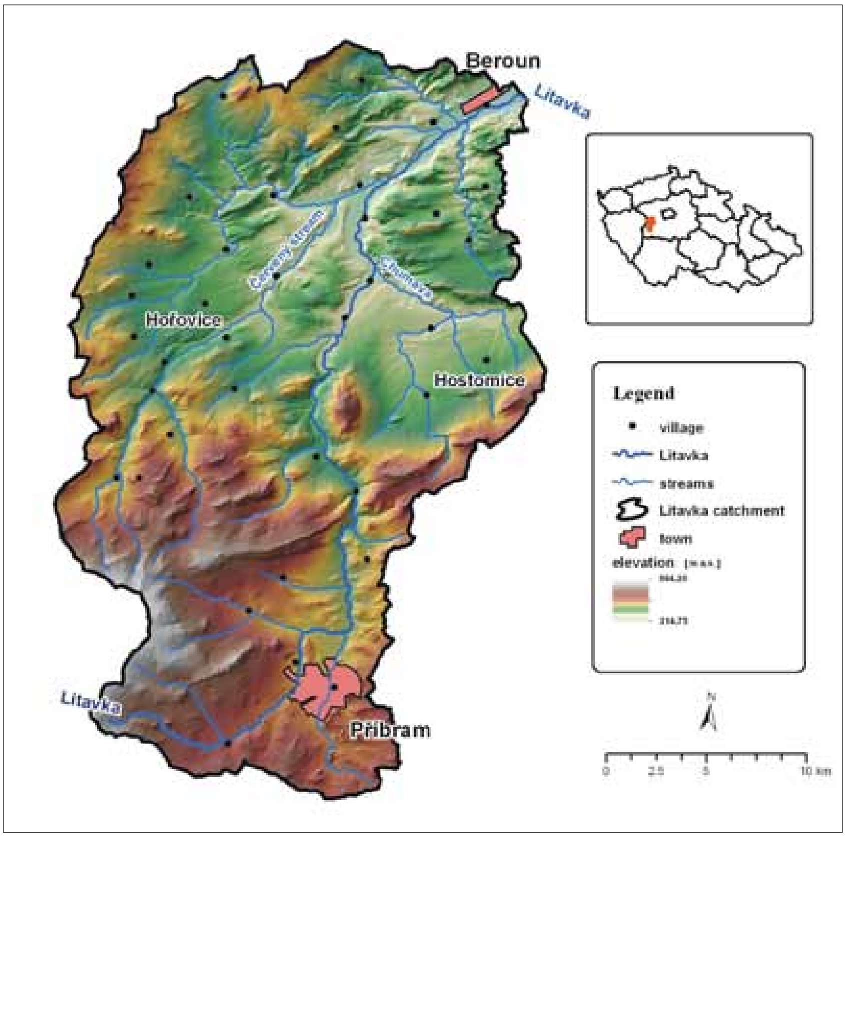

Fig. 1: Study area

Beroun at its 33.96 km. The catchment, which is mostly formed by two partial catchments of the main affluents Chumava and Červený potok, covers the surface of 628.75 km^2. The catchment contains 538 water surfaces with a total area of 225.11 ha. The largest of them are water reservoirs Pilská (20.54 ha), Láz (15.01 ha), Obecnice and Záskalská. The main factor determining the local climate is the altitude. With the increasing altitude the temperatures drop and precipitation increases. According to Quitt (1971), the catchment belongs to the climatic regions CH7 (spring part), MT3, MT5 (Březové hory Mts.), MT7, MT11 (Hořovická brázda Furrow), T2 (Zdická brázda Furrow). The area of interest is delineated in Fig. 1.

3. Material

3.1 Data for schematization of the stream channel and inundation of the Litavka water course

Among the most relevant data for hydrodynamic models are the entry data for schematization of the stream channel and water course inundation (Giannoni et al., 2003; Havlík et al., 2004; Fowler et al., 2005; Drbal et al., 2009). Data for schematization of the water course also determine the choice of the hydrodynamic model itself (Merwade et al., 2006; Merwade et al., 2008), while with regard to the requirements of altigraphic description of the water course, there are less demanding are one-dimensional (1D) models required for calculating only lateral stream channel profiles and adjacent inundations. In the case of two-dimensional (2D) models, the calculations already require a detailed digital model of the terrain precisely describing the morphology of the studied area.

To create the hydraulic model we utilized data from aerial laser scanning (ALS) in combination with geodetic surveying of the lateral stream channel profiles and objects located at the water course.

The 2 m DMT resolution was used to obtain relevant results from the hydrodynamic model.

3.1.1 Data from aerial laser scanning

Aerial laser scanning represents a relatively recent technology enabling the collection of large amounts of data within a relatively short time interval (Dolansky, 2004). The obtained altigraphy data may be applied to a number of practical disciplines.

Brázdil (2009) defined the principle of ALS as a method based on the reflection of laser rays interpreting the image of measured objects as a cloud of points. Brázdil (2009) also described the ALS method as one of the most effective methods for obtaining spatial data characterized by a relatively high degree of automation of processing during the creation of a digital model of the terrain (DMT) or a digital model of the surface.

For assessments in our alternative approach to AFM we employed data from the ongoing altigraphy mapping of the Czech Republic using the ALS method, which is conducted under the auspices of the Czech Office for Mapping, Surveying and Cadastre with the participation of the Ministry of Agriculture and Ministry of Defence (MD). The advantage of this method lies in the fast measurements, achieved precision, and amounts of the measured data and information. The new altigraphic record of the Czech Republic has achieved point density higher than 1 point/m^2 and total mean altitude error of 0.18 m in the open terrain and 0.30 m in the forested terrain (Brázdil, 2009).

The ALS data provide a high-quality background for applications in hydrodynamic models, and the usability of these data for mathematical modelling is presented in the publications by Novák et al. (2011), Roub et al. (2012), Uhlířová and Zbořil (2009).

3.1.2 Data from geodetic location

For a more detailed DMT prepared from the ALS data, i.e. for completing its relevant image in the area of the stream channel itself, we employed geodetically surveyed lateral profiles of the water course stream channels in the studied area (the ALS ray is absorbed by the water surface during the data acquisition). Geodetically surveyed lateral profiles of the water course stream channels were provided by the company Povodí Vltavy, s.p. – affiliation in Pilsen. The distance interval of the surveyed stream channel profiles was in the range from 50 m to 250 m. A shorter interval of 50 m was applied in residential areas of villages situated at the water course, while a longer interval of inter-profile distances was used outside these residential areas, providing an adequate background for further operations, as also reported by Novák et al. (2011).

3.2 Programming means for assessing AFM optimization

The choice of the models and software for optimization of the designed flood-control measures was based on high compatibility with the ESRI products. For these reasons, we selected the products of HEC (Hydrologic Engineering Center) developed by the US Army.

The geographic information systems (GIS) were defined by Rapant (2002) as computer systems for geographic data processing. Voženílek (2000) defined GIS as an analytical tool serving to link the geographic information (data on the situation, localization of the object) with the descriptive information (data on the object characteristics) by computer programmes. A more detailed explanation of the GIS notion defined at the level of relevant application was given by Rapant (2005), describing GIS as a functional unit formed through the integration of technical and programming means, geodata, working processes, user operation, and organizational context.

HEC-HMS

The HEC-HMS model (Hydrologic Engineering Center – Hydrologic Modelling System) represents a successor to the HEC-1 model (already developed since the 1960s). It is a representative of lump semi-distributed models, but great attention is currently paid to the development of components with distributed parameters. At present, this software is the most extensively used rainfall-runoff model in the USA and among freeware programmes, probably in the world as well. The model offers an advanced user interface and high flexibility in parametric representation of the rainfall-runoff model.

