Vol. 22/2014 No. 4

MORAVIAN GEOGRAPHICAL REPORTS

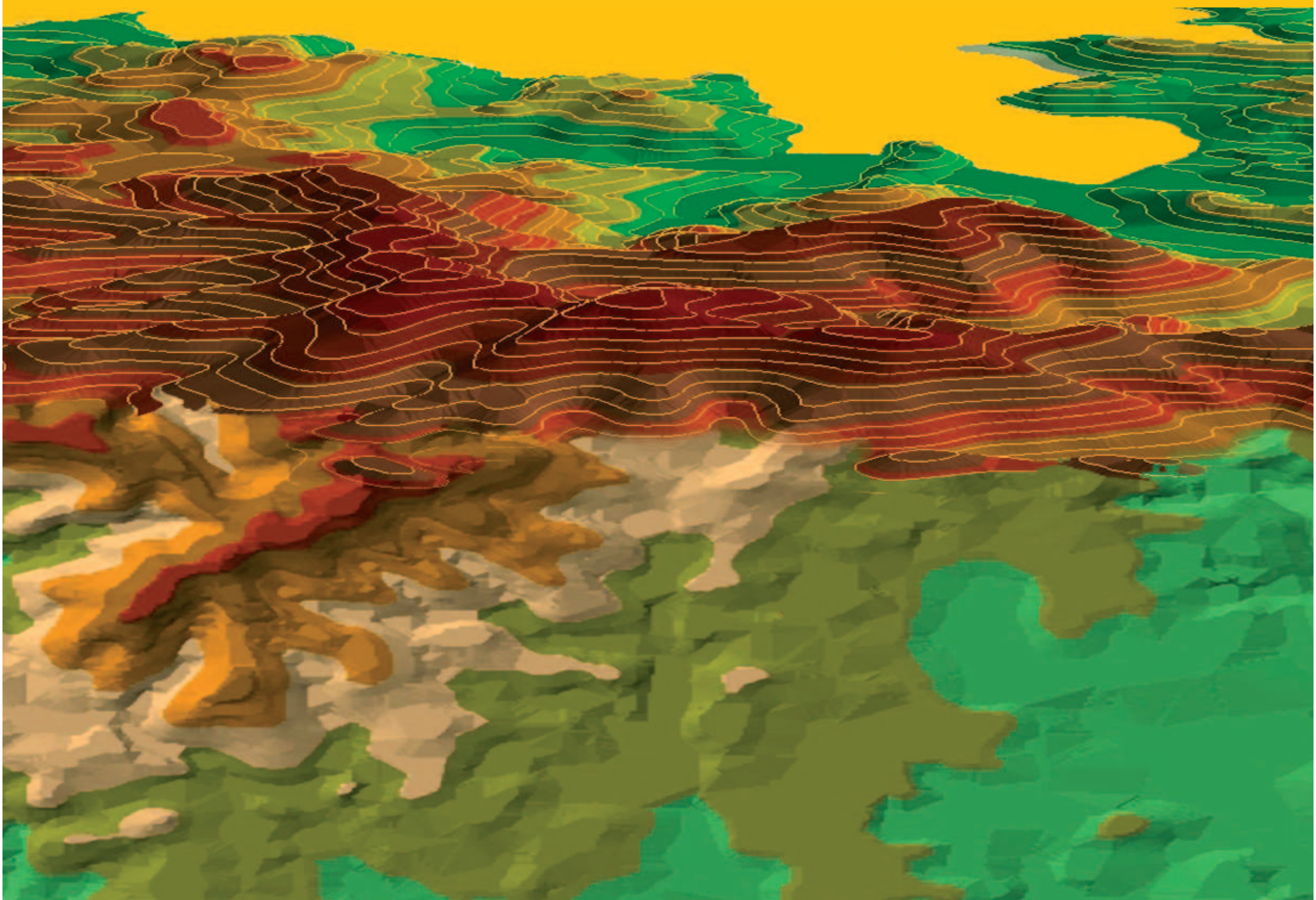

Fig. 7: Derelict buildings of the textile factory in Kreenholm island Narva (Estonia) (Photo: J. Tintěra)

Fig. 8: Former textile factory in Kreenholm island (Narva, Estonia) - view from the East (Photo: J. Tintěra)

Illustrations related to the paper by J. Tintěra, A. Ruus, E. Tovhri and Z. Kotval

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, December 31, 2014

PRINT

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

ISSN 1210-8812 (Print)
ISSN 2199-6202 (Online)

Articles:

A MULTISTAGE AGGLOMERATIVE APPROACH FOR DEFINING FUNCTIONAL REGIONS OF THE CZECH REPUBLIC: THE USE OF 2001 COMMUTING DATA

Pavel KLAPKA, Marián HALÁS, Martin ERLEBACH, Petr TONEV, Marek BEDNÁŘ

Abstract

The issue of defining functional regions in the Czech Republic is presented in this paper, which contributes to both theoretical discussions (e.g. the modifiable areal unit problem) and practical applications (e.g. spatial administration, regional planning). A multistage agglomerative approach to functional regional taxonomy is applied, which has been used in Czech geographical research for the first time only recently. The regionalisation algorithm provided four optional solutions for this issue, based on the analysis of daily travel-to-work flows from the 2001 census. The resulting regions correspond to the micro-regional level and two additional tiers were identified at this level. The basic statistics for all variants are presented.

Shrnutí

Vícestupňový aglomerační přístup k vymezení funkčních regionů České republiky: využití údajů o dojížďce z roku 2001

Článek se zabývá problémem vymezení funkčních regionů na území České republiky a přispívá jak k teoretické diskusi (např. problém modifikovatelné územní jednotky) tak k praktickým aplikacím (např. prostorová správa, regionální plánování). Je aplikován vícestupňový aglomerační přístup k funkční regionální taxonomii, jenž byl v české geografii použit poprvé zcela nedávno. Regionalizační algoritmus poskytl čtyři variantní řešení založené na analýze denních toků do zaměstnání z censu z roku 2001. Výsledné regiony odpovídají mikroregionální úrovni a v rámci této úrovně byly identifikovány další dva stupně. Ke všem variantám jsou rovněž uvedeny základní statistiky.

Key words: *functional region, daily urban system, local labour market area, regional taxonomy, multistage agglomerative method, labour commuting, Czech Republic*

1. Introduction

The recognition of functional regions has a wide potential for development of both geographical theory and practice. One primary and underlying consideration rests in a belief that administrative or political divisions of territories often tend to ignore basic functional geographical logic, asking for some kind of organisational unity and functional similarity of a region, expressed for instance by labour commuting flows. As Baumann et al. (1996), Cörvers et al. (2009) and Mitchell and Watts (2010) point out, delineation of functional regions is a part of the modifiable areal unit problem – MAUP (as addressed for example by Openshaw, 1984, or Unwin, 1996). MAUP is an inseparable part of almost any spatial analysis in cases when arbitrary and modifiable objects (spatial units) are grouped into larger areas. There is the question of the aggregation or zoning problem (i.e. which way of aggregation is used in order to amalgamate functional regions out of basic spatial units), and the question of the scale problem (i.e. how many functional regions there should be).

Theoretical considerations are closely related to a practical point of view. Administrative or political divisions do not reflect the rapid changes in geographical reality; thus, they can manifest a considerable degree of inefficiency. Correctly-defined functional regions (i.e. those based on informed choice) can serve better as a geographical tool for normative use (a virtue acknowledged by Haggett, 1965, and by Dziewoński, 1967) than administrative regions. Correctly-defined functional regions can contribute not only to statistical and regional geography, but also to spatial planning, regional economics, or administration (most recently acknowledged by Coombes, 2010; Casado-Díaz, Coombes, 2011; and Farmer, Fotheringham, 2011). Based on travel-to-work flows, functional regions can be used for the assessment of regional disparities, labour market policy, allocation of investments, planning of transport infrastructure, etc. – actually everywhere where there is a need for some kind of spatial units with an internal geographical logic, in order to reduce possible spatial bias caused for instance by political decisions or by the modifiable areal unit problem.

This paper contributes to the issue of the definition of the regional system of the Czech Republic by the application of a sophisticated regionalisation algorithm using daily travel-to-work flow data. Thus, it touches upon both aspects briefly presented above. This report has the following objectives: first, it attempts to produce four variants of the regional system of the Czech Republic, based on the size of regions and on a predominant principle for their delineation (i.e. self-containment – see below); and, second, to provide basic information on the regions and their spatial differentiation for each variant, using the same dataset as for their delineation. The variants can serve several purposes – such as a framework for spatial analyses of various human geographical phenomena, or as a correction for the existing administrative divisions. A third objective is to apply an acknowledged method for defining functional regions, which was applied in Czech geographical research for the first time only recently (see Klapka et al., 2013b and Tonev, 2013), and presents several methodological refinements. Thus, it contributes to a wider discussion on the behaviour of applied regionalisation methods under different geographical conditions. As an outcome fourth aim, this paper offers an alternative to the existing regional divisions of the Czech Republic based on the same dataset. As these objectives are defined, it should be admitted that the paper concentrates intentionally on the presentation of results, rather than on the procedure itself although it will be detailed sufficiently.

The paper is organised as follows. The following section addresses the issue of a functional region and approaches used for its delineation. It also briefly comments upon recent developments in the Czech Republic in this field of research. The subsequent section describes methodological procedure to a necessary and sufficient extent. The next section presents results for all four variants of the Czech regional system. The concluding section discusses findings of the paper and highlights its contributions.

2. Functional regions

The concept of functional regions was introduced into human geography by Philbrick (1957); Nystuen and Dacey (1961); Haggett (1965); Dziewoński (1967); and Berry (1968). A functional region (Klapka et al., 2013a) is conceived as a general concept that has to prove only the condition of self-containment, which is considered its crucial defining and identifying characteristic. Its inner structure, inner spatial flows and interactions, need not necessarily show any regular patterns – on the contrary, they can be random in some cases. Nodal regions, functional urban regions, daily urban systems, local labour market areas or travel-to-work areas, are considered special instances of a general functional region, that need to meet some specific conditions regarding the character of the region-organising interaction, the presence of urban cores, etc. (for more information, including the schemes, see Klapka et al., 2013a). Functional regions are usually understood to be the areas organised by the horizontal functional relations (flows, interactions) that are maximised within a region and minimised across its boundaries, so that the principles of internal cohesiveness and external separation regarding spatial interactions are met (for example, see Smart, 1974; Karlsson, Olsson, 2006; Farmer, Fotheringham, 2011; Klapka et al., 2013a).

Travel-to-work flows, particularly those on a daily basis, are the interactions that are commonly used in order to delineate functional regions (e.g. Goodmanm, 1970; Smart, 1974; Coombes et al., 1979; Ball, 1980). Labour commuting is the most frequent and stable regular movement of the population with a daily periodicity, and the changes in employment patterns remain modest in scale, so the use of these flows remains relevant. Functional regions based on the daily travel-to-work flows are referred to as local labour market areas (LLMA) or travel-to-work areas (TTWA). Both concepts are virtually identical (Klapka et al., 2013a) and were introduced into geography during the 1970s and early 1980s (Goodman, 1970; Smart, 1974; Coombes et al., 1979; Ball, 1980; Coombes, Openshaw, 1982). In the case that the region-organising interactions (i.e. travel-to-work flows) are oriented at an urban core, the functional regions can be denoted as daily urban systems (DUS). Daily urban systems were discussed, for instance, by Berry (1973), Hall (1974), and Coombes et al. (1978).

Functional regions are identified by a set of approaches, procedures and methods that are subsumed under the concept of functional regional taxonomy (see, for instance, the pioneering works by Spence, Taylor, 1970; Masser, Brown, 1975). According to Coombes (2000), regional taxonomy is the part of spatial analysis that attempts to set boundaries for clusters of interrelated spatial zones and to distinguish them from other clusters using the analysis of travel-to-work flows. Laan and Schalke (2001) propose that there is no sole correct method for the delineation of functional regions and that different analyses of the same data can provide considerably different results.[1]

Based on the literature, methods of defining functional regions can generally be sorted into two groups: clustering methods and multistage methods (also rule-based methods). For each group further distinct cases can be identified. Functional regions can be defined by divisive or agglomerative approaches, then by hierarchical or non-hierarchical procedures, and finally by numerical or graph theory procedures. This classification of approaches to regional taxonomy is only one of several possibilities. Alternatives are provided for instance by Coombes (2000), Laan, Schalke (2001), Casado-Díaz and Coombes (2011) or Farmer, Fotheringham (2011).

From all possible combinations, the literature tends to favour three approaches to functional regional taxonomy: clustering methods, using either (i) numerical or (ii) graph theory procedures, and (iii) multistage procedures. A review of these methods of functional regional taxonomy is presented by Casado-Díaz and Coombes (2011). The clustering methods based on numerical taxonomy were used by Brown and Holmes (1971), Smart (1974), Masser and Brown (1975), Masser and Scheurwater (1978, 1980), and Baumann et al. (1983). They mostly used the general principles of cluster analysis. Clustering methods based on graph theory approaches were proposed by Nystuen and Dacey (1961), Slater (1976), Holmes and Haggett (1977), and recently addressed by Karlsson and Olsson (2006).

These clustering methods were criticised for being too heuristic (Ball, 1980; Coombes, Openshaw, 1982), although some of their principles appear again in the latest variant of the measures produced at the Centre for Urban and Regional Development Studies (CURDS), in Newcastle, U.K. (Coombes, Bond, 2008; Coombes, 2010), as a result of the simplification of the regionalisation algorithm. On the other hand, the clustering methods were favoured against the rule-based methods relatively recently by Cörvers et al. (2009), Krygsman et al. (2009), Drobne et al. (2010), and by Mitchell and Watts (2010). Landré and Håkansson (2013) compared the results of both approaches for the territory of Sweden.

The third, multistage or rule-based approach, which is used in this paper, was proposed by the research group at CURDS (Coombes et al., 1982; 1986; Coombes, Bond, 2008; Coombes, 2010), and became probably the most successful and acknowledged approach to the functional regional taxonomy

[1] This is acknowledged by this paper as well: therefore its proposals are presented as alternatives to the existing regional divisions, and it was corroborated using the case of the Czech Republic earlier by Klapka et al. (2013b).

of several territories. Apart from the above-mentioned works that concerned the U.K., this approach was applied in Italy (Sforzi [ed.], 1997), Slovakia (Bezák, 2000; Halás et al., 2014), Spain (Casado-Díaz, 2000; Flórez- Revuelta et al., 2008), New Zealand (Papps, Newell, 2002; Newell, Perry, 2005), Belgium (Persyn, Torfs, 2011), Poland (Gruchociak, 2012), and in the Czech Republic (Klapka et al., 2013b; Tonev, 2013). The principle used in these methods lies in the definition of a set of rules that are applied in several stages and determine the results of the analyses. The rules are often used iteratively in order to reach or approximate an optimal solution, i.e. to define as many regional classes as possible according to the rules.

As for the situation in the Czech Republic and using the 2001 census commuting data, the clustering methods using graph theory approaches have been predominantly applied to date. For example, the Czech Statistical Office (ČSÚ, 2004), Hampl (2005) and Sýkora and Mulíček (2009), identified potential regional cores using their size and function, and then assigned remaining spatial zones to the cores based on the so-called first flow. Halás et al. (2010) applied similar methods that differed in the choice of potential cores. In all cases, the results had to be refined manually in order to secure the contiguity and the size of resulting regions. Multistage methods have been applied in the Czech Republic by Klapka et al. (2013b) and Tonev (2013), though only as a testing of the second variant of the CURDS algorithm in the former case, and as a tool for the assessment of the development of commuting patterns in the latter case. This paper presents the results of the first deliberate attempt to define functional regions of the Czech Republic using the multistage agglomerative approach.

All the above-mentioned methods, regardless of type and class, use various interaction measures to express the relation between spatial zones based on the travel-to-work flows, and to define functional regions based on travel-to-work flows. The interaction measures are discussed by Casado-Izquierdo and Propín-Frejomil (2008). In this paper, two interaction measures are applied ([1] and [2], below). The first one was proposed but not used by Smart (1974), and until the present remains the most-used measure as it is the mathematically most correct way of relativisation and symmetrisation of statistical interaction data. It was used also by the second and third variant of the CURDS algorithm (Coombes et al., 1986; Coombes, Bond, 2008); its notation is as follows:

Smart's measure $$\left[\frac{T_{ij}^2}{\left(\sum_k T_{ik} * \sum_k T_{kj}\right)} + \frac{T_{ji}^2}{\left(\sum_k T_{jk} * \sum_k T_{ki}\right)}\right] \quad [1],$$

where T_{ij} denotes the flow from spatial zone i to spatial zone j, and T_{ji} from j to i, $\sum_k T_{ik}$ denotes all outgoing flows from i, $\sum_k T_{kj}$ denotes all ingoing flows to j, $\sum_k T_{jk}$ denotes all outgoing flows from j, and finally $\sum_k T_{ki}$ denotes all ingoing flows to i.

The second interaction measure was proposed by Coombes et al. (1982) in the first variant of the CURDS algorithm and its notation is as follows:

CURDS measure $$\left[\frac{T_{ij}}{\sum_k T_{ik}} + \frac{T_{ij}}{\sum_k T_{kj}} + \frac{T_{ji}}{\sum_k T_{jk}} + \frac{T_{ji}}{\sum_k T_{ki}}\right] \quad [2]$$

This expression will be referred to in this paper as the CURDS measure. The notation for both measures [1] and [2] is consistent.

Preliminary analyses of the interaction data and experimentation with the algorithm showed differences in the behaviour of the two interaction measures. Generally, Smart's measure tends to mitigate the regional influence of large centres and emphasises the regional influence of smaller centres. This measure slightly equalises the size of resulting regions and allows the formation of smaller regions in the hinterlands of large centres, which conforms to the principle of spatial equity (see Bezák, 1997 or Michniak, 2003) favouring the equal accessibility of the most distant parts of regions to their regional centres.

Coombes (2010) also claims that it conforms best to the rule that any procedure should identify as many regions as possible. On the contrary, the CURDS measure emphasises the influence of large centres at the expense of the centres in their hinterlands, which frequently are not able to form their own region. As a result, the principle of spatial efficiency (Bezák, 1997; Michniak, 2003) is acknowledged favouring the conformity between regional boundaries and intra-regional interactions, in fact the self-containment of a region, when the inter-regional interactions are minimised.

3. Procedure

The adjusted and simplified second variant of the CURDS algorithm (Coombes et al., 1986) is applied in this paper. It is a multistage, agglomerative, non-hierarchical and numerical procedure of functional regional taxonomy. This version of the second variant of the algorithm is favoured over the more recent one for several purposes. First, it allows some international comparability of the procedure and the results. Second, it might be found useful to identify a set of potential regional cores, a possibility that the newest variant does not provide. Knowing the cores is important for further analyses of the inner structure of the resulting regions. Third, parameters for the second variant can be set so that the variant actually behaves in the same way as the newest variant. The procedure is described in detail by Coombes et al. (1986: 948–952). Alterations in the value of the parameters and simplifications that were made in this paper are described in the following paragraphs.

The algorithm uses the commuting data, i.e. the daily travel-to-work flows of employed persons, from the 2001 census. The data are stored in the square matrix having 6,258 rows and columns, which is the number of municipalities (basic spatial zones) as of the 2001 census. The matrix is sparse (with a great portion of zero flows) and features inner flows along its diagonal. The original data had to be refined in some cases when there were errors caused by incorrect encoding and interpretation (this problem is discussed in detail by Tonev, 2013).

The algorithm is divided into three stages, which include four steps and several operations (see below):

a. identification of proto-regions:

1) identification of potential cores; and

2) identification of multiple cores by critical values of the interaction measure;

b. assignment of remaining spatial zones:

3) assignment of spatial zones to the proto-regions by interaction measure maximisation; and

c. assessment of the validity of the solution:

4) application of the constraint function and iterative dissolution of regions that do not meet the criteria set by the constraint function.

A basic spatial zone has to meet two conditions in order to qualify as a potential regional core, i.e. a job ratio function:

$$\frac{\sum_j T_{ji}}{\sum_j T_{ij}} > 0.8 \qquad [3]$$

and supply-side (or residence-based) self-containment:

$$\frac{T_{ii}}{\sum_j T_{ij}} > 0.5 \qquad [4]$$

In the case that the potential core j does not meet the condition of a sufficient self-containment, i.e.

$$\frac{T_{ij}}{\left(\sum_k T_{jk} + \sum_k T_{kj}\right) - T_{jj}} > 0.5 \qquad [5]$$

potential groupings of the cores j are identified on the basis of mutual relations between them and the value of the interaction measure. The criterion of the value for the interaction measure was altered in comparison with the original algorithm to 0.01 in the case of Smart's measure, and to 0.2 in the case of the CURDS measure. Both values were estimated on the basis of extensive experimentation and reflect the character of the Czech settlement system. The resulting set of cores and multiple cores is considered as a set of the proto-regions.

In the next step, the remaining basic spatial zones i are sorted in descending order by the number of employed persons and assigned to the proto-region that is most strongly linked to each of them, according to the interaction measure. Once a basic spatial zone i is assigned to a proto-region j, all incident flows have to be recalculated and a new interaction matrix is formed. This step is repeated until there is no basic spatial zone i left.

The next step applies the constraint function that sets a minimum size and self-containment criteria for the resulting regions. The regions are sorted in descending order by the value of constraint function, and the lowest-ranked region that does not meet the condition of the constraint function is dissolved, its constituent basic spatial zones being assigned to another region according to Step 3. This operation is iteratively repeated until all regions meet the condition of the constraint function.

As demonstrated in the above paragraphs, the role of the constraint function is crucial for the resulting regional pattern The constraint function controls two parameters of the resulting regions and the so-called trade-off between them. Basically, it means that smaller regions have to reach a higher level of self-containment, and larger regions are allowed to manifest a lower level of self-containment. The size of regions is given by the number of employed persons. The constraint function employed in this paper has the form of a continuous curve (Fig. 1), and its shape is determined by four parameters that can be easily set by the user: the upper and lower size limits and the upper and lower self-containment limits.

The constraint function still has one important implication for this paper. It is used to estimate the parameters for the size and the self-containment of the regions. The analyses were commenced by setting the lower limits of self-containment and size to $\beta_1 = 0.6$ and $\beta_3 = 2{,}500$ in order to acquire an initial regional pattern. As the experiments showed, these limits, together with $\beta_2 = 0.65$ and $\beta_4 = 15{,}000$ as the upper limits, were sufficient enough to identify virtually all possible and basic functional regions in the Czech Republic. Two initial regional patterns were gained, one based on the application of Smart's measure, and the other based on the application of the CURDS measure.

The position of each region can be plotted on an x-y graph as a point according to the values of its size and self-containment. The regions appear in the upper right sector of the graph from the curve of the constraint function (see Fig. 1). A graphical assessment of the results can help to identify the course and position of the constraint function on the graph. If there is a considerable gap in the field of points, this is the area of the discontinuity of size and self-containment parameters, or more precisely, the trade-off of these parameters and the insertion of the constraint function into the gap is able to provide new estimates for the values of the four size and self-containment parameters.[2]

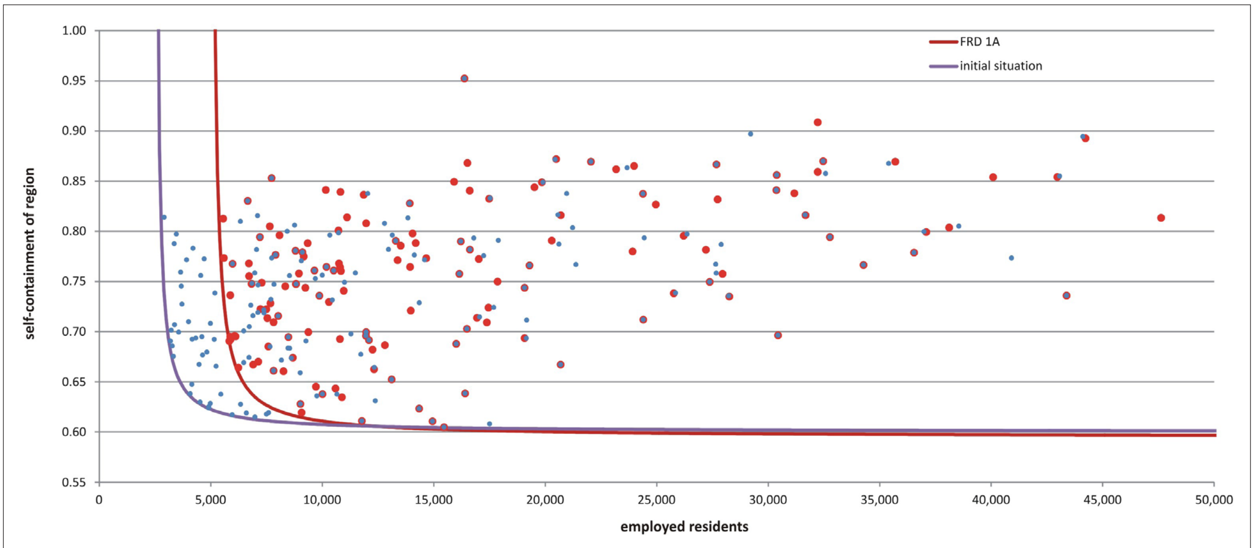

Fig. 1: An example of the use for the constraint function. Source: authors´ elaboration

[2] It should be noted that an infinite number of curves could in fact be inserted into the gap and that the presented solution is therefore not strictly objective.

The principle of the estimate is documented in Fig. 1 that presents a case of gap identification in the initial situation based on the CURDS measure, the insertion of a new constraint function with new parameters, and the plotting of new results on the graph. This operation was repeated four times in the following manner: (1) curve shift for the initial situation based on the CURDS measure (see Fig. 1 again), (2) curve shift for Variant 1, (3) curve shift for the initial situation based on Smart's measure, and (4) curve shift for Variant 3. This gradual identification of gaps in the respective point patterns produced four variants of the regional system of the Czech Republic (see the next section: where appropriate, they are denoted as "FRD" standing for functional regions based on daily interactions).

4. Results and discussion

This procedure has provided four variants of the Czech regional system at two tiers, determined by the number and size of the regions. These two tiers, however, still represent a micro-regional hierarchical level as far as population size, area and number of regions is concerned. Each tier comprises two variant solutions depending on the interaction measure employed in the algorithm, either the CURDS measure or Smart's measure. Thus there is a regional system FRD 1A (the first tier, CURDS measure), a regional system FRD 1B (the first tier, Smart's measure), a regional system FRD 2A (the second tier, CURDS measure), and a regional system FRD 2B (the second tier, Smart's measure). Basic statistics for all four variants of the Czech regional system are presented in Table 1. Beta values for all four regional systems were estimated by the procedures with the constraint function mentioned above. The total self-containment of the regional system was calculated by using the formula:

$$\frac{\sum_{j} T_{jj}}{\sum_{j}\sum_{k} T_{jk}} \qquad [6]$$

Figures 2, 3, 4 and 5 provide spatial patterns for all four regional systems respectively and the levels of the self-containment for the resulting regions. First, a note on the contiguity of regions should be made. The algorithm provides contiguous regions without the need for further adjustments with several insignificant exceptions. Only in one case is there a naturally (i.e. by the spatial pattern of interaction data) conditioned exclave: Jesenice, that belongs to the Rakovník region in the western part of central Bohemia. This discontinuity occurs in regional systems FRD 1A, FRD 1B and FRD 2A. Any remaining discontinuities that were identified are caused by the existence of geographically disjunct basic spatial units (municipalities) and as such were not taken into account.

The FRD 1A regional system consists of 160 regions (Fig. 2) and provides the most fragmented regional pattern out of all proposed variants. This can be particularly witnessed in the belt extending from northwest Bohemia to northwest Moravia, i.e. in the traditionally industrial half of present-day Czech Republic. The variations in size (total population, economically active population) and area are the greatest. As for the self-containment of the regions, the highest values are scored either for the regions of the largest centres (Prague, Brno, Pilsen), then for the border regions (Znojmo, Jeseník, Cheb, Aš), and finally for some regions in agglomerations or conurbations (Liberec, Jablonec nad Nisou, Ústí nad Labem, Děčín). Contrariwise, lower values of self-containment are scored for regions in the wider hinterland of the largest centres (e.g. Kralupy nad

Attribute for regional system	FRD 1A	FRD 1B	FRD 2A	FRD 2B
β_1 value	0.595	0.64	0.60	0.63
β_2 value	0.65	0.72	0.70	0.75
β_3 value	5,000	4,500	10,000	6,000
β_4 value	21,000	10,000	50,000	70,000
Self-containment of regional system	0.900	0.901	0.917	0.915
Number of regions	160	149	104	98
Self-containment (mean)	0.766	0.781	0.816	0.828
Self-containment (median)	0.767	0.779	0.820	0.835
Self-containment (variation coefficient)	0.097	0.082	0.081	0.064
Economically active population (mean)	32,833.75	35,257.72	50,513.46	53,606.12
Economically active population (median)	16,528.50	20,046.00	30,865.50	37,351.00
Economically active population (variation coefficient)	2.112	1.895	1.722	1.450
Population (mean)	63,937.88	68,658.12	98,365.96	104,388.40
Population (median)	32,452.50	39,407.00	61,303.00	75,130.50
Population (variation coefficient)	2.037	1.821	1.659	1.391
Area km^2 (mean)	493.22	529.62	758.79	805.24
Area km^2 (median)	393.78	466.48	633.45	736.86
Area km^2 (variation coefficient)	0.759	0.539	0.695	0.468

Tab. 1: Attributes for variants of the Czech regional system. Source: authors´ computation
Note: The value of the β_1 parameter for FRD 1A (0.595) is lower than the value of the β_1 parameter for the initial situation (0.6). It is caused by the operations related with the insertion of the constraint function curve, and it does not affect the results in any way since no region in the regional system FRD 1A has lower self-containment than 0.6.

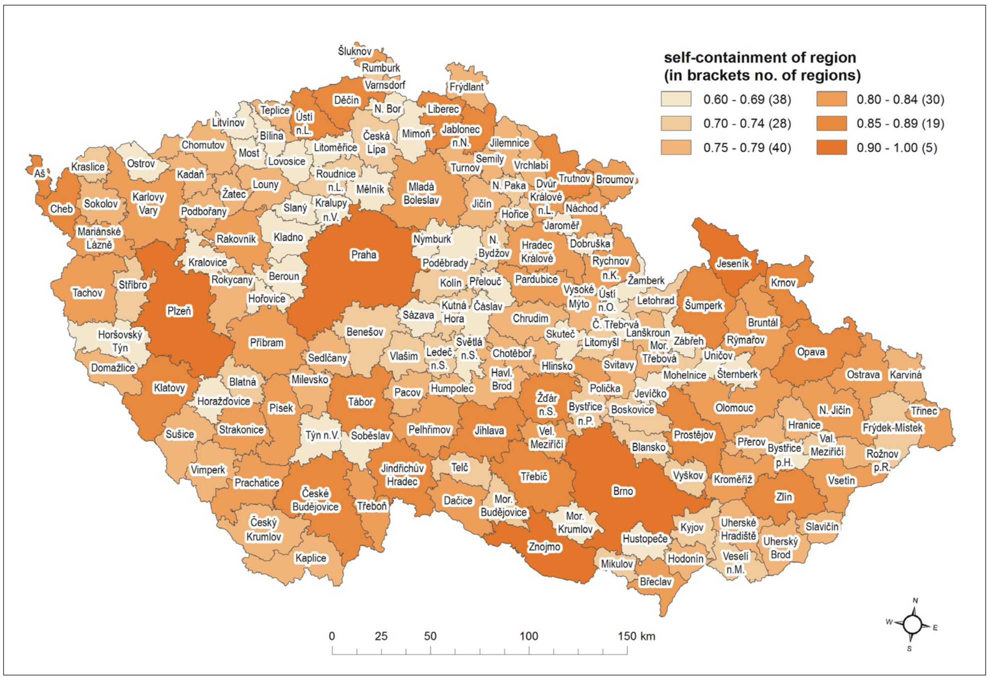

Fig. 2: FRD 1A Regional system. Source: authors' elaboration

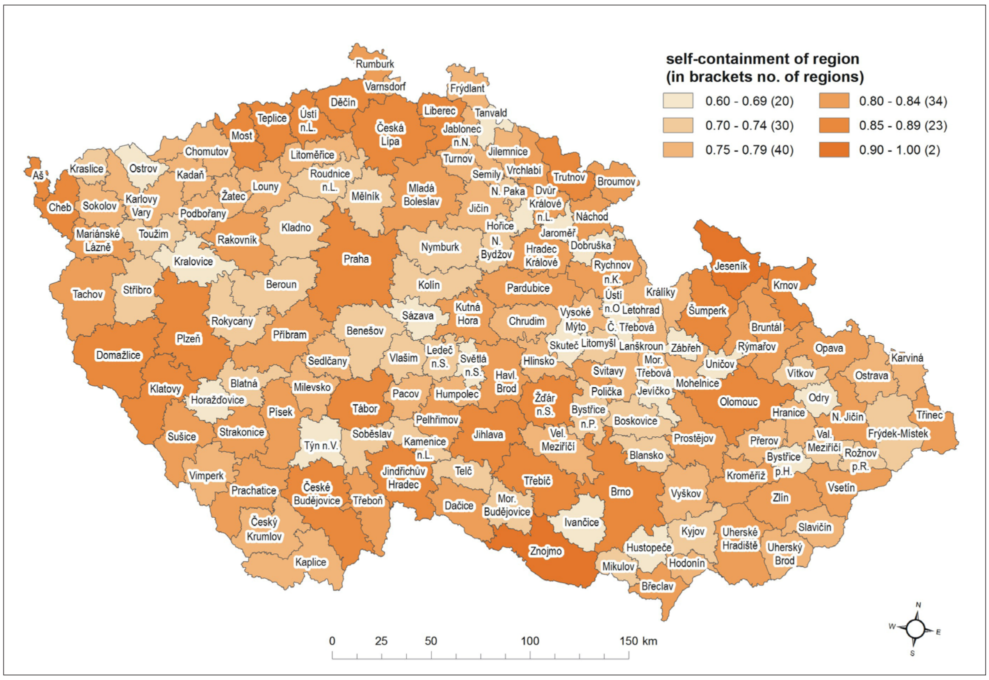

Fig. 3: FRD 1B Regional system. Source: authors' elaboration

Vltavou, Slaný, Kralovice, Moravský Krumlov, Hustopeče), for regions of smaller centres in conurbations (e.g. Litvínov, Bílina) or in the vicinity of meso-regional centres (e.g. Týn nad Vltavou, Přelouč, Šternberk), and for regions in areas with a relatively even distribution of similar smaller centres (typically eastern Bohemia and north western Moravia).

The FRD 1B regional system presents the same tier as FRD 1A and consists of 149 regions (Fig. 3). The regional pattern is more consolidated in the hinterlands of the largest centres and in agglomerations and conurbations. The spatial influence of the largest centres is mitigated as well. Fragmented patterns remain in eastern Bohemia and north-western Moravia, however. The variations in size and area become smaller in comparison to the statistics for FRD 1A. The same holds true for the self-containment of the regions. It remains highest in the border regions (again Jeseník, Aš, Cheb, Znojmo, newly for instance in Trutnov, Domažlice, Klatovy), and it has become higher in some agglomerations and conurbations due to the consolidation of regional patterns (e.g. in the belt reaching from Most to Liberec in northern Bohemia). On the contrary, the self-containment was lowered for the regions of the largest centres (Prague, Brno, Pilsen) and remains low for regions in the wider hinterland of the largest centres (Ivančice, Hustopeče, Sázava, Kralovice, Horažďovice).

The FRD 2A regional system at the second tier consists of 104 regions (Fig. 4). Its most notable feature is that the spatial influence of the largest centres is very extensive (Prague, Brno, Pilsen). The lower number of regions provides a more consolidated regional pattern even for north-eastern

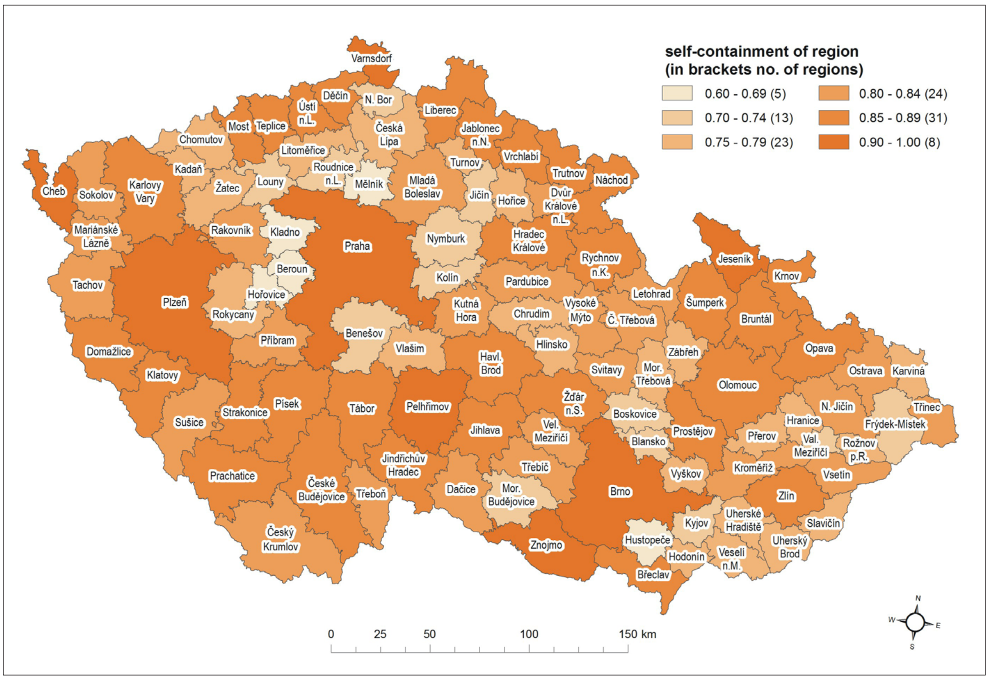

Fig. 4: FRD 2A Regional system. Source: authors' elaboration

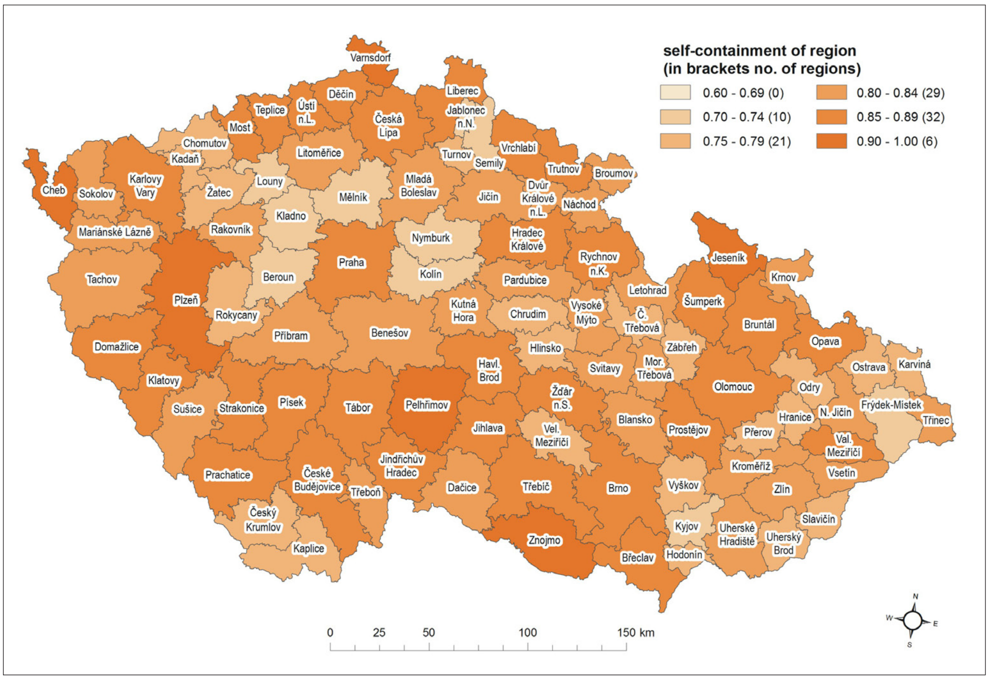

Fig. 5: FRD 2B Regional system. Source: authors' elaboration

and eastern Bohemia in this solution. Variations in size are relatively high but the variation coefficient for area is higher than for FRD 1B. The highest values for the self-containment of regions are reached in the regions of the largest centres (Prague, Brno, Pilsen), in the border regions (Jeseník, Znojmo, Cheb, Varnsdorf), in some agglomerations and conurbations (northern Bohemia), and for the first time in consolidated areas (the belt extending from Liberec to Rychnov nad Kněžnou, northwest Moravia, or the region of Pelhřimov). Lower values of self-containment are concentrated in the vicinity of the largest centres.

The FRD 2B regional system presents the same tier as FRD 2A and consists of 98 regions (Fig. 5). The regional pattern is most consolidated out of all four variants, as is shown by the variation coefficients for size and area. The pattern regarding self-containment values remained virtually the same as for FRD 2A, with minor differences in cases when the regional boundaries were reconfigured in comparison to FRD 2A (e.g. Jablonec nad Nisou and Semily).