Its native complements are HEC-GeoHMS, an extension for ArcGIS 10 (required Spatial Analyst) serving for pre-processing and schematization of the catchment from the digital terrain model, and software managing the time rows of meteorological data and results of HEC-DSSVue simulations.

To prepare the geometric data and final visualization we also used the HEC-GeoHMS, representing a set of tools and aids for processing the hydrologic characteristics of the catchment in ArcGIS using the graphic user interface (GUI). The HEC-GeoHMS extension is associated with another extended upgrade, ArcHydro Tools (Maidment, 2002), and both extensions enable acquisition of data on the catchment border, runoff directions, water accumulation, etc., all this based on the initial DMT.

HEC-RAS

The hydraulic computing system HEC-RAS – River Analysis System is intended for complex modelling of surface water courses. The HEC-RAS programme enables one-dimensional computing of both steady-state and irregular flow, sediment load transport (moving bed) or modelling of temperature changes of streaming water. The computing scheme for steady-state flow is based on the calculation of irregular water flow in stream channels using the sectional methods. The programme enables distribution of the profile into the stream channel itself ('effective' discharge area) and the left and right inundations.

Establishment of the level course in the HEC-RAS software is based on the one-dimensional solution of Bernoulli's equation (energy equation). Energetic loss is determined in the form of friction loss (Manning's equation), where local losses are expressed by coefficients (contraction/expansion coefficients). Hydraulically complicated locations such as spills, confluences, bifurcations, bridges or culverts are solved by the adapted motion equation.

To prepare geometric data and final visualization, we also used the HEC-GeoRAS extension, which represents a set of tools and aids for processing geospatial data in ArcGIS using a graphic user interface (Anderson, 2000; Colby et al., 2000; Andrysiak and Maidment, 2000). The interface enables preparation of geometric data in the form of schematization of the computing track followed by export into the HEC-RAS environment. The HEC-RAS programme was used to perform the required simulations and the results were imported back to the ArcGIS environment, where they were further visualized and underwent additional analyses (Novák et al., 2011).

ArcGIS

To assess the design of AFM for the Litavka R. catchment we used integrated, scaleable and open GIS in the form of ArcGIS made by ESRI, which offers robust tools for editing, analysis and management of data, making it the most complex GIS software on the market worldwide (Čejp and Duchan, 2008).

Particularly for the preparation of entry data and for the final visualization of the obtained results we used two specific upgrades, Spatial Analyst Tools and 3D Analyst. Spatial Analyst Tools offers a large array of tools for spatial modelling and analysis, which enable creating images, enquiring and analysing raster data. 3D Analyst provides users with effective visualization and analysis of representing data.

In the context of utilization of hydrologic models this software offers a number of functions (namely of the group Spatial Analyst Tools, 3D Analyst Tools) and particularly further extensions (HEC-GeoHMS, HEC-GeoRAS).

4. Methods

Taking into account novel data in the field of flood protection, semi-natural flood-control measures and retention in the catchment area are understood by the professional community not only as a merely complementary technical anti-flood measures, but also as one of the possible alternatives. This is due to their additional potential to effectively transform the surface runoff to groundwater runoff, replenishing the supply of underground water, creating important landscape-forming elements, eliminating erosion, and positively influencing water quality.

During the optimization of AFM in the pilot catchment of Litavka R. we proposed specific measures for complex management of the catchment in its entire surface and at the same time for ensuring a good hydromorphologic status of water.

The proposed measures in the catchment area were based on the changes in the character of vegetation and soil cover in the catchment. The influence of the vegetation on the rainfall-runoff process, and thus on the quantity of water for potential runoff from the catchment, was described by Likens and Bormann (1974); Pobědinskij and Krečmer (1984), Kantor et al. (2003), Unucka (2008), and Unucka and Adamec (2008).

Reactions of the catchment to the changes in vegetation cover were prepared in two scenario variants. Modelling of changes in runoff regime in the first variant assumed 50% grassing of land with the protection of the agricultural soil fund (ASF). In the second variant, the mathematical representation of the rainfall-runoff process was carried out on the basis of assuming as much as 100% land grassing with ASF protection in the catchment.

Because of the low demand for entry data the calculation of runoff volume was done using the SCS CN Soil Conservation Service Curve Number method (Mishra and Singh, 2003) employing CN curves to calculate the runoff loss (Janeček, 1992; Holý, 1994; Boonstra and Ritzema, 1994; Ponce and Hawkins, 1996, Feldman, 2000; Trizna, 2002; Trizna and Kyzek, 2002). Alternatively, the method of exponential decrease, constant infiltration, and the Green-Ampt method may also be used, which will be implemented in our further research.

The effective precipitation is determined by the SCS CN method employing the function of precipitation sum, soil properties, vegetation cover and previous saturation, and is calculated by using the following equation (1):

$$Q = \frac{(P - I_a)^2}{(P - I_a + S)} \qquad (1)$$

where Q is surface (Horton) runoff in time t [mm], P is cumulative rainfall in time t [mm], I_a is Initial Abstraction [mm].

S is potential maximum retention defined by equation (2):

$$S = 25.4 \times (1000 / CN - 10) \qquad (2)$$

where CN is the CN curve number [-].

Potential maximum retention is calculated from the CN curve, determined by Janeček (2002) in relation to the hydrologic group of soil (Novák, 2003) and landscape cover.

Regarding the characteristics of the Litavka River catchment and its saturation, the CN values between 65–80 were used. To determine the value of direct runoff one can choose from various modifications of unit hydrogram (Clark, Snyder, SCS). We selected the Clark's method of unit hydrogram in our assessment.

To calculate the underground runoff, as stated by Jeníček (2008) the user can choose from various approaches. They include the model of linear reservoir (O´Connor, 1976) and exponential decrease (Chow et al, 1988). To create this model we used the method of exponential decrease defining the amount of underground runoff in the given period of time based on the initial underground runoff.

Monitoring the effect of hydromorphology of the water course itself was based on significant contrast intensity of anthropogenic interventions into the Litavka R. catchment. The spring area and the upper profile of Litavka R. display a relatively natural character in contrast to intensive industry, extensive agriculture and higher proportion of urbanization in the middle and lower parts of the water course. Langhammer (2007) described adaptations to the river network and alluvial plain as a significant factor influencing the runoff process during the floods. In general, adaptations to the river network and alluvial plain have significant impact on the course of flood wave, transformation effect of the alluvial plain as well as effectiveness of utilization of the retention potential of the territory (Žikulinas, 2008).

Taufmannová and Langhammer (2007) described the stream channel of Litavka R. in almost all its length as directionally balanced in the requirements of the residential areas of settlements and employment of agricultural streamside land. Of the total length of the Litavka water course, 88% have been adapted to some extent. A purely natural stream channel can only be found above the Láz water reservoir and between river km 20.5–18.8. A number of adapted sections have spontaneously revitalized and their character has become semi-natural. The occurrence of such semi-natural sections at the Litavka River has been assessed as ca 45%. The most significant human interventions were recorded in the upper Litavka R. between Bohutín-Příbram-Lhota, near Čenkov and Jince, and from Lochovice the river is led through a trapezoidal stream channel to its mouth in Beroun (Havlová, 2001). Kaiml (2000) classified most adaptations into the group of fortifications dating from the 1970s.