Since the definition of regions is based on the daily-travel-to-work flows, the same data can be used for further characteristics of the regions by calculations of three indexes. The first index is expressed by the formula:

$$\frac{\sum_k T_{kj}}{\sum_k T_{jk}} \qquad [7]$$

and is called the job ratio. It is a ratio of jobs and employed persons. If the index value is higher than 1 it denotes that the region offers more jobs than is the number of its employed population. The results for all four variants of the regional system of the Czech Republic are shown in Fig. 6. The beige-red shades denote the in-commuting regions, basically organised around economic centres of the Czech Republic at both micro- and meso-regional levels. The blue shades denote the out-commuting regions that lack the job opportunities to various degrees. The influence of modifiable boundaries can be seen quite clearly, but the general pattern is easily identifiable.

The second index is expressed by the formula:

$$\frac{T_{jj}}{\sum_k T_{jk}} \quad [8]$$

and it is a measure of the supply-side (or residence-based) self-containment expressing the proportion of employed persons working locally. The results for all four variants of the regional system of the Czech Republic are shown in Fig. 7. This index correlates significantly with the self-containment of the regions as presented in Figures 2, 3, 4 and 5, and regional patterns have the same underlying logic and interpretation as stated above.

The third index is expressed by the formula:

$$\frac{T_{jj}}{\sum_k T_{kj}} \quad [9]$$

and it is a measure of the demand-side (or workplace-based) self-containment expressing the proportion of jobs filled by the residents. The results for all four variants of the regional system of the Czech Republic are shown in Fig. 8. Darker shades denote regions where most jobs are filled by local residents. These are basically located along the state border or in the promontories of the state territory, then in the areas that are economically less developed and the settlement system has a lower number of micro-regional centres (generally the southern part of the Czech Republic), and also in the spatially large regions of important economic centres (especially in FRD 2A).

5. Conclusions

The application of advanced methods for functional regional taxonomy as presented in this paper warrants several conclusions. First, regional patterns provided by four runs of the regionalisation algorithm do not require any significant and extensive manual and often subjective refinements and amendments, in comparison to simpler regionalisation methods. The regions are contiguous and their self-containment is ensured in order to qualify them as functional regions according to the definition stated in Section 2.

Second, the application of these methods is able to produce numerous viable and objectively unbiased solutions to the regionalisation problem, that reflect the purpose, objectives and demands for various research tasks. Moreover, only one dataset (daily travel-to-work flows) is used for all computations and under the defined rules for the regionalisation process. The only purely subjective input lies virtually in the estimation of beta parameters. Thus, the method shows a great degree of flexibility. For instance, the procedure used in this paper has provided four variants of the regional system of the Czech Republic at a micro-regional level, and two tiers of regional patterns have been identified at this level, which means there is an option of choice inherent in the method and its results.

Third, two interaction measures have been used in the regionalisation algorithm (the CURDS measure and Smart's measure) and they have provided variant solutions for each tier of the regional patterns. The solutions provided by the

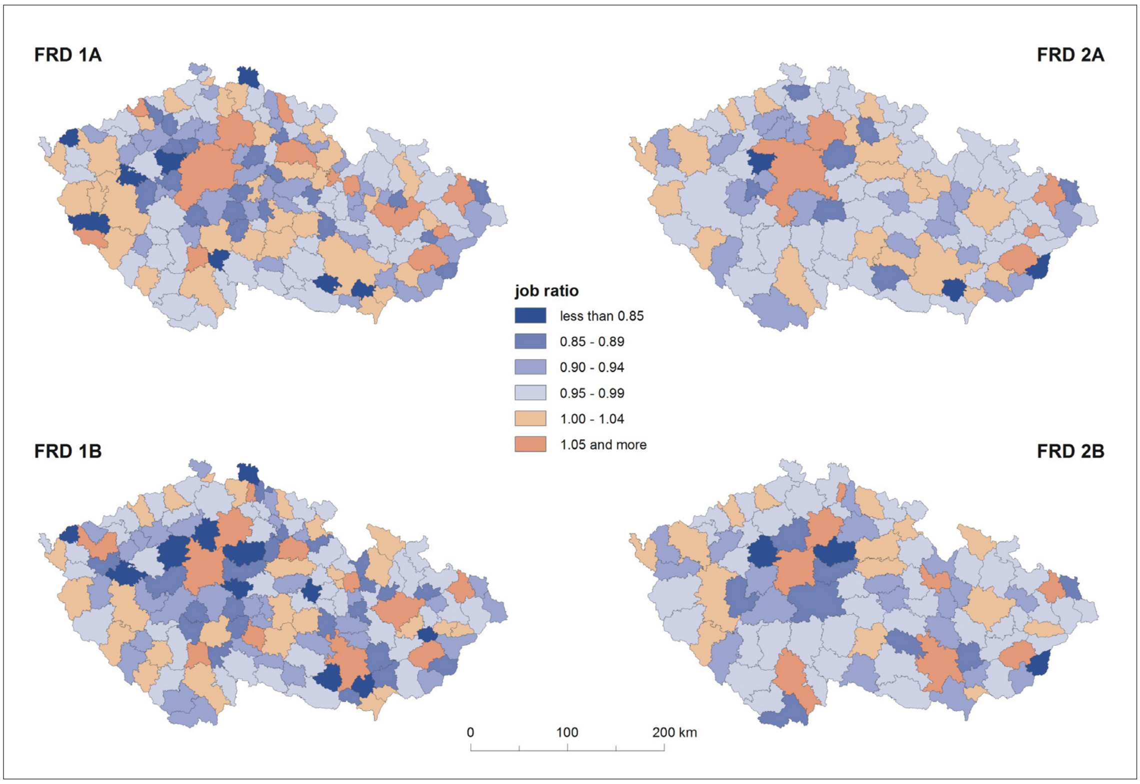

Fig. 6: Job ratio for variants of the regional system. Source: authors' elaboration
Note: For identification of regions, see Figs. 2, 3, 4 and 5

application of the CURDS measure show a greater degree of variation within the regional system and "natural" spatial relationships are recognised, for instance in the extent of hinterlands of the largest centres (Praha, Brno, Plzeň), and the principle of spatial efficiency is favoured. These regional patterns can be preferably denoted as daily urban systems or functional urban regions (based on daily interactions).

On the contrary, the solutions provided by the application of Smart's measure show a lower degree of variation within the regional system, and thus supports what can be referred to as a spatial equity principle. This principle is more advantageous also for administrative, statistical and planning purposes, and Smart's measure remains actually the sole measure usually used in this research issue. The

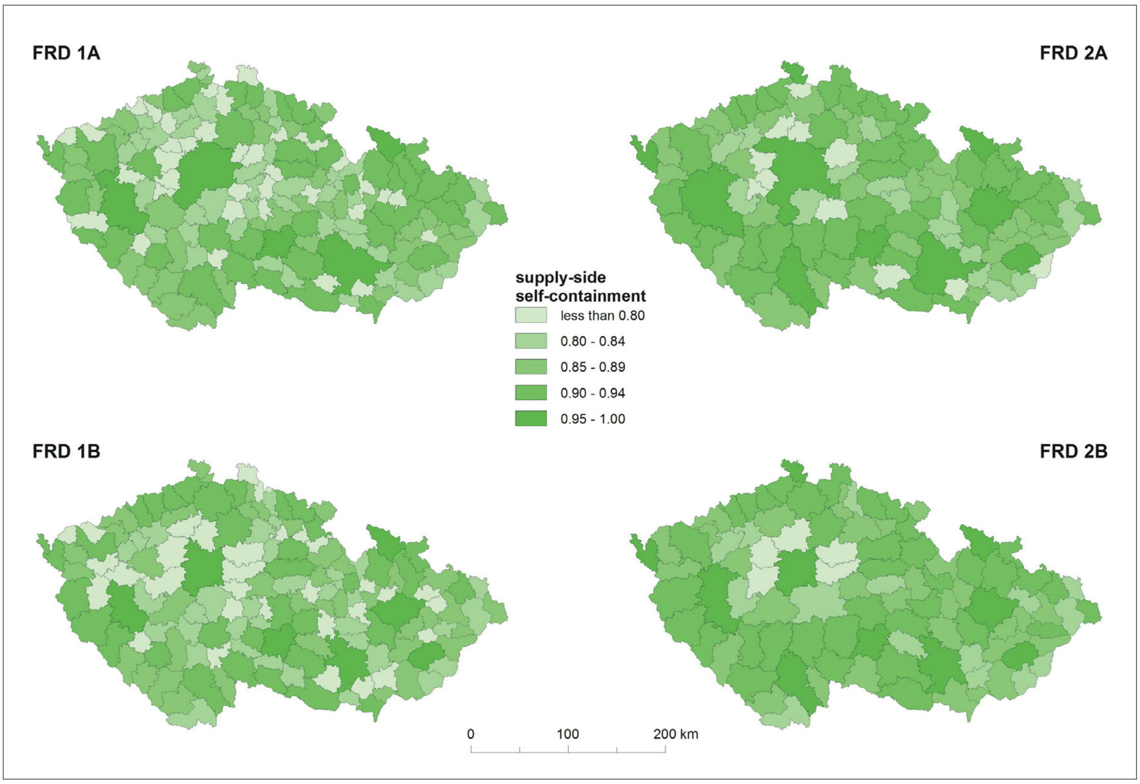

Fig. 7: Supply-side self-containment for variants of the regional system. Source: authors' elaboration
Note: For identification of regions, see Figs. 2, 3, 4 and 5

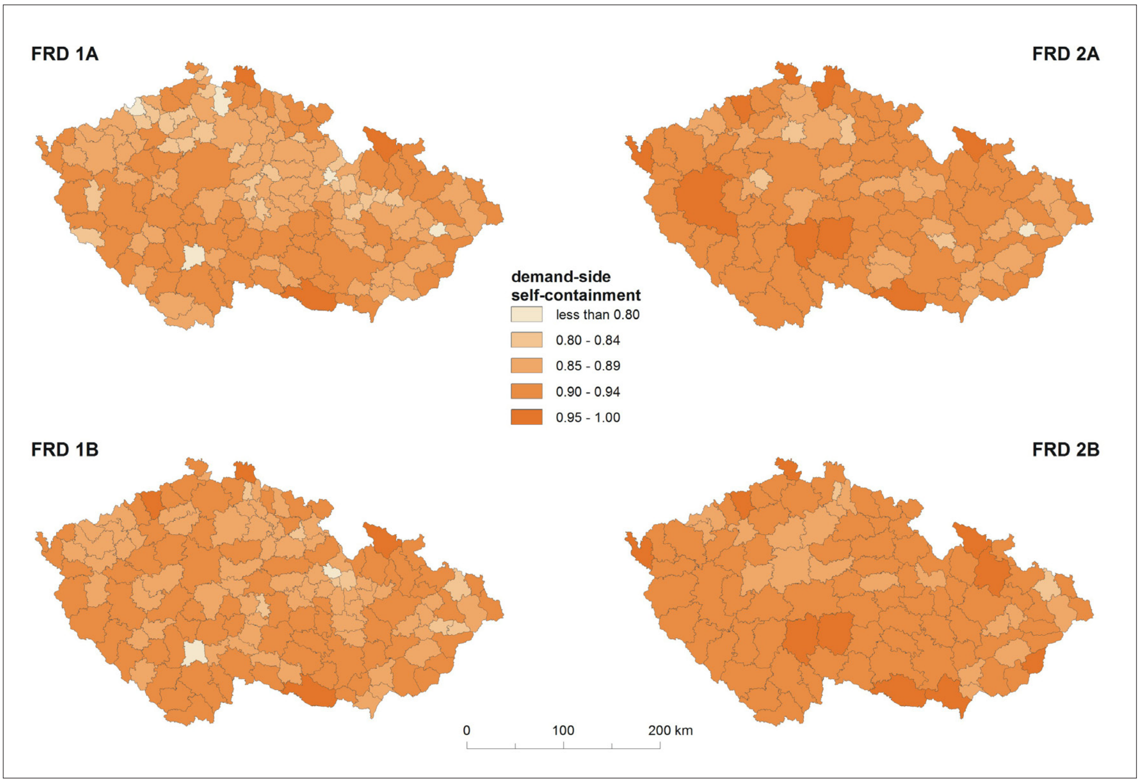

Fig. 8: Demand-side self-containment for variants of the regional system. Source: authors' elaboration
Note: For identification of regions, see Figs. 2, 3, 4 and 5

solutions for regional patterns provided by its application can be denoted as local (or regional) labour market areas or travel-to-work areas, and they are referred to as such in the literature.

As a consequence of the effective mathematical relativisation of the interaction flows, Smart's measure produces smaller regions for large centres and larger regions for small centres. This result, however, is responsible for the possibility of reaching lower total self-containment counts for the regional system. Clearly, this is evidenced in comparing the regional systems FRD 2A and FRD 2B, when the former consists of more regions, which should generally imply a lower total self-containment, but the configuration of regions actually provides a higher total self-containment. This finding lies in the fact that Smart's measure can assign basic spatial units having strong absolute links to a large centre (e.g. Praha) to another region, and this means there are more flows across regional boundaries.

Acknowledgement

This paper has been supported by the project of the Internal Grant Agency of Palacký University, Olomouc: "Human behaviour and activities in geographical environment: analysis and modelling of the organisation of space" (IGA_PrF_2014012). The authors are grateful for this support.

References:

BALL, R. M. (1980): The use and definition of travel-to-work areas in Great Britain: some problems. Regional Studies Vol. 14, No. 2, p. 125–139.

BAUMANN, J. H., FISCHER, M. M., SCHUBERT, U. (1983): A multiregional labour supply model for Austria: the effects of different regionalisations in multiregional labour market modelling. Papers in Regional Science, Vol. 52, No. 1, p. 53–83.

BERRY, B. J. L. (1968): A synthesis of formal and functional regions using a general field theory of spatial behaviour. In: Berry, B. J. L, Marble, D. F. [eds.]: Spatial Analysis. Prentice-Hall, Englewood Cliffs, p. 419–428.

BERRY, B. J. L. (1973): Growth Centers in the American Urban System: Community development and regional growth in the sixties and seventies. Balinger Publishing Company, Cambridge (Mass.), 197 pp.

BEZÁK, A. (1997): Priestorová organizácia spoločnosti a územno-správne členenie štátu. Acta Universitatis Matthiae Belii, Geografické štúdie, Vol. 3, p. 6–13.

BEZÁK, A. (2000): Funkčné mestské regióny na Slovensku. Geographia Slovaca, Vol. 15, Geografický ústav SAV, Bratislava, 89 pp.

BROWN, L. A., HOLMES, J. (1971): The delimitation of functional regions, nodal regions, and hierarchies by functional distance approaches. Journal of Regional Science, Vol. 11, No. 1, p. 57–72.

CASADO-DÍAZ, J. M. (2000): Local labour market areas in Spain: a case study. Regional Studies, Vol. 34, No. 9, p. 843–856.

CASADO-DÍAZ, J. M., COOMBES, M. (2011): The delineation of 21st century local labour markets areas: a critical review and a research agenda. Boletín de la Asociación de Geógrafos Españoles, Vol. 57, p. 7–32.

CASADO-IZQUIERDO, J. M., PROPIN-FREJOMIL, E. (2008): Praxis internacional en el estudio de mercados laborales locales. Investigaciones Geográficas, Boletín del Instituto de Geografía, Vol. 65, p. 118–137.

COOMBES, M. (2000): Defining locality boundaries with synthetic data. Environment and Planning A, Vol. 32, No. 8, p. 1499–1518.

COOMBES, M. (2010): Defining labour market areas by analysing commuting data: innovative methods in the 2007 review of Travel-to-Work Areas. In: Stillwell, J., Duke-Williams, O., Dennett, A. [eds.]: Technologies for migration and commuting analysis: spatial interaction data applications. IGI Global, Hershey, p. 227–241.

COOMBES, M. G., BOND, S. (2008): Travel-to-Work Areas: the 2007 review. Office for National Statistics, London. 57 pp.

COOMBES, M. G., DIXON, J. S., GODDARD, J. B., OPENSHAW, S., TAYLOR, P. J. (1979): Daily urban systems in Britain: from theory to practice. Environment and Planning A, Vol. 11, No. 5, p. 565–574.

COOMBES, M. G., DIXON, J. S., GODDARD, J. B., OPENSHAW, S., TAYLOR, P. J. (1982): Functional regions for the population census of Great Britain. In: Herbert, D. T., Johnston, R. J. [eds.]: Geography and the Urban Environment. Progress in Research and Applications 5, John Wiley and Sons Ltd., Chichester, p. 63– 112.

COOMBES, M. G., GREEN, A. E., OPENSHAW, S. (1986): An Efficient Algorithm to Generate Official Statistical Reporting Areas: The Case of the 1984 Travel-to-Work Areas Revision in Britain. The Journal of the Operational Research Society, Vol. 37, No. 10, p. 943–953.

COOMBES, M. G., OPENSHAW, S. (1982): The use and definition of travel-to-work areas in Great Britain: some comments. Regional Studies, Vol. 16, No. 2, p. 141–149.

COOMBES, M. G., DIXON, J. S., GODDARD, J. B., OPENSHAW, S., TAYLOR, P. J. (1978): Towards a more rational consideration of census areal units: daily urban systems in Britain. Environment and Planning A, Vol. 10, No. 10, p. 1179–1185.

CÖRVERS, F., HENSEN, M., BONGAERTS, D. (2009): Delimitation and coherence of functional and administrative regions. Regional Studies, Vol. 43, No. 1, p. 19–31.

ČSÚ (2004): Dojížďka za prací a do škol v Jihomoravském kraji (na základě výsledků Sčítání lidu, domů a bytů 2001). Český statistický úřad, Krajská reprezentace Brno, Brno. 220 pp.

DROBNE, S., KONJAR, M., LISEC, A. (2010): Razmejitev funkcionalnih regij Slovenije na podlagi analize trga dela. Geodetski vestnik, Vol. 54, No. 3, p. 481–500.

DZIEWOŃSKI, K. (1967): Concepts and terms in the field of economic regionalization. In: Macka, M. [ed.]: Economic regionalization. Academia, Praha, p. 25–36.

FARMER, C. J. Q., FOTHERINGHAM, A. S. (2011): Network-based functional regions. Environment and Planning A, Vol. 43, No. 11, p. 2723–2741.

FLÓREZ-REVUELTA, F., CASADO-DÍAZ, J. M., MARTÍNEZ-BERNABEU, L. (2008): An evolutionary approach to the delineation of functional areas based on travel-to-work flows. International Journal of Automation and Computing,Vol. 5, No. 1, p. 10–21.

GOODMAN, J. F. B. (1970): The definition and analysis of local labour markets: some empirici problems. British Journal of Industrial Relations, Vol. 8, No. 2, p. 179–196.

GRUCHOCIAK, H. (2012): Delimitacja lokalnych rynków pracy v Polsce. Przegląd statystyczny. Numer specjalny, No. 2, p. 277–297.

HAGGETT, P. (1965): Locational Analysis in Human Geography. Arnold, London, 337 pp.

HALÁS, M., KLADIVO, P., ŠIMÁČEK, P., MINTÁLOVÁ, T. (2010): Delimitation of micro-regions in the Czech Republic by nodal relations. Moravian Geographical Reports Vol. 18, No. 2, p. 16–22.

HALÁS, M., KLAPKA, P., BLEHA, B., BEDNÁŘ, M. (2014): Funkčné regióny na Slovensku podľa denných tokov do zamestnania. Geografický časopis, Vol. 66, No. 2, p. 89–114.

HALL, P. (1974): The containment of urban England. Geographical Journal, Vol. 140, No. 3, p. 386–408.

HAMPL, M. (2005): Geografická organizace společnosti v České republice: transformační procesy a jejich obecný kontext. Univerzita Karlova, Praha, 147 pp.

HOLMES, J. H., HAGGETT, P. (1977): Graph theory interpretation of flow matrices: a note on maximization procedures for identifying significant links. Geographical Analysis, Vol. 9, No. 4, p. 388–399.

KARLSSON, C., OLSSON, M. (2006): The identification of functional regions: theory, methods, and applications. The Annals of Regional Science, Vol. 40, No. 1, p. 1–18.

KLAPKA, P., HALÁS, M., TONEV, P. (2013a): Functional regions: concept and types. In 16th International Colloquium on Regional Sciences, Conference Proceedings. Brno, Masaryk University, p. 94–101.

KLAPKA, P., HALÁS, M., TONEV, P., BEDNÁŘ, M. (2013b): Functional regions of the Czech Republic: comparison of simple and advanced methods of regional taxonomy. Acta Universitatis Palackianae Olomucensis, Facultas Rerum Naturalium, Geographica, Vol. 44, No. 1, p. 45–57.

KRYGSMAN, S., DE JONG, T., NEL, J. (2009): Functional transport regions in South Africa: an examination of national commuter data. In Proceedings of the 28th Southern African Tranport Conference, p. 144–154.

LAAN, L. VAN DER, SCHALKE, R. (2001): Reality versus Policy: The Delineation and Testing of Local Labour Market and Spatial Policy Areas. European Planning Studies Vol. 9, No. 2, p. 201–221.

LANDRÉ, M., HÅKANSSON, J. (2013): Rule versus interaction function: evaluating regional aggregations of commuting flows in Sweden. European Journal of Transport and Infrastructure Research, Vol. 13, No. 1, p. 1–19.

MASSER, I., BROWN, P. J. B. (1975): Hierarchical aggregation procedures for interaction data. Environment and Planning A, Vol. 7, No. 5, p. 509–523.

MASSER, I., SCHEURWATER J. (1978): The specification of multi-level systems for spatial analysis. In: Masser, I., Brown, P. J. B. [eds.]: Spatial representation and spatial interaction. Studies in Applied Regional Science, Vol. 10, p. 151–172.

MASSER, I., SCHEURWATER J. (1980): Functional regionalisation of spatial interaction data: an evaluation of some suggested strategies. Environment and Planning A, Vol. 12, No. 12, p. 1357–1382.

MICHNIAK, D. (2003): Dostupnosť okresných miest na Slovensku. Geografický časopis, Vol. 55, No. 1, p. 21–39.

MITCHELL, W. F., WATTS, M. J. (2010). Identifying functional regions in Australia using hierarchical aggregate techniques. Geographical Research, Vol. 48, No. 1, p. 24–41.

NEWELL, J. O., PERRY, M. (2005): Explaining continuity in New Zealand's local labour market areas 1991 to 2001. Australasian Journal of Regional Studies Vol. 11, No. 2, p. 155–174.

NYSTUEN, J. D., DACEY, M. F. (1961): A graph theory interpretation of nodal regions. Regional Science Association, Papers and Proceedings, Vol. 7, No. 1, p. 29–42.

OPENSHAW, S. (1984): The Modifiable Areal Unit Problem. CATMOG 38. GeoBooks, Norwich.

PAPPS, K. L., NEWELL, J. O. (2002): Identifying functional labour market areas in New Zealand: a reconnaissance study using travel-to-work data. Discussion Paper 443. Institute for the Study of Labor, Bonn, 34 pp.

PERSYN, D., TORFS, W. (2011): Functional labour markets in Belgium: evolution over time and intersectoral comparison. In: Discussion Paper 17. Vlaams Instituut voor Economie en Samenleving. Leuven, Katholieke Universiteit, p. 1–17.

PHILBRICK, A. K. (1957): Principles of areal functional organization in regional human geography. Economic Geography, Vol. 33, No. 4, p. 299–336.

SFORZI, F. [ed.] (1997): I sistemi locali del lavoro. 1991. Istat, Roma, 393 pp.

SLATER, P. B. (1976): A hierarchical regionalization of Japanese prefectures using 1972 interprefectural migration flows. Regional Studies, Vol. 10, No. 1, p. 123–32.

SMART, M. W. (1974): Labour market areas: uses and definition. Progress in Planning, Vol. 2, No. 4, p. 239–353.

SPENCE, N. A., TAYLOR, P. J. (1970): Quantitative methods in regional taxonomy. Progress in Geography, Vol. 2, p. 1–64.

SÝKORA, L., MULÍČEK, O. (2009): The micro-regional nature of functional urban areas (FUAs): lessons from the analysis of Czech urban and regional system. Urban Research and Practice, Vol. 2, No. 3, p. 287–307.

TONEV, P. (2013): Změny v dojížďce za prací v období transformace: komparace lokálních trhů práce. Ms. (dissertation thesis, Department of Geography, Masaryk University), 122 pp.

UNWIN, D. J. (1996): GIS, spatial analysis and spatial statistics. Progress in Human Geography, Vol. 20, No. 4, p. 540–551.

Authors´ addresses:

Mgr. Pavel KLAPKA, Ph.D., e-mail: *pavel.klapka@upol.cz*
Assoc. Prof. RNDr. Marián HALÁS, Ph.D., e-mail: *marian.halas@upol.cz*
Department of Geography, Faculty of Science, Palacký University Olomouc
17. listopadu 12, 771 46 Olomouc, Czech Republic

Mgr. Martin ERLEBACH
Department of Geography, Faculty of Science, Masaryk University
Kotlářská 2, 611 37 Brno, Czech Republic
e-mail: *martin.erlebach@seznam.cz*

Mgr. Petr TONEV, Ph.D.
Dept. of Regional Economics and Administration, Faculty of Economics and Administration, Masaryk University
Lipová 41a, 602 00 Brno, Czech Republic
e-mail: *tonev@econ.muni.cz*

Ing. Marek BEDNÁŘ
Department of Ecology and Environmental Sciences, Faculty of Science, Palacký University Olomouc
Třída Svobody 26, 771 46 Olomouc, Czech Republic
e-mail: *marek.bednar@upol.cz*

Initial submission 15 April 2014, **final acceptance** 20 October 2014

Please cite this article as:

KLAPKA, P., HALÁS, M., ERLEBACH, M., TONEV, P., BEDNÁŘ, M. (2014): A multistage agglomerative approach for defining functional regions of the Czech Republic: The use of 2001 commuting data. Moravian Geographical Reports, Vol. 22, No. 4, p. 2–13. DOI: 10.1515/mgr-2014-0019.

ASSESSMENT OF THE IMPACT OF A NEW MOTORWAY CONNECTION ON THE SPATIAL DISTRIBUTION AND INTENSITY OF TRAFFIC FLOWS: A CASE STUDY OF THE D47 MOTORWAY, CZECH REPUBLIC

Jakub CHMELÍK, Miroslav MARADA

Abstract

Assessing changes in the spatial distribution and intensity of traffic flow patterns, considered one of the main direct influences of the construction of transport infrastructure, is discussed in this paper. The central element of the research is a case study assessing such changes in connection with the opening of the D47 motorway in its Lipník nad Bečvou–Ostrava section. The aim of the study is a comparison of traffic conditions before and after the opening of the motorway. The real data on the traffic load of the motorway sections are compared with the official and our own forecast, which is based on applying a basic form of the gravity model for the given area. The results of the analysis confirmed intuitive assumptions about changes in the spatial redistribution of traffic flows.

Shrnutí

Hodnocení vlivu nového dálničního spojení na prostorovou distribuci a intenzitu přepravních proudů: příklad dálnice D47

Příspěvek je zaměřen na problematiku hodnocení změn prostorové distribuce a intenzity přepravních vztahů, které jsou považovány za jeden z hlavních přímých vlivů výstavby dopravní infrastruktury. Jádro příspěvku představuje konkrétní případ hodnocení změn v souvislosti se zprovozněním dálnice D47 v úseku Lipník nad Bečvou–Ostrava. Cílem je především srovnání dopravních poměrů v oblasti před a po zprovoznění dálnice. Reálná data o zatížení dálničních úseků jsou komparována s oficiální a vlastní prognózou, která je založena na aplikaci základního tvaru gravitačního modelu v oblasti. Výsledky analýzy potvrdily intuitivní předpoklady o změnách v prostorové redistribuci přepravních proudů.

Key words: *impacts of transport infrastructure (motorways); assessment and prediction of changes in traffic flows; gravity model; motorway D47; Ostrava region; Czech Republic*

1. Introduction

The issue of the impact of new high-speed transport infrastructure is a widely discussed topic in fields studying various aspects of transport, mainly due to the existence of numerous and often very different viewpoints (economic, technical, environmental, political). Transport infrastructure is often considered one of the main factors in the competitiveness of national and regional economies, and the importance of the influence of transport infrastructure on regional development is not only frequently pointed out, but also often understood in divergent manners. In some cases, infrastructure is seen as a catalyst for economic development, while other authors perceive it only as one of many conditions necessary for development (e.g. Rephann, 1993; Bruinsma and Rietveldt, 1998). The impacts of a motorway on regional economic development are usually classified as indirect impacts of transport infrastructure (Bruinsma and Rietveld, 1998; Banister, Berechman, 2001; Jeřábek, Marada, 2003; Marada et al., 2010), including the influence of the motorway on the business environment, emergence of new companies, the labour market, land price, and on the overall image of a region. Assessing these factors, however, is very difficult and sometimes almost speculative, since it is not always possible to connect objectively certain changes of one factor with a change in transport infrastructure, or to define its weight precisely. In this regard, it is much easier to assess the direct impacts of transport infrastructure, which are connected mainly to real changes in the transport accessibility of certain points and often also to changes in the spatial distribution and intensity of traffic relations in a given area. The interconnectedness and causality of all direct and indirect impacts is beyond doubt.

Prior to assessing the impacts of a concrete transport infrastructure, it is necessary to evaluate responsibly the actual utility of a given construction from the point of view of the technical design and layout in the area, which have to provide the desired connection effectively. Western European countries with developed infrastructure planning have long-term experience with using comprehensive methodological procedures for the assessment of transport projects and actual impacts (e.g. Vickerman, 2000; Hayashi, Morisugi, 2000; Bruinsma and Rietveld, 1998; Lehovec et al., 2003), but their application is also problematic due to the difficult and often subjective translation of certain factors into financial figures. It can be assumed that immediately after the fall of the Iron Curtain in 1989, such mechanisms were not taken into account in the Czech Republic, which is why some projects were designed in a dubious way, as is evident in those in which construction continues in the third millennium. In this regard, it is possible to notice a change after the accession of the Czech Republic to the European Union (hereinafter EU), which co-finances large capital-intensive infrastructure projects from the EU budget, producing, however, more stringent requirements for proving the utility of the construction with respect to all-society impacts. It is to be noted, however, that the inclusion of specific structures for financing from the EU budget is fully within the competence of national states, which does not always guarantee that truly important projects are supported, since other factors and mechanisms undoubtedly play a role, too. Moreover, it is important to note that in Western Europe, results of the assessment of transport infrastructure economic impact often do not correspond to political preferences (Bruinsma, Rietveld, 1998).

One of the frequently discussed structures built in the Czech Republic in the last 15 years was the D47 motorway (a section of the D1 motorway), connecting the Ostrava region to motorway networks of the Czech Republic and hence also to the trans-European transport network (TEN-T). This area of north-eastern Moravia and Silesia had a relatively high quality post-war road network connecting the centres of the region to serve the needs of local heavy industries. The problem, however, was the insufficient connectedness to supra-regional and international networks, which was further compounded by the dissolution of Czechoslovakia in 1993, when the Ostrava region became the most geographically remote region from the capital (e.g. Sucháček, 2005; Kuta, 2000). An effective solution for connecting to the Ostrava region was the D47 motorway (together with the R48[1] expressway), but its construction was perpetually postponed and became a widely-discussed topic in the region among the general public, as well as political and economic leaders (Jurečka, 2003; Schejbalová, Teperová, 1999). This was mostly due to the fact that the existence of the motorway was seen as one of the requirements for the economic revitalisation of the region (e.g. Jurečka, 2003; Zahradník, 2003; Bauerová and Ramík, 2004a, 2004b; Sucháček, 2005), which faced serious structural problems due to its one-sided economic base. Sucháček (2005, p. 106) directly states that the issue of the D47 "has become during the course of the years a certain symbol of the economic, institutional and psychological circumstances of the Ostrava region restructuring…" (translation from Czech).

In connection with the D47 motorway, there was also a much discussed question of whether it was necessary for the route to run directly through the city of Ostrava, as was planned since the 1960s in government documents concerning the development of transport networks in the Czech Republic (Prášil, 2007). A number of environmental groups, in particular, voiced the opinion that the D47 motorway in the Bělotín–Ostrava–Czech-Polish state border section was not justified because it was duplicated by the R48 expressway, and that it would be possible to connect the Ostrava region by modernising the I/58 Příbor–Ostrava road or the R56 Frýdek-Místek–Ostrava expressway. In that case, the transit traffic to Poland would be realised over the already-existing Český Těšín–Chotěbuz route. This opinion was opposed, for example by Řehák (2004), who applied gravity modelling for simulating traffic relationships between the Czech Republic and its neighbouring states. Based on his results, he stated that the international connection between the Czech Republic and Poland via Ostrava would be significantly stronger than the preferred connection through Český Těšín, and that the modernisation of the I/48 road would not meet the purpose. The question of the construction of the D47 over the R48, favoured in the past, was also addressed by the Czech Supreme Audit Office (hereinafter SAO), which investigated whether the preference for the D47 was based on objective circumstances. SAO came to the conclusion that no assessment of either project had been made in which the Czech Ministry of Transport and the Road and Motorway Directorate of the Czech Republic (hereinafter RMD) identified and quantified the socio-economic benefits, and justified prioritising the D47 project (Auditing Action 04/25, SAO Bulletin, 2005). The absence of any studies demonstrating the effectiveness and societal benefits of the D47 was confirmed by the RMD from the authors' questions.

At present, the D47 is already open and it is therefore possible to evaluate its impacts, at least partially. The authors do not aim to evaluate the much-debated indirect impacts of the D47 on the economic development of the Ostrava region, which are moreover difficult to identify given the short period of time the motorway has been open. The degree of the motorway influence on the monitored indicators and their selection remains debatable. Rather, this paper focuses on a basic assessment of changes in the spatial distribution and intensity of traffic flow, which are considered some of the main direct influences of transport infrastructure construction, especially new motorways. In general, the objective of this paper is to describe basic possibilities for assessing the direct impact of motorways on transport interaction in the given area, as well as their forecasts, which is important for evaluating the utility and efficiency of the infrastructure. A brief comparison is made of these factors in the Czech Republic and in Western Europe. The core of this research is a case study for assessing changes in the spatial distribution of traffic flows intensity brought about by the opening of the D47 motorway. The primary goal is to compare traffic conditions before and after the opening of the highway, based on data from the national traffic censuses in 2000, 2005 and 2010 (National Traffic Census [hereinafter NTC], 2000, 2005, 2010). Real data on the traffic load of motorway sections will be compared to the forecast made by the investor (D47 Project Information, RMD, 2012), and to our own projections based on an applied basic form of the gravity model (Chmelík, 2008).

Another partial goal is to assess the use of typical geographic applications for this type of analysis. It is by comparing real and forecasted data that we can identify the main drawbacks of approaches based on modelling, which cannot always anticipate the real impact precisely. In this context, it is of course important to note that since the D47 was not connected by motorway to the Polish A1 motorway at the time of the last census (NTC, 2010)[2], it can be assumed that any prediction will be partially distorted and will not correspond to the foreseeable situation. This is because the north-south transit road traffic, which is included in the prediction for the motorway, was at that time still routed through the original Český Těšín–Chotěbuz vein. This fact, though, can also be considered an advantage in a certain sense, as this situation allows for the identification of the real transport potential of the Ostrava region in a narrower definition, i.e. regional centres for which the motorway is

[1] The expressway in the Bělotín–Nový Jičín–Frýdek-Místek–Český Těšín–Czech-Polish state border section.

[2] The Czech D47 was connected to the Polish A1 in 2012 for passenger cars, and in 2014 also for heavy goods vehicles.

already useful to save time. In addition, this situation allows for the elimination of one of the methodological problems, namely the lack of information on the ratio of transit traffic flows to the overall traffic load, which represents a significant part of the actual as well as predicted traffic flow in a number of motorway sections.

Analogically to the identification of the indirect impact of the D47 motorway on the development of the Ostrava region, this research does not cover in detail the above-mentioned issue of the utility of the new motorway connection with Ostrava, as this issue requires a more complex assessment beyond the scope of the work. Therefore, arguments for the necessity of construction are described only briefly from other studies. At the same time, however, the authors believe that in comparison with other projects in the Czech Republic, the D47 motorway, which connects to the second largest agglomeration of the Czech Republic, is far more significant and its existence is rational. On the other hand, it is to be noted that the present value of the intensity of traffic on the D47 route, and even in the six-lane Lipník nad Bečvou–Bělotín[3] section carrying all north-south transport, is a cause for reflection. It should be emphasized once again, however, that this situation can be connected to the incomplete transit functionality of the motorway at the time of the study.

2. Assessing direct impacts of motorways on transport relations

The issue of identifying and evaluating the direct impact of linear transport infrastructure is addressed relatively often and not only as a part of transport-geographical research. This is mostly due to the influence of the time-space convergence of centres. This convergence is connected to a lower resistance to travel, which is caused both by a decrease in the time needed for reaching a certain point due to new and usually high-speed infrastructure, and by a decrease in transportation costs (Gutierrez, Urbano, 1996; Vickerman et al., 1999; Rietveld, Vickerman, 2004; Preston, O'Connor, 2008).

For expressing potential spatial impacts of the new transport infrastructure on the pattern of traffic flow intensity, it is possible to use the concept of generative and distributive effects[4] (for more details, see Rietveld, Bruinsma, 1998), which was primarily applied to identify changes in the localisation of economic activities. The generative effect instigates completely new activities, which analogically mean generating new traffic as to the direct impact of motorways. This effect is directly related to the decrease in the time needed for travel and the consequent new possibilities for each of the newly-connected points and positive stimulation of the mobility of persons and goods, coupled with growing employment opportunities and new types of activities. In terms of indirect impacts, though, the aspects of improved mutual accessibility do not often bring only positive effects, since a good quality connection can increase competitive pressure on the local market in the newly-connected area and gradually "drain" the activities from the weaker region (Jeřábek, Marada, 2003). The distributive effect causes only a shift of the traffic, usually in favour of the new motorway, which has a positive influence on regional centres previously overburdened by transit traffic.

In this context, it is possible to say that as to significant projects, only those with a strategic potential for the generative effect should be considered, while in the case of a need for improving a current unsuitable traffic situation, it is more efficient to seek a solution by means of traffic redistribution. Such a polarized division is hardly ever the case, however, and it can be assumed that the structure of traffic intensity in the new sections is at all times partly caused by the generative effect (new traffic participants) and partly by traffic shifted from other roads which are less convenient than the new connection. The assumption of a shift of some of the traffic flows to the new connection closely relates to the so-called intervening opportunity, which had been stated as a part of spatial interaction theory by Ullman (Ullman, 1956, cited in Rodrigue et al., 2006). From the methodological point of view, distinguishing the effects (generative or distributive) remains problematic, as it is limited by the nature of the databases and by the methods. This happens not only when assessing the indirect impacts (such as motivation and preference of a certain location for economic activities), but especially in assessing the impacts of a specific transport infrastructure project on traffic relations in the area.

Data on individual car traffic, which generates most of the interactions on the road network with regard to passenger transport, are rather limited. The main and often the only commonly available data on individual car traffic are traffic intensities on individual counting sections in which the vehicles are counted. In the Czech Republic, this information is provided by the RMD, which conducts a national traffic census every five years, in which information can be found on the traffic intensity according to different vehicle types (cars, trucks, motorcycles, buses) on Czech roads and motorways. Information on the sections of motorways and expressways with automated traffic counters is provided in a shorter interval of time. The value of the traffic load on a given section is in principal the aggregated result of the behaviour of all traffic participants, who make their decisions about where to travel according to their personal needs (Brůhová-Foltýnová et al., 2008), while the beginning, aim, frequency or purpose of their journey is not known.

When identifying the influence of a new connection, the most limiting absence of information is seen in the aim of the journey (i.e. the structure of traffic intensity on a given section according to the beginning and the end of the journey), with which it would be possible to find out concrete volumes of the redistributed traffic. Data on the direction relationships, including the prediction of their change caused by changes in the network, are usually replaced by estimates based on both basic gravity models (Řehák, 1997, 2004; Halás, 2005; Kraft, Blažek, 2012) and transport models generated by specialized software. The gravity model is one of the most used tools in traditional transport geography research. The

[3] According to the RMD, the large-scale six-lane design was adopted because of the junction with the D1 motorway (to Přerov) and the R35 expressway (to Olomouc) on one side, and the D47 motorway (to Ostrava) and the R48 expressway (to Nový Jičín) on the other side. At the same time, the study for RMD (ADIAS, 2001) states that in this section the motorway has a significant extra capacity.

[4] In traffic engineering disciplines, "induced transport" (generative effects) and "shifted transport" (distributive effects) are commonly used, referring essentially to these effects.

quite simple use for assessing changes in spatial interactions in the transport network (e.g. building a new highway) is the main advantage of this model. In the Czech Republic, studies by Řehák (1992, 1997, 2004) are well recognised using the planned road system based on various types of gravity model. In international research, the gravity model is still used namely for basic travel demand estimates, for example in the field of the airline traffic volume estimation (e.g. Grosche et al., 2007; Matsumoto, 2007).