With respect to the transformation effect of flood events, the most significant role is played by the geometry of the lateral and longitudinal profiles. For these reasons we adapted the initial DMT, in which we changed the lateral profile in locations of the water course with high stream channel capacity, and the longitudinal profile was modified in order to promote forking and surface spill into the alluvial plain.

Outside the residential area of settlements, the AFM were therefore designed to decrease the capacity of the stream channel and to augment the frequency of surface spill into alluvial plains, contributing to the natural transformation of flood discharge. In the territories inside the residential area of settlements, DMT was modified with the aim to increase the capacity of the stream channel and accelerate the runoff; we also proposed a composed profile with mobile cunette, including the possibility of damming the built-up areas or installing movable dams. While planning the AFM we also found locations with favourable profiles for the transformation of the flood wave in dry retention reservoirs or polders, which however were not included into this stage of assessment.

The setup of the hydrodynamic models for comparative analyses of the present state after AFM design was made using a 1D hydrodynamic model in HEC-RAS software.

5. Results and Discussion

The goal of our report was to set up rainfall-runoff models for modelling the retention measures in the area of the catchment and for the design of a new lateral profile of the Litavka River, i.e. adaptation of its present layout. The design of AFM was followed by the setup of hydrodynamic models for the assessment of the proposed measures. We compared the present state with conditions reflecting the retention measures in the area of the catchment, including hydromorphologic measures at the water course itself. The comparison of particular scenarios was focused on verifying the contribution of the suggested semi-natural flood-control measures, including measures in the catchment area aimed at transforming flood waves and eliminating the extent of flood threats.

A significant step to calibration of the real event model was represented by the setup of the initial layer of landscape cover, which was delineated in a combination of data sources from CORINE (COoRdination of INformation on the Environment), see Fig. 2, and LPIS (Land Parcels Information System), see Fig. 3. For higher resolution we also considered including data from digital cadastral maps (DCM) or digitized cadastral maps (CMD) into the final image; however, with regard to the stage of their processing (1/3 of the catchment) we abandoned this idea.

The simulation itself of the effect of landscape cover was based on a selected event related to the rainfall-runoff episode of August 2–26, 2002. The sum of precipitation for the period of August 6–12, 2002 exceeded the values of 150 mm in all precipitation gauge stations in the catchment. The culmination flow in the closing profile (Beroun profile) reached the value of 244 $m^3.s^{-1}$, corresponding to a 10-year flood event (Q50 – 263 $m^3.s^{-1}$). The precipitation sums reached at individual gauge stations are given in Table 1.

The modelled flood event (Fig. 4) discussed here represents a characteristic reaction of the Litavka R. catchment to a precipitation event. Typically there is a very fast response of the catchment, which in this case reacted namely to the precipitation in the period of August 11–12, 2002, reflected in the hydrogram in the form of two separate culmination flows with values of 244 $m^3.s^{-1}$ and 214 $m^3.s^{-1}$, respectively.

Date	Total precipitation amount [mm]			
	Láz	Obecnice	Pilská	Záskalská
6.8.2002	18.3	17.1	18.1	–
7.8.2002	21.1	23.5	4.1	38.0
8.8.2002	2.4	39.0	4.1	0.4
9.8.2002	–	–	–	–
10.8.2002	–	–	3.1	–
11.8.2002	35.0	40.0	31	64.0
12.8.2002	106.3	76.9	52.0	58.0

Tab. 1: Precipitation at stations

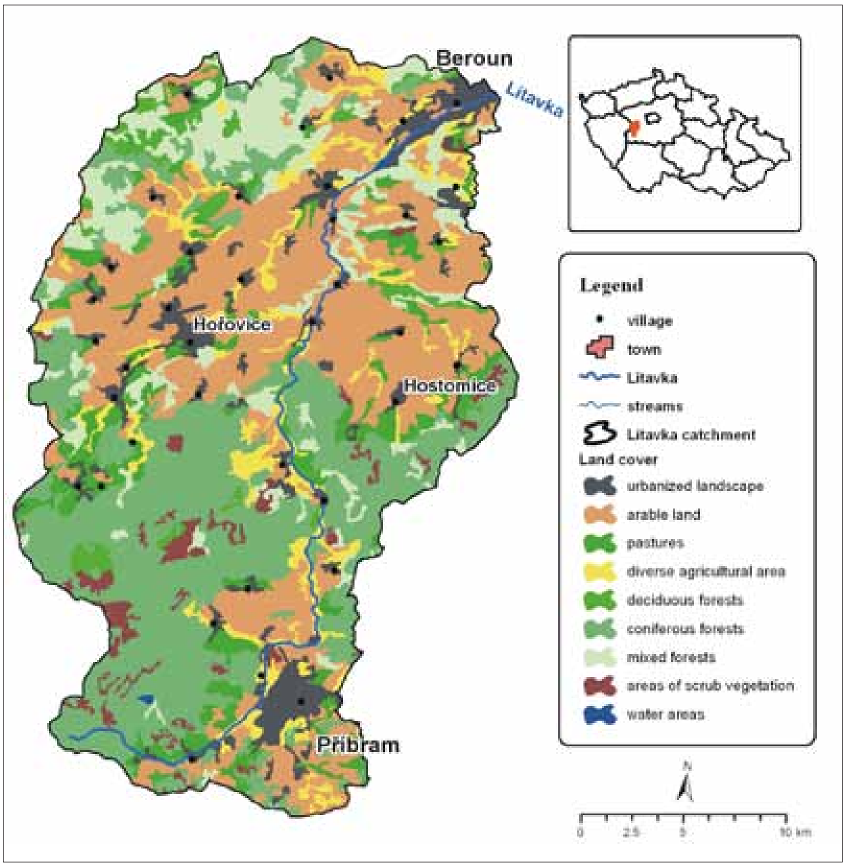

Fig. 2: Land cover (CORINE)

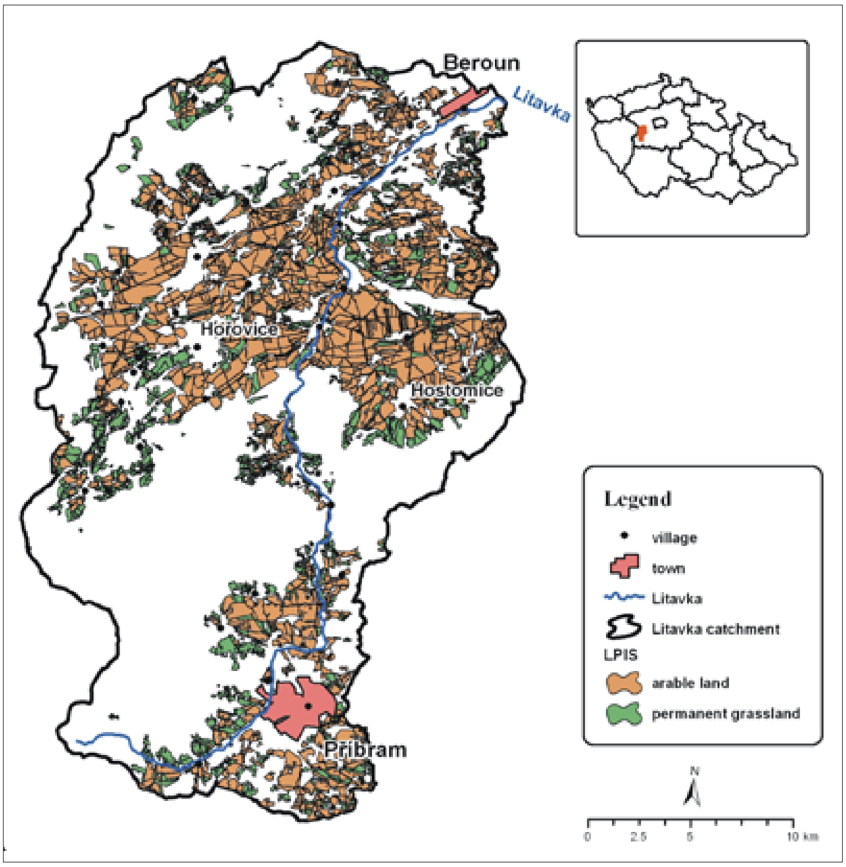

Fig. 3: Land cover (LPIS)

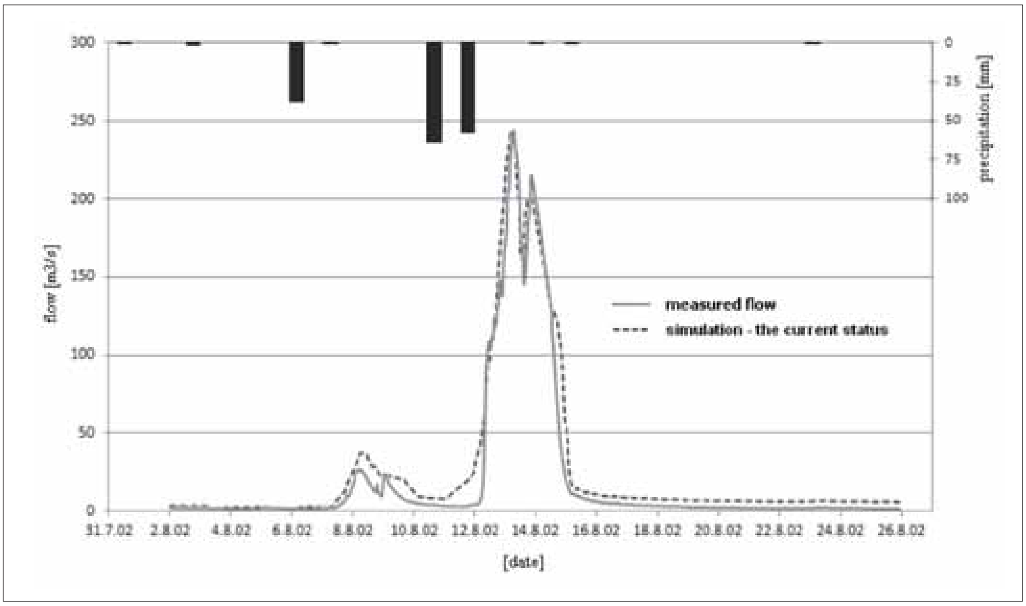

Fig. 4: Flood event (simulated flood event) in August 2002

For the event simulation itself (August 2–26, 2002) in the programme HEC-HMS we succeeded in recording both culmination values (Fig. 4), and mainly in the case of the first one we achieved a very satisfactory correlation. The recording of the second culmination was not so successful, which was already caused by a partial drop between the culminations.

The results obtained by simulation of the landscape cover adaptations for the scenario of total grassing of ALF (Fig. 5) are demonstrated by the transformation of the flood event to the culmination flow of 184 $m^3.s^{-1}$, representing a 15% drop compared to real conditions. The scenario based on 50% grassing was not further analysed because we did not obtain evidence for an effect of the landscape cover on the monitored flood event. In case of 100% ALF grassing, we can also see a shift of culmination itself, which in this simulated scenario reached only one culmination value. The hydrograms of the measured flows, including simulation of the current state of landscape cover and simulation with 100% ALF grassing, can be seen in Fig. 6.

To prepare the hydrodynamic model for assessment of the semi-natural measures we used two DMTs. For the first variant we used the DMT reflecting the real state of the territory. For the second variant, the initial DMT was adapted according to the given methodology. To achieve relevant results we used ALS data for DMT construction and the preparation of computation