In the Czech Republic, the prediction of traffic intensity is formally bound by technical conditions. From these technical conditions, the prediction is made either by way of a growth coefficient assuming stable development of intensity on the roads of the same class, or by a mathematical model of the traffic flow on a network, which takes into account factors causing unstable development of transport relations (Bartoš et al., 2010). In the case of an existing transport connection, the beginning and the end of the journey can also be identified by simple analytical methods, such as the frequently-used transport divide method (Hůrský, 1978; Marada, 2008; currently Kraft et al., 2014). According to this method, a corresponding value of traffic intensity is assigned to each of the sections connecting the regional centres. In all cases, the data of course refer to the number of vehicles and not to the number of passengers, which usually complicates a comparison with, for example, data on the number of persons using a specific mode of public transport. In connection with the above facts, a question remains whether detailed data on the direction of individual transport passenger mobility are necessary, considering the high financial cost for the technical and organisational aspects of their collection, or whether the models give us satisfactory results. They should at least identify a basic structure of the directions for a given section, capture the major trends and predict the order of spatial impacts on the network, usually based on changes in the time required to reach a certain destination.

High quality information on current and expected traffic flows should be one of the main inputs in the process of assessing the priorities of needs when evaluating transport infrastructure construction, since it is evident that the transport needs of people generate a justified demand for improving the transport situation. In countries with developed transport infrastructure, the main method applied for assessing transport infrastructure building projects has for a number of decades been cost-benefit analysis (further CBA), which is often combined with a multi-criteria analysis comparing multiple projects (see the overviews in Hayashi, Morisugi, 2000; Quinet, 2000; Morisugi, 2000; Lee Jr., 2000; Gühnemann et al., 2012). The criterion capturing best the direct impacts of a project is economy of time, which is often one of the most important indicators. In the UK, for instance, it is considered the main criterion, together with the reduction of traffic accidents (Vickerman, 2000). Frequently connected to the criterion of time economy is a necessary forecast of transport demand, which is usually based on national transport models in which the impact of a new project on the current intensity distribution is simulated according to changes in the required inputs. The prediction is closely connected to the indicator of time value for different categories of passengers. This indicator is important for assessing economic impacts and for expressing time economy in financial figures – the time value based on qualitative survey research (Hayashi and Morisugi, 2000). A practical example of the combination of cost-benefit analysis and multi-criteria analysis, including the ranking of individual projects, can be found, for example, in Guhnemann et al. (2012).

In the Czech Republic, the situation is somewhat different because the hierarchy of priorities of high-capacity road infrastructure construction was never a long-term conceptual solution, from the point of view of investment benefits. In this regard, reference can be made to the SAO's audit conclusions, which state that the Ministry of Transport, being the public administrative body responsible for formulating transport policy, did not assess the societal benefits of any of the high-capacity road infrastructure projects described in the concept paper, Proposal for Development of Transport Networks in the Czech Republic until 2010. According to the SAO investigation, the only criterion for the inclusion of a project was the value of traffic load on roads operating in the route of the planned motorway or expressway, without stating any priority for projects in terms of strategic goals. Also taken into account were projects, which had been prepared in the past (Control Action 02/10, SAO Bulletin, 2003). The lack of methodology for assessing transport infrastructure project benefits is pointed out by Viturka et al. (2012), where it is also mentioned that the current regime gives preference to the factor of zoning preparedness (as well as negotiability at consulting points) over society-wide benefits. The authors offer their own ranking of significant projects based on the chosen utility assessment methodology. Among other events, in response to criticism by SAO, civic initiatives and the European Commission, the Ministry of Transport began in 2011 to develop a project called "Transport Sector Strategy, 2nd Phase", which states individual priorities in transport infrastructure construction to be co-financed by EU (in more detail see www.dopravnistrategie.cz).

Within the procedures of project assessment, the first step was to construct a transport model of the Czech Republic which takes into account current conditions and limits, and, based on the scenarios for the development of each model, components predictions were made for the years 2020 and 2050. The analytical part, in which the transport demand and its expected development should primarily be identified, is the basis for the designing part, in which the priorities for transport infrastructure construction in the Czech Republic are stated, and multi-criteria evaluation is applied. The results confirmed intuitive premises: the greatest number of points were given to the missing part of the R1 Prague ring between Běchovice and the D1 motorway, followed by the section of the D1 between Říkovice and Přerov, and the missing sections of the R35 expressway (see more details in Vachtl et al., 2013).

3. Assessing traffic intensity changes in the affected area: Case study – D47 motorway

For the assessment of changes in traffic intensities in the area affected by the opening of the D47, the data from the traffic census on Czech motorways and roads were used. The census is conducted by RMD every five years. The required time series were obtained by using data from 2000, 2005 and 2010 (NTC, 2000, 2005, 2010), bearing in mind, though, that the 2010 data do not necessarily reflect the change in route selection preference of all potential D47 users, since the service was limited in part of the year 2010, and also due to the then-ongoing process of "acclimation" to the new alternative. From this point of view, it will be results obtained in 2015 that will be significant, as at that time the route preferences will be stabilized. The data used were the basic data showing the annual average of daily traffic (AADT) indicating the number of passenger vehicles in 24 hours on a given section[5]. The methodological approach first involved the definition of the affected road network (see Fig. 1), in which traffic conditions could be influenced by changes in route preference connected to the opening of the motorway. The monitored network was subsequently divided into sections (edges between major centres or nodes), for which relevant values of traffic intensity were defined based on the traffic census data. The procedure consisted in finding the point of the lowest traffic intensity between two centres or nodes, i.e. finding a section in rural areas with the lowest traffic load. These least-frequented sections between centres should theoretically best reflect the real contact between them, since it can be postulated that this eliminates the traffic relations connected to reaching facilities, which are more influenced by regular short-distance travelling (e.g. more intensive contacts are to be identified at counting points located between the centre of a town and its surrounding area).

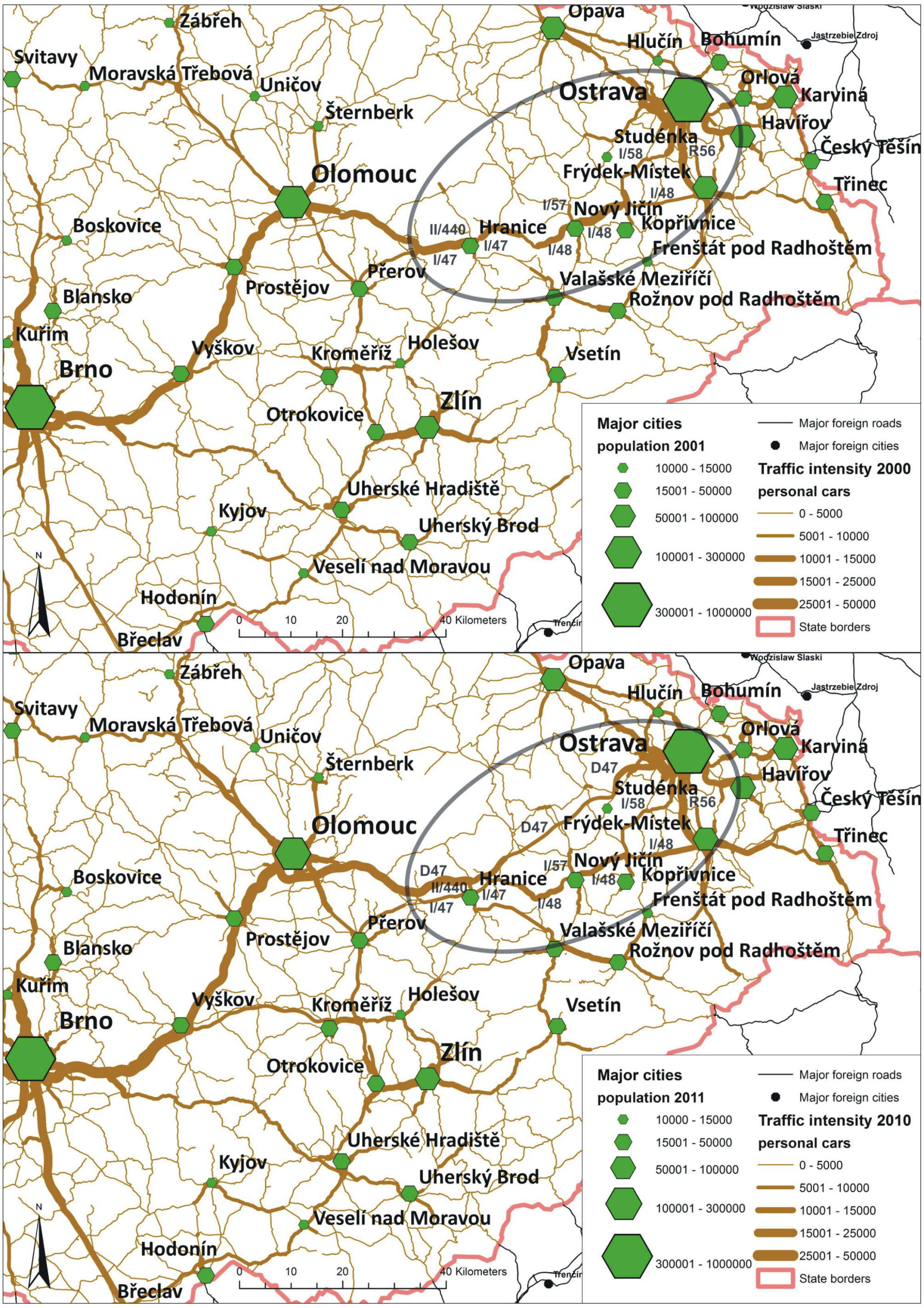

Fig. 1: Determination of relevant road network, including traffic volume (2000 and 2010)
Sources: NTC 2000, 2010

[5] Focusing mainly on the analysis of passenger vehicles is necessary due to the methodological changes in the heavy goods vehicles census between 2005 and 2010. The use of passenger cars is simultaneously preferable for their greater flexibility and possibility to use the unfinished D47 at a higher rate than trucks in 2010.

This applied concept of the point with the lowest traffic intensity is one of the analytical methods used by the transport geographer J. Hůrský (1978) for identifying traffic divisions. Given the need to compare different sections in three time series, it was always necessary to monitor the same census section, since in some cases during the years the lowest traffic point shifted on the monitored edge of the network if it had more sections. Since the focus is on the assessment of the D47, the basic census section was the point with the lowest traffic intensity as of the year 2010, and this section was subsequently compared to the identical section in 2005 and 2000, provided that it had existed and had been monitored at that time. It is necessary to point out a number of partial limitations of this procedure and methodology (such as the selection of a representative section with the lowest traffic, general impact of transport behaviour changes on traffic intensity without the influence of the new motorway, the lack of data on directional relationships of each section, and the consequent lack of data on the ratio of local, regional and transit traffic flows, etc.). These limitations can eventually influence the final assessment, which is in some cases supported by subjective decisions of the authors. The partial limitations, however, do not preclude structural and chronological comparison, since the results of the censuses obtained in different years are comparable (a similar methodology had been used).

For assessing the D47 degree of impact on the changes in traffic relations, it was useful to select sections, which had been used prior to the opening of the motorway, mostly for connecting the Ostrava region with other regions of the Czech Republic and also for transit connection, especially in the south-west–north-east axis. In particular these were the roads I/58 in the Ostrava–Příbor section, R56 in the Ostrava–Frýdek-Místek section, R/I/48 in the Frýdek-Místek–Bělotín section and I/47 in the Bělotín–Lipník nad Bečvou section. Results of the traffic intensity in the monitored sections in each year confirm the intuitive premises of the change in the spatial distribution of traffic relations in the affected area. This is evident from Table 1, which contains the values of intensities in sections which were previously (during the censuses of 2000 and 2005) used for supra-regional contacts, now redistributed to the D47 (the 2010 traffic census). In these sections, it can be noticed that after the previous growth or stagnation between the years 2000 and 2005, the traffic intensities decreased significantly (by several dozen percentage points) between 2005 and 2010, especially in the case of the Ostrava connection by the road I/58 (decrease by 27.4%) followed by the I/48 (decrease by 10.6–23.6%) and the I/47 (decrease by 43.4–57.9%) in the direction of Olomouc.

Changes are also evident in the sections of roads I/57 and II/440, which are concurrently fulfilling the role of feeder roads to the motorway in the direction of Nový Jičín and Hranice, where, by contrast, the traffic intensity has increased. From the point of view of traffic shift in favour of the D47, the values for the lowest traffic points in the Ostrava–Frýdek-Místek section remained surprisingly practically unchanged (decrease by 4.0%) between 2005 and 2010. From this, it can be deduced that the section was not preferred as a connection between the Ostrava region and the main network of the Czech Republic even earlier, despite its high quality and large capacity. On the other hand, it is also possible that the difference in intensities caused by the shift of traffic to the D47 is not evident because of increasing contacts between Ostrava and Frýdek-Místek. This is further intensified by residential buildings near the Beskydy Mts., whose inhabitants usually work in the regional centre and therefore mostly use the R56 for individual transport given a large percentage of car transport. These arguments are, however, only speculative, since they cannot be confirmed using the available database, which does not capture destinations of traffic relations which constitute aggregated traffic intensity. In order to find out actual information on the traffic load structure in a specific section, it would be necessary to conduct a costly traffic survey that would be extremely difficult for individual car transport.

Although the traffic census data concerning the heavy good vehicles are affected by methodological changes between the years 2005 and 2010, the monitored sections were also calculated for this type of road transport modes. From this point of view, the results have to be used more carefully because the causality of the main changes can be connected with the variable quality of the data. In general, it is possible to suppose similar changes in the traffic distribution of all road transport modes. The results of the basic analysis confirmed analogous changes mainly in the Ostrava–Příbor–Nový Jičín–Hranice axis, where the traffic intensities decreased significantly (more than in the changes of passenger vehicles) between 2005 and 2010, following previous growth in 2000 and 2005. The greatest changes were identified in the Bělotín–Lipník nad Bečvou section (decrease by ca. 80%), which was practically fully opened also for heavy goods vehicles in 2010. Changes are also obvious in

Section	Traffic intensity (AADT)			Change (%)	
	2000	2005	2010	2000/2005	2005/2010
R56 Ostrava - Frýdek-Místek	13,906	21,877	21,002	57.3	– 4.0
I/58 Ostrava - Příbor	9,858	10,069	7,311	2.1	– 27.4
I/48 Frýdek-Místek - Příbor	8,526	9,893	8,840	16.0	– 10.6
I/48 Příbor - Nový Jičín	16,002	18,997	14,523	18.7	– 23.6
I/R 48 Nový Jičín - Bělotín	10,239	12,114	9,711	18.3	– 19.8
I/57 Hladké Životice - Nový Jičín	2,468	2,797	4,401	13.3	57.3
I/47 Bělotín - Hranice	13,403	13,947	5,866	4.1	– 57.9
I/47 Hranice - Lipník nad Bečvou	15,377	16,839	9,526	9.5	– 43.4
II/440 MÚK Hranice - Hranice	2,935	2,576	5,001	– 12.2	94.1

Tab. 1: Traffic intensity values of passenger vehicles in the monitored sections of the affected road network
Sources: NTC 2000, 2005, 2010; authors´ calculations

the sections of roads I/58 (decrease by nearly 60%) and I/48 (decrease by ca. 50%). On the other hand, in case of the Ostrava connection by the road R56, the increased (20%) heavy vehicles transport between 2005 and 2010 was hardly noticed. In the Ostrava–Frýdek-Místek section, different results for R56 were identified in assessing changes in passenger car intensities as well.

4. Traffic intensity on the D47 motorway: forecast vs. reality

The actual utilisation of the new D47 motorway, which has changed the route preference for many connections and especially connections with supra-regional centres, can be again demonstrated by data from the 2010 traffic census (NTC, 2010). Analogically to the procedure described in the previous section, elements of the motorway were roughly determined (see Fig. 1), and for each of them the census section with the lowest traffic intensity was identified. The obtained real values of traffic intensities for the year 2010 were subsequently compared with the predictions of traffic load for 2010, 2030 (both derived from the 2000 data) and 2040 (based on data from 2010), which are presented by RMD in their information materials (RMD, 2009, 2012)[6]. Again, only those census sections with the lowest predicted values were taken into account. Finally, in the following section the real and predicted values are compared with the results of the authors' own predictions, which were based on a gravity model applied to the given area.

The values of real traffic intensities (see Tab. 2) on the D47 ranged from about 13,000 vehicles in the section with the lowest traffic load to 22,000 vehicles in the section with the highest traffic load. Compared with the RMD prediction based on the 2000 data and followed by adjustments according to growth coefficients, real values were approximately by 5,000–10,000 vehicles lower than expected in 2010. The same can be seen in the case of predictions for more distant dates, when the traffic intensity grew together with the assumed further growth of motorization, an increased ratio of individual car transport in the overall passenger transport performance and more flexible freight transport. Even if this is a long-term perspective, it is already possible to point out the relatively high values of traffic intensity predicted for 2040 based on the 2010 data, when the expected daily intensity for the section of the D47 between Lipník nad Bečvou and Bělotín is expected to reach over 50,000 vehicles (in 2030 approx. 35,000).

It may be noted for comparison that traffic intensities on the busiest motorway in the Czech Republic (D1) in the section between Mirošovice (exit 21) and Kývalka (exit 182), which is now already less burdened by regular traffic between Prague and Brno than it was in 2010, are by 10,000–15,000 vehicles lower than those predicted for the D47 Lipník nad Bečvou–Bělotín section. The current traffic intensity in this section is comparable to the intensity of the D11 motorway and the R10 road on the borders of the Central Bohemia region, or the D2 motorway between exit 11 and Břeclav (exit 48). The intensity of the Bělotín–Ostrava section is then comparable to the traffic load on the R4, R6 and R7 expressways at a distance of approximately 20 km from the administrative borders of Prague. It is also comparable to the most frequented first-class roads (such as the road I/3 and I/35). Based on what has been stated above, it is possible to conclude that the predictions of traffic intensities for the D47 presented by RMD before the construction, were overestimated as compared with the already known real data. However, it is necessary to objectively recall that the predictions were construed for the whole D47 route, i.e. counting on its connection with the Polish A1, which had not been finished by the time of the 2010 census.

Section	Real traffic intensity (AADT)	Prediction of traffic intensity by RMD			Own prediction of traffic intensity
	2010	2010	2030	2040	2015
D47 Ostrava – Hladké Životice	13,189	18,000	21,900	33,000	33,260
D47 Hladké Životice – Bělotín	13,761	16,900	20,600	32,000	30,220
D47 Bělotín – MÚK Hranice	16,500	29,800	36,300	53,000	31,440
D47 MÚK Hranice – Lipník nad Bečvou	22,561	29,500	35,900	52,000	31,440

Tab. 2: Real and predicted traffic intensities on the monitored D47 sections. Sources: NTC 2010; RMD 2009, 2012; authors´ own calculations
Note: All values include information for the volume of all road transport vehicles

5. Gravity model application on the affected area

Our own prediction, which, by means of a comparison with the "official" RMD predictions and real data, can contribute to the discussion, is based on the gravity model (for more detail see Chmelík, 2008; Chmelík, 2008, quoted in Marada et al., 2010). The application of the gravity model is still useful for studying traffic relations, especially when identifying basic interaction intensities in space or simulating changes of traffic relations distribution caused by a new route. A general prerequisite for modelling is the assertion that a certain spatial distribution of regional centres together with a certain configuration of transport network, objectively determines the basic features of spatial interaction in a given area (Řehák, 1992). For the application itself, we used a basic form of the model (e.g. Řehák, 1992; Haggett, 2001; Black, 2003; Rodrigue et al., 2006), which is for each pair of centres determined by the general formula:

$$\mathbf{X}_{ij} = (\mathbf{M}_i \times \mathbf{M}_j) / \mathbf{D}_{ij}^{\mathbf{b}},$$

where X_{ij} is a dimensionless expression of the strength of mutual relations between the centres i and j, i.e. the

[6] Real values for all transport volumes were used for a comparison in the year 2010 because the prediction of traffic load by RMD was based on total traffic load. The results may be affected by methodological changes in the traffic census of heavy goods vehicles between 2005 and 2010.

interaction or the traffic relation between these two centres; M_i and M_j are so-called masses of the centres; D_{ij} is a distance between the centres; and *b* is a parameter determining the distance typical of a given task.

This model monitors the major road network influencing traffic relations in the Ostrava region, whose territory corresponded to the meso-region of Ostrava determined during the division of the Czech Republic into socio-geographical regions in 2001 (Hampl, 2005). The mutual relationships between micro-regional centres, as well as between main centres of the Ostrava region and inter-regional and national centres of the Czech Republic and its neighbouring states, are combined on the monitored road network. In the case of the Czech Republic, the mass of the centre in this model is represented by the indicator of complex size (an aggregate based on the number of inhabitants and jobs, for more details see Hampl, 2005), and the number of inhabitants in the case of centres in another state. The model is considered symmetrical with the assumption that the emissivity and attractiveness of each of the monitored centres with a mass are directly proportional to the mass of the centre. The distance between the centres is expressed as time required for the travel, with road network changes in the surveyed years being taken into account.

The model was at first constructed for the years 1990 and 2000, based on data from the national traffic census. For each edge of the monitored network, we used the intensity value, which corresponded to the point with the lowest traffic load between two centres. The aim of the calibration was to find such values for the distance influence parameter b, with which the real values for the surveyed years would correspond to the model values as much as possible. After having obtained these parameter values from the calibration for 1990 (b = 2.4) and 2000 (b = 2.1), which corresponded to the expected transport trends (decreasing importance of distance on transport interactions, increasing transport intensities), it was possible to determine the parameter used in model construction for the period after 2010 (b = 2.0)[7]. This model is based on the form of a reference equation used for the year 2000, while it also already includes expected changes in the temporal distance between the centres due to the construction of D47. At the same time, the predicted values for each of the edges were adjusted by way of the divergence of real (for 2005) and theoretical (model-based) traffic loads, so that they would correspond to actual relations in the system existing in 2005 as much as possible. This procedure is obviously only a very simplified prediction and features all of the problems connected with the application of basic interaction models (distance being the only differentiating factor; theoretical assumption of a stable regional system; the very settings of the model, including the subjective perspective of the researcher, etc.). Therefore, it is necessary to perceive the obtained results of the predicted intensities only as a rough estimate, which is nevertheless still valuable, especially if compared with analogical outputs.

The model we used generated results of expected traffic load for the D47 (see Tab. 2), for which the value of intensity for the complete monitored section was slightly over 30,000 vehicles per day. This traffic load corresponds to the values given by RMD (for 2010 and 2030) in the prediction for the section Lipník nad Bečvou–Bělotín, which is used for all long-distance or transit transport in the south-west–north-east axis. The real traffic load in 2010 was, however, lower than both of the predictions by approximately 10,000–15,000 vehicles. In contrast to the "official" prediction, our model overestimated the Bělotín–Ostrava section, predicting the traffic load to be higher by 10,000–15,000 vehicles. Moreover, real values for this section in 2010 were lower by approximately 20,000 vehicles. As mentioned with respect to the RMD forecast, it is also necessary in this context to note that our model was constructed upon the assumption that the motorway would be completed and would provide not only a connection with the domestic network but also with Poland, which was not achieved by the time of the 2010 census. Some reasons for such a high traffic load model values can be found mainly in the overestimated traffic connections with the Katowice conurbation, the realistic connection of which to the Ostrava region and other metropolitan regions in the Czech Republic is in reality probably much weaker (see also Körner, 2012).

This prediction is also due to the nature of the model, which takes into account only the size characteristics and change in the distance, ignoring any qualitative aspect of mutual relations, which is, especially in the context of structural issues of both neighbouring regions, one of the factors influencing lower demand and supply. This is also confirmed by the fact that for the Ostrava–Bohumín motorway section, from which most contacts between the Ostrava region and Poland are realised (including those which are realised through the border crossing in Český Těšín/Chotěbuz), the model predicted a high and for the following decades probably unreal value, of more than 50,000 vehicles per day. From a methodological point of view, in order to eliminate the improbable values, it is possible to include in the model input data such measures like decreasing the size of centres in another state or quantifying the barrier of the state border, by which the mutual resistance of the centres is theoretically increased. The second reason for the high traffic load value in the Bělotín–Ostrava section is a generally assumed increase in the interaction between Ostrava and the surveyed centres of the Czech Republic, and also with the districts of Nový Jičín and Valašské Meziříčí, for which Ostrava will become better accessible because of the motorway.

Apart from the prediction of the D47 traffic load, it is possible to compare the results obtained from our model for the monitored network with real values for 2012. In general, the model predicted a significant shift of traffic relations from the previous Ostrava–Příbor–Nový Jičín transit axis realised by the I/56 and I/48 roads, in favour of the D47. Compared to real data, the model predicted an even steeper drop of traffic intensities in these sections (by approximately 3,000–8,000), especially due to the premise that all contacts would be already realised by the connection, which is more convenient in terms of time economy. It is obvious that this premise, necessary for the construction of the basic model, however, can not be objectively fulfilled, since many factors influence route preference, including the financial aspect concerning motorway fees. Similarly, in accordance with the real data analysis (see above), the model also predicted that the D47 would have only a limited influence on the traffic load in the Ostrava–Frýdek-Místek section. By contrast, the results obtained from the model predicted a higher traffic load, which was mostly influenced by the general increase of intensities caused by the selected distance parameters used for the model construction.

[7] Derived empirically, the value stated above corresponds to the values usually applied in gravity modelling.

In addition to the above stated results, the model can also to a certain degree make up for the main absence of traffic load data on network edges, i.e. for the proportion of each relation on the overall traffic load. This procedure has also been applied in the above-mentioned study (Chmelík, 2008), where the author made an illustrative estimate of the proportion of each connection in the Příbor–Nový Jičín section, by which all the long-distance transport from/to Ostrava and the transit transport through the region, was realised in the surveyed year of 2000. Based on the results of the model, it is possible to state that traffic relations between Ostrava and other centres included in the model constitute 50% of the overall traffic burden on the monitored section. Next come (again strong – see above) transit relations with Katowice and Krakow with 35%, and other relations between the inter-regional (e.g. Frýdek Místek–Prague) and micro-regional (e.g. Frýdek-Místek–Nový Jičín) centres with the remaining 15%. These are, however, only approximate results, as it is practically impossible to verify them with real data with respect to directions.

6. Conclusions

This discussion of approaches to the assessment of effectiveness and societal benefits of a transport infrastructure project based on considering the spatial distribution and traffic interaction intensity as the major direct impacts, allows for pointing out significant differences between the situation in the Czech Republic and Western Europe. Especially in the Anglo-Saxon countries, the assessment of transport infrastructure projects is based on methods (reviewed in Hayashi, Morisugi, 2000), which take into account mainly time economy as the most significant factor causing changes in transport intensities. In the Czech Republic, this approach was not fully embraced, especially in the past. Factors other than transport effectiveness are often used for prioritisation, especially territorial preparedness (see Viturka et al., 2012), which is related to the ease of negotiation across the consulting points. This can be proved easily by the R35 expressway project, which has been for a long time presented by political representatives and transport experts as a condition necessary for connecting Bohemia and Moravia as an alternative to the motorway D1, but the pace of realisation has been very slow compared to other projects. A signal for improving prioritisation in the transport infrastructure of the Czech Republic can be seen in the project of transport strategies currently being prepared by the Ministry of Transport, as it should define priorities binding for transport infrastructure construction, based on the assessment of peoples' actual needs.

Another issue which precedes the prioritisation issue is data input, which is necessary for any relevant assessment. The restrictions of databases are not only an issue in the Czech Republic. The main problem is the lack of data on traffic flow, i.e. about the starting point and destination of traffic participants. This, though, is absolutely logical given the nature of individual transport. By contrast, the data on traffic intensity in individual sections are easily accessible from the national traffic census. These data, however, provide no information on direction and are therefore more difficult to use for assessing the impact of new connections in a given area. For this reason, they are often subsequently adjusted in order to fit the analyses, transport models and simulations.

The core of this paper was a case study in which we at first evaluated changes in transport intensities in concrete sections of a relevant road network, which might have been due to changes in route preference due to the opening of the D47. The results of the basic analysis, which capture the development of traffic intensities of passenger vehicles in the predefined sections, confirmed the intuitive premises about the redistribution of traffic relations in those centres for which the new connection offered a more time-saving alternative. In particular, a greater part of traffic flow in the Ostrava–Příbor–Nový Jičín–Hranice axis was shifted to the new motorway. By contrast, the traffic on the Ostrava–Frýdek-Místek–Příbor route changed less significantly, which confirms the assumption that this section had not been used for supra-regional relations even in the past. This assumption is in conflict with some of the earlier proposals for connecting the Ostrava region on the motorway network only by the R56 expressway (see, e.g. Robeš, Růžička, 1998).

The general question is how to distinguish between the distributive and generative effects of new transport intensities on the D47, which is difficult, among other factors, also due to the necessity of assessing impacts on the competitiveness of major transport modes. Nevertheless, it can be assumed that a significant part of the traffic load is the shifted traffic (distributive effect), which can be supported both by the fact that traffic intensities between 2005 and 2010 stagnated (see Viturka et al., 2012), and by the fact that the commuter traffic flow from the Ostrava region streaming especially to Prague is much more than in other Czech regions realised by high-quality railway transport, which can compete with car transport. The process of transport induction (generative effect) will then probably be evident especially in those sections where residents of settlements near entrance ramps can potentially commute daily to other centres, especially Ostrava, due to the decrease in time needed for the travel. This assumption, though, should be confirmed first by detailed research in which it would also be possible to compare traffic intensity changes on motorways and expressways heading in a radial manner towards Prague, where the changes can be expected to be more dynamic.

The second part of the case study dealt with an evaluation of the utility and significance of construction, part of which is the prediction of traffic intensity values. In the case of the D47, the prediction was even more interesting because the decision-making bodies did not make any relevant assessments, and therefore it was not possible to compare alternatives or conclude that this project was needed more than the other ones. The accessible data on the traffic load in 2010 allowed for a comparison of the official prediction elaborated for RMD before the motorway opening, based on modelling in a specialized software in which the future growth rates of traffic intensities were included (ADIAS, 2001; RMD, 2009, 2012). These results were also compared with our own prediction based on a gravity model for the affected area. A partial aim of both predictions was to find out if the geographic application of this elementary form of the gravity model based on the selection of major interrelated centres in the region and relevant centres outside the region, and including also changes in the size and significance parameter, can compete with the output of software used by transport engineers. The results showed that the predicted values were overestimated, especially the values predicted in our model for the sections leading to Ostrava. This does not diminish the value of such predictions, since they were calculated with the assumption that the motorway would be completed, which was not yet the case by the 2010 traffic census, as has been already stated above. But, in this context, we should point to Körner's opinion (2012) that predictions are sometimes deliberately overestimated in order to push the motorway project through.

Nevertheless, the results confirmed that the application of a basic gravity model can generate relevant and valuable output, especially when taking into account that after further adjustments of the input, it could be comparable to the official models based on which the factual decisions about transport infrastructure building are made. This is a key matter in the situation in which the complexity of the official models practically does not allow an intuitive review of the output data. It is also likely that the application of such models will still be topical given the permanent lack of the required more accurate directional data. And, since every model significantly generalizes reality, a sensitive interpretation of results and their critical assessment will continue to be a necessity.

Acknowledgement

This contribution was prepared from the research project number P404/12/1035: "Spatial Dynamics of Transport Relationships in the Settlement System of Czechia", granted by the Grant Agency of the Czech Republic. The authors are much obliged for this generous support.

References:

ADIAS (2001): Dálnice D1 a D47 v úseku Holubice–Polsko. Stanovení intenzit dopravy – průvodní zpráva. ADIAS, Brno, 10 pp.

BANISTER, D., BERECHMAN, Y. (2001): Transport investment and the promotion of economic growth. Journal of Transport Geography, Vol. 9, No. 3, p. 209–218.

BARTOŠ, L. et al. (2010): Prognóza intenzit automobilové dopravy (TP 225). EDIP, 22 pp.

BAUEROVÁ, D., RAMÍK, J. (2004a): Modeling the Influence of the New Motorway D47 from Lipník to Ostrava by the Concept of Economic Potential of the Regions. In: Bulava, P. et al. [eds.]: Studies and Analyses of the Macro- and Microeconomic Systems Structures and Behavior Using the Economic-Mathematical Methods. VŠB-TU, Ostrava, p. 141–162.

BAUEROVÁ, D., RAMÍK, J. (2004b): Economic Potential of the Regions Based on Gravity Models. In: Bauer, L.: Proceedings of the 22nd International Conference Mathematical Methods of Economics 2004, Masarykova univerzita, Brno, p. 16–21.

BLACK, W. R. (2003): Transportation: a geographical analysis. The Guilford Press, New York, 375 pp.

BRŮHOVÁ-FOLTÝNOVÁ, H. et al. (2008): Analýza každodenního dopravního chování dospělého městského obyvatelstva a nástroje regulace dopravy. Závěrečná zpráva z projektu MD 24/2006-430-OPI/3 z OP „Infrastruktura" – Priorita 2 (2.4). Univerzita Karlova v Praze, Centrum pro otázky životního prostředí, 281 pp.

HALÁS, M. (2005): Dopravný potenciál regiónov Slovenska. Geografie, 110, No. 4, p. 257–270.

CHMELÍK, J. (2008): Modelování prostorových interakcí na příkladu Ostravska. Diplomová práce. Katedra sociální geografie a regionálního rozvoje PřF UK, Praha, 97 pp.

GROSCHE, T., ROTHLAUF, F., HEINZL, A. (2007): Gravity models for airline passenger volume estimation. Journal of Air Transport Managment, Vol. 13, p. 175–183.

GÜHNEMANN, A., LAIRD, J. J., PEARMAN, A. D. (2012): Combining cost-benefit and multi-criteria analysis to prioritise a national road infrastructure programme. Transport Policy, Vol. 23, p. 15–24.

GUTIÉRREZ, J. (2001): Location, Economic Potential and Daily Accessibility: An Analysis of the Accessibility Impact of the High-speed Line Madrid–Barcelona–French border. Journal of Transport Geography, Vol. 9, No. 4, Dublin, p. 229–242.

GUTIÉRREZ, J., URBANO, P. (1996): Accessibility in the European Union: the impact of the trans-European road network. Journal of Transport Geography, Vol. 4, No. 1, p. 15–25.

HAGGETT, P. (2001): Geography – a Global Synthesis. Prentice Hall, London, 833 pp.

HAMPL, M. (2005): Geografická organizace společnosti v České republice: Transformační procesy a jejich obecný kontext. Katedra sociální geografie a regionálního rozvoje, PřF UK, Praha, 148 pp.

HAYASHI, Y., MORISUGI, H. (2000): International comparison of background concept and methodology of transport projects appraisal. Transport Policy, Vol. 7, p. 73–88.

HŮRSKÝ, J. (1978): Metody oblastního členění podle dopravního spádu: úvod do teorie předělů osobní dopravy. Rozpravy ČSAV, 6, Academia, Praha, 96 pp.

JEŘÁBEK, M., MARADA, M. (2003): Regionálněgeografické hodnocení území ovlivněného trasou dálnice D8 a výběr ukazatelů pro stanovení nepřímého užitku výstavby dopravní infrastruktury (příloha). In: Lehovec, F. et al.: Komplexní hodnocení užitku výstavby dopravní infrastruktury. Fakulta stavební, ČVUT v Praze, Praha, 18 pp.

JUREČKA, V. (2003): Přeměna „D47" v politicko-ekonomický fenomén. In: VI. Mezinárodní kolokvium o regionálních vědách, Masarykova univerzita, Brno, p. 79–85.

KÖRNER, M. (2012): K hodnocení přínosů vybraných tras silniční infrastruktury. Urbanismus a územní rozvoj, Vol. XV, No. 2, p. 35–36.

KRAFT, S., BLAŽEK, J. (2012): Spatial interactions and regionalisation of the Vysočina Region using the gravity models. Acta Universitatis Palackianae Olomucensis, Facultas Rerum Naturalium, Geographica, Vol. 43, No. 2, p. 65–82.

KRAFT, S., MARADA, M., POPJAKOVÁ, D. (2014): Delimitation of nodal regions based on transport flows: case study of the Czech Republic. Quaestiones Geographicae, Vol. 33, No. 2, p. 139–150.

KUTA, V. (2000): Rozvojové problémy ostravské aglomerace. Magistrát města Ostravy – Útvar hlavního architekta, Ostrava, 253 pp.

LEE Jr., D. B. (2000): Methods for evaluation of transportation projects in the USA. Transport Policy, Vol. 7, p. 41–50.

LEHOVEC, F. et al. (2003): Komplexní hodnocení užitku výstavby dopravní infrastruktury. Fakulta stavební, ČVUT v Praze, Praha, 74 pp.

MATSUMOTO, H. (2007): International air network structures and air traffic density of world cities. Transportation Research Part E, 43, Elsevier, p. 269–272.

MARADA, M. (2008): Transport and geographical organization of society: Case study of Czechia. Geografie, Vol. 113, No. 2, p. 285–301.

MARADA, M., KVĚTOŇ, V., VONDRÁČKOVÁ, P. (2010): Doprava a geografická organizace společnosti v Česku. Edice Geographica, ČGS, Praha, 165 pp.

MORISUGI, H. (2000): Evalution methodologies of transportation projects in Japan. Transport Policy, Vol. 7, p. 35 – 40.

NTC (2000): National Traffic Census 2000. [online] [cit. 25.02.2013] Available at: URL: www.rsd.cz/doprava/scitani_2000/start.htm

NTC (2005): National Traffic Census 2005. [online] [cit. 25.02.2013] Available at: URL: www.scitani2005.rsd.cz

NTC (2010): National Traffic Census 2010. [online] [cit. 25.02.2013] Available at: URL: http://scitani2010.rsd.cz/

PRÁŠIL, M. (2007): Dálnice 1967–2007. Zvon, 134 pp.

PRESTON, J., O'CONNOR, K. (2008): Revitalized transport geographies. In: Knowles, R. [ed.]: Transport geographies: Mobilities, Flows and Spaces. Blackwell Publishing Ltd., Oxford, p. 227 – 237.

QUINET, E. (2000): Evalution methodologies of transportation projects in France. Transport Policy, Vol. 7, Elsevier Science, p. 27 – 34.

ŘEHÁK, S. (1992): Sídelně dopravní model ČSFR a jeho územní souvislosti. Geografický časopis, Vol. 44, No. 1, p. 59–72.

ŘEHÁK, S. (1997): Modely jako nástroj včasného varování. In: Patrik, M. [ed.]: Alternativní trendy dopravní politiky v ČR. Sborník ze semináře v Rybníku u Poběžovic. Český a Slovenský dopravní klub, Brno, p. 27–35.

ŘEHÁK, S. (2004): Geografický potenciál pohraničí. In: Jeřábek, M., Dokoupil, J., Havlíček, T. et al.: České pohraničí – bariéra nebo prostor zprostředkování? Academia, Praha, p. 67–74.

REPHANN, T. J. (1993): Highway Investment and Regional Economic Development: Decision Methods and Empirical Foundations. Urban Studies, 30, No. 2, p. 437 – 450.

RIETVELD, P., BRUINSMA, F. (1998): Is Transport Infrastructure Effective? Transport Infrastructure and Accessibility: Impacts on the Space Economy. Springer-Verlag, Berlin-Heidelberg, 383 pp.

RIETVELD, P., VICKERMAN, R. (2004): Transport in regional science: The "death of distance" is premature. Papers in Regional Science 83, RSAI, p. 229 – 248.

RMD (2009): Informační publikace o projektu D47. [online] [cit. 15.09.2010] Available at: URL: http://www.rsd.cz/doc/Silnicni-a-dalnicni-sit/Dalnice/publikace-o-projektu-d47

RMD (2012): Informační publikace o projektu D47. [online] [cit. 02.08.2012] Available at: URL: http://www.rsd.cz/doc/Silnicni-a-dalnicni-sit/Dalnice/publikace-o-projektu-d47

ROBEŠ, M., RŮŽIČKA, J. (1998): Alternativní návrh koncepce rozvoje dopravních sítí České republiky do roku 2010. Český a Slovenský dopravní klub. [online] [cit. 25.09.2012] Available at: URL: http://dopravniklub.ecn.cz/texty_alter.shtml

RODRIGUE, J.-P., COMTOIS, C., SLACK, B. (2006): The Geography of Transport Systems. Routledge, London, 284 pp.

SAO Bulletin (2003): Auditing Action 02/10, Finanční prostředky vynaložené na rozvoj dopravních sítí v České republice. p. 122–131. [online] [cit. 25.09.2012] Available at: URL: < http://www.nku.cz/kon-zavery/K02010.pdf>

SAO Bulletin (2005): Auditing Action 04/25, Rozvoj dopravní infrastruktury v regionech soudržnosti Střední Morava a Ostravsko. p. 223–230. [online] [cit. 25.09.2012] Available at: URL: < http://www.nku.cz/kon-zavery/K04025.pdf >

SCHEJBALOVÁ, B., TEPEROVÁ, K. (1999): Co očekáváte od dálnice D47, Ostravané? Urbanismus a územní rozvoj, No. II, No. 5, p. 11 – 12.

SUCHÁČEK, J. (2005): Restrukturalizace tradičních průmyslových regionů v tranzitivních ekonomikách. VŠB-TU, Ekonomická fakulta, Ostrava, 221 pp.

VACHTL, M. et al. (2013): Dopravní sektorové strategie 2. fáze (souhrnný dokument). Ministerstvo dopravy, Praha, 305 pp. [online] [cit. 05.08.2013] Available at: URL: http://www.dopravnistrategie.cz/

VICKERMAN, R. (2000): Evaluation methodologies for transport projects in the United Kingdom. Transport Policy, Vol. 7, p. 7 – 16.

VICKERMAN, R. W., SPIEKERMAN, K., WEGENER, M. (1999): Accessibility and Economic Development in Europe. Regional Studies, Vol. 33, No. 1. p. 1–15.