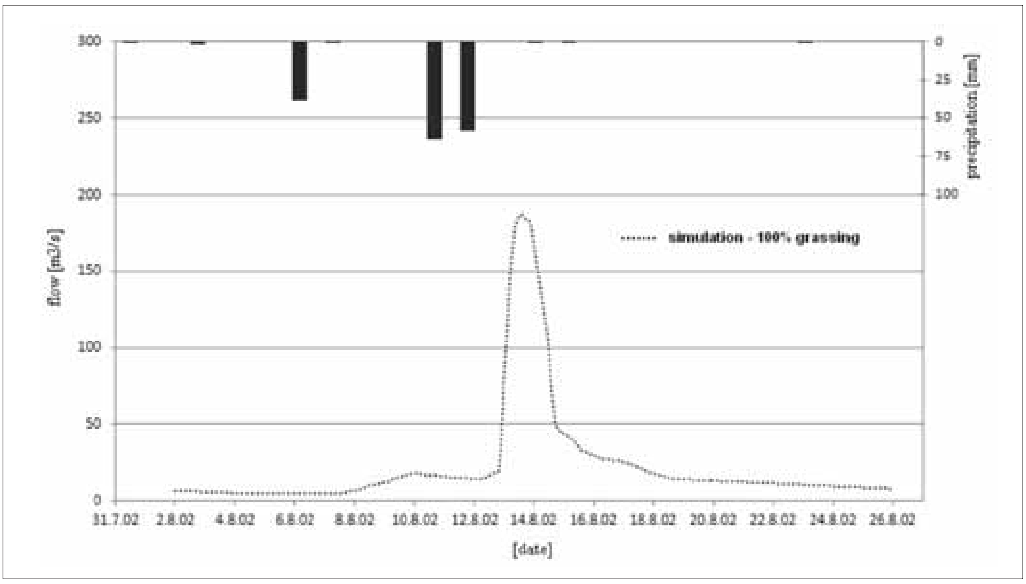

Fig. 5: Influence of grassing basin

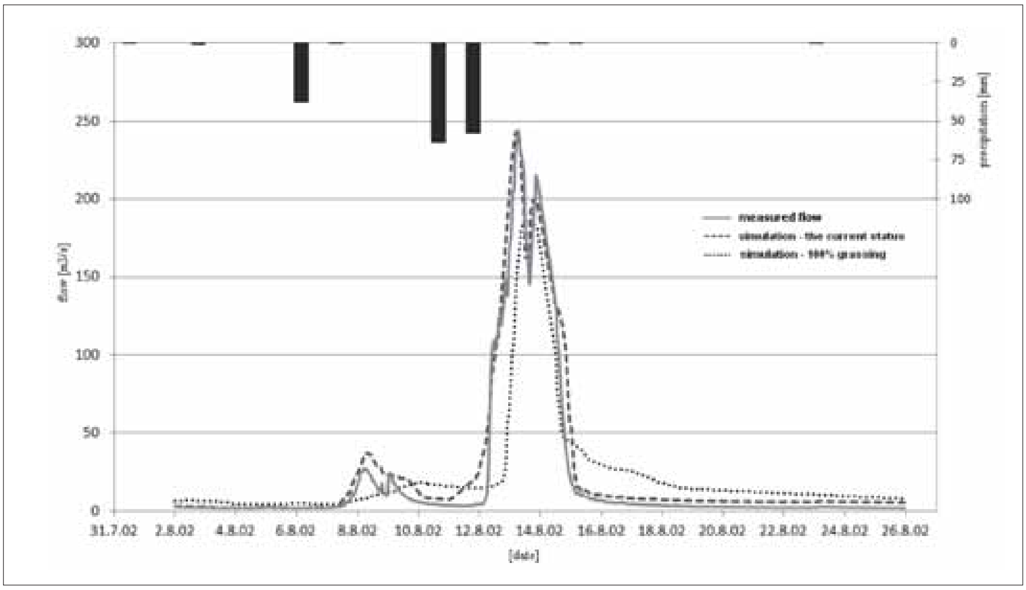

Fig. 6: All scenarios for flood events in August 2002

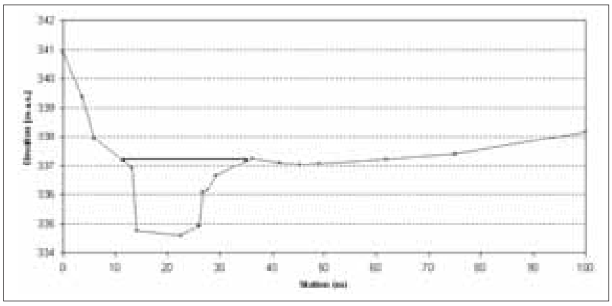

Fig. 7: Crosssection variations a

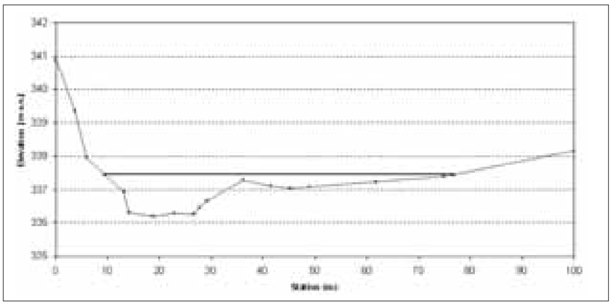

Fig. 8: Crosssection variations b

geometry of water courses, which were elaborated in more detail by subsequent surveying and existing data stores (geodetically surveyed lateral profiles). This approach is shown in Fig. 7 and Fig. 8.

The main goal of flood-control measures is to provide for the discharge capacity of the river bed and adjacent river inundation in order to divert the excess volume of the flood water with the least problems possible. Principally this means the removal of deposits from the river bed, an appropriate structure of vegetation and agricultural management in the inundation, minimal building in the active river inundation and other measures. The second goal is to decrease the extent of flood wave culmination and deceleration of its progress. This can be achieved by building dams and, to a lesser extent, polders by using ponds with flood pre-manipulation and namely by enabling natural lateral surface spills of the flood wave into the inundation.

While designing dams we must take into account that the main problem in Bohemia is lack of water. This means that the dams must retain part of the flood volume for dry periods, which in this region occur in multiple-year cycles. Of high significance among flood-control measures is prolongation of the prognosis time for the precipitation volume and flood discharge using the most recent mathematical programmes and subsequent mathematical modelling of surface spills, depth and speed of water in the courses during the particular flood. The results of the mathematical modelling recorded in the orthophotocharts and digitized cadastral maps represent an excellent background for early anti-flood operations in the inundation area before the onset of flood culminations.

For some objects, unfavourably built in the past in the submersion area of the river, in justified and economically acceptable cases, protection can be provided by building protective dams and compacting the subsoil, or optionally by draining the underground water. The construction of flood dams, however, must be performed with caution, when possible in an inactive flow zone, in the least possible volume of the protected area, and after detailed investigation of the effect on the river levels upstream and downstream from this construction and of the effect on underground water outside the flood construction.

The flood-control dams provide protection against floods only to the extent of the designed flow capacity. When this extent is exceeded, the protected area is flooded. These only locally effective flood-control constructions are very costly, mostly because of the need to compact the subsoil. The solution is often complicated by communications, sewage, distribution systems, and local brooks. Although the flood-control dams are often combined with short-term-use movable walls, the intervention into the landscape and land appearance is significant.

To confirm the proposed hypotheses about the effect of water course tracing on the transformation of flood discharge and on the effect of the landscape cover on the retention in the catchment area we simulated three scenarios in the environment of the hydrodynamic model. The first scenario was prepared based on the real state of the catchment and served as a reference. The second scenario employed identical hydrologic data as in the first case but used an adjusted DMT. The third scenario was based on the adjusted DMT, but also on the results obtained during rainfall-runoff simulations with changed landscape cover. The last scenario thus evaluated the entire system of the proposed measures, in the catchment area as well as in the alluvial plain of the water course.

The results obtained using the hydrodynamic model clearly point to the justification of the assumed hypotheses (Fig. 9). Although the effect of grassing during the simulation of the precipitation event was not so marked as shown by other authors, e.g. Unucka and Adamec (2008), (who studied the effect of landscape cover in the Olše River catchment and achieved as high as 56% transformation of the precipitation event with 100% catchment forestation, the transforming potential of grassing observed in this project was positive. The lower transforming capacity of grassing may be caused primarily by the morphology of the Litavka R. catchment (Fig. 10), characterized by the documented fast reaction to the precipitation event, and this may lead to a less noticeable retention, i.e. infiltration potential.

The assessment of AFM on the water course itself led to the conclusion that beside the transforming potential of inundation there is a significant shift of the culmination, which provides the time needed for possible evacuations of threatened persons and protective work during the crisis management of the crisis.

6. Conclusion

In the Czech Republic, there is still a tendency to manage the hydrological problems using technical measures, which offer fast but only one-sided solutions. Preference is given to the measures of the type of protective reservoirs, dams, or increased river bed capacities, which result in further water management problems lower downstream however, and cause serious ecological problems.

This report contributed to the validation of the transforming effect of semi-natural flood-control measures and retention measures in the catchment area. In addition, we also found a positive contribution of the ALS data to the creation of hydrodynamic models in variant conditions of DMT formation.

In view of the disastrous floods observed in the recent decade, the issue discussed in this report is very pressing, also with regard to the Floods Directive adopted by the European Parliament and Council at that time (2007/60/ES of October 23, 2007) on the assessment and management of flood risks. Our project offers an alternative approach to the problems of flood protection, leading not only to a better status for the landscape and the migration permissiveness of water courses, but also to important saving of costs. This approach also enables larger numbers of flood analyses to be processed, and consequently leads to secondary application of the results to the protection of citizens' lives and property, crisis management, or complex land adaptation design.

The main measures considered in the catchment area should reduce water erosion and eliminate the nutrient load of water, increase water retention in the landscape and at the same time preserve the productive capacity of the soil. These measures are associated with the implementation of adequate agricultural practices. The measures in the landscape should not be underestimated because they represent an important part of the preventive measures.

In terms of the economic effectiveness of the proposed measures, a large number of flood-control measures should be implemented, with significant consequences for the crisis management, as well as their incorporation into the flood-control plans of settlements, larger villages and regions, thus eliminating the impact of flood events on human health, the environment, cultural heritage and agricultural activities.

Another highly positive effect is the use of the territory for developing the quality of surface and underground water. The fact that the territory exploitation and especially grassing positively influences water quality has been demonstrated in many research reports: see, for example, Klimeš and

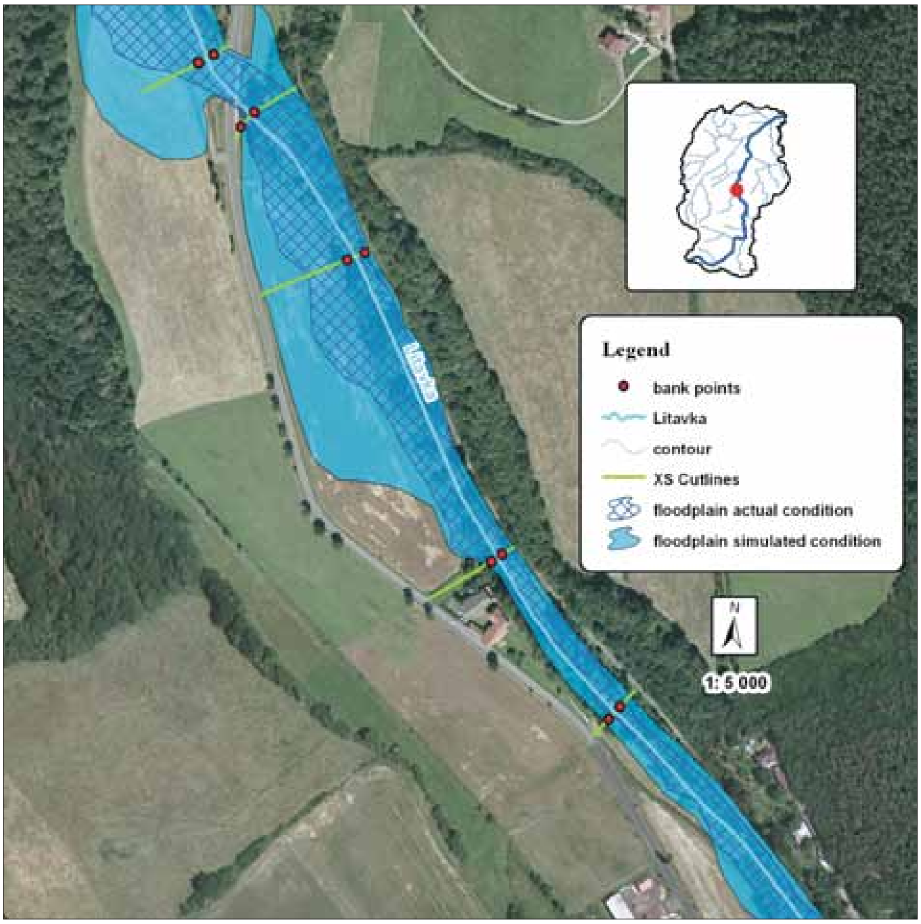

Fig. 9: Floodplain

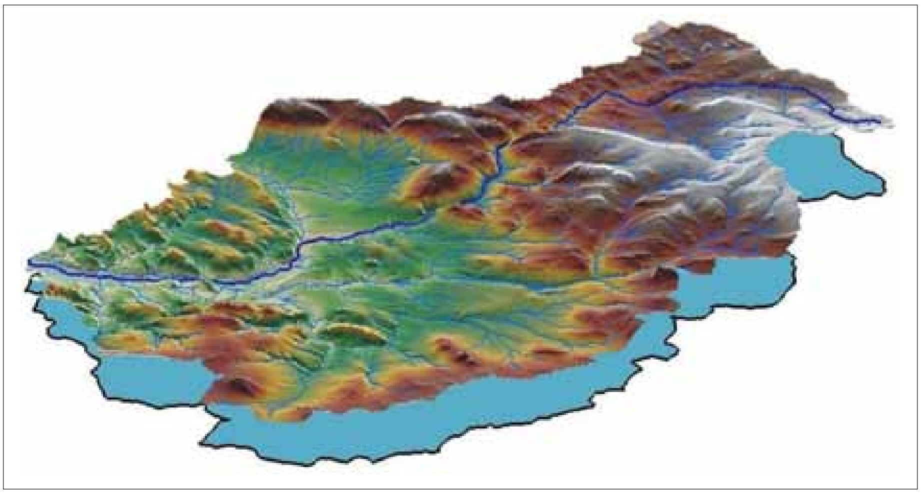

Fig. 10: Morphology of the catchment

Kužel (2004), Klimeš et al. (2004), Kvítek (2002), Poor and McDonnell (2007), and Stanley et al. (2003).

Although we cannot generalize these partial results, we can conclude that our proposed AFM will improve conditions of life for water organisms, the self-cleaning capacity of the water course, and namely increase flood protection both at the water course and in the alluvial plain.

Acknowledgement

This contribution was supported by the Research Programmes of the Ministry of Agriculture of the Czech Republic No. MZE 0002704902, by the Project No. TA02020139 of the Technology Agency of the Czech Republic and with the support by the Project No. QH QI91C200 of the National Agency for Agricultural Research of the Czech Republic.

References:

ADAMEC, M., BŘEZKOVÁ, L., HANZLOVÁ, M., HORÁK, J., UNUCKA, J. (2006): Modelování vlivu land use na srážkoodtokové vztahy s podporou GIS. Příspěvek na konferenci Říční krajina 4. Olomouc, PřF UPOL, p. 335–350.

ADAMEC, M., UNUCKA, J. (2007): Modelování vlivu land use na erozní procesy s podporou GIS. In: sborník konference Říční krajina 2007. PřF UP, Olomouc, 10 pp.

ANDERSON, D. J. (2000): GIS-based hydrologic and hydraulic modeling for floodplain delineation at highway river crossings. MS, University of Texas at Austin, URL: http://www.crwr.utexas.edu/online.shtml.

ANDRYSIAK, P. B., MAIDMENT, D. (2000): Visual Floodplain Modeling with Geographic Information Systems (GIS). MS, University of Texas at Austin. Available at: URL: http://www.crwr.utexas.edu/online.html.

BIČÍK, I., LANGHAMMER, J., ŠTYCH, P., KUPKOVÁ, L. (2008): Long-term land-use changes in Czechia as a flood risk influencing factor. Acta Universitatis Carolinae, Geographica, Vol. 45, No. 1–2, p. 29–52.

BOONSTRA, J., RITZEMA, H. P. [editor-in-chief] (1994): Drainage Principles and Applications. ILRI Publication 16. ILRI, P.O.Box 45, 6700AA Wageningen,The Netherlands.

BRÁZDIL, K. (2009): Projekt tvorby nového výškopisu území České republiky. Geodetický a kartografický obzor, Vol. 55 (97), No. 7, p. 145–151.

COLBY, J. D., MULCAHY, K. A., WANG, Y. (2000): Modeling flooding extent from Hurricane Floyd in the coastal plains of North Carolina. Environmental Hazards, Vol. 2, p. 157–168.

DOLANSKÝ, T. (2004): Lidary a letecké laserové skenování. Acta Universitatis Purkynianae, Vol. 99, Studia geoinformatica, Univerzita J. E. Purkyně v Ústí nad Labem, 100 pp.

DRBAL, K. et al. (2009): Metodika tvorby map povodňového nebezpečí a povodňových rizik. Ministerstvo životního prostředí, 84 pp.

FELDMAN, A. D. (2000): Hydrologic Modeling System HEC-HMS, Technical Reference Manual. USACE, Davis, 155 pp.

FOWLER, H. J., EKSTRÖM, M., KILSBY, C. G., JONES, P. D. (2005): New estimates of future changes in extreme rainfall across the UK using regional climate model integrations. Assessment of control climate. Journal of Hydrology No. 300, p. 212–233.

GIANNONI, F., SMITH, J. A., ZHANG, Y., ROTH, G. (2003): Hydrologic modeling of extreme floods using radar rainfall estimates. Advances in Water Resources, Vol. 26, No. 2, p. 195–203.

HALL, D. G. M, REEVE, M. J, THOMASSON, A. J, WRIGHT, V. F. (1977): Water retention porosity and density of field soils. Soil Survey Technical Monograph No. 9: Soil Survey of England and Wales. (Lawes Agricultural Trust: Harpenden), 75 pp.