VITURKA, M., PAŘIL, P., TONEV, P. (2012): Hodnocení účelnosti projektů výstavby dopravní infrastruktury (Případová studie dálnic a rychlostních silnic České republiky). Urbanismus a územní rozvoj, Vol. XV, No. 2, p. 28 – 34.

ZAHRADNÍK, P. (2003): Zhodnocení přínosů a nákladů dálnice D47 na ekonomický a sociální vývoj České republiky, dotčených regionů, měst a obcí: kvalitativní a kvantitativní analýza. 43 pp. [online] [cit. 15.12.2007] Available at: URL: www.darius.cz/ag_nikola/zahradnik_studie.doc

Authors' addresses:

Mgr. Jakub CHMELÍK, e-mail: *jakub.chmelik@natur.cuni.cz*
RNDr. Miroslav MARADA, Ph.D., e-mail: *miroslav.marada@natur.cuni.cz*
Department of Social Geography and Regional Development, Faculty of Science, Charles University in Prague
Albertov 6, 128 43 Praha 2, Czech Republic

Initial submission 2 October 2013, **final acceptance** 26 September 2014

Please cite this article as:

CHMELÍK, J., MARADA, M. (2014): Assessment of the impact of a new motorway connection on the spatial distribution and intensity of traffic flows: A case study of the D47 motorway, Czech Republic. Moravian Geographical Reports, Vol. 22, No. 4, p. 14–24. DOI: 10.1515/mgr-2014-0020.

URBAN BROWNFIELDS IN ESTONIA: SCOPE, CONSEQUENCES AND REDEVELOPMENT BARRIERS AS PERCEIVED BY LOCAL GOVERNMENTS

Jiří TINTĚRA, Aime RUUS, Epi TOHVRI, Zenia KOTVAL

Abstract

Awareness of brownfields is limited in Estonia. In fact, there is no specific term officially used for brownfields at present. The aim of this study is to examine concerns in the redevelopment of brownfields and to present preliminary findings regarding the scope, consequences and redevelopment barriers of Estonian urban brownfields, as perceived and assessed by local authorities. The perceived importance of the negative impacts of brownfields on urban space is more than the mere number of brownfields and their total area, as it is influenced by the presence of other negative socioeconomic phenomena, such as local unemployment or population decline. According to municipal authorities, major barriers to the redevelopment of Estonian urban brownfields, besides the economic issues, are both the lack of knowledge regarding state and local measures and tools to help the public sector deal with brownfields, and the common perception that brownfields re-development is a private sector issue.

Shrnutí

Urbánní brownfieldy v Estonsku: rozsah, dopady a revitalizační bariéry z pohledu městských samospráv

Povědomí o problematice brownfields je v Estonsku slabé, dodnes pro ně neexistuje žádný konkrétní oficiální termín. Cílem této práce je prozkoumat zájem městských samospráv o regeneraci brownfields a analyzovat rozsah, dopady a bariéry rozvoje urbánních brownfields v Estonsku ve vnímání a hodnocení místních samospráv. Vnímaná důležitost negativních dopadů brownfields je spíše než množstvím a rozlohou brownfields ve městech ovlivněna přítomností dalších negativních socioekonomických jevů jako lokální nezaměstnanost či úbytek populace. Podle samospráv obcí představují kromě ekonomických faktorů hlavní překážky regenerace městských brownfields v Estonsku jednak nedostatek znalostí možných nástrojů k podpoře regenerace brownfields ze strany statní správy a samosprávy a také široce rozšířený názor, že regenerace brownfields má být záležitostí soukromého sektoru.

Keywords: *urban brownfields, sustainability, land management, legal definition, negative impacts, barriers to development, Estonia*

1. Introduction

After the collapse of the Soviet Union in the early 1990s and similarly with other Baltic countries, Estonia went through radical structural changes in its economy and politics. As a result, an increasing number of urban brownfields emerged. Despite this fact, abandoned urban space is only seldom re-used for new development. Due to its economic growth, accession to the European Union and access to the EU structural funds, Estonia is now reaching the point where it would be able to start to deal with brownfields redevelopment. Awareness of brownfields, however, their opportunities and constraints, remains fairly limited in Estonia. Currently, there is no specific term or legal definition for brownfields in the Estonian language. Drawing on the experience of other countries, it is possible to assume that local governments, which are on the frontline when it comes to dealing with negative impacts of the presence of brownfields in their administrative area, will also be the first to show interest in brownfields regeneration (CABERNET, 2006).

Given this background, the aims of this study are to examine local governments' interest in brownfields regeneration in Estonia, to present preliminary data regarding the extent and the perception of Estonian urban brownfields and their redevelopment from the perspective of municipal governments, as well as to understand public sector concerns and issues related to such redevelopment. Drawing on Estonian survey-based research, this research will show the scale and nature of urban brownfield redevelopment problems that municipalities of former Soviet countries are facing, and will highlight the most affected towns. The critical question is: Does the presence of brownfield sites have any impact on the quality of life in Estonian towns?

This paper seeks to answer this main question from four different aspects:

1. How do local governments perceive the extent, cause and nature of brownfields in Estonian towns?
2. What geographical and socioeconomic factors affect the spatial diffusion and extent of brownfield areas in towns?
3. What do local governments perceive as the most important negative impacts of brownfields on local communities' quality of life and how significant are these impacts? and
4. What do local government officials consider to be the main barriers to redevelopment of urban brownfields?

Once answered, these questions can begin to provide a sense of the magnitude and nature of the brownfield redevelopment tasks, and could serve as a starting point for possible future policy of brownfields redevelopment in Estonia. Responses to these questions were collected from survey data and interviews with local government officials. The feedback received also contains implications for future research and planning, providing an initial empirical basis for assessing the scale of the problem of brownfields in Estonian towns, and the resulting problems that municipal governments face.

2. Urban brownfields redevelopment

Successful redevelopment of urban brownfields requires effective public and private sector cooperation. Redeveloping a brownfield is far more complicated and difficult than building a new structure on a greenfield site. Benefits gained by the local community from such redevelopment, however, could be immense: from financial advantages (tax income from the site) to qualitative factors, such as environmental clean-up and an improved quality of life. The attitudes of the community towards redevelopment are critical (Kotval and Mullin, 2009), and local governments have a key role in shaping these attitudes. For successful brownfield redevelopment, local authorities need to be able to communicate factually and openly with local residents about potential risks of such redevelopment (Eiser et al., 2007). Local authority regulators are one of key stakeholders involved in the redevelopment of brownfield sites (Williams and Dair, 2007).

CABERNET (Concerted Action on Brownfield and Economic Regeneration Network) is a European multi-stakeholder network that focuses on the complex issues that are raised by brownfields regeneration. CABERNET, in its report "Sustainable Brownfields Regeneration", describes key governance and institutional issues in the regeneration of brownfields. This report also highlights the fact that municipal governments are one of the key decision makers with an impact on brownfields regeneration processes. "Municipalities' actions, or indeed inaction, can have impact on the manner and pace at which brownfield land is brought back into use, or the degree to which it might remain under-used or derelict. Therefore, there is a strong need for a brownfield specific strategic approach for regeneration at the local government level" (CABERNET, 2006).

Among a number of issues that need to be considered when reviewing the role of municipalities, this report states that two of the key problems are a low awareness of the issue among municipal governments, and a lack of adequate knowledge about the scale of the problem. The report further underlines the need of policy makers and developers for reliable and up-to-date information in order to facilitate the re-use of land. It highlights the importance of national land use databases, which would incorporate both the extent and the nature of brownfield lands. Such databases would help member states to deal with the problem of brownfield sites and would be useful "in taking advantage of the opportunities for increased competitiveness presented by successful brownfields regeneration and urban land management" (CABERNET, 2006).

Oliver et al. (2006) divide EU countries into three groups – by competitiveness and population density. The first group is represented by the Scandinavian countries and Ireland. These countries, with a high level of competitiveness and relatively low population density, focus on the regeneration of brownfields by resolving the issues of contamination. In the second group, represented by Western European countries such as Germany and France, high population densities and the lack of available greenfield sites has already created a priority for land regeneration through brownfields redevelopment. The third group is represented mostly by the EU member states from the Mediterranean region and Eastern Europe. These countries have medium relative population densities and a relatively low competitiveness. Due to a lack of any contact with the CABERNET network, Estonia is not mentioned among the selected countries in the CABERNET report. Considering its current state of economic development and past economic structural change, however, it can be presumed that Estonia, despite its low density of population, would be classified in the third group: "It is perhaps these countries [from the third group] that have the most to gain from maximizing the potential for creating more competitive cities that are available through the successful regeneration of urban brownfield land" (Oliver et al., 2006).

This paper reacts to the CABERNET network's recommendations and aims to deliver preliminary findings enabling the establishment of an Estonian national land use database in the future. It also shows local governments' perceptions and awareness of the brownfield issue. The first step towards dealing with the 'brownfield issue' in Estonia is to give it a name. Currently, there is no specific term for brownfields in the Estonian language. Mostly, some equivalent to spoiled or polluted area is used. The term 'tühermaa', which could be translated as a bare or empty plot of land, is noticed more frequently. This term has not been clearly defined yet, however, nor is it exclusively used for brownfield sites. Therefore, for the purposes of the present study, the international term 'brownfield' is used.

The second step towards understanding the full dimensions of the 'brownfield issue' is to define the term. Defining the term and evaluating the problems associated with it makes an essential contribution to its solution (Alker et al., 2000; Adams, De Sousa and Tiesdell, 2010). The definition and the approach to deal with brownfields differ by country and are developing over time (Adams, De Sousa and Tiesdell, 2010; Thornton et al., 2007). While in most of the EU member countries the concept of brownfields as previously-developed land is prevalent (Oliver et al., 2006; ODPM, 2005), both in North America and Australia definitions continue to refer to both known and potentially-contaminated sites (Adams, De Sousa and Tiesdell, 2010). Even in these countries, the focus is shifting from mostly 'contaminated areas' towards 'previously developed land' (Hula and Bromley-Trujillo, 2010; Susilawati and Thomas, 2012). Initially, the term brownfield was associated primarily with urban regeneration, which later began to cover rural areas, too (Frantál et al., 2013). At the moment, there is no standard definition for brownfields across the EU, and legal definitions differ from one EU member state to another (CABERNET, 2006; Oliver et al., 2006). CABERNET, as one of the first approaches at a European level to unify the term, defines brownfields as sites that: (i) have been affected by the former uses of the site and surrounding land; (ii) are derelict or under-used and may have real or perceived contamination problems; (iii) are mainly situated in developed urban areas; and (iv) require intervention to bring them back to beneficial use.

In a similar way that an Estonian term for brownfields is lacking, there is still no legal or commonly-used definition for a brownfield site, either. The concept of brownfields as being previously-developed land seemed to be more appropriate for the Estonian context, and hence the definition elaborated by CABERNET has been used in this study. The definition specifies urban brownfields, but in the context of Estonia, referring solely to urban areas could be problematic. Due to various economic transformation processes in its recent past, Estonia has been left to deal with a number of derelict former agricultural complexes from the socialist era. These are mainly 'Kolkhozes' (collective farms) and 'Sovkhozes' (farms of collective management). These complexes are situated mostly in the countryside, outside of larger settlements. Narrowing down the definition to only sites in the developed urban areas would ignore the reality of Estonian brownfield sites, and could be a limiting factor in finding a successful solution.

The presence of unused, derelict areas and deteriorated buildings within the compact pattern of a town reduces the attractiveness of a site. It also reduces the value of land and properties in the neighbourhood for potential investors, the existing business sector, as well as for residents. Economic and environmental problems may occur and accumulate in the area and it may start to contrast sharply with both stabilized and new development zones. A large number of brownfields on the administrative territory of a town aggravates problems and may make the area, as a whole, unattractive both for investors and residents. This could lead to growing unemployment and decreasing population (Susilawati and Thomas, 2012). Urban sprawl into outlying green spaces, a hollow urban core and redundant infrastructure, are further products of the missing brownfield policy (Brill, 2009). Unattractive environments, especially if marked by derelict buildings and overgrown lots, detract from the beauty of the surroundings, and give the place an air of neglect. This affects residents' pride, their sense of identity and the perception of attachment to the neighbourhood, which are important for possible future improvements in such areas. Letang and Taylor (2012) state that from the perspective of residents, improved environmental aesthetics are one of the most desired outcomes of successful brownfield redevelopment. The main types of problems caused by or negatively influenced by the presence of brownfields can be listed as follows: economic, financial, spatial, environmental and social. For the purposes of this study, the categorization by Kadeřábková and Piecha (2009), of brownfield's negative impacts on the quality of life within towns, was adapted for use in the questionnaire used (see results in Tab. 3, below).

Compared with greenfield sites, brownfields are often not economically competitive for regeneration without public intervention. Various authors discussing brownfields have identified a number of barriers to redevelopment that may be addressed through government policies. Susilawati and Thomas (2012) see the public perception of brownfields sites as contaminated as one of the main barriers to brownfield redevelopment, even when it is not necessarily the case. Whitney (2003) notes two main barriers: the cost of clean-up and legal concerns. De Sousa (2006) conceptualizes the main constraints on brownfields redevelopment as falling under three categories: development barriers, governance issues and neighbourhood-based drawbacks or under planning/regulatory constraints, physical and ownership constraints (Adams, De Sousa and Tiesdell, 2010). Economic, environmental and social barriers are often present at the sites, hindering the return of brownfields to beneficial use. Public incentives could make brownfields regeneration more attractive. Two types of incentives are applicable: financial incentives including direct and indirect funding, and legal incentives including spatial planning and regulatory drivers (Thornton, 2007).

The present study examines local governments' perceptions of the main constraints that need to be addressed in relation to improving overall brownfield policies in Estonia, and in providing public incentives for undertaking brownfields redevelopment. For the purposes of this study, a list of the development barriers and governance issues relating to brownfields redevelopment, based on De Sousa's (2006) categories, has been incorporated into the questionnaire. The importance of each barrier has also been examined (see results in Tab. 4, below).

Frantál et al. (2013) show that brownfields located in municipalities with a higher local development potential are more likely to be redeveloped. There are different geographical and socioeconomic indicators that can characterize the development potential of a municipality. The results of this study are interpreted in relation to these two types of indicators: (a) geographical indicators – town size, population and proximity to Estonia's capital city, Tallinn; and (b) socioeconomic factors, including the relative changes in population and registered unemployment.

3. Geographical context of the study

Estonia is a small country in the Baltic region of Northern Europe. With a population of 1,339,662 (January 1, 2012) and a total area of 45,227 km^2 its population density is 31 inhabitants per km^2. The Estonian territory is divided administratively into fifteen counties and 226 administrative units managed by local governments, including 33 towns, 193 rural municipalities and fourteen towns without municipal status (ES, 2012). The populations of all 47 towns (with or without municipal status) vary from 1,040 to 397,617 inhabitants. Fourteen towns have a population of more than 10,000 inhabitants and six of them more than 20,000 (Fig. 1). Population is distributed unevenly, with a higher density in northern parts of the country. The location and size of Estonian towns mirror the distribution of population. Apart from the capital of Tallinn in Harju County and the towns of Tartu (Tartu County) and Pärnu (Pärnu County), all other larger towns are concentrated in the East-Viru County in the most north-eastern part of Estonia (Fig. 1).

Since the collapse of the Soviet Union, the size of the Estonian population has continually decreased. According to the 2011 Population and Housing Census, 1,294,455 permanent residents lived in Estonia. Compared to the previous census of 2000, the population of Estonia decreased by 75,597 persons, i.e. by 5.5%. The census results also indicate the continuing concentration of the population around major cities. This is mainly occurring around the capital of Tallinn, but also around the towns of Tartu and Pärnu. These shifting population densities have resulted in the general shrinkage of Estonian towns (ES, 2013b). There are only three towns (Saue, Maardu, Keila), where the population has increased between the two censuses. All of them are situated in relative close proximity of the capital and their growth can be explained as an effect of urban sprawl (Roose, Kull, Gauk and Tali, 2013). In the remaining towns, the population has decreased. Compared to 2000, the decrease in population has been the most notable in smaller towns (Fig. 2). Mõisaküla, Kallaste and Püssi were the most affected towns, losing 29.2%, 29.7% and 42.1% of their population, respectively. Tallinn, the capital city, and Tartu, the second largest city, have lost only a moderate 1.8% and 3.5%, respectively (ES, 2013b).

The socioeconomic situation of Estonian regions varies significantly. This can be demonstrated by the distribution of registered unemployment across the country. Looking at other socio-economic parameters, such as median household income or the number of persons living below the poverty line

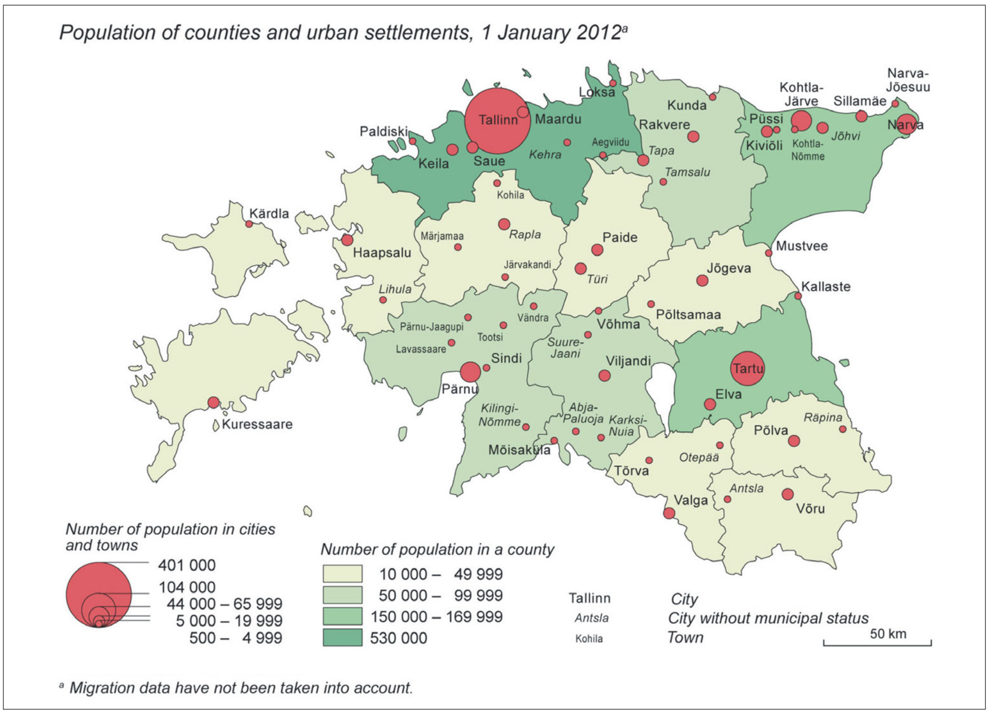

Fig. 1: Population of counties and urban settlements (January 1, 2012)
Source: ES (2012); Graphic courtesy of Statistics Estonia (2012)

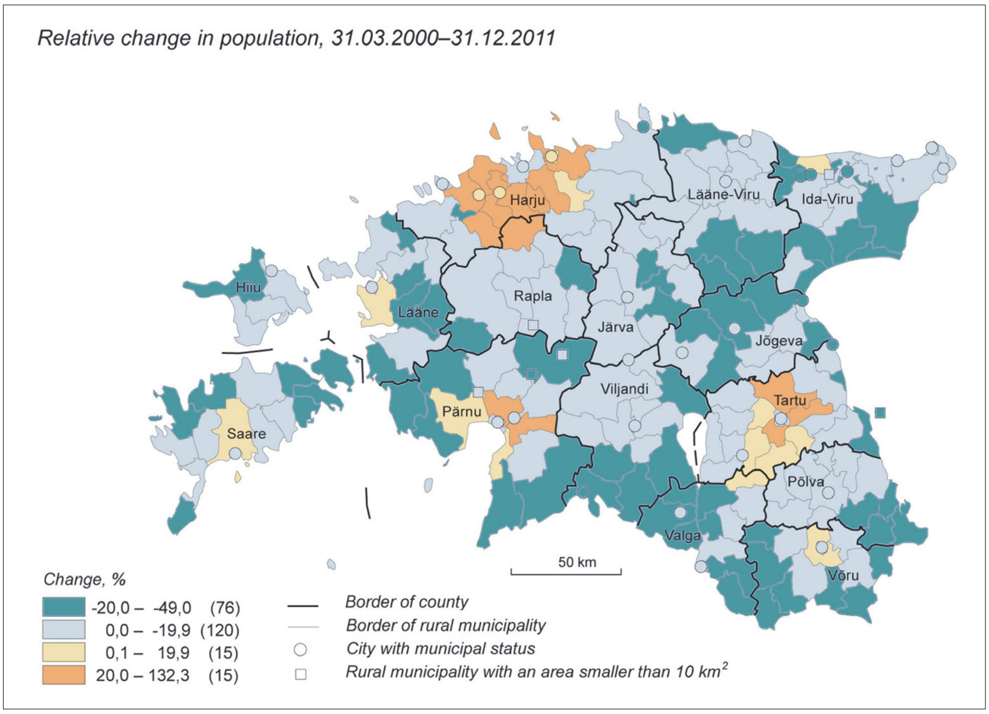

Fig. 2: Relative change in the population of Estonia (31.03.2000–31.12.2011)
Source: ES (2013a); Graphic courtesy of Statistics Estonia

(Letang and Taylor, 2012), would show similar distributions. Areas most affected by unemployment are the regions of the East-Viru County (towns of Narva, Kohtla-Järve, Silamäe, Jőhvi, Kiviőli, Püssi) and the Valga County (town of Valga). The lowest rates are recorded in the Viljandi County and the Jőgeva County (Fig. 3). The East-Viru County is historically a highly industrialized region with large deposits of oil shale and a concentration of heavy industry. The population of the East-Viru County amounts to 166,548, constituting 12.6% of the total Estonian population. Although the Valga County is a rural region on the border between Estonia and Latvia with a population of 34,135 inhabitants, the town of Valga itself has a strong industrial and military past.

Knowledge about brownfields, their opportunities and constraints, is fairly limited in Estonia. The Estonian government has shown a certain interest in the issue and awareness of the problem, however. The National Environmental Action plan of Estonia for 2007–2013, published by the Ministry of the Environment, states that under the planned action 1.8.3.2, there is a need for 'the elaboration of the principles of financing the cultivation, restoration and arrangement of spoilt areas and elimination

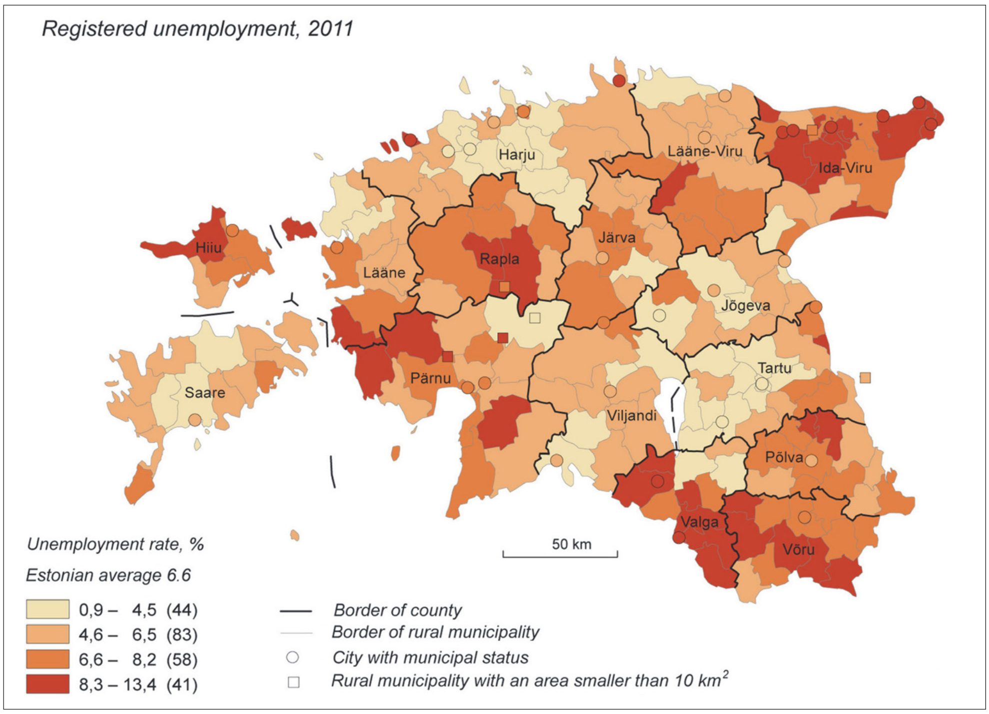

Fig. 3: Registered unemployment in Estonia (2011)
Data sources: ES (2013a); Graphic courtesy of Statistics Estonia

of littering objects', and under action 1.8.3.3 a need for 'the support for arrangement of spoilt and polluted areas (e.g. military areas, quarries, peat production areas, agricultural areas, etc.)' (Ministry of the Environment, 2008). In the national governmental Action Programme for 2012–2015, the need for establishing a national land pollution database, creating measures to reduce ownership constraints and enabling funding from state sources, is mentioned (Eesti Vabariigi Valitsus, 2011).

While these intentions continue to be nothing more than just plans, one already-functioning action can be pointed out. Site owners now have the possibility to apply for a grant from the government agency Environmental Investment Centre (EIC) for the 'demolition of structures damaging the landscape' within their property. This measure corresponds well with Letang and Taylor's (2012) concept of improving environmental aesthetics, as pointed out above. Since this measure is applicable only to old industrial, military and agricultural facilities situated outside of urban areas or in their periphery, however, it can be a tool for remediating only a small part of urban brownfield sites.

4. Data and methods

To gain an overview of how aware the government is of the brownfield problem, certain state institutions were contacted. The Ministry of the Environment, the Ministry of Economy and Communication, the Ministry of the Interior and the Estonian Land Board were asked for written contributions and comments. The Ministry of Economy and Communication and the Ministry of the Interior were responsive, both pointing out a real need to analyse the issue of urban brownfields in Estonia and giving their full support to this study. At the same time, however, they underlined the fact that in Estonia, it is local governments that are primarily responsible for local spatial development planning. As a result of the 'absent' brownfield policy and uncertainty as to who is responsible for it, there is not any clear and united approach among Estonian stakeholders in the propagation of brownfields redevelopment.

Neither the state nor the local governments have an accurate picture of the extent of urban brownfields within their territories. Due to the missing definition for brownfields, a systematic inventory of brownfields is difficult to conduct. Brownfield areas in current local comprehensive plans and master plans are mainly marked according to their last use or – less frequently – according to their intended use. Such plans do not give any information about their actual use, however. Presuming that town government officials responsible for environmental protection or planning are those who are aware of possible brownfield areas in their towns, our survey targetted local governments for information on urban brownfields. Roose, Kull, Gauk and Tali (2013) give a deeper overview of the actual state of land use planning in Estonia, the role of local governments in this process and limits to their activities. Data for this study were gathered between December 2011 and July 2012 from mail-out questionnaires and visits to 47 Estonian towns. These 47 towns included all Estonian towns with or without the municipal status. In order to help local governments become more willing to participate in the research, written support letters from the Ministry of Economy and Communication, the Ministry of the Interior and Estonian Town Association (ELL) were mailed in the autumn of 2011.

A modified and translated CABERNET definition of brownfields was part of a mail-out questionnaire for local government officials. The questionnaire comprised eleven questions designed to identify or determine:

- possible previous brownfield redevelopment policies in town governance;
- local government's perception of the extent and nature of local brownfield sites;
- preferences for the future use of brownfield land;
- relative importance of actual new construction on brownfield land;
- importance of negative impacts of brownfield sites on local life;

- types of negative impacts on local life; and
- barriers inhibiting redevelopment of urban brownfields.

For questions in parts five to seven, respondents were asked to choose three answers from the given list and mark with three (3) points as the most important, two (2) points as the second most important, and with one (1) point as the third most important option. The option "other", requiring further comments was also available.

The questionnaires were first mailed out in December 2011, using the Estonian Town Association's mailing list. They were mainly sent to officials responsible for environmental protection or planning in town government bodies. As not all Estonian towns are members of ELL, an official University e-mail was sent to non-members in January 2012. Follow up e-mails were sent in March and April 2012. The e-mails attempted to target officials at higher positions who were responsible for planning. In the case of small towns, this might have even been the mayor. Throughout the data gathering process, researchers were available to receive questions and provide further information and, where necessary, personal visits to stakeholders were offered. In fact, the e-mail sent out in April proposed only the latter. The need for a personal visit occurred only in larger towns. Three towns were visited: Tallinn (twice), Tartu and Maardu. In all cases, one of the contact persons was an official from the department of town planning. In Tartu, a Town Architect and in Maardu, a Deputy Mayor were also present. Interviews were composed of two parts. During the first part, brownfields were delineated on a printed town development plan. Their previous utilization and actual ownership were added. During the second part, questions similar to those in the e-mailed survey were asked. Sections referring to local government's perception of brownfields' negative impact on their town's quality of life and their view of barriers inhibiting redevelopment of urban brownfields, were the focus of the discussions. After each visit, the Estonian Geoportal (GIS system) was used for gaining more precise data regarding the number and size of brownfields in the areas pointed out by local government officials.

In total, data from twenty towns were gathered, with the response rate being 43%. Eighteen of the returned questionnaires included all data asked for. Respondents from the remaining two towns only stated, without filling out the questionnaire, that there were no brownfields in their territory. Officials of larger towns tended to display more interest in the research. Ten out of fifteen towns with a population larger than 10,000 participated in the survey.

5. Scale and characteristics of urban brownfields in Estonia as perceived by local governments

Respondents were asked whether the redevelopment of brownfields had already been discussed in their town and, if so, with what results. Although ten out of eighteen respondents affirmed that there had been some discussion on this issue, only two of them were able to specify the results. The Paldiski town government official noted that land use was specified for the whole town territory (including brownfields) in the town's master plan. In the case of Sillamäe, removal of contamination from a former large industrial plot and the development of plans for the site were mentioned.

5.1 Estimation of the extent of urban brownfields in Estonia

The study revealed that local governments have a very limited overview of the actual land use in their towns' territory, including the possible presence of brownfields. There are no municipal brownfield inventories. Data about the quantity and areal surface of brownfields presented in this paper are only estimates, the quality of which depends considerably on the accuracy of respondents' survey answers. Although the definition of brownfield was presented in the questionnaires, we cannot presume that all respondents understood the term in the same way. There is a need to improve the depth of knowledge about brownfields among Estonian stakeholders, as this may help to make the term clearer. We assume that large brownfield areas with higher negative impacts on their surroundings were more often detected than smaller ones. And also that the time and effort contributed by the respondents differed significantly. Nevertheless, the results give an idea of the extent of urban brownfields in Estonia.

Local government representatives were asked to estimate the number and size of brownfields in their municipalities. No local governments involved in the research had a formal brownfields inventory from which to derive an estimate. Twenty towns provided an estimated number of brownfield sites; eighteen of them also estimated brownfield area. Responses ranged from zero (Loksa, Suure-Jaani) to 283 (Tallinn), covering from zero to 9.7% (Tamsalu) of their area (Tab. 1).

Although a significant correlation between the relative extent of brownfields in a town (as a % of a total area) and the town size or population was not detected (see Table 2), it is remarkable that the proportion of brownfields in the four largest towns (ranking from 0.5 to 2.2%) is lower than in most of the middle-sized (< 20,000) and smaller towns (see Table 1). Decline in population is strongly associated with the town's location in terms of proximity to the capital city (Pearson's $r = -0.596$), but none of those factors seem to influence the presence of brownfields in a town. Even registered unemployment is not significantly associated with the estimated size of brownfields (Pearson's $r = 0.139$). Because of the potential inaccuracy of respondents' estimations of the quantity and areal surface of urban brownfields, an affirmation that the extent of brownfields is not associated with a town's geographical location and its socioeconomic situation would be premature. There is a need for more precise inventories of Estonian brownfields.

Industrial heritage is another important factor influencing the presence of brownfields in a town (Filip and Cocean, 2012). While towns with a strong industrial past (Tamsalu, Maardu, Rakvere, Võhma, Sillamäe, Valga) declare the proportion of their brownfields to be between 5 and 9.7%, less industrialized towns such as Saue, Loksa and Suure-Jaani state that they have practically no brownfields within their territory (Table 1). In the case of towns such as Valga and Rakvere, the former presence of large Soviet bases has likely played an important role in the extent of brownfield sites within these towns.

On average, brownfields in the participating twenty towns occupy approximately 2.5% of urban land. This is less than estimations in De Sousa's (2006) similar study for Canada (3.3%) and USA (6%), but not unusual, given Estonia's different, less industrial, history. Within the participating towns, 695 potential brownfield sites with a total area of 1,152 ha were detected. Assuming that this average percentage of brownfield area is applicable to all 47 Estonian towns, including those not included in the study, approximately 1,000 brownfields with a total of up to about 1,600 ha may be present in the Estonian towns.

Town name	Population[a]	Total area[b] (ha)	Unemployment rate[d]	Population change[e]	Regional location[g] (km)	Number of brownfields[k]	Area of brownfields[k] (ha)	BF as % of total urban area	Perceived importance[m]
Tallinn	397,617	15,827	3.3	– 1.8	0	283	272.0	1.7	2.0
Tartu	102,414	3,880	3.2	– 3.5	186	34	86.0	2.2	3.0
Narva	66,453	8,454	12.6	– 14.6	213	53	117.8	1.4	5.0
Viljandi	20,117	1,462	4.2	– 15.8	161	3	7.2	0.5	2.0
Rakvere	16,612	1,064	5.0	– 10.7	100	120	74.7	7.0	2.0
Maardu	6,549	2,276	5.8	4.7	20	46	218.3	9.6	4.0
Sillamäe	16,392	1,054	8.0	– 17.1	187	2	65.2	6.2	3.0
Kuressaare	14,965	1,495	4.7	– 11.8	220	33	34.5	2.3	4.0
Valga	13,789	1,654	10.7	– 14.4	240	19	93.4	5.6	4.0
Kiviőli	6,749	1,175	11.4	– 23.9	145	22	43.0	3.7	4.0
Rapla	5,641	472	5.9	– 9.7	53	15	n/a	n/a	3.0
Saue	5,142	349	2.9	11.2	22	1	1.4	0.4	1.0
Paldiski	4,154	6,017	8.9	– 3.8	49	17	66.3	1.1	3.0
Kärdla	3,678	450	6.4	– 19.6	158	12	n/a	n/a	2.0
Loksa	3,437	381	7.8	– 21.0	69	0	0.0	0.0	n/a
Tamsalu	2,544	402	7.4	– 14.5	102	18	39.0	9.7	4.0
Võhma	1,515	193	5.8	– 17.7	132	3	13.1	6.8	3.0
Lihula	1,425	417	7.1	– 10.6	113	11	11.4	2.7	3.0
Suure-Jaani	1,236	223	4.0	– 21.5	145	0	0.0	0.0	n/a
Mõisaküla	1,040	220	4.8	– 29.2	191	3	8.9	4.0	4.0
Total		**47,465**				**695**	**1,152.2**	**2.5**	**3.1**

Tab. 1: Geographical and socioeconomic indicators of participating towns and perceived extent of brownfield problem
Notes:
[a] Statistics Estonia. Data as of 1 January 2012 (ES 2012);
[b] Estonian Land Board. Data as of 1 January 2007; [d] Statistics Estonia based on the data of the Estonian Unemployment Insurance Fund. Data for the year 2012 (ES 2013a);
[e] Statistics Estonia. Relative population change between the two censuses 2000 and 2011;
[g] Estonian Road Administration. The distance of the town from Tallinn. Data as of 30 July 2003 (ES 2013a); [k] Authors' own survey (estimate);
[m] Authors' own survey. Perceived Importance of brownfields negative impact on the quality of life (5 = extremely high importance);
[o] Total area of Paldiski includes two uninhabited islands (1,287 and 1,160 ha).

	Population	Total area	Unemployment	Population change	Regional location	BF as % of total u. area	Perceived importance
Unemployment	– 0.258	0.031	1.000	– 0.347	0.326	0.139	0.652
Population change	0.304	0.337	– 0.347	1.000	– 0.596	0.003	– 0.411
Regional location	– 0.300	– 0.256	0.326	– 0.596	1.000	– 0.007	0.484
% of total urban area	– 0.183	– 0.246	0.139	0.003	– 0.007	1.000	0.322
Perceived importance	– 0.208	– 0.008	0.652	– 0.411	0.484	0.322	1.000

Tab. 2: Inter-correlation matrix of geographical and socioeconomic indicators and extent of brownfield problem

Given the unstructured selection of the towns participating in this survey, however, this assumption is not necessarily correct and would need to be checked by further research. We can assume though that, in reality, these counts and areas are likely to be higher than those estimated here, as the survey results depended on the ability and willingness of respondents to detect brownfields on their municipal lands.

Similar estimations concerning only urban brownfields in other countries are not available. Oliver et al. (2006) lists the available data for a range of brownfield types in some European countries, and Adams, De Sousa and Tiesdell (2010) for USA and Canada. In Filip and Cocean's (2012) analysis of 60 from 320 Romanian cities, 222 industrial urban brownfields were identified taking up from 0.1 to 17.3% of the administrative area of each city. Note, however, that we have to be aware of limitations in comparing all of these presented data due to the use of varying brownfield definitions (Alker et al., 2000), different study focuses, such as only on urban or only on industrial brownfields, and different data collection methods.

5.2 Structure of Estonia's urban brownfields

Respondents were asked to divide their detected brownfields into groups by former use and ownership. Figure 4 shows that most urban brownfields in Estonia consist of former industrial premises (35%), followed by post-military sites (30.8%), and then residential (18.1%) land. By its area, the former industrial land occupies almost a half (47.9%) of all brownfield areas and the post-military sites occupy almost a quarter (24.3%). The relative importance of the former residential land is relatively low (5%). The majority of brownfield sites are owned by the private sector (63.3% by number and 71.4% by area – Fig. 5). Still, more than one-third (25% by area) of the detected brownfields are in public (municipal or state) ownership. For the rest of the sites, local respondents were not able to specify the actual ownership.

Data relating to the former use of urban brownfields reveal that most of the abandoned sites were previously used for industry. This is in accordance with other countries' experiences (Czech Invest, 2008; De Sousa, 2002). Post-military sites, however, constitute an important share of extant brownfields. In the middle of the 1980s, before the collapse of the Soviet Union in 1991, around 122,480 Soviet soldiers were resident in Estonia with their families and service personnel (Pärn, Hergauk and Őun, 2006). When the Soviet troops withdrew in 1994, many military bases were left empty. Most of them were located in rural areas, but some were also in developed urban areas. Typically, those sites remained in the state's possession and when local governments showed any interest, they were transferred to them. This can explain the quite high proportion of public sector ownership of detected brownfields, as compared for example with the situation in the Czech Republic (Czech Invest, 2008).

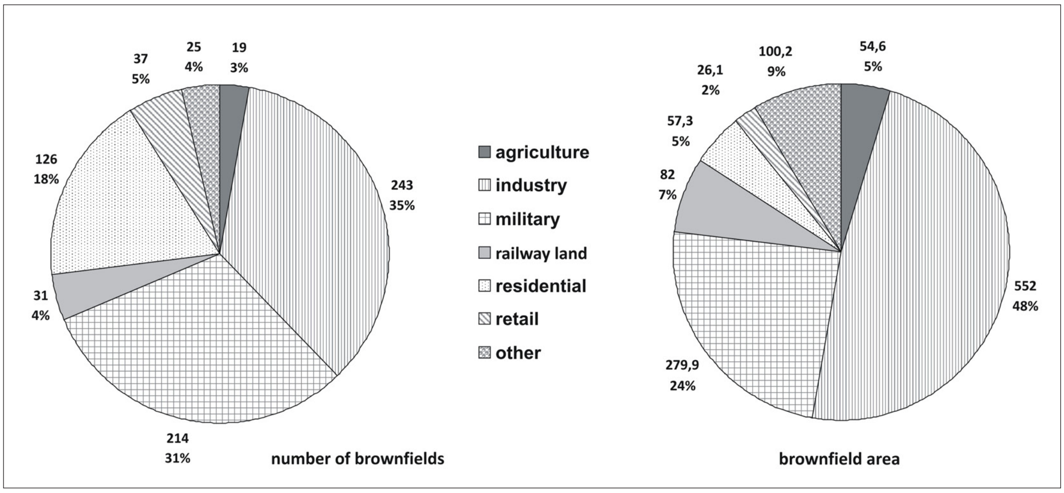

Fig. 4: Distribution by former land use. Source: authors' survey

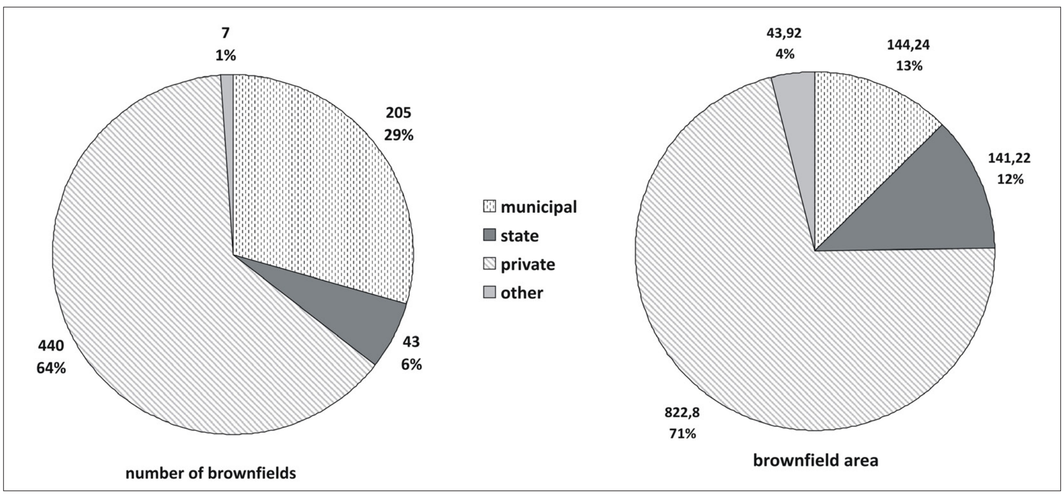

Fig. 5: Distribution by ownership. Source: authors' survey

Public ownership can be an advantage for successful redevelopment of brownfield sites, because ownership constraints represent one of the main barriers to redevelopment (Adams, De Sousa and Tiesdell, 2010). Public ownership simplifies the redevelopment of a brownfield site for non-profit use, turning it into a green space, for example (De Sousa, 2003; Franz, Gules and Prey, 2008). It also makes interim or temporary use easier (Rall and Haase, 2011). And lastly, in Estonia, public ownership provides better access to grant funding. The Estonian Environmental Investment Centre (EIC), provides landowners with the possibility to apply for a grant for "the demolition of structures damaging the landscape" from their property. According to EIC rules, private site owners need to co-finance at least 50% of the removal costs. In the case of sites in public possession, 10% of co-investment is acceptable (EIC, 2012).