HAVLÍK, A., SALAJ, M., SATRAPA, L., FOŠUMPAUR, P., HORSKÝ, M. (2004): Metodika mapování povodňových rizik s pomocí geografických informačních systémů. Praha, ČVUT, Fakulta stavební, 34 pp.

HAVLOVÁ, J. (2001): Ekologická studie Litavky. Hydroprojekt. Praha, 332 pp.

HOLÝ, M. (1994): Eroze a životní prostředí, Vydavatelství ČVUT Praha, 383 pp.

HORNBECK, J. W., BAILEY, S. W., BUSO, D. C., SHANLEY, J. B. (1997): Streamwater Chemistry and Nutrient Budgets for Forested Watersheds in New England: Variability and Management Implications. Forest Ecology and Management, No. 93, p. 73–89.

HRABĚ, F., BUCHGRABER, K. (2004): Pícninářství, Travní porosty, Brno, MZLU (Skriptum), 151 pp.

CHLEBEK, A., JAŘABÁČ, M. (1988): Důsledky porostních obnov na odtok vody z beskydských experimentálních povodí, Zprávy lesnického výzkumu, No. 4, p. 7–12.

CHOW, V. T., MAIDMENT, D. R., MAYS, L. W. (1998): Applied hydrology, McGraw-Hill, New York, 570 pp.

JANEČEK, M. et al. (1992): Ochrana zemědělské půdy před erozí: Metodika UVTIZ No. 5, 110 pp.

JANEČEK, M. et al. (2002): Ochrana zemědělské půdy před erozí. 1. vyd. Praha, ISV, 201 pp.

JENÍČEK, M. (2008): Přehled srážko-odtokových modelů, studijní materiál pro potřeby posluchačů předmětu „Modelování hydrologických procesů“, Univerzita Karlova v Praze.

JENÍČEK, M. (2009): Runoff changes in areas differing in land-use in the Blanice River basin – application of the deterministic model. Journal of Hydrology and Hydromechanics, Vol. 57, No. 3, p. 154–161.

KAIML, P. (2000): Kvalita povrchových vod v povodí Litavky. Diplomová práce. KFGG PřF UK, Praha, 142 pp.

KANTOR, P., KREČMER, V., ŠACH, F., ŠVIHLA, V., ČERNOHOUS, V. (2003): Lesy a povodně: Souhrnná studie; Praha, Národní lesnický komitét a Ministerstvo životního prostředí, p. 48.

KLEMENTOVÁ, E., JURÁKOVÁ, M. (2003): Mokradě v systéme protipovodňovej ochrany. Životné prostredie, Vol. 37, No. 4. Available at: URL: http://www. seps.sk/zp/casopisy/zp/2003/zp4/index.htm.

KLIMEŠ, F. et al. (2004): A possibility to control of ground water contamination with nitrates by suitable grassland management. Coll. of Sci. Papers, Faculty of agriculturae in České Budějovice, Series of Crop Science, Vol. 21, No. 1, p. 41–43.

KLIMEŠ, F., KUŽEL, S. (2004): Application of modelling by the study of ground water contamination with nitrates under grasslands. Plant Soil and Envir., Vol. 50, No. 3, p. 122–128.

KOSUGI, K., MORI, K., YASUDA, H. (2001): An inverse modeling approach for the characterization of unsaturated water flow in an organic forest floor. Journal of Hydrology, No. 246, p. 96–108.

KŘOVÁK, F., PÁNKOVÁ, E., DOLEŽAL, F. (2004): Vliv lesních ekosystémů na hydrický režim krajiny. Aktuality šumavského výzkumu II, Srní 4.–7. října 2004, p. 44–48.

KVÍTEK, T. et al. (2002): Diferencovaný způsob obhospodařování travních porostů ve vztahu k jakosti vody a stanovištním podmínkám. Sborník z mezinárodní konference „Obhospodařování travních porostů a jejich využití skotem v době přibližování ČR do evropské unie", VÚRV Praha, 20.3.2002, p. 113–220.

LANGHAMMER, J. (2007): Upravenost toků a údolní nivy jako faktor ovlivňující průběh a následky povodní, In: Langhammer, J. [ed]: Sborník Změny v krajině a povodňové riziko, p. 129–142.

LIKENS, G. E., BORMANN, F. H. (1974): Effects of Forest Clearing on the Northern Hardwood Forest Ecosystom and its Biochemistry. Proceedings of the First International Congres of Ecology, 8–14.9. 1974; The Hague; The Netherlands. Wageningen: Centre for Agricultural Publishing and Documentation, p. 330–335.

MAHE, G. E., SERVAT (2005): The impact of land use change on soil water holding capacity and river flow modelling in the Nakambe River, Burkina-Faso. Journal of Hydrology, Vol. 300, p. 33–43.

MAIDMENT, D. R. (2002): ArcHydro – GIS for Water Resources. Publisher: ESRI Press, DVD-ROM, 220 p.

MAGUNDA, M. K., LARSON, W. E., LINDEN, D. R., Nater, E. A. (1997): Changes in microrelief and their effects on infiltration and erosion during simulated rainfall. Soil Technology, Vol. 10, No. 1, p. 57–67.

MAUCHAMP, A., CHAUVELON, P., GRILLAS, P. (2002): Restoration of floodplain wetlands: Opening polders along a coastal river in Mediterranean France, Vistre marshes. Ecological Engineering, p. 619–632.

MERWADE, V. M., COOK, A., COONROD, J. (2008): GIS techniques for creating river terrain models for hydrodynamic modeling and flood inundation mapping, Environmental Modelling & Software, Vol. 23, p. 1300–1311.

MERWADE, V. M., MAIDMEND. R., GOFF, J. A. (2006): Anisotropic considerations while interpolating river channel bathymetry. Journal of Hydrology, No. 331, p. 731–41.

MISHRA, S. K., SINGH, V. P. (2003): Soil Conservation Service Curve Numer (SCS-CN) Methodology. Dordrecht, Kluwer Academic Publisher, 511 pp.

MUNZAR, J., ONDRÁČEK, S., ELLEDER, L., SAWICKI, K. (2008): Disastrous floods in Central Europe at the end of July 1897 and the lessons learnt. Moravian Geographical Reports, Vol. 16, No. 3, p. 13–26.

NOVÁK P., ROUB, R., HEJDUK T. (2011): Využití hydrologického měření při tvorbě hydrodynamických modelů z dat leteckého laserového skenování. Vodní hospodářství, Vol. 61, No. 8, p. 297–302.

NOVÁK, P. et al. (2003): Zpracování digitálních map hydropedologických charakteristik půd České republiky. Závěrečná zpráva a výstup 02 projektu QD 1368 „Verifikace metod odvození hydrologických podkladů pro posuzování bezpečnosti vodních děl za povodní", VÚMOP, Praha, 11 pp.

O´CONNOR, K. M. (1976): A discrete linear cascade model for hydrology. Journal of Hydrology, Vol. 29, p. 203–242.

PETŘÍČEK, V., CUDLÍN, P. (2003): Máme bojovat proti povodním? Životné prostredie, Vol. 37, No. 4, p. 177–179. Available at: URL: http://www.seps.sk/zp/casopisy/ zp/2003/zp4/index.htm.

POBĚDINSKIJ, A. V., KREČMER, V. (1984): Funkce lesů v ochraně vod a půdy, 1. vyd. Praha, Státní zemědělské nakladatelství, 256 pp.

PODRÁZSKÝ, V., REMEŠ, J. (2006): Retenční schopnost lesních ekosystémů. Lesnická práce, Vol. 85, No. 7, p. 232, URL: http://lesprace.silvarium.cz.

PONCE, V. M., HAWKINS, R. H. (1996): Runoff Curve Number: Has it Reached Maturity. Journal of Hydrologic Engineering, Vol. 1, No. 1, ASCE, USA (p. 11–19).

POOR, C. J., MCDONNELL, J. J. (2007): The effect of land use on stream nitrate dynamics. Jurnal of Hydrology, No. 332, p. 54–68.

QUITT, E. (1971): Klimatické oblasti Československa. Studia Geographica 16, Brno, Academia, Geografický ústav ČSAV, 73 pp.

RAPANT, P. (2002): Úvod do geografických informačních systémů. Vysoká škola báňská – Technická univerzita Ostrava, Hornicko-geologická fakulta, Institut ekonomiky a systémů řízení, oddělení GIS, Ostrava, 110 pp.

RAPANT, P. (2005): Geoinformační technologie. Vysoká škola báňská – Technická univerzita Ostrava, Hornicko-geologická fakulta, Institut geoinformatiky, Ostrava, 125 pp.

ROUB, R., HEJDUK, T., NOVÁK, P. (2012): Využití dat z tvorby nového výškopisu území České republiky metodou leteckého laserového skenování při analýze a mapování povodňových rizik. Geodetický a kartografický obzor, Vol. 58/100, No. 1, p. 4–8.

SHALABY, A., TATEISHI, R. (2007): Remote sensing and GIS for mapping and monitoring land cover and land-use changes in the Northwestern coastal zone of Egypt. Applied Geography, Vol. 27, No. 1, p. 28–41.

SKALOŠ, J.,WEBER, M., LIPSKÝ, Z., ŘEPÁKOVÁ, I., ŠANTRŮČKOVÁ, M., UHLÍŘOVÁ, L., KUKLA, P. (2011): Using old military survey maps and orthophotograph maps to analyse long-term land cover changes: case study (Czech Republic). Applied Geography, No. 31, p. 426–438.

SMĚRNICE EVROPSKÉHO PARLAMENTU A RADY 2007/60/ES ze dne 23. října 2007 o vyhodnocování a zvládání povodňových rizik (povodňová směrnice).

STANLEY, C. D., CLARKE, R. A., McNEAL, B. L., MACLEOD, B. W. (2003): Impact of Agricultural Land Use on Nitrate Levels in Lake Manatee, Florida. Soil and Water Science Department, Florida Cooperative Extension Service, IFAS, University of Florida, 9 pp.

TAUFMANNOVÁ, A., LANGHAMMER, J. (2007): Mapování antropogenní upravenosti toků a následků povodní v povodí Horní Litavky. In: Langhammer, J. [ed.]: Změny v krajině a povodňové riziko, p. 213–220.

TESAŘ, M., ŠÍR, M., DVOŘÁK, I. J. (2003): Vliv vegetačního porostu a jeho změn na vodní režim půd v pramenných oblastech Krkonoš. In: Sborník mezinárodní vědecké konference „Geologické problémy Krkonoš“. Szklarska Poręba, listopad 2003, p. 30–37.

TRIMBLE, S. W. (2003): Historical hydrographic and hydrologic changes in the San Diego creek wathershed, Newport Bay, California. Journal of Historical Geography, Vol. 29, No. 3, p. 422–444.

TRIZNA, M. (2002): Runoff modelling and its spatial variability in dependence on land use. Moravian Geographical Reports, Vol. 15, No. 3, p. 41–58.

TRIZNA, M., KYZEK, F. (2002): Modelovanie špecifických zrážkovo-odtokových situácií vo vybranom povodí. In: Balej, M., Jančák, V., Jeřábek, M., Oršulák, T. [eds.]: Česká společnost a krajina, Sborník s XX. Sjezdu České geografické společnosti, Ústí nad Labem, p. 56–72.

UHLÍŘOVÁ, K., ZBOŘIL, A. (2009): Možnosti využití Laserového snímání povrchu pro vodohospodářské účely. Vodní hospodářství, Vol. 59, No. 12, p. 11–15.

UNUCKA, J., ADAMEC, M. (2008): Modelování vlivu krajinného pokryvu na srážkoodtokové vztahy v povodí Olše. Journal of Hydrol. Hydromech., Vol. 56, No. 4, p. 257–271.

UNUCKA, J. (2008): Modelování vlivu lesa na srážkoodtokové vztahy a vodní erozi s pomocí GIS. Vodní hospodářství, Vol. 58, No. 7, p. 225–231.

VOPÁLKA, J. (2003): Přístup ministerstva životního prostředí k problematice povodní. In: Celostátní seminář Lesy a povodně. Praha, ČLS, MŽP, MZe, 25.6.2003, p. 8–11.

VOŽENÍLEK, V. (2000): Geografické informační systémy I: Pojetí, historie, základní komponenty. Olomouc, Přírodovědecká fakulta Univerzity Palackého, 174 pp.

WEYSKRABOVÁ, L., VALENTOVÁ, J., VALENTA, P., MYSLIVEC, D., FOŠUMPAUR, P., ŠEPELÁK, J. (2010): Hydraulické a hydrologické přístupy ke stanovení retenční kapacity říční nivy. In: sborník konference Voda a krajina. Praha, Katedra hydromeliorací a krajinného inženýrství, ČVUT v Praze, Fakulta stavební, p. 134–141.

Zákon č. 254/2001 Sb. o vodách a o změně některých zákonů (vodní zákon).

ŽIKULINAS, J. (2008): Hydrographic changes of the Streva Basin in the 20th century. Part 1. Water streams. Geografija, Vol. 44, No. 1, p. 26–30.

Authors´ addresses:

Ing. Radek ROUB, Ph.D., e-mail: *roub@fzp.czu.cz*
Czech University of Life Sciences Prague, Faculty of Environmental Sciences
Department of Water Resources and Environmental Modeling
Kamýcká 129, 165 21 Praha 6–Suchdol, Czech Republic

RNDr. Pavel NOVÁK, e-mail: *novak.pavel@vumop.cz*
Research Institute for Soil and Water Conservation
Žabovřeská 250, 156 27 Prague 5–Zbraslav, Czech Republic

Ing. Tomáš HEJDUK, e-mail: *hejduk.tomas@vumop.cz*
Research Institute for Soil and Water Conservation
Žabovřeská 250, 156 27 Prague 5–Zbraslav, Czech Republic

Initial submission 30 June 2012, **final acceptance** 10 March 2013

Please cite his article as:

ROUB, R., HEJDUK, T., NOVÁK, P. (2013): Optimization of Flood Protection by Semi-natural Means and Retention in the Catchment Area: A Case Study of Litavka River (Czech Republic). Moravian Geographical Reports, Vol. 21, No. 1, p. 51–66.

MORAVIAN GEOGRAPHICAL REPORTS

Aims and Scope of the Journal

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

Instructions for authors

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

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

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

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

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

Fig. 3: Kašperk, the guard-castle at the Czech-Bavarian border, founded by the emperor Charles IV. and one of the most distinctive tourist attraction of the Šumava foothills (Photo: J. Navrátil)

Fig. 4: The landscape of the dissettled borderland alongside the Czech-Austrian border in Novohradské hory Mountain, settlement Pohoří na Šumavě (Photo: J. Navrátilová)

Illustrations related to the paper by J. Navrátil et al.