The process described above can be illustrated by the case of a former military airport situated in Tartu, the second largest town in Estonia. This formerly important Soviet military airport lies partially within the town's borders, the rest lying within the territory of the neighbouring village. The airport was abandoned by the Soviet army in 1992. Service buildings, including barracks, remained empty. The majority of the airport territory is in the state's possession. Ownership of the land where the barracks are located was transferred to the Tartu government. In November 2012, the town government decided to demolish the remaining barracks with a grant from the EIC. Town co-investment was 10% (Tartu Linnavolikogu, 2012). In Tartu's master plan, this area is marked for future reuse as land for public buildings.

Between 2011 and 2013, EIC supported 45 demolition projects of structures "damaging the landscape". The total amount of grant funding supplied was 1,236,015 EUR. Twenty-one applications were submitted by the public sector. Only three of these demolitions took place on the lands of any of the 47 Estonian towns (EIC, 2013).

5.3 Future land use in local governments' preferences

The relative importance of actual new construction on brownfields was also examined. Town representatives counted the number of all permits for new buildings issued by local government from the year 2005 until now, and estimated how many of them concerned brownfields. The estimated data show a wide variation. Eleven out of nineteen towns replied that there were no building developments on their brownfields at all, while four towns estimated the share of new construction on brownfields to be higher than 10%. Two towns indicated an extremely high percentage. In Kiviőli it was 23.7%, and in Sillamäe, the estimate was up to 54.5%. Both are small former mining and industrial towns with a considerable number of brownfields. These estimates, however, will need to be validated by further research.

Permits issued for brownfield land in all nineteen towns represented on average 5.6% of all permits for new buildings. In England, the proportion of new dwellings built on previously developed land is the main figure used for monitoring the success of planning policy. This figure has risen from 57% in 1996 to 77% in 2007 (Baing, 2010). Compared to this, the proportion (5.6%) for Estonia is very low and shows space for future improvement.

To gather information about town governments' preferences towards the future use of the detected brownfields, a list of common land use options was compiled and respondents were asked to mark all suitable options. Although the questionnaire included the option of 'no preference' for the future use of brownfields, most respondents did indicate their preferences.

In terms of desired future uses, retail (13 points), industry (13 points) and residential (10 points) use were the most popular (Fig. 6). The key issue in reuse, however, needs to be flexibility. As Adams, De Sousa and Tiesdell (2010) state: "… local planning authorities may wish to reserve sites for an apparently useful purpose for which current demand is low (for example, manufacturing industry) by preventing their immediate development for another purpose for which current demand is high (for example, housing)". Local governments should try to make their planning regulations concerning brownfield sites as flexible as possible, so as not to stiffen the constraints to brownfield redevelopment.

5.4 Negative effects of brownfields

As Letang and Taylor (2012) argue, citizens and local authorities have different perspectives concerning the perception of brownfields, their negative impact and the success of their redevelopment. While local authorities tend to put more emphasis on economic aspects, citizens rate neighbourhood quality of life higher. The following results therefore need to be addressed with this perspective in mind. Municipal officials were asked how important they considered the negative impact of brownfields to be on local quality of life. One out of twenty respondents stated it had extremely high importance, six considered it highly important, another six marked the option 'medium importance', four 'low importance' and one respondent did not see it as important at all (Table 1). It can be understood then that most municipalities acknowledge the need for action in this domain. For thirteen out of eighteen local governments, brownfields' negative impacts on the quality of life in their town were of at least medium importance.

The size of a town or its population did not significantly affect the perceived importance of brownfields' presence (see Tab. 2), although a correlation (Pearson's r = 0.322) with the relative extent of brownfields in a city (as % of total area) can be seen. However, even this relationship has a lot of exceptions. For example, the town of Rakvere has one of the largest proportions of brownfields (7.0% of total city area), but it is not perceived as a serious problem there. On the contrary, Narva reported its percentage of brownfields to be only 1.4%, while also noting that the negative presence of brownfields has an extremely high importance (Fig. 7 – see cover p. 2).

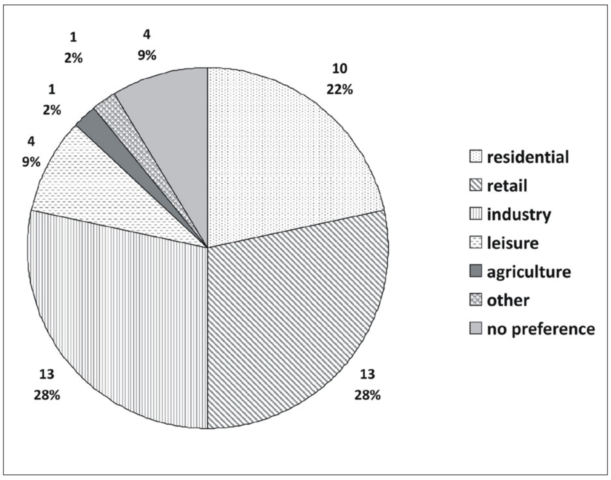

Fig. 6: Preferred land use by municipalities
Source: authors' survey

It is interesting that such differing results were received from respondents. It seems the perceived importance of brownfield sites on town land better expresses the size of the brownfield problem than data relating to the relative extent of brownfield sites in the area. Respondents seem to be more precise in the evaluation of brownfields' negative impacts on a town's life than in the estimation of the real extent of brownfields in their municipalities. A more important correlation though is between the growth or decline of population in the last decade and the perceived importance of negative impacts (Pearson's r = – 0.411). An example of this correlation can be seen when comparing towns that present completely opposite perceptions of brownfield importance. The town of Saue reported no negative impacts from brownfields. Saue is situated in close proximity of the capital, and is one of three towns where the population has been increasing during the last decade (+ 11.2% between 2000 and 2011 census) as a result of Tallinn's urban sprawl. In contrast, the town official from Narva noted that the negative impact on the quality of life in their town was of extremely high importance. Narva, the most populated town in the East-Viru county, and a large town in the Estonian context with more than 60,000 inhabitants, represents a typical shrinking city (Schetke and Haase, 2008; Rall and Haase, 2011). Due to historical reasons, a former high level of industrialization, the social composition of inhabitants and its current economic decline, Narva is experiencing a massive depopulation trend. Between the years 2000 and 2011, its population declined from 68,680 to 58,663 (– 14.6%).

There are also exceptions to this pattern, however. Contrary to the town of Saue, the town of Maardu, another of three growing towns (+ 4.7%), marked the effect of brownfields as being highly important. Among the group of towns losing more than 15% of population, Mőisaküla (– 29.2%) and Kiviőli (– 23.9%) perceive the negative impact of brownfield sites as highly important, while Kärdla (– 19.2%) and Viljandi (– 15.2%) seem not to be concerned. To understand this contradiction we must look more into the history of these communities. All three towns acknowledging problems with abandoned sites (Maardu, Mőisaküla and Kiviőli) were important industrial towns of the former Soviet Union. Since its collapse in 1991, which resulted in radical structural changes in the Estonian economy, these towns have struggled to deal with their industrial heritage. Even the growth in population as a result of urban sprawl from Tallinn during the last decade, has not helped Maardu deal with its former industrial sites. Kärdla and Viljandi, on the other hand, have always been important tourist towns. Viljandi is a mediaeval town with a well-developed cultural life (folk festival, theatre, cultural academy) and Kärdla is a seaside resort town. As such, the loss of population does not seem to be connected to the presence of brownfields.

The regional location of towns, represented by distance from the capital of Tallinn, also plays an important role in the perceived importance of brownfields (Pearson's r = 0.484). Among seven towns that rated the negative impact of brownfields as having a high or extremely high importance, four are situated relatively far away from the capital (Valga, Kuresaare, Narva and Mőisaküla). Only one of them, the above-mentioned industrial town of Maardu, is situated in close proximity to Tallinn. An even stronger correlation can be seen between registered unemployment and the perceived negative impact of brownfields (Pearson's r = 0.652). Narva, as a town with the highest unemployment rate in Estonia, perceives the importance of brownfields as extremely high (Fig. 8, see cover p. 2). Among six towns that rated negative impacts as having a high importance, three suffer from unemployment higher than the Estonian average (Valga, Kiviőli and Maardu). Conversely, three towns from four, which perceive the effect of brownfields as either being of low or no importance (Saue, Tallinn and Viljandi), have unemployment rates lower than average.

Towns with an industrial past (Narva, Kiviőli, Maardu, Mőisaküla, Tamsalu, Valga) see the presence of brownfields in their territory as being important. These towns tend to have weaker real estate markets and are struggling with the much stronger negative influence that the presence of brownfield sites pose. Towns with many abandoned industrial or military sites have a hard time attracting private investors, which can in turn cause higher unemployment. Town governments in economically distressed areas also have limited resources to put towards these sites. As a result, these town officials feel a real need for their towns' regeneration. Towns that see the negative impacts of brownfield sites as having a low importance are towns that have historically been attractive for tourists (Viljandi, Rakvere, Kärdla), as well as the capital Tallinn. The latter seems to be able, due to its economic power, to deal with a rather high number of brownfields without any considerable perceived negative impact on its inhabitants' quality of life. The actual socio-economic situation of a town in combination with its historical, industrial or military heritage, are the main factors influencing the perceptions of abandoned or under-used areas in Estonia.

The survey results show that there was consensus on the types of negative impacts that brownfield sites pose on a local community's quality of life. Loss of town attractiveness for investors and citizens was pointed out as the most important one (39 points). Brownfields also tend to generate lower municipal revenues through unpaid taxes (15 points), and cause devaluation of their surroundings (11 points). The loss of town attractiveness for tourists and environmental damage (soil, water and air pollution) were also mentioned (8 points each). Other negative impacts received five points or less (see Tab. 3).

Municipalities are clear about the nature of the main negative impact, which is the loss of attractiveness for citizens and investors. For most of them, the presence of brownfields symbolizes depopulation and declining local economic and social activity, which threatens the town's future. Environmental issues only play a secondary role for them. The town of Valga is a good example of such development. Valga is situated in South–Estonia, on the border between Estonia and Latvia. Valga is a medieval town where the main development occurred at the end of the 19th century; then it became an important railway junction. Before the First World War, its population peaked at 20,000 inhabitants. As a result of the collapse of the Russian Empire, Valga was divided between Estonia and Latvia and lived through economic decline. After the Second World War, during the time of the Soviet occupation, Valga became an important industrial and military centre and its population peaked at 18,500 citizens by the end of the 1980s in the Estonian part of the town. To house the incoming workers and soldiers, large numbers of new pre-fabricated apartment blocks were raised. After the collapse of the Soviet Union, military troops left the town and Valga lost more than 4,000 people in one year. As a result of industry restructuring, Valga's current permanent population is a little higher than 12,000 people (ES, 2013b). Because of a large surplus of apartments after the military withdrew at the beginning of the 1990s, many people moved from the historical, mainly wooden apartment houses with

Rank	Negative impact	Category	Points
1.	Loss of town attractiveness for investors and citizens	Economic	39
2.	Decreasing tax revenue, loss of tax base	Financial	15
3.	Deprivation of brownfields' surrounding	Spatial	11
4.	Loss of town attractiveness for tourists	Economic	8
5.	Environmental damages (soil, water and air pollution)	Environmental	8
6.	Deterioration of market climate	Economic	5
7.	Urban sprawl	Spatial	5
8.	Higher unemployment	Social	5
9.	Rising crime rate	Social	5
10.	Increasing need for social security benefits	Social	1
11.	Reduction of local government's budget (risk of failure in financing actual level of public good)	Financial	0

Tab. 3. Negative impact of brownfields on life in towns as perceived by local governments. Source: authors' survey

poor facilities to relatively new ones made of pre-fabricated panels. Nowadays the town's historical centre, which is under heritage protection, is practically empty. Of eight historical buildings around the main church, only two are occupied: the town hall and a music school. Vacant, unused buildings contribute to a loss in property value. They also have a negative effect on citizens' sense of attachment to the place (Letang and Taylor, 2012) and a trust in the town's future. This results in civil apathy and low citizen involvement in town affairs. Given the above results, it might be safe to say that in Estonia, brownfield perception has less to do with actual environmental contamination and is more a result of the legacy of Soviet heritage and regional development.

5.5 Barriers to redevelopment of brownfields

As to the impediments to redevelopment for potential investors, there was a consensus among municipalities on two responses in terms of both rank and frequency: additional costs associated with the site clean-up and redevelopment (23 points); and low real estate value of the site (20 pts.). Unsuitable site location (15 pts.), investors' fear of risk (13 pts.) and longer project duration (13 pts.), were also often pointed out. Other forms of negative impact received six points or less (Tab. 4).

The main barriers slowing down the process of brownfields revitalization in Estonia, from the municipalities' point of view, were the municipalities' limited financial resources

Rank	Barriers to brownfields redevelopment	Points
	Development barriers	
1.	Additional costs associated with clean-up and redevelopment	23
2.	Low real estate value	20
3.	Site location	15
4.	Fear of risk	13
5.	Project duration	13
6.	Responsibility issues	6
7.	Other	6
8.	Lack of access to funding	5
9.	Ownership constraints	2
	Governance issues	
1.	Municipality's limited financial resources	27
2.	Lack of funding from state or municipal sources	19
3.	Perception that such development is a private sector issue	19
4.	Municipality's limited administrative resources	13
5.	Lack of a proactive brownfields management strategy	8
6.	Lack of political will	5
7.	Competing municipal priorities	4
8.	Lack of government awareness of the problem	3
9.	Restrictive zoning	2
10.	Lack of site inventories	1
11.	Other	1

Tab. 4: Local governments' perception of main barriers to brownfields redevelopment. Source: authors' survey

(27 points), followed by the lack of funding for potential investors from state or municipal sources and the perception that such development is a private sector issue (both 19 points – see Tab. 4).

Finally, respondents were asked to point out any state program or activity that would help to improve the situation. Typically, various subsidies or grants were mentioned: either direct subsidies for investors to improve the economic viability of projects on brownfield sites (three respondents) or grants for municipalities or site owners for site clean-up (three respondents). Also the need for improved municipal measures to help make site owners take responsibility for their properties was stated twice. One respondent suggested a change in legal regulations to simplify site expropriation and re-privatization; to increase land tax differentiation and generally to improve regional politics.

As for the reason why investors are not in general willing to invest in brownfield sites, local government representatives most often suggested additional costs associated with site clean-up and redevelopment, combined with low real estate value of the site. This reveals the need for measures to decrease the gap between the investments in greenfield and brownfield projects. One of the major barriers to the redevelopment of Estonian urban brownfields is the lack of knowledge about possible state incentives to help the public sector deal with brownfield issues.

The main solution for brownfields redevelopment suggested by municipalities was increasing their financial resources and the implementation of funding for potential investors by state or municipal sources. For both of these measures, municipalities seem to expect special funds from the central government. In addition to these resources, municipalities also expect the government to change legal regulation in order to make site owners more responsible for their property and to increase the possibilities of local governments to impose and control this responsibility.

Central and local governments' perceptions that brownfields development is primarily a private sector issue, also plays an important role. And this is not just the governments' point of view, but seems to be the attitude of the stakeholders involved in land use planning and regulation on the whole – regulators, statutory consultants, service providers, councillors, interest groups, and individuals (Williams and Dair, 2007).

Rates of real estate ownership in Estonia went through significant changes with the end of the Soviet Union. At the beginning of the 1990s, land and real estate that was originally in state ownership was by processes of privatization and restitution transferred to private hands. The significance of those changes can be demonstrated by housing statistics, which show that 95.8% of dwellings in 2012 were privately owned, primarily as a result of this reform. Local governments own 3.2% and the state owns 2% of the dwelling stock. Such figures place Estonia at the forefront of residential property ownership rates within Europe as the share of privately-owned residential properties in Western Europe is around 40–55% (ES, 2012). At the same time, the prevailing liberal-conservative market ideology of the Estonian government has led to a modest regulation of land and real estate use (Roose, Kull, Gauk and Tali, 2013). As a result of these factors, the majority of brownfield sites are owned by the private sector (Fig. 5).

In general, prevailing governmental attitudes on both state and local levels do not facilitate the redevelopment of privately-owned brownfield land. A good example here can be found in section 5.2 above: EIC's different co-financing rules for private and public owners. In spite of the fact that municipalities experience the negative impact of brownfields in their towns, from their point of view it is the owner of each site who is mainly responsible for its redevelopment. And if such redevelopment is not economically viable for the owner, the site stays abandoned. This results in latent conflict between local governments and landowners. Municipalities accuse owners of not using their property and owners accuse municipalities for the economic decline of their town. This conflict needs to be resolved through a better cooperation between the public and private sectors. The public sector needs to play an active role with private sector entities to promote brownfields redevelopment. Currently, the governments on both levels have fairly limited knowledge to be able to do so. The present study aims to contribute to changing that.

5.6 Lack of clear responsibility for the redevelopment of brownfields

Currently there is no government policy to simplify urban brownfield redevelopment in Estonia on a state or local level. The present study shows that, on both levels, officials are aware of the problem and are prepared to deal with it but the ideas on how to start are lacking. During the preparatory work for this study, communication with state institutions revealed the problem of responsibility. In general, there is no governmental institution currently responsible for this issue and prepared to coordinate a possible brownfield policy.

State Government, in its Action programme for 2012–2015 (Eesti Vabariigi Valitsus, 2011) and the Ministry of the Environment in the National Environmental Action plan of Estonia for 2007–2013 (Ministry of the Environment, 2008), shows its willingness to participate in any action in this domain. It is however the Environmental Investment Centre (EIC), falling under the Ministry of Finance, which distributes grants to demolish structures damaging the landscape: this is the only specific measure already used to help brownfields redevelopment. The Ministry of the Interior, which exercises in Estonia the competences of the Ministry of Regional Affairs and is therefore responsible for the coordination of spatial planning, also admitted its responsibility in this regard. At the same time, all state officials stressed it is local governments that are primarily responsible for local spatial development planning. As experience from other countries shows, for the successful redevelopment of brownfields to occur, clear and mature policy at both state and local levels needs to be developed (Adams, De Sousa and Tiesdell, 2010).

6. Conclusions

The present study reveals that, while at the local government level a considerable interest towards brownfields redevelopment is apparent, most Estonian towns are struggling with the challenge. During the study, 695 urban brownfield sites with a total area of 1,152 ha were detected. They constituted on average 2.5% of municipal territories. Correlations between the relative extent of brownfield areas in towns and certain geographical factors (town size, population and spatial peripherality), and socioeconomic factors (relative change in population and registered unemployment) were not shown to be significant. This may be a result of limits presented by the chosen data gathering method. Middle-sized and smaller towns with strong industrial pasts showed a higher proportion of brownfields in their territory. Post-military sites in public possession, representing an important part of all urban brownfields, are easier to reuse for local governments, although only a modest share of new construction is actually carried out on this previously-developed land.

The perception of the importance of brownfields' negative impacts differs among Estonian towns, with such impacts being perceived as more important in historically industrial towns with a weaker real estate market. Rapidly depopulating towns are the most affected. There is a certain correlation between the importance of brownfields as perceived by local governments and the extent of brownfield area in the town. However, the perceived negative impact of brownfields on a town's life is more influenced by its relative change in population, location and local unemployment. The socio-economic circumstances of a town, in combination with its historical, industrial and/or military heritage, are the main factors influencing the negative perception of abandoned or under-used areas in Estonia. The decline of a town's attractiveness for investors and citizens is most often mentioned as the main negative impact of brownfields on local life. Brownfields symbolize depopulation and decreasing local social and economic activity.

The main barriers inhibiting the redevelopment of Estonian urban brownfields are, in the municipalities' point of view, the lack of assistance from the central government and the widespread opinion that brownfields redevelopment is a private sector issue. There is a strong need for a mature brownfields policy with clearly divided responsibilities at the state level. Measures need to be taken that make investments in brownfields more profitable for investors. Municipalities are also calling for changes in legal regulations that would clarify who is responsible for the property regeneration.

This study has taken some first steps by showing that brownfields do present a problem and are recognized by local governments as an issue that needs attention. The next step could be a detailed study of one Estonian town to create a model process for the inventory and assessment of all brownfield areas. Other important work would be the prioritization of sites by their development potential, the documenting of barriers to development and the creation of model regulations and policies to encourage development. In essence, while municipal officials realize that urban brownfields are a problem that needs to be addressed, the full scope and nature of brownfields redevelopment is not yet understood or measured. If Estonia is to protect its open lands and continue to concentrate development in existing built-up areas, the public sector will need to play an active role with private sector entities to make brownfields revitalization a priority.

Acknowledgements

This study was conducted by Tallinn University of Technology (Tartu College) within the framework of the authors' doctoral studies and was partly funded by grant ETF 9362 of Estonian Science Foundation.

References:

ADAMS, D., DE SOUSA, C. A., TIESDELL, S. (2010): Brownfield Development: A Comparison of North American and British Approaches. Urban Studies, Vol. 47, No. 1, p. 75–104.

ALKER, S., JOY, V., ROBERTS, P., SMITH, N. (2000): The Definition of Brownfield. Journal of Environmental Planning and Management, Vol. 43, No. 1, p. 49–69.

BAING, A. S. (2010): Containing Urban Sprawl? Comparing Brownfield Reuse Policies in England. International Planning Studies, Vol. 15, No. 1, p. 25–35.

BRILL, C. W. (2009): Using GIS to Contrast Perceived Versus Preferred Priorities for Brownfield Redevelopment in Worcester, Massachusetts. Journal of the Urban and Regional Information Systems Association, Vol. 21, No. 2, p. 49–57.

CABERNET COORDINATION TEAM (2006): Sustainable Brownfield Regeneration: CABERNET Network Report. University of Nottingham [online]. [cit: 17.9.2014] Available at: http://www.cabernet.org.uk/resourcefs/427.pdf

CZECHINVEST (2008): National Strategy for Brownfields Regeneration of the Czech Republic [online]. [cit: 17.9.2014] Ministry of Industry and Business. Available at: http://www.czechinvest.org/data/files/strategie-regenerace-vlada-1079.pdf

DE SOUSA, C. A. (2002): Brownfield Redevelopment in Toronto: an Examination of Past Trends and Future Prospects. Land Use Policy, Vol. 19, No. 4, p. 297–309.

DE SOUSA, C. A. (2003): Turning Brownfields into Green Space in the City of Toronto. Landscape and Urban Planning, Vol. 62, No. 4, p. 181–198.

DE SOUSA, C. A. (2006): Urban Brownfields Redevelopment in Canada: the Role of Local Government. The Canadian Geographer / Le Géographe canadien, Vol. 50, No. 3, p. 392–407.

EIC (Keskkonnainvesteeringute Keskus) [Environmental Investment Centre] (2012): Keskkonnaprojektide finantseerimisekord [financing arrangements of environmental projects] [online]. [cit: 17.9.2014] Keskkonnainvesteeringute Keskus. Available at: http://www.kik.ee/et/taotlejale/keskkonnaprogramm/oigusraamid/keskkonnaprogrammi-finantseerimise-kord

EIC (Keskkonnainvesteeringute Keskus) [Environmental Investment Centre] (2013): Keskkonnaprogrammi rahastatud projektid alates 2011 [Environment Programme-funded projects from 2011] [online]. [cit: 17.9.2014] Keskkonnainvesteeringute Keskus. Available at: http://kik.ee/et/taotlejale/keskkonnaprogramm/rahastatud-projektid?searchname=&selectprogram=4&selectprogram2=73&selectyear=&selectarea=

EISER, J. R., STAFFORD, T., HENNEBERRY, J., CATNEY, P. (2007): Risk perception and trust in the context of urban brownfields. Environmental Hazards, Vol. 7, No. 2, p. 150–156.

ES (Eesti statistika) [Statistics Estonia] (2012): Eesti statistika aastaraamat [Statistical Yearbook of Estonia] [online]. [cit: 17.9.2014] Eesti statistika. Available at: http://www.stat.ee/publication-download-pdf?publication_id=29873

ES (Eesti statistika) [Statistics Estonia] (2013a): Eesti piirkondlik areng [Regional Development in Estonia] [online]. [cit: 17.9.2014] Eesti statistika. Available at: http://www.stat.ee/publication-download-pdf?publication_id=34209

ES (Eesti statistika) [Statistics Estonia] (2013b): Rahva ja eluruumide loendus 2011 [Population and Housing Census 2011] [online]. [cit: 17.9.2014] Eesti statistika. Available at: http://www.stat.ee/publication-download-pdf?publication_id=35128

EESTI VABARIIGI VALITSUS [Estonian government] (2011): Vabariigi Valitsuse tegevusprogramm 2011–2015 [Government Action Programme 2011-2015] [online]. [cit: 17.9.2014] Eesti Vabariigi Valitsus. Available at: https://www.riigiteataja.ee/aktilisa/3100/5201/1001/VVk_209_lisa1.pdf

FILIP, S., COCEAN, P. (2012): Urban Industrial Brownfields: Constraints and Opportunities in Romania. Carpathian Journal of Earth and Environmental Sciences, Vol. 7, No. 4, p. 155–164.

FRANTÁL, B., KUNC, J., NOVÁKOVÁ, E., KLUSÁČEK, P., MARTINÁT, S., OSMAN, R. (2013): Location matters! Exploring brownfields regeneration in a spatial context (case study of the South Moravian Region, Czech Republic). Moravian Geographical Reports, Vol. 21, No. 2, p. 5–19.

FRANZ, M., GULES, O., PREY, G. (2008): Place-making and green reuses of Brownfields in the Ruhr. Tijdschrift voor Economische en Sociale Geografie, Vol. 99, No. 3, p. 316–328.

HULA, R. C., BROMLEY-TRUJILLO, R. (2010): Cleaning Up the Mess: Redevelopment of Urban Brownfields. Economic Development Quarterly, Vol. 24, No. 3, p. 276–287.

KADEŘÁNKOVÁ, B., PIECHA, M. et al. (2009): Brownfields, jak vznikají a co s nimi. Praha: C. H. Beck, 138 pp.

KOTVAL, Z., MULLIN, J. (2009): The Revitalization of New England's Small Town Mills: Breathing New Life into Old Places. Local Economy, Vol. 24, No. 2, p. 151–167.

LETANG, S. J., TAYLOR, R. (2012): Community perception of redevelopment changes and its impact on brownfields redevelopment success. OIDA International Journal of Sustainable Development, Vol. 5, No. 11, p. 21–42.

MINISTRY OF THE ENVIRONMENT (2008): National Environmental Action Plan of Estonia for 2007–2013 [online]. [cit: 17.9.2014] Ministry of the Environment. Available at: http:/www.envir.ee/2851

ODPM – Office of the Deputy Prime Minister (2005): Sustainable Communities: Homes for All: Cm 6424 [online]. [cit: 17.9.2014] ODPM. Available at: http://www.westminsteronline.org/housingcommission/downloads/FiveYearStrategyODPM.pdf

OLIVER, L., FERBER, U., GRIMSKI, D., MILLAR, K., NATHANAIL, P. (2005): The scale and nature of European brownfields. In: CABERNET 2005 – International Conference on Managing Urban Land LQM Ltd, Nottingham, UK, Belfast, Northern Ireland, UK [online]. [cit: 17.9.2014] Available at: http://www.cabernet.org.uk/resourcefs/417.pdf

PÄRN, J., HERGAUK M., ŐUN, M. (2006): Vőőrväed Eestis 20. sajandi lőpukümnendeil [Foreign troops in Estonia in 20th century's last decades]. Tallinn: Sentinel. 116 pp.

RALL, E. L., HAASE, D. (2011): Creative intervention in a dynamic city: A sustainability assessment of an interim use strategy for brownfields in Leipzig, Germany. Landscape and Urban Planning, Vol. 100, No. 3, p. 189–201.

ROOSE, A., KULL, A., GAUK, M., TALI T. (2013): Land use policy shock in the post-communist urban fringe: A case study of Estonia. Land Use Policy, Vol. 30, No. 1, p. 76–83.

SCHETKE, S., HAASE, D. (2008): Multi-criteria Assessment of Socio-environmental Aspects in Shrinking Cities – Experiences from Eastern Germany. Environmental Impact Assessment Review, Vol. 28, No. 7, p. 483–503.

SUSILAWATI, C., THOMAS, K. (2012): Perception of brownfield sites: Myth or reality? Remediation Australia, Vol. 11, p. 34–37.

TARTU LINNAVOLIKOGU [Tartu City Council] (2012): Tartu Linnavolikogu pressiteade 8.11.2012 [online]. [cit: 17.9.2014] Tartu linnavolikogu. Available at: http://www.tartu.ee/index.php?page_id=36&lang_id=1&menu_id=6&lotus_url=/teated.nsf/web/viited/09466917CFC32C8FC2257AB0004EAF0C?OpenDocument

THORNTON, G., FRANZ, M., EDWARDS, D., PAHLEN, G., NATHANAIL, P. (2007): The Challenge of Sustainability: Incentives for Brownfield Regeneration in Europe. Environmental science & policy, Vol. 10, p. 116–134.

WHITNEY, H. (2003): Cities and superfund: Encouraging brownfield redevelopment. Ecology Law Quarterly, Vol. 30, p. 59–112.

WILLIAMS, K., DAIR C. (2007): A framework for assessing the sustainability of brownfield developments. Journal of Environmental Planning and Management, Vol. 50, No. 1, p. 23–40.

Authors' addresses:

Jiří TINTĚRA, e-mail: *jiri.tintera@ttu.ee*
Aime RUUS, Ph.D., e-mail: *aime.ruus@ttu.ee*
Epi TOHVRI, Ph.D., e-mail: *epi.tohvri@ttu.ee*
Tallinn University of Technology (Tartu College)
Puiestee 78, 51008 Tartu, Estonia

Zenia KOTVAL, Ph.D.
AICP, Michigan State University
East Lansing, MI 48824, USA
e-mail: *kotval@msu.edu*

Initial submission 1 October 2013, **final acceptance** 2 October 2014

Please cite this article as:

TINTĚRA, J., RUUS, A., TOHVRI, E., KOTVAL, Z. (2014): Urban brownfields in Estonia: scope, consequences and redevelopment barriers as perceived by local governments. Moravian Geographical Reports, Vol. 22, No. 4, p. 25–38. DOI: 10.1515/mgr-2014-0021.

THE LONG-TERM DEVELOPMENT OF WATER BODIES IN THE CONTEXT OF LAND USE: THE CASE OF THE KYJOVKA AND TRKMANKA RIVER BASINS (CZECH REPUBLIC)

Marek HAVLÍČEK, Renata PAVELKOVÁ, Jindřich FRAJER, Hana SKOKANOVÁ

Abstract

The long-term development of water bodies is investigated in this article using the cases of two river basins with similar natural conditions: the Kyjovka and Trkmanka River Basins in the Czech Republic. Using old topographic maps, land use development was assessed and the analysis of driving forces of land use changes was carried out. The essential land use changes in these areas are connected with the processes of agricultural intensification and urbanisation. The largest area of water bodies was recorded in both river basins in 1763. In the second half of the 19th century, the disappearance of most water bodies in the two basins was significantly affected by the above-mentioned driving forces. After World War II, some of the water bodies in the Kyjovka River Basin were restored and new ponds were established. In contrast, no significant water bodies were restored in the Trkmanka River Basin.

Shrnutí

Dlouhodobý vývoj vodních ploch v povodí Kyjovky a Trkmanky v kontextu využití krajiny (Česká republika)

Tato studie zkoumá dlouhodobý vývoj vodních ploch na příkladu dvou povodí s podobnými přírodními podmínkami (Povodí Kyjovky a povodí Trkmanky v České republice). S využitím starých topografických map byl vyhodnocen vývoj využití krajiny a proveden rozbor hybných sil změn využití krajiny. Zásadní změny využití krajiny jsou v tomto území spojeny s procesy zemědělské intenzifikace a urbanizace. Nejvyšší výměra vodních ploch byla zaznamenána v obou povodích v roce 1763. V druhé polovině 19. století se významně projevily zásadní hybné síly vedoucí k zániku většiny vodních ploch v obou povodích. Po druhé světové válce došlo k obnově některých vodních ploch v povodí Kyjovky, zároveň byly zakládány i nové rybníky. Naopak v povodí Trkmanky nebyly obnoveny žádné významné vodní plochy.

***Key words:** water body, fishpond system, land use, Kyjovka and Trkmanka River Basins, Czech Republic*

1. Introduction

The historical development of water bodies is an important indicator of the overall development of land and, therefore, is generally perceived as part of long-term land use studies. Land use development is of considerable significance for understanding existing as well as historical links and relations in the landscape. Studying the driving forces of land use changes allows researchers to evaluate impacts of the activities of society on the historical and present landscape structure (Bičík et al., 2001; Hersperger and Bürgi, 2009; Havlíček and Chrudina, 2013).

One of the fundamental prerequisites for evaluating long-term land use and the development of water bodies in an integrated river basin is the study of old topographic maps, preferably at a medium scale (Palang et al., 1998; Haase et al., 2007; Swetnam, 2007; Van Eetvelde and Antrop, 2009; Mackovčin, 2009; Skaloš et al., 2011; Demek et al., 2011; Skokanová et al., 2012; Havlíček et al., 2012; Mojses and Petrovič, 2013). When evaluating the development of water bodies and driving forces of land use changes, it is extremely appropriate to combine old topographic maps with historical data sources and available regional literature (Demek et al., 2011; Havlíček and Chrudina, 2013). The long-term development of water bodies was studied on the basis of old topographic maps in several European countries – e.g. in Poland (Pieńkowski, 2003), France (Passy et al., 2012) and Great Britain (Wood and Barker, 2000). Water bodies, however, are often addressed in the context of overall land use (Haase et al., 2007; Swetnam, 2007; Skaloš et al., 2011; Demek et al., 2011). In the Czech Republic, the long-term development of water bodies has been evaluated in research published by Pavelková Chmelová et al. (2012), Frajer et al. (2013) and Havlíček et al. (2013b).

Topographic maps at a medium scale (from 1:10 000 to 1:100 000) make it possible to study relatively accurate changes in Central European landscapes from the mid 19th century. The oldest usable map sets in the territory of the Czech Republic are topographic maps of the 1st and 2nd Austrian Military Surveys (1836–1852, 1876–1880). The usability of the maps from the 1st Austrian Military Survey for detailed analyses of land use changes is limited by their insufficient planimetric accuracy (Brůna et al., 2002; Mackovčin, 2009). Yet, it is possible to use these maps for a provisional identification of the development of some land use categories. They are very valuable for the development of water bodies (Demek et al., 2011; Havlíček et al., 2013b). The first studies on the development of water bodies in South Moravia worked also with older maps, e.g. Müller's map of Moravia from 1716 (Koláček, 1930).

In the Czech Republic, small water reservoirs have a significant historical tradition. This tradition links particularly with fish farming and pond construction (Pavelková Chmelová et al., 2012). Pond construction was closely connected with the activities of religious orders and the use of fish as a fasting meal. Systematic construction of ponds by religious orders dates back to the 11th and 12th centuries Urbánek, 2012). The greatest boom of fish farming took place in the Czech Lands in the 15th and 16th centuries, in conjunction with the boom of the economically profitable fish breeding managed by distinguished noble families. Available historical sources, however, enable a more or less accurate mapping of fishpond systems and ponds only from the end of the 18th century and the mid-19th century.

This study investigates the development of water bodies since 1763 until the present, including the analysis of land use development and driving forces of land use changes, using the cases of the Kyjovka and Trkmanka River Basins. The aim is to find out whether a similar development of water bodies and similar processes of land use change took place in these two river basins, given their similar natural conditions.

The historical development of fishpond systems in the Kyjovka and Trkmanka River Basins was researched especially by Hurt (Hurt, 1954; Hurt et al., 1970); water bodies in parts of the Kyjovka and Trkmanka River Basins were also studied in other papers (Koláček, 1930; Hlavinka and Noháč, 1926).

Long-term land use has been studied in different parts of the Kyjovka River Basin, for instance in research focusing on the development of land use in the Hodonín District (Havlíček et al., 2012), in the Dolnomoravský Úval Graben (Demek et al., 2009), in the South-Moravian grabens and river floodplains (Demek et al., 2011), and in the upper part of the Kyjovka River Basin. The land use in the entire Trkmanka River Basin was studied by Kilianová et al. (2008). A more detailed evaluation of the development of water bodies based on the study of old topographic maps was part of a monograph focusing on ecotones in the landscape of the Trkmanka River Basin (Kilianová et al., 2009).

2. Study area

The Kyjovka River Basin is located in south-eastern Moravia (Fig. 1). It is a river basin of order IV according to Gravelius. Its total area is 678.28 km^2. The Kyjovka R. is a left-bank tributary of the Dyje River and originates in the Chřiby Highland at an elevation of 518 m a.s.l., close to the highest elevation of Bradlo (578.5 m a.s.l.). The Kyjovka River flows through the Chřiby Highland, then through the Kyjovská Pahorkatina Hilly Land and enters the Dyje River in the Dolnomoravský Úval Graben at an elevation of 152 m a.s.l.

The Trkmanka River Basin borders on the Kyjovka River Basin (Fig. 1). It is a river basin of order IV according to Gravelius. The total area of the Trkmanka River Basin is 363.26 km^2. The source of the Trkmanka River lies at an elevation of 249 m a.s.l. below the elevation of Radlovec (426.0 m a.s.l.) in the Ždánický les Highland. The highest point of the entire river basin is the highest peak of the Ždánický les Highland – U Slepice (437.4 m a.s.l.). The lowest point of the Trkmanka River Basin is the confluence

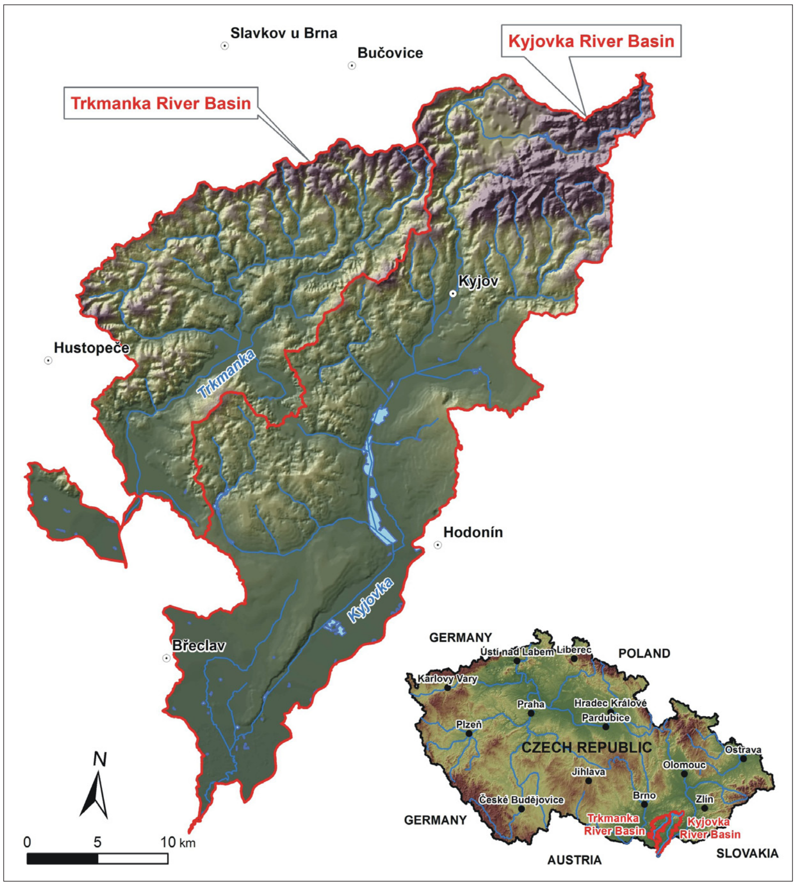

Fig. 1: The study area of the Kyjovka and Trkmanka River Basins, marking the current water bodies and watercourses; location of the study area in the Czech Republic (right down)
Source: The Silva Tarouca Research Institute for Landscape and Ornamental Gardening, v. v. i.; the geographic base data of the Czech Republic (ZABAGED®)

with the Dyje River at an elevation of 152 m a.s.l. The Trkmanka River Basin has an asymmetrical shape; right-bank tributaries are more significant and longer.

The relief of both river basins shows some similar features – approximately 83% of the area in the Kyjovka River Basin and approximately 84% of the area in the Trkmanka River Basin are located at elevations up to 299.9 m a.s.l. (see Fig. 2 – cover p. 4). The difference, however, is in a notably higher proportion of the area with an elevation below 200 m a.s.l. in the Kyjovka River Basin (Tab. 1). In the Kyjovka River Basin, there is a higher proportion of flat area with a slope of 0–1.9 °, which is ideal for the construction of ponds and fishpond systems (Tab. 2). By contrast, the Trkmanka River Basin is characterised by a higher proportion of steeper slopes.

Rocks of the Flysch Belt of the Western Carpathians and Miocene sediments of the Vienna Basin and the Carpathian Foredeep can be found in the Kyjovka and Trkmanka River Basins. The Quaternary sediments in the Kyjovka and Trkmanka River Basins are represented by loess and loess loam, aeolian sands and floodplain sediments (Hrnčiarová et al., 2009).

Average annual air temperature in the two river basins ranges between 7 °C in spring areas and 9 °C in the lower parts of the river basins (Hrnčiarová, et al., 2009). Average annual precipitation in the source area of the Kyjovská pahorkatina Hilly Land reaches up to 650 mm and in the source area of the Trkmanka River up to 550 mm. Most areas of both river basins, however, feature an average annual precipitation between 450 and 500 mm. The Kyjovka and Trkmanka River Basins therefore are parts of the warmest and driest areas of the Czech Republic. They are in essence highly comparable.

3. Materials and methods

The historical development of water bodies and land use changes were analysed from layers of spatial objects created by vectorisation of old maps in the GIS software ArcGIS. For studying land use changes and the development of water bodies, a total of five map sets was used:

Category of elevation (m a.s.l.)	Kyjovka River Basin	Trkmanka River Basin
up to 199.9	43.99	27.09
200.0 – 299.9	38.92	56.52
300.0 – 399.9	10.91	15.56
more than 400.0	6.19	0.83

Tab. 1: Proportions of elevation categories in the Kyjovka and Trkmanka River Basins (%)

Category of slope angle (°)	Kyjovka River Basin	Trkmanka River Basin
0–1.9	54.98	28.79
2.0–4.9	17.63	21.58
5.0–9.9	18.72	33.05
10.0–14.9	8.38	16.35
15.0–24.9	0.28	0.22
25.0 and more	0.01	0.01

Tab. 2: Proportions of slope categories in the Kyjovka and Trkmanka River Basins (%)

- 2nd Austrian Military Survey on a scale 1:28 800 (1836–1841) – source: Austrian State Archive/Military Archive, Vienna; Geoinformatics Laboratory, J. E. Purkyně University, Ústí nad Labem;
- 3rd Austrian Military Survey on a scale 1:25 000 (1876) – source: Map Collection, Faculty of Science, Charles University in Prague; Silva Tarouca Research Institute for Landscape and Ornamental Gardening;
- Czechoslovak military topographic maps on a scale 1:25 000 (1953–1955) – source: Department of Military Geography and Meteorology, University of Defence, Brno; Silva Tarouca Research Institute for Landscape and Ornamental Gardening;
- Czechoslovak military topographic maps on a scale 1:25 000 (1991) – source: Military Geography and Hydrometeorology Office, Dobruška; Silva Tarouca Research Institute for Landscape and Ornamental Gardening; and
- Czech base maps on a scale 1:10 000 (2010) – source: digital vector model ZABAGED (already rectified), Czech Office for Surveying, Mapping and Cadastre.

Maps from the first four periods were originally in analogue format. They were scanned using a large-format scanner at a resolution of 400 dpi. They were subsequently transformed into the S-JTSK (System of Unified Czech/Slovak Trigonometrical Cadastral Net) co-ordinate system and mosaiced. For the transformation, pre-defined global transformation keys and non-residual Jungman transformation (Skokanová et al., 2012), as well as control points (minimum 4, average 8–14) and polynomial transformations of the first order were used. Maps from the 2nd and 3rd Austrian Military Survey were geo-referenced at a planimetric accuracy of 13–30 m. The geo-referencing of maps from the Czechoslovak and Czech military mapping in the periods 1953–1955 and 1991 was carried out in the programme ArcGIS, version 9.x, using the control points, and the mean planimetric accuracy was 10–15 m (Mackovčin, 2009).

Maps from the 1st Austrian Military Survey at a scale 1:28 800 (1763) represented a supplementary map set used for the assessment of the development of water bodies in the Kyjovka and Trkmanka River Basins. This map set enables the identification of the approximate values of the surface areas of individual water bodies and the approximate location of these water bodies, using the present relief and suitable areas for surface water accumulation. The methodology of the Silva Tarouca Research Institute for Landscape and Ornamental Gardening, v. v. i. (Mackovčin, 2009; Skokanová, 2009) was used for data preparation and subsequent analyses. This methodology distinguishes nine basic land use categories: 1 – arable land; 2 – permanent grassland; 3 – orchard; 4 – vineyard and hop-field; 5 – forest; 6 – water area; 7 – built-up area; 8 – recreational area; and 0 – other area.

Vector data derived from the old topographic maps were overlaid in GIS. As a result, a GIS database for further analyses was created. This database, however, had to be first adjusted by overlaying the vector data as sliver polygons were produced. The sliver polygons were eliminated with the use of the ArcGIS software according to its predefined criteria (area smaller than 5,000 m and width less than 10 m). These criteria were chosen based on a series of tests conducted at the authors' workplace (Skokanová, 2009).

Maps of land use change processes were created by comparing the land use change between two adjacent time periods. In total, nine types of processes were distinguished: transition into arable land; transition into permanent grassland; transition into orchard; transition into forest; transition into water area; transition into built-up area; transition into recreational area; transition into other area; and, areas under stable land use (Skokanová et al, 2012). For evaluating changes in water area, types of land use change were studied, comprising a combination of the land use categories from all five periods. These types were defined by five-digit codes, which corresponded to the number of used map sets. Each digit in the code is a land use record for each study period. With respect to the subject of this study, attention was focused on codes with the occurrence of digit 6 (water area), and their digit combinations in the overall type of land use changes.

4. Results and Discussion

4.1 Development of water bodies in the Kyjovka River basin and the Trkmanka River Basin

Using the maps from 1763, 55 water bodies with a total area of 1,256 ha were identified in the Kyjovka River Basin (Tab. 3). In particular, the Nesyt Pond with an approximate area of 262 ha was among the largest water bodies in this basin. According to Koláček (1930), its area was 562 ha. The figure can be considered as overestimated with respect to the accuracy of Müller's Map of Moravia from 1716. The Nesyt Pond was also considered as one of the largest water bodies in Moravia by other authors (Hlavinka and Noháč, 1926), who state that the Nesyt Pond was supplied both by the Kyjovka River and the Morava River. A drawing of the Nesyt Pond in the maps from the year 1763 supports the statement.

Other important ponds from 1763 included the Mistřínský rybník Pond (209 ha), the Jarohněvický rybník Pond (156 ha), the Písečný rybník Pond (143 ha), the Brodský rybník Pond (115 ha), and the Svatobořický rybník Pond (76 ha). All these ponds were located directly on the Kyjovka River and in its immediate vicinity. At the same time, there were also fishpond systems on the Kyjovka River tributaries. A significant number of these ponds in this period were bound to watermills, because they partly served as their retention basins (Hurt, 1970). There were also natural small lakes existing near the villages of Vracov and Vacenovice. Originally, these natural lakes were larger but gradually became silted up (Břízová, 2001).

In the maps from the years 1836–1841, 41 water bodies with a total area of 508 ha were identified (Tab. 3). The number of water bodies decreased very significantly in contrast to the previous period; the Nesyt Pond, the Mistřínský rybník Pond, the Svatobořický rybník Pond and many smaller ponds both on the Kyjovka River and its tributaries disappeared. The Písečný rybník Pond – Sand Teich (264 ha) and the Jarohněvický rybník Pond (117 ha) can be mentioned as examples of the largest ponds preserved to the present.

Year	Number of water bodies	Number of water bodies larger than 1 ha	Total area in ha
1763	55	46	1256
1836–1841	41	18	508
1876	61	11	71
1953–1955	69	34	439
1991	94	69	712
2010	284	80	723

Tab. 3: The number and area (ha) of water bodies in the Kyjovka River Basin

Maps from the year 1876 indicate a fish-farming decline. Although 61 water bodies were identified in that period, only 11 of them were larger than one hectare (Tab. 3) and the total area of all water bodies was only 71 ha. A significant decrease of water bodies was also recorded in other parts of South Moravia in that period (Demek et al., 2009, 2011; Havlíček et al., 2012; Kilianová, 2008). The largest pond in the basin was the Písečný rybník Pond (20 ha) near Milotice: its important compositional function within the wider settings of the Milotice Castle park prevented the conversion of this water body into arable land. The high number of small water bodies was represented by small ponds in villages (used as fire protection reservoirs), by smaller reservoirs near industrial premises, by anthropogenic reservoirs resulting from lignite mining at small depths below the surface, and by natural lakes in the area of Aeolian sands.

The disappearance of most fishpond systems in the second half of the 19th century resulted principally from the development of the sugar industry and lignite mining in this region (Havlíček et al., 2012, 2013a). There were 13 sugar factories operating in the basin and its surroundings (Gebler et al., 2007). Moreover, these predominant driving forces were intensified by a growing demand of the industry for technical crops. Owners of large estates responded to the trend by a large-scale drainage of ponds – to increase the area of arable land (Hurt, 1970; Havlíček et al., 2013a; Demek et al., 2009).

Maps from the years 1953–1955 show a restoration of some water bodies. In this period, 69 water bodies with a total area of 439 ha were identified, 34 of them being larger than 1 ha (Tab. 3). This high number was a result of the establishment of smaller ponds for fish breeding and for poultry farming on the sites of the original Písečný rybník and Brodský (Zbrodský) rybník Ponds. The Písečný state farm was established and later converted into the Fishery Hodonín, which played a crucial role in restoring water bodies in this basin. The largest water body in this period was the fishpond system of the Písečný rybník Pond in the surroundings of Hodonín (180 ha), consisting of seven ponds. The second largest water body was the Jarohněvický rybník Pond (104 ha) and the fishpond system of the Brodský rybník Pond (86 ha) with 11 fish-breeding ponds. Neither the Nesyt Pond near Hodonín, the former largest pond in the study basin, nor the Mistřínský rybník Pond, or the majority of ponds on the Prušánka Creek (a right tributary of the Kyjovka R.), were restored (Demek et al., 2009; Havlíček et al., 2012).

In 1991, 94 water bodies with a total area of 712 ha were identified (Tab. 3). In addition to the further development of water bodies intended for fish breeding and water poultry farming, new reservoirs were established in the second half of the 20th century and were used as drinking water sources (water reservoir Koryčany – 34 ha) or for irrigation (Velký Bílovec – 38 ha). The largest water bodies again included the fishpond systems of the Písečný rybník Pond near Hodonín (237 ha), the Brodský rybník Pond (105 ha) and the Jarohněvický rybník Pond (104 ha – see Fig. 3, cover p. 4). Water bodies formed after sand extraction, e.g. near Moravská Nová Ves (67 ha), became notable too.

Current base maps (2010) show that 284 water bodies with a total area of 723 ha occur in the Kyjovka River Basin (Tab. 3). This high number mainly results from the different scale of these maps (1:10 000). The number of water bodies larger than 1 ha (80 bodies), however, is comparable with the previous period. The fishpond system on the Kyjovka River represented again one the largest water bodies. In contrast with the year 1991, the most significant change was the construction of the Třetí Zbrod Pond (32 ha), which is part of the fishpond system of the Zbrodský rybník Pond near Mutěnice. Flood prevention measures partly increased the number of water bodies in this period. The construction of new water bodies based on the identification of old ones from the old maps was not common. Therefore, water bodies were constructed at places with no previous occurrence of ponds. In some localities of the former ponds (e.g. on the Prušánka Creek), natural processes caused the development of temporary or even permanent wetlands.

In 1763, 57 water bodies were identified in the Trkmanka River Basin, with a total area of 996 ha (Tab. 4). Compared to the maps of the Kyjovka River Basin, the drawings of significant water bodies in the Trkmanka River Basin are inaccurate. The largest water bodies on the maps are the Schön Sthras Pond in the Násedlovice surroundings (109 ha), a water body in the surroundings of Velké Pavlovice and Bořetice (101 ha), and the Kobylské jezero Lake (99 ha). All of these water bodies were adjacent to the Trkmanka River.

The most questionable is the delineation of the two originally largest water bodies in this basin. While the topographically inaccurate map from 1763 shows the Kobylské jezero Lake as very narrow and long-shaped and only 99 ha in area, a much more accurate map from 1836 indicates its area to be 414 ha. A similar discrepancy was also found in the case of the Čejčské jezero Lake, which was strongly undersized (32 ha) in 1763, whereas in 1836 it reached 114 ha, being the second largest water body in the Trkmanka River Basin in this period. The total area of water bodies in 1763 could therefore range from 1,100 to 1,300 ha.

In total, 730 ha of water bodies were still recorded in 1836–1841 but the number of water bodies decreased by more than one half (Tab. 4).

As in the case of the Kyjovka River Basin, a crucial decline of water bodies occurred between 1836–1841 and 1876 in the Trkmanka River Basin (Tab. 4). Efforts to extend arable land for growing technical crops, including sugar beet, can also be considered as predominant driving forces in this basin. In total, seven sugar factories were operating

Year	Number of water bodies	Number of water bodies larger than 1 ha	Total area in ha
1763	57	53	996
1836–1841	27	23	730
1876	36	10	50
1953–1955	23	11	28
1991	27	15	38
2010	103	22	75

Tab. 4: The number and area of water bodies in the Trkmanka River Basin

in the region and its close vicinity (Gebler et al., 2007). The occurrence of two large lakes – the Kobylské jezero and the Čejčské jezero Lakes – was a unique feature. These natural lakes were formed in the Late Glacial and Holocene. Their formation is connected with the tectonic activation of cross faults in this region (Břízová, 2002). Drainage works of the Kobylské jezero Lake started in 1834 and the Čejčské jezero Lake was drained during 1857–1858. The latter drainage is directly connected with the development of lignite mining at the edge of the lake, and with a rising demand for new arable land needed for sugar beet growing (Havlíček et al., 2013a).

During 1953–1955, only 28 ha of water bodies were documented and the number and total area of water bodies did not significantly increase in later periods (Tab. 4). In contrast to the Kyjovka River Basin, there was no important enterprise engaged in fish breeding. This could be explained by different natural conditions in the Trkmanka River Basin: e.g. by the lower proportion of flat plains and by a consequent pressure to use these areas as arable land.

The high number of water bodies in 2010 was a result of different map scales (Tab. 4). In contrast to the Kyjovka River Basin, a positive trend was observed in the development of water bodies as a slight increase in the number was recorded for water bodies over 1 ha. Here, flood prevention and water retention measures contributed to the increased number of water bodies. The new water bodies are situated primarily in localities with occurrence of previous ones; however, their size is significantly smaller.

4.2 Land use development in the Kyjovka and Trkmanka River Basins

Long-term land use development was evaluated based on five land use maps from 1836–1841, 1876, 1953–1955, 1991 and 2002–2006. Arable land dominated in all of these periods (Figs. 4 and 5). The steepest decline was found in the category of permanent grassland (Figs. 4 and 5). Most of the permanent grassland areas disappeared in both study basins and their last remnants are often subject to nature conservation. In contrast, orchards gradually increased their proportion. They were mostly planted on the slopes around villages in the Kyjovská pahorkatina Hilly Land, often on new large-scale terraces. Vineyards reached their maximum in 1991, mainly as a result of large-scale farming in this region. The proportion of forests was slowly increasing both in the Kyjovka River Floodplain and in the Chřiby and Ždánický les Highlands (Figs. 4 and 5). The specific development in the water area was described in detail previously. In the Kyjovka River Basin, recreational areas are located mainly at the edges of forested slopes of the Chřiby Highland and in the surroundings of the town of Kyjov; in the Trkmanka River Basin, they can be found only sporadically.

Similar results in land use development were also recorded in other studies dealing with adjacent areas. A very significant decline of permanent grassland was found, for example, in the Dolnomoravský úval Graben (Demek et al., 2009), in the Hodonín district (Havlíček et al., 2012), and in the Trkmanka River Basin (Kilianová et al., 2008). A gradual growth of areas covered by forests was documented both in the regional studies of the surrounding areas (Demek et al., 2011; Skokanová et al., 2012; Havlíček et al., 2012; Mackovčin et al., 2012), and in studies covering the whole Czech Republic (Bičík et al., 2001; Štych, 2011). Changes in vineyards and orchards correspond with results of studies from the Hodonín District (Havlíček et al., 2012).

4.3 Processes of land use change and driving forces in the Kyjovka and Trkmanka River Basins

The dominant land use change processes in the Kyjovka and Trkmanka River Basins between 1836–1841 and 1876 included the transition into arable land that occurred on 15.3% and 9.9% of the study areas, respectively (Fig. 6). These processes were concentrated mainly in the close vicinity of the Kyjovka and Trkmanka Rivers and other water streams. In most cases, they occurred at the expense of permanent grassland and water areas or were part of the usual crop rotation (arable land – vineyard – orchard). In the Kyjovka River Basin, the transition into forest (2.0%) as well as into permanent grassland (1.6%)

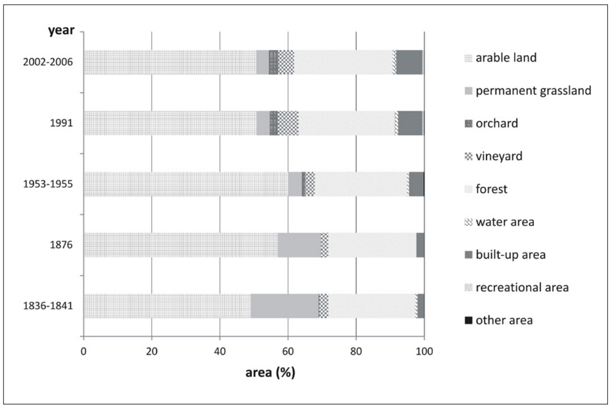

Fig. 4: Land use development in the Kyjovka River Basin: 1836–2006 (%)

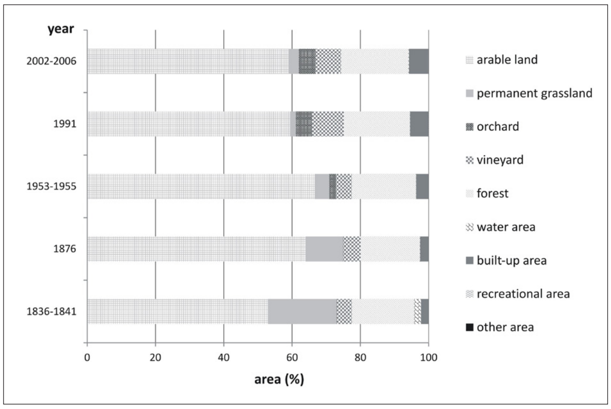

Fig. 5: Land use development in the Trkmanka River Basin: 1836–2006 (%)

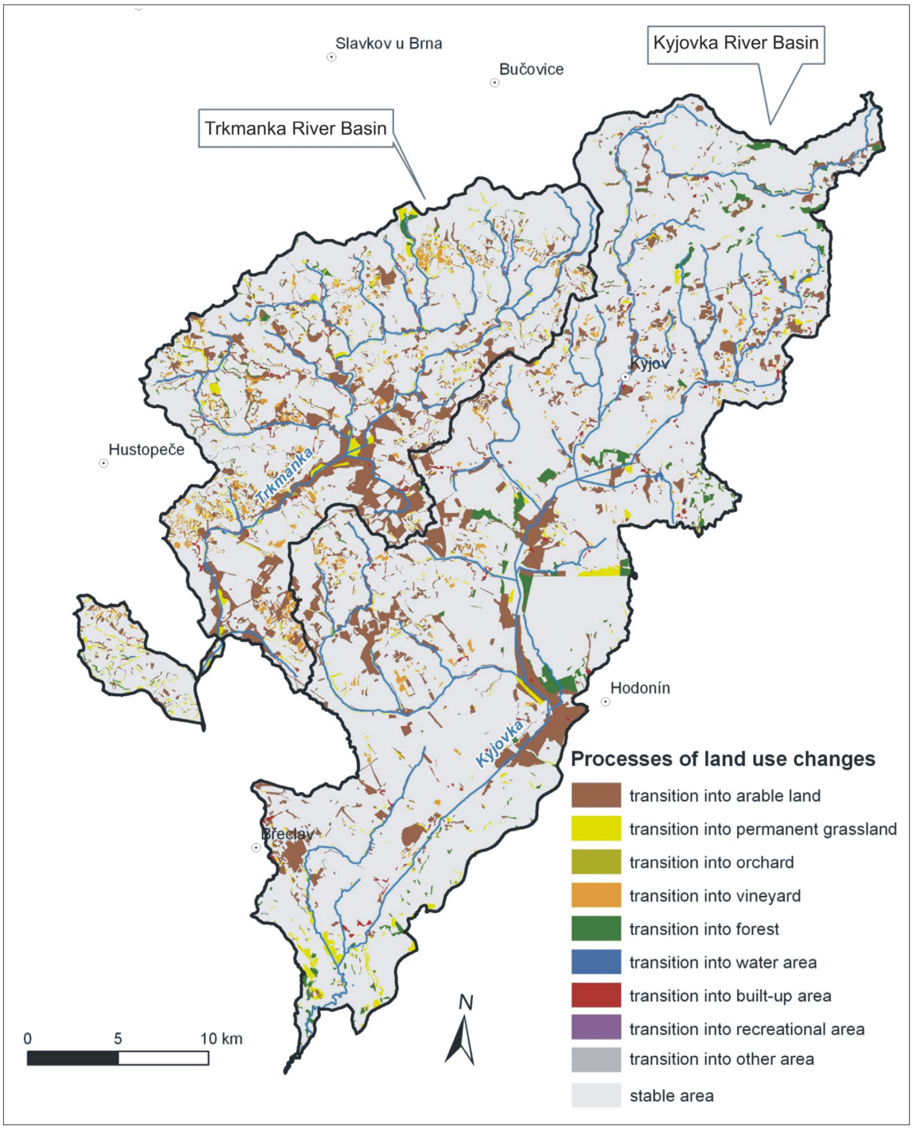

Fig. 6: Processes of land use change in the Kyjovka and Trkmanka River Basins between 1836–1841 and 1876
Source: The Silva Tarouca Research Institute for Landscape and Ornamental Gardening, v. v. i.

was also significant, whereas the transition into permanent grassland (2.7%) and vineyards (2.4%) dominated in the Trkmanka River Basin. The principal driving forces of land use change between these two periods were related to the agrarian revolution leading to a higher consumption of food and to changes in animal farming (Bičík et al., 2001). The strong effect of sugar industry development was also significant in the region (Havlíček et al., 2012).

Between 1876 and 1953–1955, dominant processes in the two river basins were again the transition into arable land (8.5% of the Kyjovka River Basin and 8.2% of the Trkmanka River Basin), mainly due to the ploughing of permanent grassland and partly as a result of the already-mentioned rotation (Fig. 7). Other significant processes in the Kyjovka River Basin included the transition into forest (2.4%), built-up areas (2.0%) and vineyards (1.7%). A significant proportion of newly-created water bodies in this basin (1.0%) should also be mentioned, with more details described above. Other significant processes in the Trkmanka River Basin included the transition into vineyards (2.2%), orchards (1.9%) and forest (1.7%). The conversion to socialist large-scale farming (Bičík et al., 2001) and the development of industrial and residential complexes due to industrialisation and urbanisation, can be considered as generally applicable driving forces between 1876 and 1953–1955. The economic activity of the Fishery Hodonín, leading to a restoration of water bodies on the Kyjovka River, can be considered as a special driving force affecting land use change processes between these two periods.

The land use change processes in the Kyjovka and Trkmanka River Basins between 1953–1955 and 1991 were much different from the previous periods (Fig. 8). In both basins, the transition into vineyards predominated (4.5% and 6.1%, respectively), resulting especially from newly-planted large-scale vineyards during the period of socialist agriculture. The second most significant process was the transition into arable land (3.0% and 5.4%, respectively). This was followed by the transition into built-up areas (2.9%) in the Kyjovka River Basin and by the transition into orchards in the Trkmanka River Basin. The processes of agriculture intensification or urbanisation therefore continued in both river basins.

The notably lower proportions of changed areas between 1991 and 2002–2006 are influenced by the shorter interval in comparison with the previous periods (Fig. 9). Particularly the transition of vineyards and orchards into arable land predominated (3.9% in both basins). Processes of transition into permanent grassland, orchards and vineyards occurred on an area larger than 1% as well. Driving forces

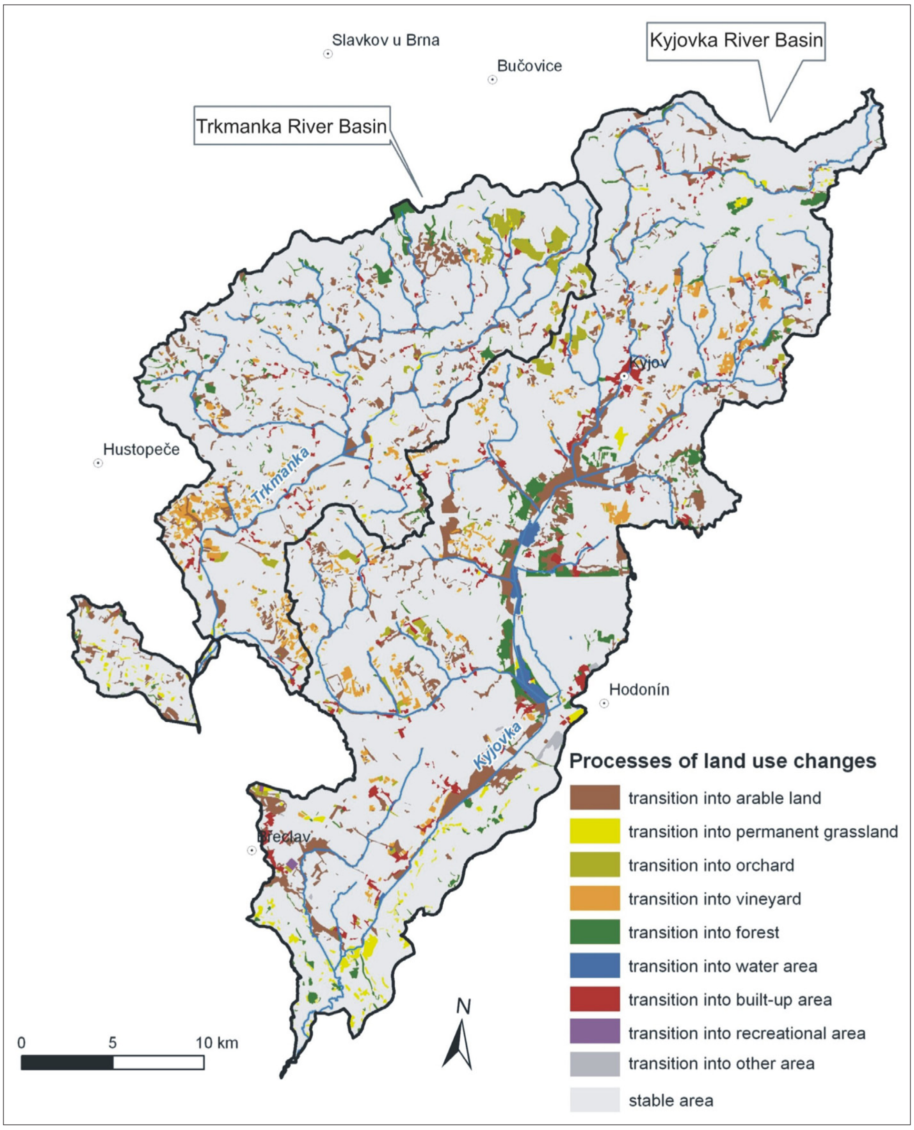

Fig. 7: Processes of land use change in the Kyjovka and Trkmanka River Basins between 1876 and 1953–1955
Source: The Silva Tarouca Research Institute for Landscape and Ornamental Gardening, v. v. i.

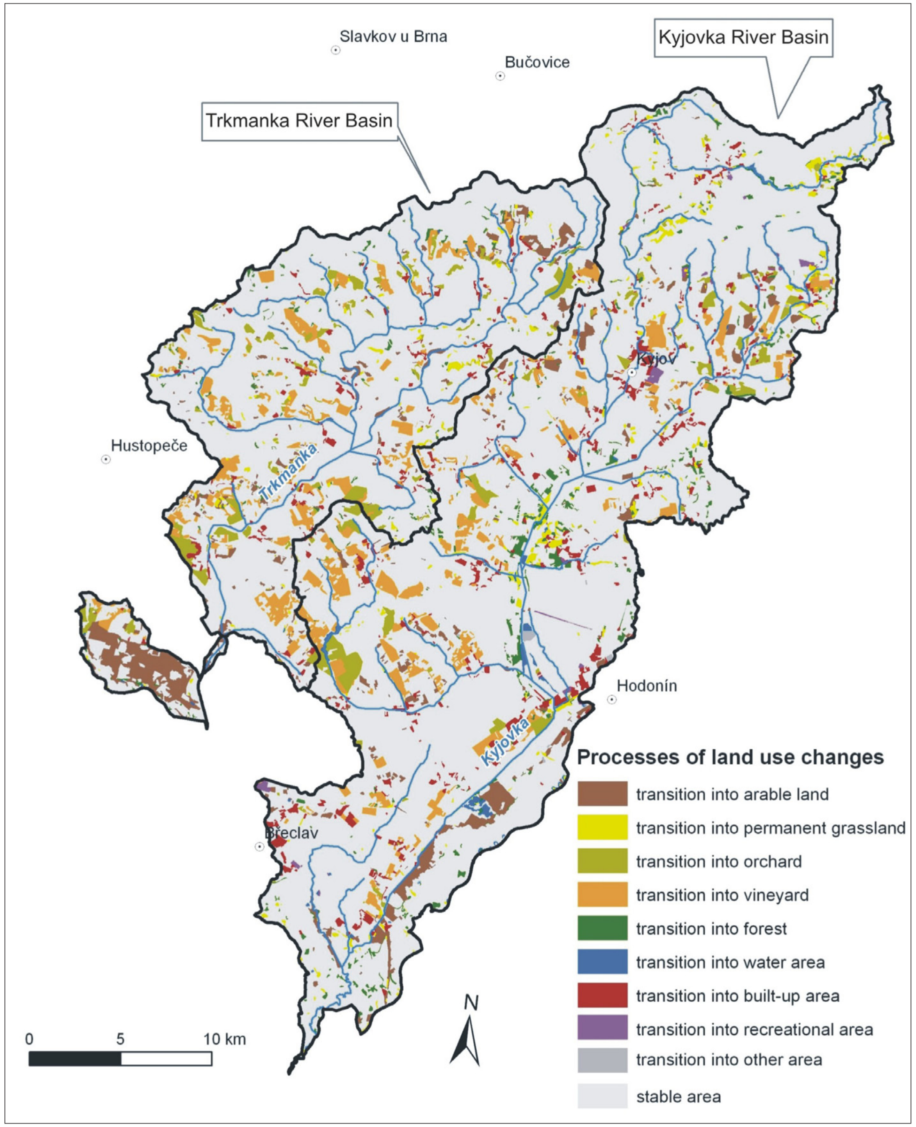

Fig. 8: Processes of land use change in the Kyjovka and Trkmanka River Basins between 1953–1955 and 1991. Source: The Silva Tarouca Research Institute for Landscape and Ornamental Gardening, v. v. i.

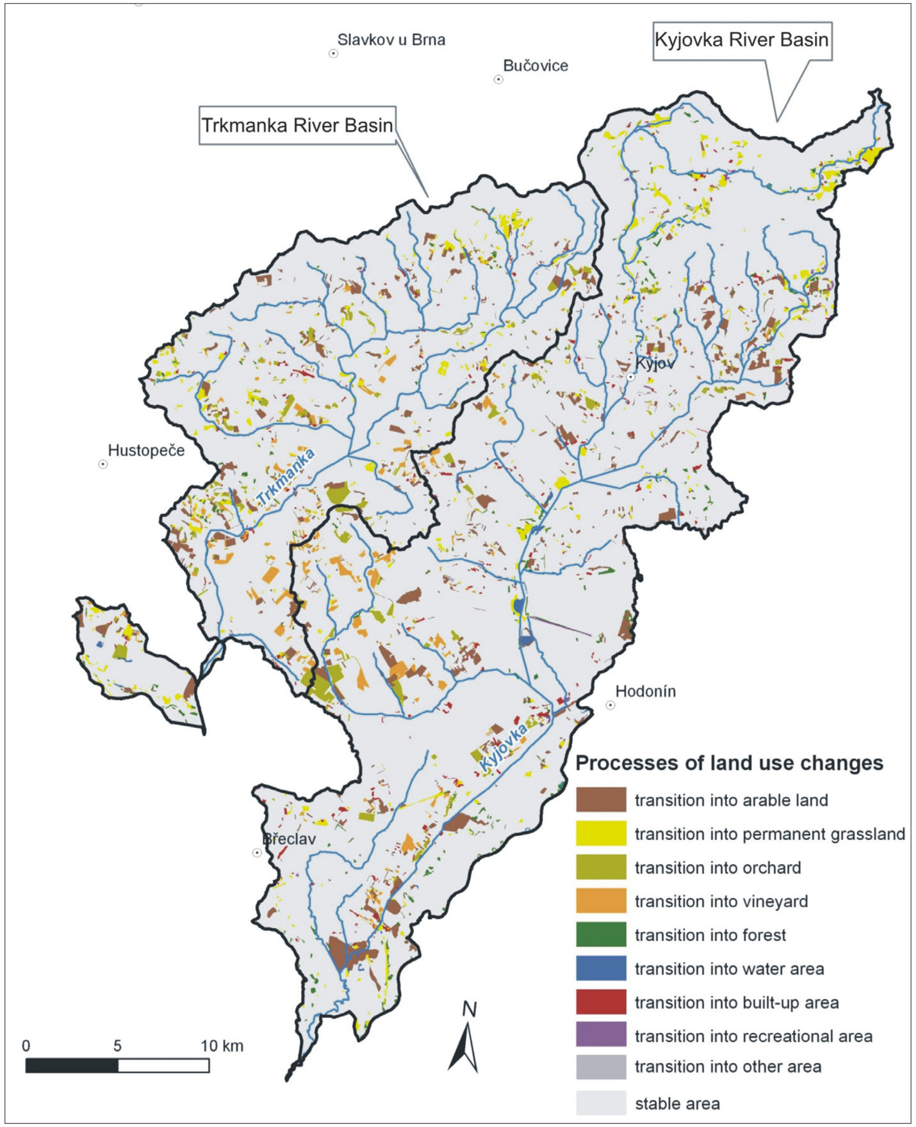

Fig. 9: Processes of land use change in the Kyjovka and Trkmanka River Basins between 1991 and 2002–2006. Source: The Silva Tarouca Research Institute for Landscape and Ornamental Gardening, v. v. i.

leading to the decline of some agricultural areas predominantly included agricultural transformation, transition to the market economy and restitution of agricultural land (Bičík et al., 2001). The restoration of permanent grassland was also caused by changes in agriculture and by the subsidised conversion of arable land into meadows and pastures in less favourable agricultural regions (in this case mainly in the Chřiby and Ždánický les Highlands).

4.4 Types of land use change in water bodies

This overview of the types of land use change clearly documents fundamental differences in the development of water bodies in the Kyjovka and Trkmanka River Basins (Tab. 5). In the Kyjovka River Basin, the type 61666 predominated, i.e. the disappearance of water bodies between 1836–1841 and 1876 and their restoration in the following period (1953–1955). This relates to the restoration of the fishpond system on the Kyjovka River indicated above. A large area of newly-created water bodies was formed from the original permanent grasslands (types 22666 and 22266). Restoration of fishpond systems in this basin is also documented by the high proportion of restored water bodies – see types 61666, 62666, 61166, 61266 and 61566. On the other hand, the very low proportion of water bodies steadily used is rather surprising (type 66666). Only three ponds were documented on all five map sets in the Kyjovka River Basin – the Milotický rybník Pond, the Hovoranský rybník Pond and the Žižkovský rybník Pond.

Types of land use change leading to the disappearance of water bodies without their restoration predominated in the Trkmanka River Basin. The most frequent type of land use change was their direct conversion into arable land (types 61111 and 66111) or their gradual transition through permanent grassland into arable land (types 62111 and 62211). Types of land use change leading to the disappearance of water bodies through their conversion into arable land and later into built-up areas (types 61117, 61177 and 61777) also occur in abundance. Water bodies steadily used (type 66666) cover only 2.5 ha in the Trkmanka River Basin, which is even less than in the Kyjovka River Basin. They are represented by a small pond in the village of Brumovice and by an oxbow lake of the Dyje River in the southern part of the basin.

4.5 Changes in the elevation of water bodies

Data about the elevation of water bodies also show interesting results and contribute to information about their spatial distribution in the two studied basins. To increase the accuracy of the comparison and analysis of the distribution of water bodies in the selected elevation intervals, only periods represented by medium-scale maps (1:28 800 and 1:25 000) were chosen.

The average elevation of water bodies in the Kyjovka River Basin showed the highest elevation at the beginning of the studied period (Tab. 6), when the water bodies were uniformly distributed across the whole basin, i.e. concurrently at the lowest, medium and highest elevations. A decline of the average elevation in the Kyjovka River Basin between 1953–1955 and 1991 was caused by the disappearance of water bodies in the higher parts of the river basin and by the construction of ponds in the lower parts.

Kyjovka River Basin		Trkmanka River Basin	
Type of land use change	Area in ha	Type of land use change	Area in ha
61666	212.8	61111	524.3
22666	84.2	62111	199.1
22266	73.6	62211	21.9
61111	42.0	66111	11.9
22166	27.9	22166	6.2
55566	25.8	22216	5.9
22226	24.6	61211	5.6
21166	23.4	61117	5.3
62666	22.9	61177	4.8
61166	21.0	61777	4.3
22126	20.6	62212	3.7
11166	16.9	26111	3.3
61266	16.8	21166	3.2
55565	14.7	61112	2.9
21666	14.6	66666	2.5
61122	13.9	61131	2.5
55506	13.1	61115	2.4
22566	12.6	67777	2.3
61566	11.0	22116	2.3
66666	9.9	22226	2.0

Tab. 5: Overview of the twenty most significant types of land use change in the Kyjovka and Trkmanka River Basins (Legend: 1 – arable land, 2 – permanent grassland, 3 – garden and orchard, 4 – vineyard and hop-field, 5 – forest, 6 – water area, 7 – built-up area, 8 – recreational area, 0 – other area)

Period	1763	1836–1841	1876	1953–1955	1991
Kyjovka River Basin	204	193	197	182	185
Trkmanka River Basin	200	199	200	189	203

Tab. 6: Average elevation of water bodies in the Kyjovka and Trkmanka River Basins (m a. s. l.)

Table 6 shows a higher average elevation of water bodies in the Trkmanka River Basin than in the Kyjovka River Basin. The lower proportion of lowlands (Tab. 1) can explain this finding. Fluctuations of the average elevation in this basin are not so strong (Tab. 6), except for the period 1953–1955, with the lowest number of water bodies in the river basin and with the preserved water bodies located in the lower part of the river basin.

The numbers of water bodies according to elevation intervals (Tabs. 7 and 8) show a crucial difference in the development of water bodies in the two basins. Restored and newly-founded ponds in the lower part of the Kyjovka River Basin (around the town of Hodonín) gradually increased the number of water bodies in the lowest parts of the basin. In the Trkmanka River Basin, the decline of water bodies in the elevation interval 190.0–209.0 m a.s.l. is very notable. This was, among other things, due to the fact that ponds with watermills concentrated in the central part of the Trkmanka River between 1763 and 1836–1841 ceased to exist, and have never been restored in later periods.

5. Conclusions

The Kyjovka and Trkmanka River Basins are typical agricultural areas of South Moravia. From the perspective of long-term land use development, it is clear that the category of permanent grassland has undergone the greatest changes. Agricultural intensification and gradual urbanisation have led to the disappearance of a majority of meadows and pastures. In both basins, the proportion of arable land, vineyard and orchard has increased. The proportion of forests, originally covering about a quarter of the Kyjovka River Basin and about a fifth of the Trkmanka River Basin, has slowly increased. The proportion of built-up areas has been increasing systematically; it has quadrupled in the Kyjovka River Basin and doubled in the Trkmanka River Basin over the period under study.

The largest area covered by water bodies in both basins was observed in 1736: 1,256 ha in the Kyjovka River Basin and 996 ha in the Trkmanka River Basin. These values are very likely overestimated due to the inaccuracy of the source map.

In the second half of the 19th century, the principal driving forces leading to the disappearance of an absolute majority of water bodies in both basins dominated. Unprofitable fish breeding, the development of the sugar industry in the region and higher demands for food and technical crops for industrial production, were the main driving forces for the disappearance. While numerous water bodies were gradually restored in the Kyjovka River Basin, their restoration in the Trkmanka River Basin was negligible. This fact might be explained by higher slopes occurring in the basin and by flat areas being predominantly used as arable land. The restoration of water bodies in the Kyjovka River Basin after World War II was connected with the development of fish farming on the Kyjovka River; some water bodies were also newly re-managed as sources for drinking water or irrigation. Some water bodies were not restored at all. In total, 723 ha of water bodies are currently present in the Kyjovka River Basin and only 75 ha in the Trkmanka River Basin. The marked decline of water bodies in the Trkmanka River Basin has led to a decrease of ecological functions and impaired the overall biodiversity in the region. By contrast, despite the predominant production function of the restored pond systems in the Kyjovka River Basin, we can see their positive ecological impact on the landscapes, such as maintaining the diversity of aquatic birds, positive impacts on microclimate, water retention, etc.

The present situation shows efforts to restore water bodies in the region as a means of flood protection and water retention, and this is also supported by individual investors, landowners and municipality authorities in the

Elevation interval (m a.s.l.)	1763	1836–1841	1876	1953–1955	1991
150.0–169.9	3	12	8	24	41
170.0–189.9	23	5	22	27	28
190.0–209.9	13	16	21	11	11
210.0–229.9	4	4	4	4	4
230.0 and more	12	4	6	3	10

Tab. 7: The number of water bodies according to elevation intervals in the Kyjovka River Basin

Elevation interval (m a.s.l.)	1763	1836–1841	1876	1953–1955	1991
150.0–169.9	1	3	3	3	4
170.0–189.9	17	8	12	12	9
190.0–209.9	20	9	4	1	4
210.0–229.9	10	2	7	4	4
230.0 and more	7	5	10	3	6

Tab. 8: The number of water bodies according to elevation intervals in the Trkmanka River Basin

region. While many ponds in the Trkmanka River Basin were restored in places of the former ponds, ponds in the Kyjovka River Basin were largely constructed in places with no former pond occurrence. Therefore, this study can contribute in the identification of the most suitable localities for the restoration of ponds.

Acknowledgement

This paper was prepared at Palacký University in Olomouc, with the support of the project QJ1220233 NAZV MZe ČR, and at the Silva Tarouca Research Institute for Landscape and Ornamental Gardening, v. v. i. (public research institution), with institutional support of VUKOZ-IP-00027073.

References:

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

BRŮNA, V., BUCHTA, I., UHLÍŘOVÁ, L. (2002): Identifikace historické sítě prvků ekologické stability krajiny na mapách vojenských mapování. In: Acta Universitatis Purkynianae – Studia Geoinformatica II., No. 81, Univerzita Jana Evangelisty Purkyně Ústí nad Labem, 46 pp.

BŘÍZOVÁ, E. (2001): Palynologický a paleoalgologický výzkum přírodní památky Jezero u Vacenovic v okrese Hodonín. Příroda, No. 19, p. 131–134.

BŘÍZOVÁ, E. (2002): Paleoekologický výzkum bývalých jihomoravských jezer. In: Kirchner, K., Roštínský, P. [eds.]: Geomorfologický sborník 1, Brno, p. 29–34.

DEMEK, J., HAVLÍČEK, M., MACKOVČIN, P. (2009): Landscape Changes in the Dyjsko-svratecký and Dolnomoravský Grabens in the period 1764–2009 (Czech Republic). Acta Pruhoniciana, No. 91, p. 23–30.

DEMEK, J., HAVLÍČEK, M., MACKOVČIN, P., SLAVÍK, P. (2011): Změny ekosystémových služeb poříčních a údolních niv v České republice jako výsledek vývoje využívání země v posledních 250 letech. Acta Pruhoniciana, No. 98, p. 47–53.

FRAJER, J., KLADIVO, P., GELETIČ, J. (2013): Reconstruction of extinct ponds using old maps, historical cadastres and the Digital Terrain Model of the Czech Republic of the 5th Generation. Acta Universitatis Palackianae Olomoucensis, Facultas Rerum Naturalium, Geographica, Vol. 44, No. 1, p. 59– 69.

GEBLER, J., MAREK, B., FRANĚK, D. (2007): Cukrovarnický průmysl na území České republiky. Historický přehled – 220 let výroby cukru: 1787–2007. Listy cukrovarnické a řepařské, Vol. 123, No. 7–8, p. 252–258.

HAASE, D., WALZ, U., NEUBERT, M., ROSENBERG, M. (2007): Changes to Central European landscapes – Analysing historical maps to approach current environmental issues, examples form Saxony, Central Germany. Land Use Policy, Vol. 24, No. 1, p. 248–263.

HAVLÍČEK, M., CHRUDINA, Z., SVOBODA, J. (2012): Vývoj využití krajiny v geomorfologických celcích okresu Hodonín. Acta Pruhoniciana, No. 100, p. 73–86.

HAVLÍČEK, M., CHRUDINA, Z. (2013): Long-term land use changes in relation to selected relief characteristics in Western Carpathians and Western Pannonian basin – case study from Hodonín District (Czech Republic). Carpathian Journal of Earth and Environmental Sciences, Vol. 8, No. 3, p. 231–244.

HAVLÍČEK, M., SVOBODA, J., DOSTÁL, I. (2013a): Vliv rozvoje cukrovarnictví v okrese Hodonín na změny využití krajiny a dopravní infrastrukturu. Listy cukrovarnické a řepařské, Vol. 129, No. 9–10, p. 312–316.

HAVLÍČEK, M., PAVELKOVÁ-CHMELOVÁ, R., FRAJER, J., NETOPIL P. (2013b): Vývoj využiti krajiny a vodních ploch v povodí Kyjovky od roku 1763 do současnosti. Acta Pruhoniciana, No. 104, p. 39–48.

HERSPERGER, A. M., BÜRGI, M. (2009): Going beyond landscape change description: Quantifying the importance of driving forces of landscape change in a Central Europe case study. Land Use Policy, No. 26, Vol. 3, p. 640–648.

HLAVINKA, K., NOHÁČ, J. (1926): Vlastivěda moravská II. Místopis Moravy, č. 45, Hodonínský okres. Muzejní spolek Brno, 259 pp.

HRNČIAROVÁ, T., MACKOVČIN, P., ZVARA, I. et al. (2009): Atlas krajiny České republiky. Praha: Ministerstvo životního prostředí ČR, Průhonice: Výzkumný ústav Silva Taroucy pro krajinu a okrasné zahradnictví, v. v. i., 332 pp.

HURT, R. (1954): Rybníkářství na Kyjovsku. Vlastivědný věstník moravský. Musejní spolek, Brno, p. 1–7.

HURT, R. (1960): Dějiny rybníkářství na Moravě a ve Slezsku, I. a II. díl. Ostrava, Krajské nakladatelství v Ostravě, 274 pp. (I. díl), 323 pp. (II. díl).

HURT, R. et al. (1970): Vlastivěda moravská. Kyjovsko. Muzejní spolek Brno, 537 p.

KILIANOVÁ, H., PECHANEC, V., ZAPLETALOVÁ, Z. (2008): Změny využití zemědělské krajiny v povodí Trkmanky. In: Špulerová J. Hrnčiarová T. [eds.]: Ochrana a manažment poľnohospodárskej krajiny. Zborník príspevkov z vedeckej konferencie. Bratislava: Ústav krajinné ekologie SAV, p. 199–206.

KILIANOVÁ, H., PECHANEC, V., LACINA, J., HALAS P. et al. (2009). Ekotony v současné krajině. Vydavatelství UP, Olomouc, 168 pp.

KOLÁČEK, F. (1930): O vypuštěných rybnících jihomoravských. Sborník Československé společnosti zeměpisné, p. 158–164.

MACKOVČIN, P. (2009): Land use categorization based on topographic maps. Acta Pruhoniciana, No. 91, p. 5–13.

MACKOVČIN, P., DEMEK, J., SLAVÍK, P. (2012): Problém stability středoevropské kulturní krajiny v období agrární a průmyslové revoluce: příkladová studie z České republiky. Acta Pruhoniciana, No. 101, p. 33–40.

MOJSES, M., PETROVIČ, M. (2013): Land use changes of historical structures in the agricultural landscape at the local level – Hriňová case study. Ekológia (Bratislava), Vol. 32, No. 1, p. 1–12.

PALANG, H., MANDER, U., LUUD, A. (1998): Landscape diversity changes in Estonia. Landscape and Urban Planning, Vol. 41, No. 3–4, p. 163–169.

PASSY, P., GARNIER, J., BILLEN, G., FESNEAU, C., TOURNEBIZE, J. (2012): Restoration of ponds in rural landscapes: Modelling the effect on nitrate contamination of surface water (the Seine River Basin, France). Science of the Total Environment, No. 430, p. 280–290.

PAVELKOVÁ CHMELOVÁ, R., FRAJER, J., PAVKA, P., DZURÁKOVÁ, M., ADÁMEK, P. (2012): Identification and Analysis of Areas of Historical Ponds on the Basis of Available Map Bases: Case Study of the Chrudimka River Basin. Acta Universitatis Palackianae Olomucensis, Facultas Rerum Naturalium, Geographica, Vol. 43, No. 2, p. 117–132.

PIEŃKOWSKI, P. (2003): Disappearance of the mid field ponds as a result of agriculture intensification. Electronic Journal of Polish Agricultural Universities, Vol. 6, No. 2, 11 pp.

SKALOŠ, J, WEBER, M., LIPSKÝ, Z., TRPÁKOVÁ, 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, Vol. 31, No. 2, p. 426–438.

SKOKANOVÁ, H. (2009): Application of methodological principles for assessment of land use changes trajectories and processes in South-eastern Moravia for the period 1836–2006. Acta Pruhoniciana, No. 91, p. 15–21.

SKOKANOVÁ, H., HAVLÍČEK, M., BOROVEC, R., DEMEK, J., EREMIÁŠOVÁ, R., CHRUDINA, Z., MACKOVČIN, P., RYSKOVÁ, R., SLAVÍK, P., STRÁNSKÁ, T., SVOBODA, J. (2012): Development of land use and main land use change processes in the period 1836–2006: case study in the Czech Republic. Journal of maps, Vol. 8, No. 1, p. 88–96.

SWETNAM, R. D. (2007): Rural land use in England and Wales between 1930 and 1998: Mapping trajectories of change with a high resolution spatio-temporal dataset. Landscape and Urban Planning, Vol. 81, No. 1–2, p. 91–103.

ŠTYCH, P. (2011): Comparative Analysis of the Impact of Slope Inclination and Altitude on Long-term Land Use Changes in Czechia. AUC Geographica, Vol. 46, No. 1, p.71–76.

URBÁNEK, M. [ed.] (2012): Naše rybářství. Rybářské sdružení České republiky, 244 p.

VAN EETVELDE, V., ANTROP, M. (2009): Indicators for assessing changing landscape character of cultural landscapes in Flanders (Belgium). Land Use Policy, Vol. 26, No. 4, p. 901–910.

WOOD, P. J., BARKER, S. (2000): Old industrial mill ponds: A neglected ecological resource. Applied Geography, Vol. 20, No. 1, p. 65–81.

Authors' addresses:

Mgr. Marek HAVLÍČEK, Ph.D., e-mail: *marek.havlicek@vukoz.cz*
Mgr. Hana SKOKANOVÁ, Ph.D., e-mail: *hanka@skokan.net*
The Silva Tarouca Research Institute for Landscape and Ornamental Gardening, v. v. i.
Lidická 25/27, 602 00 Brno, Czech Republic

RNDr. Renata PAVELKOVÁ, Ph.D.
Department of Geography at the Faculty of Science, Palacký University in Olomouc
tř. 17. Listopadu 12, 771 46 Olomouc, Czech Republic
e-mail: *r.pavelkova@upol.cz*

Mgr. Jindřich FRAJER, Ph.D.
Department of Geography at the Faculty of Economics, University of West Bohemia
Tylova 18, 306 14 Plzeň, Czech Republic
e-mail: *frajer.jindrich@seznam.cz*

Initial submission 30 November 2013, **final acceptance** 20 August 2014

Please cite this article as:

HAVLÍČEK, M., PAVELKOVÁ, R., FRAJER, J., SKOKANOVÁ, H. (2014): The long-term development of water bodies in the context of land use: The case of the Kyjovka and Trkmanka River Basins (Czech Republic). Moravian Geographical Reports, Vol. 22, No. 4, p. 39–50. DOI: 10.1515/mgr-2014-0022.

THE IMPACTS OF THE EUROPEAN UNION'S COMMON AGRICULTURAL POLICY ON AGRICULTURE IN SLOVAKIA

Jana NÉMETHOVÁ, Alena DUBCOVÁ, Hilda KRAMÁREKOVÁ

Abstract

The impacts of the Common Agricultural Policy of the European Union on Slovak agriculture since the accession of Slovakia to the European Union, are discussed in this paper. Structural changes that were made are reflected in the developmental trends of various agricultural areas. In this paper, the changes in agricultural land use and its categories, in particular landscape types, as well as changes in the numbers and structure of the labour force, changes in the organizational structure of agricultural holdings, the development of cropland areas of the most important crops in crop production, and changes in the number of livestock, are discussed. This analysis also focuses on Slovakia's position in terms of overall agricultural production within the EU member states.

Shrnutí

Dopady společné zemědělské politiky Evropské unie na zemědělství Slovenska

Příspěvek se zabývá dopady společné zemědělské politiky Evropské unie na zemědělství Slovenska od vstupu Slovenska do Evropské unie. Strukturální změny, které nastaly se odrazily v trendech vývoje více oblastí zemědělství. V příspěvku proto analyzujeme změny využití zemědělské půdy a jejích kategorií v jednotlivých typech krajiny i změny týkající se vývoje počtu a struktury pracovní síly, organizační struktury zemědělských podniků, osevních ploch nejdůležitějších plodin rostlinné výroby a stavu hospodářských zvířat. Analýza je zaměřena i na postavení Slovenska v zemědělské produkci v rámci států Evropské unie.

Keywords: *European Union, Common Agricultural Policy, agricultural land, labour force, structure of holdings, structure of crops, number of livestock, agricultural production, Slovakia*

1. Introduction

By joining the European Union in 2004, Slovakia made an important step in its historical development. Integration into the European Union has affected all areas of the economic and social lives of citizens. Agricultural policy is a key element of the economic policy of each EU country. Agriculture is one of the most sensitive sectors of the economy, not only in Slovakia but also in the whole European Union. As an economic sector, it has specific characteristics and regardless of its size or share in the national economy, it is strategic for any country. Maintaining agricultural production in less developed regions is one of the objectives of the Common Agricultural Policy (CAP), which is the most integrated of all EU policies and represents a relatively large share of the EU budget. The financial resources are redistributed at a European level among the EU-27 countries. The share of CAP in the EU budget has decreased sharply in recent decades: from 70% in the 1970s to around 40–34% in the period from 2003 to 2012. This decrease reflects the increase of EU competences in other areas and savings, which brought reforms but also the accession of 12 New Member States (NMS), without a significant increase of CAP costs.

A fundamental CAP reform was adopted in June 2003 (the so-called Fischler Reform), which changed the support for farmers. Its essence lies in the elimination of the connection between financial aid and production. The introduction of a common payment scheme for farmers paves the way for a greater focus on demand and therefore on the consumer, because without regard to what they produce, they will receive aid at the same level. The farmers could adapt to market requirements even more. Eco-production programmes and the proper treatment of animals are being stressed, and a greater emphasis is placed on rural development and biodiversity. CAP objectives are designed to enhance the effectiveness of support, to increase the productivity of agriculture through technological development and the optimum use of production factors, such as capital, agricultural land, and the labour force. The support should ensure the standard of living of the population working in agriculture. The support provision in the EU-27 countries gives farmers a guarantee of minimum prices and protects them from competition by third countries. To achieve the CAP objectives, the Common Market Organization was used. When problems with overproduction had emerged, the EU adopted various measures, especially lower guaranteed prices and common responsibility for overproduction (Buday et al., 2012).

Slovakia started preparations for accession to the EU in 1995. To prepare Slovakia for using financial resources from the funds of the European Union, the SAPARD Agency was established, through which projects within the pre-accession program were implemented until Slovakia entered the EU. In particular, the SAPARD program and also the PHARE program, as well as the bilateral support of EU member states, are directed to agriculture for adapting to the conditions of the Common Agricultural Policy. Since 2003, the Agricultural Paying Agency has started to act in Slovakia, through which all subsidy flows from the EU funds and from the financial resources of national supports, directed to the field of agriculture and rural development, are administrated. By joining the EU, Slovakia has accepted the support rules of the agricultural sector, i.e. adopting the same support mechanisms, which are valid in the EU and the gradual increase of contributions to agricultural holdings from the EU budget until 2013. Direct payments granted to farmers in EU-27 had a different development in the original EU-15 and in the New Member States (NMS) after 2004 (EU-12). The prime intention of the CAP was to settle direct payments of the NMS (EU-12) to the level of the original EU-15 by 2013. They started at 25% and currently reach 90% of subsidies of the original member states. In the accession treaty, the NMS negotiated an option to add European subsidies from national budgets. Slovakia did not fully use this opportunity, thus reducing its competitiveness, and supports the expansion of foreign products on the Slovak market.

The aim of this paper is to assess the situation in Slovak agriculture on the basis of selected indicators in the pre-accession period and at present after joining the European Union. Moreover, we focus on the developmental trends of Slovakia's membership in the EU and on the adoption of the EU Common Agricultural Policy in the period of 2004–2010. Under the influence of the CAP, there were several structural changes in the NMS, which are related to the decline in the size of land and its use, decline and changes in the structure of workers in agriculture, as well as holdings in agriculture. These changes are reflected in the size of agricultural production and in the size and structure of cropland areas. We analyse in detail the changes and the use of agricultural land in the period of 2004–2010 in three types of agricultural landscapes in Slovakia (the landscape type with a prevailing share of arable land, the type of landscape with an almost balanced share of arable land and permanent grasslands, and the type of landscape with prevailing permanent grasslands), which were defined by Zelenský (2002b). A partial objective of the paper is also an analysis aimed to compare the CAP impacts on the development of EU-27 agricultural production in the period of 2004–2010. This comparison concerns the most important elements of crop and livestock production in the different groupings of the EU-27, EU-15, NMS, and Slovakia.

2. Theoretical and methodological background

Slovakia's accession to the EU in 2004 and the subsequent implementation of the Common Agricultural Policy and its impact on agriculture in Slovakia, is reflected in the works of not only agronomists and economists, but also geographers, ecologists and other professionals. Agro-economic research is presented in the works of economists, particularly by Buday (2004, 2006) and Buday, Bradáčová (2009), who deal with the market of agricultural land and land resources management after the enlargement of the European Union. Furthermore, Buchta (2003), Buchta, Buchta, T. (2009) and Buchta, Federičová (2009), address the issue of employment in agriculture and deal with the impact of EU funds on agriculture and rural development in Slovakia. Comparing the CAP impact on the development of agricultural production – the production and volume of foreign trade in the EU-27 since 2004, was studied by Buday et al. (2012). The expected impact of EU agricultural policy on the development of agricultural production in Slovakia was studied by Falťanová (2008). Marušinec, Škriečka (2009) dealt with the analysis of the support system in agriculture. Geographers have researched this issue not only in Slovakia, but also in other NMS of the EU. Each of them brought into their works specifics of their countries and the impact of CAP on the development of agriculture and rural development. Some authors studied the impacts of CAP and the consequences of agricultural transformation at a national level, e.g. Jančák, Götz (1997); Bičík, Jančák (2005); Kabrda, Jančák (2006); Konečný (2010); Štolbová and Hlavsa (2008); Věžník and Bartošová (2004); and Věžník, Konečný (2011) in the Czech Republic, Hasinski (1999) and Kulikowski (2005) in Poland, etc. In Slovakia, Drgoňa, Dubcová, Kramáreková (1998) or Dubcová et al. (2008) deal with changes in the sectors of agricultural production and their spatial differentiation during the transformation of agriculture and the accession of Slovakia. Spišiak et al. (2005) address the socio-economic conditions of the Slovak countryside in relation to agriculture from 1989 to the present. Changes in arable land use in Slovakia and Bulgaria in two time horizons, 1990–2000 and 2000–2006, are studied by Kopecká et al. (2012).

On the other hand, the CAP impact on crop and livestock production is monitored in selected regions of Slovakia (e.g. Némethová, 2009a, 2009b, 2010; Spišiak, Némethová, 2008; etc.). Works of this nature are the interest of several experts – as well as geographers in the Czech Republic, such as Střeleček, Lososová, Kvapilík (2004), Svobodová and Věžník (2008), Svobodová (2010), and Vaishar, Zapletalová (2009). According to Svobodová and Věžník (2011), the impacts of the Common Agricultural Policy are both positive and negative. Positive impacts are reflected in the increased financial resources for farmers (even though they are not as high as in the older EU member states), which is associated with greater demands on administration. The most significant impact of the CAP is a decline in livestock production. Svobodová (2011) studied the impacts of the CAP in the Vysočina Region. On the one hand, they are positive – farmers have more income through subsidies, but on the other hand, in relation to the current setting of the CAP, which is grossly unfair for the NMS, there are significant changes in the structure of agricultural production and in other related industries.

Changes in agriculture are also more motivated by the present form of the EU's CAP which increasingly abandons the support provided for production and product, and puts a greater emphasis on environmental protection, development and maintenance of landscape, food safety, and proper conditions for breeding livestock (Ward et al., 2008 in Věžník, Konečný, 2011). Buchenrieder et al. (2010) deal with the characteristics and current trends in the rural areas of the NMS. They present a typology of rural areas and set out the main trends that have been recorded in these areas. Buchenrieder, Möllers [eds.] (2009) analyse in their case studies, rural development and comparisons of structural changes in agriculture in some NMS (Romania, Poland, Hungary, Bulgaria) after accession to the EU. Experiences from rural development after joining the EU are presented in another study focused on selected regions of the EU-15. Davidova et al. (2010) deal with detailed analyses of the SCARLED (Structural Change in Agriculture and Rural Livelihoods) survey, which is focused on the adaptation of the workforce, self-supply and poverty, market integration and management, and topics related to agricultural holdings. The results of the SCARLED project are presented also in the study by Möllers, Buchenrieder, Csaki [eds.] (2011).

Shucksmith, Thomson, Roberts (2005) provide insight into the diversity of the rural environment in terms of demography and related indicators (education, productive age of workers in agriculture), as well as from an environmental aspect. Furthermore, these authors focus on the different economic performance of the rural environment (market functioning, institutions, networks, organizations). According to these authors, rural regions contribute to the quality of life due to their wide range of options. For the case of Ireland, the Rural Environment Protection Scheme (REPS) is introduced and other examples of applications of different approaches and policies are shown for France, Austria, and Finland. In their conclusions, they discuss the European programme Leader and its tasks for the period from 2000–2006.

This paper deals with the period from 2004–2010. Obtaining information from various available sources was also dependent on that period. Data on the development and structure of the labour force and agricultural holdings were obtained from the publication Poľnohospodárstvo SR v rokoch 1970–2005 (Agriculture of the Slovak Republic in 1970–2005), the Regional Branch of the Statistical Office of the Slovak Republic in Nitra, and from the 2010 Statistical Yearbook of the Land Fund in the Slovak Republic. We also used internal materials of the Research Institute of Agricultural and Food Economics in Bratislava. Changes in agricultural land use at the level of districts in Slovakia were analysed on the basis of statistical data obtained from the Regional Database at www.statistics.sk. We studied closely the development of the areas of arable land, permanent crops, permanent grasslands, and total agricultural land in 2004 and 2010. When analysing the development of agricultural land use changes, a basis was provided by the work of Blažík, Falťan, Tarasovičová and Saksa (2011). We examined an index of land use change – a synthetic indicator, which evaluates, using a single number, the proportion of areas where a change occurred in basic categories of agricultural land, at the level of districts in Slovakia between the two time horizons. This indicator shows the intensity of agricultural land use change. The indicator includes changes in all categories, but does not clarify the exact nature of the changes. Therefore, it had to be complemented with other indicators, e.g. an increase/decrease index.

The mathematical expression of the change index is as follows:

$$IZ_{(a-b)} = \left[\left(\sum_{i=1}^{n} |r_{ib} - r_{ia}|\right) / 2c\right] \times 100\ [\%]$$

where, $IZ_{(a-b)}$ is the change index in the period from a to b, n is the number of land use categories (agricultural land), r_{ia} is the land area at the beginning of the period and r_{ib} at the end of the period, and c is the total area of the studied territorial unit.

The indicator which reflects the percentage increase (decrease) in various categories of land use (agricultural land), has the following mathematical expression:

$$ZR_{k(a-b)} = ([(r_{ib}/c_{ib})/(r_{ia}/c_{ia})] \times 100) - 100\ [\%]$$

where, $ZR_{k(a-b)}$ is the change in the area of a particular land use category (decrease/increase index), r_{ia} is the area of land at the beginning of the period and r_{ib} at the end of the period, c_{ia} is the total area of the studied territorial unit at the beginning and c_{ib} at the end of the studied period.

The change index was also used for analysing the number of workers in agriculture and the development of agricultural holdings in the period 2004–2010. By using this indicator, we illustrated the developmental trends in the size of cropland areas of the most important crops in the Slovak Republic and the trends in the number of livestock. The analysis that aimed to compare the CAP impacts on the development of agricultural production in the EU-27 was elaborated on the basis of data from Eurostat available at www.statistics.sk. From the obtained statistical data, we calculated the change index in the individual years of development and used them to calculate the average change index for the period 2004–2010. Using this indicator, we could analyse and compare the impacts of the CAP in different groupings of the EU-27, EU-15 and individual countries, namely Slovakia. When comparing the selected indicators of agricultural production, we focused on developmental trends in the EU NMS.

3. The impact of the CAP on the development of the land fund area

Before dealing with the development of agricultural land use, we have to look at the development of land resources as a whole in the study period 2004–2010. The development of various forms of the utilization of land resources was analysed on the basis of a simple change index which expresses the share of the areas between two time horizons. As for agricultural land and its various categories, we recorded a decrease in the size as compared with the increase in other forms of land resources use. The most significant increase can be seen in the 'other' area (5.5%) and in the built-up area (2.2%). Regarding agricultural land, the most significant decrease was recorded in the size of hop gardens (– 7.3%) and orchards (– 4.9%). A decrease in size was recorded also in agricultural land (– 0.8 %) and arable land (– 1.0%). Moreover, the decrease concerned also gardens (– 1.0%), vineyards (– 0.9%) and permanent grasslands (– 0.5%).

The size of agricultural land in the study period decreased each year because of the development of Slovak society, its economic direction, the construction of commercial and residential suburbanization in green areas, but also due to the agricultural policy of the state. Changes in the structure of agricultural land and its size had started already in the period of agriculture transformation after 1989 and continue to the present. The decrease in the cropland areas of major crops in the Slovak Republic, as well as the decrease in the number of livestock, especially cattle and pigs connected with the transformation of agriculture, is reflected in various land use changes. The current trend of decreasing agricultural land area will continue, as a result of the development of society and its economic activities. Since 1990, the size of agricultural land gradually decreased from 2,453 thousand ha representing 50.0% of the total land area of Slovakia, to 2,434 thousand ha in 2004; in 2010, it amounted only to 2,414 thousand ha (49.2%). The largest share of agricultural land is seen in arable land, which in the years 2004–2010 decreased by 13,961 ha and thus its share in 2010 reached 58.7% (in 1990, the share of arable land was 61.5%). Arable land was used mostly for residential developments, industry and transport structures. In mountainous areas at higher altitudes and slopes, arable land was unused or turned to grasslands. In the structure of agricultural land use, permanent grasslands recorded the second largest area with 876,484 ha (36.3% of agricultural land) in 2010. The share of permanent crops grown on agricultural land was the smallest (5.0 %) with 121,174 ha.

After Slovakia's accession to the EU, the demand for land increased, especially on the part of foreign developers, which also is reflected in the increasing prices of land. Currently, the market price of agricultural land differs significantly from the level of official land prices and the difference will continue to increase. According to Buday (2006), the market price ranges from the average official land price to three times its value. The land market changes mainly to non-agricultural purposes, for the construction of industrial, logistic and retail parks, where the main investors are foreign entities, and also for the purposes of civil and housing construction in municipalities and suburban areas. The average official price of agricultural land in Slovakia is 1,256 € / 1 ha^{-1}: arable land at 1,759 € / 1 ha^{-1} and permanent grasslands at 400 € / 1 ha^{-1}. The most expensive agricultural lands occur in the western part of Slovakia. This area includes districts with the highest-quality land in the Slovak Republic and the highest share of arable land: Dunajská Streda, Galanta, and Trnava in the Trnava Region; and Nové Zámky, Šaľa, Komárno, Nitra in the Nitra Region (internal materials of the Research Institute of Agricultural and Food Economics, 2009).

4. Development of agricultural land use in the landscape types of Slovakia: 2004–2010

Based on the influence of physical-geographical factors, Zelenský (2002a, 2002b) recognized three types of agricultural landscapes in Slovakia: landscapes with a predominant share of arable land; landscapes with an almost balanced share of arable land and permanent grasslands; and landscapes with predominantly permanent grasslands. The type of agricultural landscape with larger shares of arable land is situated in lowlands and low-lying basins of Slovakia, where arable land prevails over permanent grasslands. Arable land covers more than 70% of agricultural land and permanent grasslands cover only about 20%. This type can be found in the southernmost parts of Slovakia with the most suitable soil and climatic conditions for growing most of the crops. It is an area comprising the Podunajská rovina (plain), Podunajská pahorkatina (hills), Juhoslovenská kotlina (basin), Košická kotlina (basin), východoslovenská nížina (lowland), and part of the Záhorská nížina (lowland). This landscape type is a major production area for cereals, grain maize, root crops and vineyards in Slovakia. Cereals cover about 44% of the arable land, mostly wheat and barley. Sugar beet, which was characteristic for this type of agricultural landscape, has almost disappeared from the fields. Growing sugar beet was replaced by oilseeds, which currently represent the most favoured product on the market.

The development of agriculture in the period 2004–2010 was reflected not only in the decline of agricultural land, but also in the structure of its use. When analysing these changes, we used the synthetic change index and the decrease/increase index. The synthetic change index was used to monitor agricultural land use changes between the two time horizons of 2004 and 2010, which also included changes in the internal structure of land use. According to this indicator, we recorded mainly a decrease of agricultural land in all three landscape types. In the type of landscape with a predominant share of arable land, a high decrease (– 0.4%) was recorded mainly in the area of the Podunajská pahorkatina (hills): the Trnavská pahorkatina (hills), Nitrianská pahorkatina (hills), and the Žitavská pahorkatina (hills). The lowest decrease, ranging from 0–(– 0.2)%, was recorded in the districts of the Podunajská rovina (plain), Hronská pahorkatina (hills), and in the Košická kotlina (basin) (Fig. 1). Only in the two districts of Košice IV and Michalovce, was a positive change index recorded, which reflected an increase in agricultural land.

The type of landscape with an almost balanced share of arable land and permanent grasslands can be found only locally at higher elevations of the Turčianska kotlina, Popradská kotlina, and Hornádska kotlina (basins). Mainly barley and potatoes are grown there. In almost all the regions belonging to this type, we recorded a decreasing size of agricultural land, with the greatest decline over – 0.4% observed in regions of north-eastern Slovakia. The type of landscape with prevailing permanent grasslands covers higher and the highest basins, highlands, and partly mountains. It is located mainly in the northern, north-eastern, and also in the central part of Slovakia. In this type of landscape, more than 60% is covered with permanent grasslands and the rest is arable land and permanent crops. It represents the largest potato growing area in Slovakia. It is also the largest area for growing rye. In regions situated more to the south, wheat and grain maize are also being grown. In this landscape type, the change index obtains predominantly negative values except for the border districts such as Čadca, Námestovo, Púchov, and Dolný Kubín and Sabinov in the north-eastern region of Slovakia. Generally, values of the change index range mostly from – 0.2% to – 0.4% (Fig. 1).

The second indicator is the increase/decrease index representing a relationship between the increase or decrease of land in each category – agricultural land, arable land, permanent crops, and permanent grasslands. According to this index, the landscape type with the prevailing share of arable land is characterized by a slight decrease of agricultural land (from 0–(– 0.1)%. Studying the changes of agricultural land as a single unit (without changes in its internal structure), we recorded minor changes in its dynamics. Decreases indicating changes concerned the hilly regions of the Danube Lowland, the Juhoslovenská kotlina (basin), and in particular the Východoslovenská nížina (lowland). Larger decreases in agricultural land (> – 0.1%) and more can be seen in the regions lying at the Trnavská pahorkatina and Nitrianská pahorkatina (hills) in the western part of Slovakia. This agricultural land was used more for non-agricultural purposes. Part of the Košická kotlina (basin) is characterized by an increasing size of agricultural land. Similarly, a slight decrease of agricultural land is also characteristic for the type of landscape with an almost balanced share of arable land and permanent grasslands. A decrease of agricultural land can be seen also in the landscape type with prevailing permanent grasslands, except for the border regions in the north of Slovakia where the area of agricultural land increased. This agricultural land is used for cattle and sheep breeding. Similarly, we used the increase/decrease index to study changes in other categories of agricultural land. An increase in arable land was recorded in the type of landscape with the prevailing share of arable land locally in the Záhorská nížina (lowland), Podunajská rovina (plain), Hronská pahorkatina (hills), and in the Košická kotlina (basin) in Eastern Slovakia. Other regions of this type recorded a decrease. The type of landscape with an almost balanced share of arable land and permanent grasslands was also characterized by a decrease in arable land, except for the district of Sabinov. Locally, a slight increase in arable land could be observed even in regions belonging to the type of landscape with predominant permanent grasslands. Other regions of this type recorded a decrease in arable land, with a more significant decrease seen in the northern and central parts of Slovakia. A greater part of arable land in these regions is under grass and is used for extensive cattle and sheep breeding (Fig. 2).

Permanent crops recorded a decrease in all landscape types of Slovakia. A more significant decrease in the landscape type with a prevailing share of arable land can be seen in the Záhorská nížina (lowland) and in the southern part of the Trnavská pahorkatina (hills). A minimal increase in permanent crops is seen in the regions of the Juhoslovenská kotlina (basin) and in the southern part of the Východoslovenská nížina (lowland). Also, the regions with the type of landscape with an almost balanced share of both

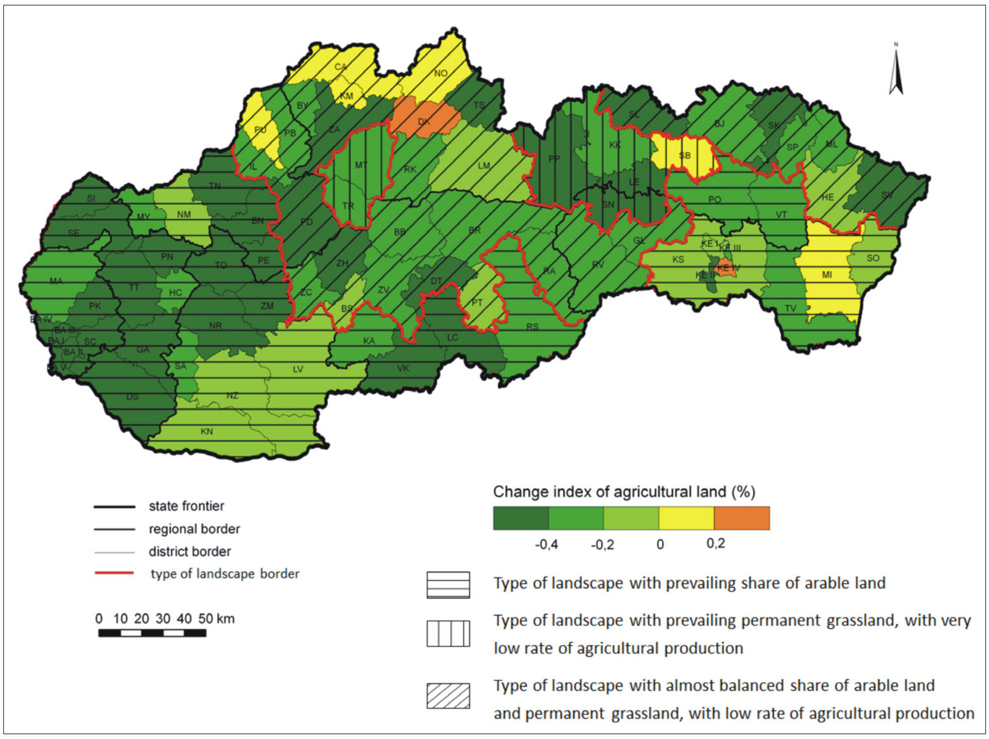

Fig. 1: Change index of agricultural land in the districts of the Slovak Republic: 2004–2010
Sources: Regional database of the Statistical Office of the Slovak Republic, 2013; authors´ calculations

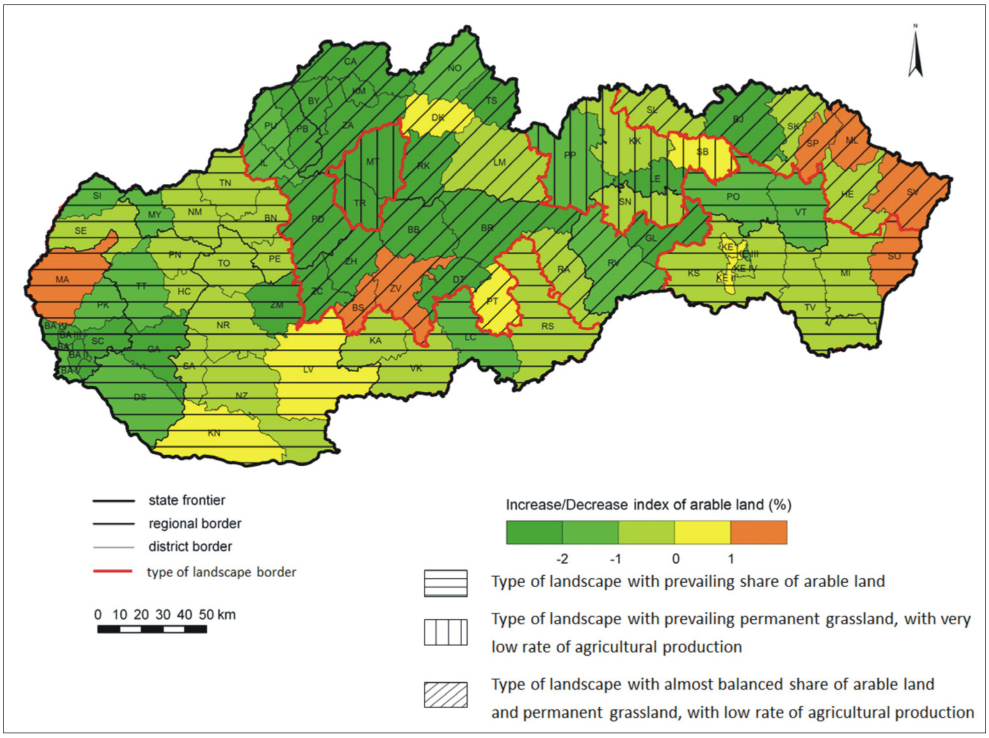

Fig. 2: Increase and decrease of arable land in the districts of the Slovak Republic: 2004–2010
Sources: Regional database of the Statistical Office of the Slovak Republic, 2013; authors´ calculations

categories are characterized by a decrease, except for the district of Martin. All regions with predominant grasslands are characterized by a decrease in permanent crops, except for the districts of Rožňava and Tvrdošín. A more significant decrease of permanent crops is recorded in northern and northeastern Slovakia and in medium elevations basins – Žiar, Pliešovce, Zvolen, and Horehronské podolie. In the type of landscape with prevailing permanent grasslands, we can observe also a significant increase (over 1%), mainly in the districts in the north of Slovakia. A moderate increase of this category is observed also in Eastern Slovakia. Other regions belonging to this type are characterized by a slight decrease. Also in regions with a balanced share of both categories, we can see an increase in permanent grasslands, while a greater increase (over 1%) is recorded for the Turčianská kotlina (basin). In contrast, districts belonging to the landscape type with a predominance of arable land, demonstrate a decrease of permanent grassland. A considerable decrease can be seen in hills of the Podunajská nížina (lowland). An increase is observed only locally in the Podunajská nížina (lowland), especially in the regions of the Chvojnická and Myjavská pahorkatina (hills). A continuous strip of increase can be seen in the northern part of the Východoslovenská nížina (lowland) (Fig. 3).

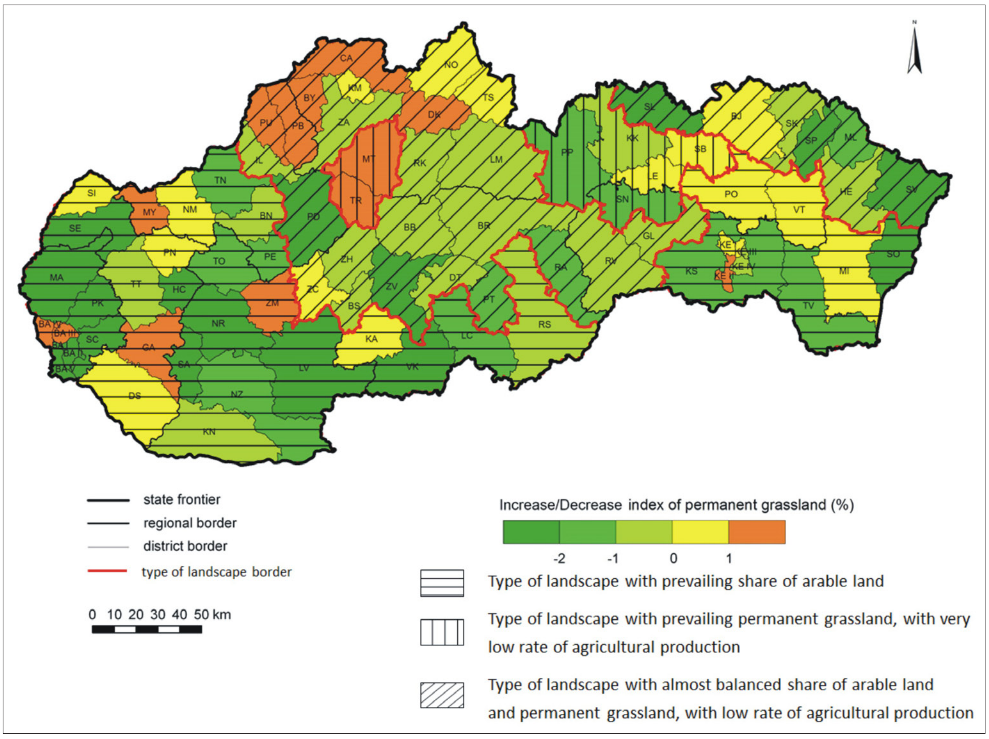

Fig. 3: Increase and decrease of permanent grasslands in the districts of the Slovak Republic: 2004–2010
Sources: Regional database of the Statistical Office of the Slovak Republic, 2013; authors´ calculations

5. CAP impact on the development of the labour force in agriculture

Employment in Slovak agriculture has gone through significant changes. Before 1989, agriculture was characterized by a high number of employees, because it employed so-called marginal social groups that had no other opportunities for local employment and it fulfilled an important social function, especially in employing the rural population. In this way, "hidden employment" emerged. The decline in such employment of Slovakia in the 1990s was influenced primarily by 'existential' problems of agricultural holdings, and by problems with ensuring the functioning of agricultural production because of changes in the country's agricultural policy. Production costs increased due to increasing input prices (oil, fertilizers, seeds, feeds) and, on the other hand, the income from agricultural production decreased (Falťanová, 2008). The dramatic decrease of workers in agriculture also changed the overall structure of the rural population. In 1990, Slovak agriculture employed 301,500 workers, representing 13.3% of the total labour force. In 1994, this figure was only 178,700 (10.2%), while in the EU-15 it was 5.3%. The decline of the labour force in Slovak agriculture persisted even at the time of the country's accession in the EU. In 2004, agriculture employed 86,600 workers, of whom 63,100 were men

Year	1994	1998	2000	2004	2005	2006	2007	2008	2009	2010	Change index 2010/2004	Decrease (in %)
Number of employees (in thousands)	178,7	134,8	111,9	86,6	81,5	77,4	75,5	72,3	65,3	56,3	65.0	– 35.0

Tab. 1: Development of the number of employees in Slovak agriculture
Sources: Internal materials of the Regional Office of the Statistical Office of the Slovak Republic, Nitra, 2012; Agriculture of the Slovak Republic in the years 1970–2005

and 23,500 women. By 2010, agriculture recorded a significant decrease in the number of workers by up to 35%: the number of workers decreased to 56,300, of whom 42,600 were men and 13,700 women (Tab. 1).

The development of the number of agricultural holdings is also reflected in the employment rate of different organizational and legal forms. With the decreasing number of cooperatives, the share of employees in them decreased (e.g. in 2000, the share was 70.4%, but in 2007 it was only 64.2%). On the other hand, with the increase in the number of business companies, the share of employment in this organizational-legal form also increased. While in 2000, 27.3% of persons worked in business companies, in 2007 it was 34.6%. Reducing the number of employees in agriculture also had a positive impact on the growth of labour productivity in this sector, as well as on the more efficient use of significantly lower subsidies going to agriculture. Changes in employment in agriculture is basically in accordance with the structural changes that took place in the whole of Slovakia, as well as in other EU countries (e.g. in EU-15 in 2006 3.7% of workers was employed in agriculture and in Slovakia it was 3.6%).

In recent years, the decline of the labour force in agriculture has been more intensive in the NMS than in the countries of EU-15. In countries such as Slovenia, Latvia, Lithuania and Poland – countries with many small farms – there was much less outflow of labour in the first half of the 1990s. In these countries, agricultural employment gradually started declining in the second half of the 1990s. In Romania, on the other hand, agricultural employment continued to increase until 2001 (employment increased in the period of 1996–2001). This increase resulted mainly from the strong general economic decline between the years 1996–1999, when reductions in industrial employment caused people to fall back on farming as a survival strategy. Since 2001, however, agricultural employment has started declining like in all other NMS (Davidova et al., 2010 in SCARLED).

Despite the declining share of agricultural employment in the NMS, however, the agricultural sector remains important as it accounts for 4% of GDP and 15% of total employment. This is a large difference if compared with the EU-15, where the share of agriculture in GDP is only 1.7% and its share in employment is 3%. In most of the NMS, there is still a significant share in agricultural employment. There are also large differences among the NMS (Davidova et al., 2010 in SCARLED). An overwhelming high share of employment can be observed in Romania (29.5% in 2007), but also in Poland and Slovenia it is above 10%. Most of the land in these countries is managed by small family farms, which makes the restructuring of agriculture and the increase of productivity difficult. Farms are characterized by hidden unemployment, low levels of education of workers, difficult access to inputs, inefficient size, etc. High shares in employment do not correspond with the relative contribution of agriculture to GDP in these countries. While in Hungary, Poland, and Slovenia, agriculture accounts for less than 5% of GDP, it is still important for Romania (8.8%) and Bulgaria (6.2%).

In all five countries, however, the share of agriculture in GDP has been declining since economic growth started after the transition shock to the market economy (Buchenrieder et al., 2010 in SCARLED). Currently, the EU-27 features a growing service sector and a decline of employment in industry and agriculture.

One positive phenomenon is that the educational structure of workers in Slovak agriculture has improved. The share of highly skilled people mainly with university education has grown steadily. In the structure of the workforce in 2004, the share of skilled workers accounted for some 53.9%. By 2010, their share had increased to 57.3%. The second largest group in 2004 included workers with only completed secondary education; their share in the total amount of workers amounted to 25.5%. In 2010, however, their share was only 19.4%. Workers with primary education were counted at 13.9% in 2004. By 2010, their share had increased to 14.7%, due to the departure of young skilled workers from agriculture, the subsequent increasing share of older age groups, as well as the nature of agriculture, which for undemanding tasks in certain facilities continues to require workers with only primary education. Highly skilled workers in 2004 amounted to only 6.9%. During the studied period, there was a favourable, but still insufficient increase in their share to 7.5%. The introduction of innovations, reduction of financial costs, simplification of the manufacturing processes or increase in revenues from the sales of goods and services, require a highly skilled labour force which is still lacking in Slovak agriculture.

Differing in extent, Western and Eastern European countries show an over-ageing in the group of private farm household operators: e.g. in Hungary only 8% of farm operators are younger than 35 years, while 45% are 55 years and older. A majority of the workforce within the group of small farms, but also in large farms, has moved into retirement. These developments entail strong implications for a structural change of the farm. The high share of farmers aged 55 and above gives a significant hint that the next 15 years will be characterized by an intensive phase of potential farm transfers or farm closings, because of the absence of a successor generation of farmers.

Farm closures, in turn, entail an acceleration of structural change by way of thinning the number of farms as well as increasing farm sizes. The low percentage of young farmers in the group of individual farms shows that the private agricultural sector does not attract many young people. Agriculture lacks qualified personnel and this problem affects even larger farms (Davidova et al., 2010 in SCARLED). In Slovakia, legal entities dominate over natural persons in the structure of holdings operating in agriculture. Family farms, which are typical for other EU member states, account only for minimal numbers in the structure of agricultural holdings in Slovakia; however, their numbers are beginning to rise.

The decreased number of employees in agriculture is reflected in negative changes of the age structure of the workforce in Slovakia, in all types of holdings. During the studied period, there was a growing share of workers in older age categories, while the share of younger workers declined steadily. While in 2004 the share of workers aged 55–59 years was 9.7%, in 2010 it was about 16.7%. The share of workers aged 50–54 years compared to 2004 increased to 22.5% of the total number of workers. For this age category, the situation in the labour market is difficult in the case of work change. The upward trend is also in the oldest age category (60–64), the share of which increased from 1.4% in 2004 to 4.0% in 2010: Slovak agriculture is ageing, too. Conversely, the share of younger age categories is continuously declining. In 2004, the share of workers in the age category of 30–34 years was 8.5% while in 2010 it was only 5.4%. A similar decrease was in the category of workers aged 20–24 years the proportion of which decreased from 3.9% to 2.3%.

This lack of interest to work in agriculture on the part of young people is caused mainly by minimum salaries. The average monthly wage in agriculture is one of the lowest within all sectors of the economy. In 2010, it amounted to 75.6% (581 €) compared to the average monthly wage in the national economy (769 €). Currently, the average nominal wage in agriculture demonstrates a slowly growing trend. Working in this sector of the economy appears to be unattractive and physically demanding to young people. Currently, in the NMS, agricultural workers quit their jobs predominantly because of retirement or younger and more educated workers apply for a job in other sectors with better financial conditions. It is not expected that these workers will affect migration to the EU-15 countries. In rural regions of the poorest and least developed NMS, agriculture remains an important source of income since a large percentage of the rural population is employed in agriculture (e.g. in Romania and Bulgaria). In more developed rural regions of the NMS, rural employment includes new activities such as landscape protection and development with regard to ecology and production of energy from biomass. Diversification of agricultural activities is an important source of employment, especially in the area of processing agricultural crops, services, agritourism, etc.

6. CAP impact on the development of the structure of agricultural holdings and land ownership

Changes associated with the transformation of the society to a market economy led to the end of agricultural holdings operating before 1989 and to the emergence of new agricultural holdings. State-owned companies almost disappeared and the total number of holdings rapidly increased, holdings which were created during the first stage of the disintegration of collective agrarian cooperatives and later state properties. Private ownership and on-going restitution gave rise to self-employed farmers. Some of the state-owned companies are still operating as strategic entities with a focus on scientific and research activities, e.g. plant and animal production research institutes, research institutes, breeding institute, or state companies specialized in gene-pool conservation. In 1990, there were 1,187 holdings dealing with agricultural production. By 1999, their number increased to 22,689 and from that year, their number began to decrease rapidly (e.g. in 2001 there were only 7,510 holdings). In 2004, altogether 9,757 holdings were dealing with agricultural production in Slovakia. By 2010, the number of holdings increased slightly to 9,802 by 0.46% (Tab. 2).

In the studied period, agricultural cooperatives recorded a decrease by 84 holdings. In terms of farmland area, cooperatives retain a dominant position in agriculture, but their share in the total area is declining every year. While in 1994 cooperatives owned almost 70% of agricultural land, in 2007 it was only 40%. The number of business companies has increased dynamically and also their share of agricultural land has increased (e.g. in 1994 they farmed on less than 5% of land and in 2007 it was 45%). From business companies, a greater part of agricultural land (over 35%) is managed by limited liability companies (s.r.o.). In 2004, there were 1,171 business companies. By 2010, their number increased to 1,518, which is an increase of 29.6%. Within the business companies, the largest group is represented by limited liability companies with 1,044 holdings. By 2010, their number had increased to 1,389 (by 33.1%). Every year, there is a fluctuating number of natural persons working in Slovak agriculture (self-employed farmers), but their share in farming agricultural land is increasing. At present, legal entities manage 90% of agricultural land and the rest of land is used by natural persons, especially by self-employed farmers.

According to the Farm Accountancy Data Network (FADN, 2004), in the Slovak Republic there are on average 550.83 ha of agricultural land per farm, which is

Year/Legal form	State-owned companies	Agricultural cooperatives	Business companies				Other legal entities	Natural persons	Total
			total	v.o.s	s.r.o.	a.s.			
1994	211	961	128	1	98	29	50	7,581	9,059
1998	4	831	529	7	451	71	0	16,909	18,802
2000	1	738	647	3	559	85	0	20,355	22,388
2004	6	668	1,171	1	1,044	126	72	6,669	9,757
2005	5	601	1,087	1	959	127	110	7,172	10,062
2007	5	603	1,285	2	1,159	123	148	6,893	10,218
2008	5	596	1,251	1	1,121	129	111	7,050	10,264
2009	6	597	1,325	1	1,195	128	141	7,000	10,393
2010	5	584	1,518	1	1,389	128	148	6,029	9,802
Change index 2010/2004 (in %)	83.33	87.43	129.63	100.00	133.05	101.59	205.56	90.40	100.46
Increase/decrease (in %)	– 16.67	– 12.57	29.63	0.00	33.05	1.59	105.56	– 9.60	0.46

Tab. 2: Development of the number and structure of agricultural holdings in Slovakia (note: v.o.s. – public business company, s.r.o. – limited liability company, a.s. – joint-stock company)
Sources: Internal materials of the Regional Office of the Statistical Office of the Slovak Republic, Nitra, 2012; Agriculture of the Slovak Republic in the Years 1970–2005

the most among the 24 member states (Malta, Romania and Bulgaria were not included in the statistics for the studied period). This means that in the Slovak Republic, the farmed agricultural land is managed by a small number of holdings, which manage large areas of land. The average for the 24 monitored countries is 34.33 ha per farm, and only in three other countries does the concentration of farmed land attain about 100 ha per farm – Czech Republic (266.23 ha), UK (140.05 ha), Estonia (107.76 ha) (Marušinec, Škriečka, 2009). Other EU countries reach significantly lower average areas of land. In most NMS, there is a high share of small farm holdings. From about 10 millions of farms up to 4 ESU in the EU-27, seven million are located in Bulgaria, Hungary, Poland, Romania, and Slovenia. Those farms are usually subsistence and semi-subsistence farms marketing only their annual surplus. Structural change in rural areas calls for reducing the share of small farms and for strengthening competitive commercialised family farms and large-scale corporate holdings. The Farm Structure Survey for 2007 found a decreasing number of agricultural holdings in all monitored countries and the group of competitive commercialised farms was still underdeveloped. It remains a major task to solve this structural problem, otherwise the NMS will not catch up with the EU-15 in the productivity and competitiveness of the agricultural sector (Buchenrieder et al., 2010 in SCARLED). Holdings with a larger farmland area are characterized by higher production and greater competitiveness. Conversely, small holdings with a smaller area of agricultural land are characterized by the low concentration of capital, land and labour force, and have low ability to succeed in markets with high volumes of production (as the large holdings do). Therefore, customers are pushing to reduce selling prices continuously, which may result in a loss of position on both domestic and foreign markets. Small producers with no profit leave the agricultural sector due to the increase of larger production units, which is understandable, since the benefits of favourable market and strategic conditions (approaching prices, direct payments, and access to investment support) increase proportionally with the farm size (Buchenrieder et al., 2010 in SCARLED).

While European farmers operate on average 50% of leased land, Slovak farmers and also Czech farmers, compared to other European farmers, operate mostly leased lands, which represents more than 90% of agricultural land. By far the greatest part of agricultural land is used by legal entities – cooperatives, joint-stock companies (a.s.), and limited liability companies (s.r.o.) which do not own the land but lease the land from the Slovak Land Fund or from the owners, for very low rents amounting to 1–2% of the official land price.

7. CAP impact on the development of agricultural production

After the transition of Slovak agriculture to a market economy after 1989, structural changes have taken place associated with the change of ownership, the organizational structure of holdings, the number of employees, and the policy of subsidies. The first years of transformation were the most critical in the overall existence of agriculture. The situation was complicated by decreased or cancelled agricultural subsidies, by constantly rising prices of inputs into production, or by existential problems or termination of several agricultural first-production holdings. Consumer prices increased while real incomes fell many times and domestic demand declined. All of this was also reflected in lower agricultural production in the first years of transformation.

The development of agricultural production gradually stabilized after Slovakia's accession to the EU-27. When comparing the years 2004 and 2010, there is a slight increase in gross agricultural production (GAP) by 5.9%. A higher increase by 10.4% is recorded in gross crop output (GCO), while gross animal output (GAO) decreased by (– 1.9%). During the transformation of agriculture in Slovakia, GAO prevailed over GCO. Basically, its dominance lasted until 2006, and from 2007 GCO has begun to prevail. In 2010, livestock production accounted for 43.8% and crop production for 56.2%. The decrease in the share of livestock production from total agricultural production resulted from the decreased total number of livestock in this period. In the EU-15 during the studied period, there was an increase in all production indicators, as well as within the EU-27 where the increase in current prices amounted to more than 11%. Slovakia increased agricultural production in 2010 compared to 2004 at current prices by 5.9% (95 million €), crop production increased by 82 million €, and livestock production decreased by 15 million €. In all NMS except for Greece and Hungary, agricultural production increased. In these two countries, there was also a decrease in crop production while in the other EU-12 countries, crop production in 2010 increased as compared with the year 2004. Only Slovakia and Bulgaria are characterized by a decrease in livestock production. Other EU-27 recorded an increase in livestock production (Eurostat Database, 2012; Buday et al., 2012).

Growing agricultural crops heavily depends on the market economy. Regional markets for agricultural products in Slovakia are practically non-existent, and agricultural holdings are linked to national and global markets. The constant opening of gaps between the growing prices of inputs and stagnant or declining prices of products causes a constant decrease in the profits of agricultural holdings and hence their added value. This forces them to reduce input costs and thus seek new possibilities of production. The pressure of global markets to reduce prices of agricultural stock forces agricultural holdings mainly to introduce technological and process innovations, which would make it possible to increase work productivity.

After Slovakia's accession to the EU, significant changes occurred in the cropland areas. This had to do particularly with the exclusion of certain commodities from the policy of subsidies; cropland areas of potatoes and quotas of sugar beet production decreased. The structure of crops in 2004 was dominated by cereals, which accounted for 61.0%. By the end of the period (2010), however, their share decreased to 50.4%; nevertheless, cereals still remain dominant in the structure of crops. The biggest decrease in cereals is recorded in the cropland areas of rye, barley, and oats. In most EU-27 (in 24 countries) the trend of development of cereals production was declining. Cereals production increased only in Latvia, Estonia, and Belgium. In 2010 as compared to 2004, the production of cereals decreased in the EU-27 by 12.9% and in the EU-15 by 10.5% (Tab. 3). The development of cereals production in Slovakia had a declining trend except for the year 2008. In 2010, Slovakia's share in the production of cereals within the EU-27 accounted for only 0.9%. Up to 72.3% of cereals are produced in the EU-15 countries.

In the structure of crops, growing grain maize plays an important role, which results from the suitable climatic conditions of Slovakia. During the period 2004–2010,

Country, Grouping	2004	2005	2006	2007	2008	2009	2010	Average index	Change index 2010/2004	Decrease (in %)
EU-27	324,765	287,290	269,057	260,041	315,353	296,267	282,900	98.2	87.1	– 12.9
EU-15	228,686	202,188	198,011	196,254	227,865	213,455	204,655	98.5	89.5	– 10.5
Slovakia	**3,793**	**3,585**	**2,929**	**2,793**	**4,137**	**3,330**	**2,571**	**96.2**	**67.8**	**– 32.2**

Tab. 3: Development of cereals production in thousand tons
Sources: Eurostat Database, 2012; Buday et al., 2012

cropland areas of grain maize increased by 13.6%. According to available data in the EU-27 and also in the EU-15, the production of grain maize had a decreasing trend in these groupings. Slovakia increased the production of grain maize by 10.4%, representing an increase of 90 thousand tons. Besides Slovakia, in 2010 as compared to 2004, only the Czech Republic and Lithuania recorded an increase from the NMS. After the decline of livestock production, which consumed two-thirds of the total cereals production, biofuel processors have become an alternative, which allow farmers continuous land management. About 200,000 tons are used for the production of compound feeds. The rest of the grain maize is, in addition to food purposes, used to produce biofuels – similar to oilseed rape.

In 2010 as compared to 2004, cropland areas of potatoes in Slovakia recorded the most significant decrease (– 54.2%). Similarly, in the development of potato production in Slovakia, there was the biggest decrease (by 67%) in 2010 as compared to 2004. The production of potatoes decreased by 256,000 tons. Slovakia was an important potato growing country in the past: it has become a significant importer of this crop, however, particularly from Poland. Even within the EU-27 and EU-15, we record a decrease in the production of this crop. The biggest producers of potatoes from the EU-12 are Poland and Romania. When entering the EU, Slovakia defended sugar production quotas to the satisfaction of sugar companies, the number of sugar beet growers began to decline thereafter because there was not a mutual agreement among the processors and growers of sugar beet. The cropland areas of sugar beet began to shrink and sugar factories were closed. In 2004, the cropland areas of sugar beet represented 2.6%, but in 2010, it was only 1.2%.

Oil seeds are very important crops in Slovakia, demanded on the market for energy purposes, which is reflected in their relatively large share in the structure of crops (in 2004 – 13.7%, in 2010 – 19.8%). Development of oilseed rape production from 2004 to 2010 had an increasing trend both in the EU-27 and in the EU-15. Development of oilseed rape production in Slovakia in the studied period also recorded a significant increase by 30.1%, which is an increase by 79 thousand tons. Slovakia's share on the production of oilseed rape in the EU accounted for about 2%. According to available data, all EU-27 are characterized by increased production. In 2010 as compared to 2004, we recorded a decrease in the production of legumes (– 20.0%), grapes (– 17.7%), and annual fodder crops (– 19.3%) in the structure of crops in Slovakia. After the accession to the EU, mainly vegetable growers had problems with competitors (decrease in the cropland areas). The opening of the European market meant an influx of cheap surplus vegetables and potatoes from the other EU countries. Gradually, we have recorded an increase in the cropland areas of vegetables and perennial fodder crops since 2008. This increase is conditioned by the gradual reclamation of permanent grasslands, as well as by the support from the EU for breeding livestock on permanent grasslands.

Before the transformation of agriculture, livestock production was characterized by a high number of animals as their breeding was more subsidized by the state. When comparing the years 1990 and 2007, the number of cattle decreased by 68%, pigs by 62%, sheep by 42%, and poultry by 21% (Falťanová, 2008). Due to decreasing subsidies, there are problems of covering the costs for production, which is reflected in increasing prices of products from livestock production on the market. It can be seen mostly in the decreased consumer demand for beef and pork meat and a sharp increase of demand for poultry meat, which is cheaper. The year 2004 was an unfavourable period for livestock production. This was mainly due to problems in the sales of meat and meat products because of the increasingly competitive environment in the common EU market. Unequal conditions between the old EU countries and NMS caused a further reduction of cattle and pigs, resulting in the loss of self-sufficiency in meat production in Slovakia. Currently, the Slovak market lacks meat, which is compensated by increased imports of cheap meat from abroad. Slovakia used to be self-sufficient in meat production, but it has become dependent on meat imports since 2000. Almost one half of the meat consumption is imported from abroad. While the number of cattle was 540 thousand heads in 2004, in 2010 it was only 467 thousand heads, which represents a decline by 13.5%. The decrease in the number of cattle was affected by the size of the production of concentrated feeds and roughage.

After Slovakia's accession to the EU, the policy of subsidies positively affected cattle breeding without the market production of milk. This breeding is important especially in areas in which landscape management for agricultural purposes is difficult. In 2010 as compared to 2004, the production of slaughter cattle in the EU-27 decreased by 4.6%. A similar decrease by 2.3% was recorded in the EU-15. In Slovakia, the production decreased by 22 thousand tons representing a decrease by 46.8% (Tab. 4). The number of cattle decreased by 13.5%. Slovakia's share in the total production of the EU-27 accounts for only 0.18%. EU-15 countries produce up to 91.9% of slaughter cattle. Poland is the biggest producer from the EU-12. All NMS are characterized by decreased production – only in Poland and Cyprus has production increased.

The breeding of pigs in Slovakia was affected by a strong decrease in their numbers, which could be related to their exclusion from EU subsidies. During the studied period of 2004–2010, there was a significant decrease in the number of pigs by 40.2% due to increased prices of feed,

Country, Grouping	2004	2005	2006	2007	2008	2009	2010	Average index	Change index 2010/2004	Decrease (in %)
EU-27	8,299	8,083	8,132	8,204	8,072	7,717	7,918	99.2	95.4	– 4.6
EU-15	7,446	7,270	7,299	7,334	7,227	7,066	7,273	99.6	97.7	– 2.3
Slovakia	**26**	**26**	**21**	**23**	**20**	**16**	**14**	**90.6**	**53.2**	**– 46.8**

Tab. 4: Development of slaughter cattle production in thousand tons
Sources: Eurostat Database, 2012; Buday et al., 2012

lower purchasing prices of meat, and cheaper imports from abroad. When comparing the years 2004 and 2010 in EU-27, we can see an increase by 1.6%. A similar situation is in EU-15 with an increase by 6.9%. During this period, Slovakia radically reduced production by 58.4%, representing a decrease by 96 thousand tons. Slovakia's share in the European production is only 0.31%. The EU-15 countries maintain levels of production of 86.5%. Among the NMS, a significant producer is Poland. A slight increase can be observed in Cyprus, while the other NMS are characterized by declining production levels.

The number of poultry in Slovakia did not record as much a decline as livestock. In 2004, there were 14 million poultry units and by 2010, the number declined by 5.8% to 13 million units. EU-15 as well as the whole European Union recorded an increase in production. The cause of production decrease in Slovakia is particularly the openness of the European market. Poultry is being imported mainly from Poland and Hungary. In Slovakia, the production decreased by 29% representing a decrease by 26 thousand tons. Slovakia's share in the production of EU-27 is about 0.58%. From the NMS, a slight increase in production was recorded in Poland, the Baltic countries, Greece, and the Czech Republic. The domestic production of poultry meat is impaired also by the policy of retail chains. They, in fact, prefer foreign suppliers who offer poultry for a price much lower than the price of Slovak producers.

Sheep and rams are the only type of livestock recording growth in Slovakia during the studied period, from 321 thousand units in 2004 to 394 thousand units in 2010. This increase was conditioned also by the gradual improvement of permanent grasslands, as well as by the support of animal husbandry on permanent grasslands from the EU. The breeding of goats is considered a complementary sector of livestock production in Slovakia, which is reflected in their numbers. In 2004, there were 39 thousand units in Slovakia, while in 2010 their number decreased to only 35 thousand units, which represents a decline by 9.5%.

8. Conclusions

Slovak agriculture is currently in a difficult economic situation occasioned by structural problems and the economic crisis, but also a failing market due to the existence of many externalities caused mainly by excessive market regulation which is influenced by the CAP of the EU. Using a subsidy support, CAP tries to keep agriculture viable even in the less developed regions of the EU, thereby ensuring the development of these regions and an adequate standard of living for their populations. Structural changes that have occurred in Slovak agriculture after its accession to the EU are reflected in a number of areas. As for the size and structure of the area of agricultural land in Slovakia, we recorded changes during the period of 2004–2010 which were associated with a decrease of agricultural land at the expense of an increase in built-up and other areas. The relatively high rate of arable land within agricultural lands in the regions of Slovakia calls for environmental actions focused on soil conservation, which is mainly reflected in the increase of permanent grasslands in these years.

When analysing changes in the development of agricultural land and its internal structure in the period from 2004 to 2010, using a synthetic change index, we recorded large decreases of agricultural land. Such large decreases, however, occurred in the type of landscape with a prevailing share of arable land. While observing the changes in the area of agricultural land as a single unit using the increase/decrease index, we can see small decreases of agricultural land in all types of landscapes. By using this indicator, we expressed the specific nature of the changes regarding increase or decrease, except for agricultural land and arable land, permanent crops, and permanent grasslands. The increase of agricultural land in the type of landscape with prevailing permanent grasslands was associated with the increase of permanent grasslands in this region. The loss of arable land in some regions of particular landscapes was influenced by the increase in permanent crops or permanent grasslands in these regions. A great decrease of arable land, however, can be seen in regions of the landscape type with prevailing permanent grasslands. The increase in the size of arable land in some regions in the landscape type with prevailing permanent grasslands was influenced by the loss of permanent grasslands in this type of landscape, as well as by the loss of permanent crops.

Agriculture is still one of the sectors of the economy which shows a reduction in labour force. In the educational structure of workers, change associated with an improving qualification structure of employees can be observed. An adverse phenomenon remains the insufficient inflow of young workers, thus increasing the proportion of employees in higher age categories. We do not expect an increased interest of young workers in this sector of the economy. During the study period, there was a decline of agricultural holdings including natural persons, and also cooperatives. On the other hand, because of the size of agricultural production, in addition to cooperatives, also limited liability companies (s.r.o.) are important and their numbers have significantly increased.

Slovakia's accession to the EU resulted in Slovak agriculture adapting to the Common Agricultural Policy of the EU and to the conditions of the Common Market. On the one hand, Slovak agriculture must be competitive in the Common Market area of the EU countries. On the other hand, there are not the same farming conditions in all EU countries, which is reflected in lower subsidies from the EU to the NMS compared to the other older EU member states. Accession to the EU was reflected in higher expenses of the state for agriculture and caused a faster approach of agricultural prices to the level of prices in the EU. Disparities among the EU countries are reflected also in the results of management in Slovakia. During the studied period 2004–2010, there was a slight increase in gross agricultural production in Slovakia. Gross crop output also increased, and began to slightly dominate over gross animal output, which decreased during the study period. Animal output recorded a decrease in almost all species of livestock in Slovakia during the studied period. The most rapid decrease was in the number of pigs (– 40.2%), and cattle decreased by nearly 14% which is associated with the strong competitive environment of the EU countries and higher inputs into production. The most grown crops in Slovakia are cereals and oil seeds. In most of the main agricultural crops, we recorded decreased cropland areas except for oilseeds (increase by 34.2%) because of their use for energy purposes. The largest decrease was seen in potatoes (– 54.2%) and sugar beet (– 48.6%).

The CAP impact on the development of agricultural production since 2004 was different not only in the individual member states, but also in the groupings of EU-27, EU-15, NMS, and Slovakia. At current prices, we recorded an increase in gross agricultural production when comparing the years 2004 and 2010. The positive fact is an increased gross crop output in the groupings of the EU-27, EU-15, and Slovakia. Compared with the groupings of the EU-27 and EU-15, where gross animal output increased, Slovakia is characterized by a decline in this indicator.

All NMS with the exception of Greece and Hungary, are characterized by increased gross agricultural production in the studied period. These two countries recorded also a decline in gross crop output. Only Slovakia and Bulgaria are characterized by a decline in livestock production. Other EU-27 countries recorded an increase in livestock production.

As for the development of monitored crops in the EU-27, EU-15, and Slovakia, we recorded a decline except for oilseed rape. Slovakia has also increased production of grain maize, but a significant decrease can be seen in the production of potatoes. As compared with the year 2004, EU-27 and EU-15 showed a decline in cattle and pigs, and an increase in poultry in 2010. Development in Slovakia in all monitored species of livestock is marked by a decline in production, namely in pig breeding. A negative feature of the development of Slovak agriculture in the period of accession to the EU is the reduction of food self-sufficiency, which is compensated by imports mainly of meat, as well as fruits and vegetables from the other EU countries. Slovakia, basically, produces only a sufficient amount of cereals. Moreover, Slovakia also exports cereals, grain maize, and oilseed rape.

Slovakia's accession to the EU has brought some stability to market conditions and the political environment. The CAP brought more competitiveness to agricultural holdings. The problems of the economic crisis, both on the domestic and foreign markets, is reflected also in the declining number of agricultural holdings. In market agriculture, greater holdings have success and they appear to be more stable. The strongly competitive environment of the European market has brought greater reliance of agricultural holdings on subsidies from their own countries, but also on the aid from the EU which is gradually increasing in the NMS. Only efficient and competitive agriculture will support the viability of the rural economy and will remain an important part of rural activities. The aim of the Europe 2020 strategy is mainly the support of the competitiveness of Slovak agriculture, sustainable management of natural resources, and economic development of rural areas.

References:

Agriculture in the Slovak Republic in the Years 1970–2005, Bratislava, Statistical Office of the Slovak Republic, 71 pp.

BIČÍK, I., JANČÁK, V. (2005): Transformační procesy v českém zemědělství po roce 1990. Praha, Univerzita Karlova v Praze, 103 pp.

BLAŽÍK, T., FALŤAN, V., TARASOVIČOVÁ, Z., SAKSA, M. (2011): Zmeny využitia zeme vybraných okresov rôznych poľnohospodárskych produkčných oblastí v kontexte prebiehajúcich transformačných procesov. Geografický časopis, Vol. 63, No. 4, p. 301–323.

BUDAY, Š. (2004): Development of business structure in agricultural companies in Slovakia. Zemědělská ekonomika, Vol. 50, No. 3, p. 116–119.

BUDAY, Š. (2006): Trh s poľnohospodárskou pôdou na Slovensku. In: Rozvoj trhu s pôdou a hospodárenie na pôdnom fonde po rozšírení Európskej únie. Zborník z medzinárodnej vedeckej konferencie. Nový Smokovec, 2.– 6. októbra 2006. Bratislava, Výskumný ústav ekonomiky poľnohospodárstva a potravinárstva, p. 6–15.

BUDAY, Š., BRADÁČOVÁ, K. (2009): Analýza vybraných faktorov na transakcie s poľnohospodárskou pôdou. Ekonomika poľnohospodárstva, Vol. IX, No. 2, p. 40–49.

BUDAY, Š., CHRASTINOVÁ, Z., KRÍŽOVÁ, S., GÁLIK, J. (2012): Porovnanie dopadov SPP na vývoj poľnohospodárskej výroby a objem zahraničného obchodu. Bratislava, Výskumný ústav ekonomiky poľnohospodárstva a potravinárstva, 19 pp.

BUCHENRIEDER, G., MÖLLERS, J., JUVANČIČ, L., BALMANN, A. (2010): Key characteristics and recent trends in rural areas. In: Csaki, C. et al. [eds.]: Structural Change in Agriculture and Rural Livelihoods: Policy Recommendations, Detailed Report, Chapter 3, Project "SCARLED" SSPE-CT-2006-044201. [online]. [cit. 03.09.2013]. Available at: http://www.scarled.eu/uploads/media/SCARLED_D10_2_final_2013 _01.pdf

BUCHENRIEDER, G., MÖLLERS, J. [eds.] (2009): Structural change in Europe's rural regions, Farm livelihoods between subsistence orientation, modernisation and non-farm diversification, Studies on the Agricultural and Food Sector in central and Eastern Europe, Vol. 49, IAMO, Halle. [online]. [cit. 10.09.2013] Available at: http://ageconsearch.umn.edu/bitstream/53334/2/IAMO%20studies%20series_vol49.pdf

BUCHTA, S. (2003): Stav a vývoj sociodemografickej štruktúry pracovných síl v poľnohospodárstve. Ekonomika poľnohospodárstva, No. 2, p. 25–31.

BUCHTA, S., BUCHTA, T. (2009): Impact of the investment grants from the European funds on the development of agriculture and rural areas. Agricultural ekonomics = Zemědělská ekonomika, Vol. 55, No. 2, p. 59–66.

BUCHTA, S., FEDERIČOVÁ, Z. (2009): Hodnotenie implemementácie dopadov programových dokumentov v poľnohospodárstve za obdobie 2004–2007. Bratislava, Výskumný ústav ekonomiky poľnohospodárstva a potravinárstva, 85 pp.

DAVIDOVA, S., FREDRIKSSON, L., BAILEY, A., BUCHENRIEDER, G., MÖLLERS, J., BALMANN, A., SCHNICKE, H., SALASAN, C., SWINNEN, K. van H., J., MILCZAREK, D. (2010): In-depth analysis of rural livelihoods in NMS. In: Csaki, C. et al. [eds.]: Structural Change in Agriculture and Rural Livelihoods: Policy Recommendations, Detailed Report, Chapter 4, Project “SCARLED” SSPE-CT-2006-044201. [online]. [cit. 03.09.2013]. Available at: http://www.scarled.eu/uploads/media/SCARLED_D10_2_final_2013 _01.pdf

DRGOŇA, V., DUBCOVÁ, A., KRAMÁREKOVÁ, H. (1998): Slovakia: Privatization in rural Eastern Europe: the process of restitution and restructuring. Edward Elgar Publishing, UK, p. 251–273.

DUBCOVÁ, A. et al. (2008): Geografia Slovenska. Nitra, Univerzita Konštantína Filozofa, Fakulta prírodných vied, 351 pp.

Eurostat Database. [online] [cit. 05.12.2012] Available at: http://epp.eurostat.ec.europa.eu, 2012

HASINSKI, W. (1999): Rolnictvo indywidualne na Dolnym Slasku w okresie transformaci systemowej. Wroclaw, Uniwersytet Wroclawski, 290 pp.

FALŤANOVÁ, N. (2008): Očakávané vplyvy agrárnej politiky EÚ na vývoj poľnohospodárskej výroby SR. Bratislava, Prognostický ústav SAV, 39 pp.

Internal materials of the Research Institute of Agricultural and Food Economics, 2009.

Internal materials of the Regional Office of the Statistical Office of the Slovak Republic in Nitra, 2012.

JANČÁK, V., GÖTZ, A. (1997): Územní diferenciace českého zemědělství a její vývoj, Praha, Univerzita Karlova, Přírodovědecká fakulta, 81 pp.

KABRDA, J., JANČÁK, V. (2006). České zemědělství a krajina po vstupu Česka do EU: nový institucionální rámec. XXI. sjezd České geografické společnosti. České Budějovice, p. 104–112.

KONEČNÝ, O. (2010): Agricultural Transition in the Czech Republic: Case of Concentration. Geografie pro život ve 21. století. Ostrava, Ostravská univerzita, p. 725–730.

KOPECKÁ, M., VATSEVA, R., FERANEC, J., OŤAHEĽ, J., STOIMENOV, A. NOVÁČEK, J., DIMITROV, V. (2012): Selected changes of arable land in Slovakia and Bulgaria during the period 1990–2006. Moravian Geographical Reports, Vol. 20, No. 1, p. 43–54.

KULIKOWSKI, R. (2005): Agricultural problems areas in Poland, 2002. Moravian Geographical Reports, Vol. 19, No. 1, p. 50–60.

MARUŠINEC, J., ŠKRIEČKA, M. (2009). Analýza systému podpory v pôdohospodárstve. Analýzy – Argumenty – Názory. Pracovné materiály 9. Bratislava, M.E.S.A. 10 – Centrum pre ekonomické a sociálne analýzy. 24 pp.

MÖLLERS, J., BUCHENRIEDER, G., CSAKI, C. [eds.] (2011): Structural Change in Agriculture and Rural Livelihoods: Ploicy Implications for the New Member States of the Euroepan Union, Studies on the Agricultural and Food Sector in central and Eastern Europe, Vol. 61, IAMO, Halle. (results of the SCARLED project).

NÉMETHOVÁ, J. (2009a): Agropotravinárske štruktúry okresu Nitra. Nitra, Univerzita Konštantína Filozofa, Fakulta prírodných vied, 163 pp.

NÉMETHOVÁ, J. (2009b): Agroštruktúry vysokoprodukčného regiónu Slovenska. Ekonomika poľnohospodárstva, Vol. 9, No. 2, p. 50–58.

NÉMETHOVÁ, J. (2010): Types of agricultural enterprises in the high production region in Slovakia (sample area of the Nitra district): Typizácia vybraných agrosubjektov vysokoprodukčného regiónu Slovenska (modelové územie okres Nitra), 2010. Agricultural ekonomics = Zemědělská ekonomika, Vol. 56, No. 1, p. 25-31.

Regional Database of the Statistical Office of the Slovak Republic, 2013.

SHUCKSMITH, M., THOMSON, K. J., ROBERTS, D. (2005): CAP and the Regions: The Territorial Impact of Common Agricultural Policy, CABI Publishing, Wallingford (UK) [online]. [cit. 10.11.2013] Available at: http://books.google.at/books?id=R000DK-1cfIC&pg=PA149&sig=gQNd558qBEe2-_BDRqo0tzHyqNg

SPIŠIAK, P. NÉMETHOVÁ, J. (2008): Agrosubjekty regiónu Nitra vo vzťahu k odberateľom poľnohospodárskych surovín, 2008. Geografický časopis, Vol. 60, No. 1, p. 63–87.

SPIŠIAK, P. et al. (2005): Agrorurálne štruktúry Slovenska po roku 1989. Bratislava, Geo-grafika, 183 pp.

Statistical Yearbook of the Land Fund in the Slovak Republic 2010 (state for the 1.1.2010). Geodesy, Cartography and Cadastre Authority of Slovak Republic, 128 pp.

STŘELEČEK, F., LOSOSOVÁ, J., KVAPILÍK, J. (2004): Development of livestock in numbers and structure from the regional and administrative aspect. Agricultural Economics, Vol. 50, No. 2, p. 47–57.

SVOBODOVÁ, H., VĚŽNÍK, A. (2008): Dopady SZP EU na stav a možní rozvoj zemědělství v mikroregiónu Hrotovicko. Geografické informácie, Vol. 12, No. 1, p. 151–157.

SVOBODOVÁ, H., VĚŽNÍK, A. (2011): Impacts of the commom agricultural policy of the European union in the Vysočina region (Czech Republic) by the view of the farmers. Journal of Central European Agriculture, Vol. 12, No. 4, p. 733–743.

SVOBODOVÁ, H. (2010): Vliv společné zemědělské politiky na stav a možnosti rozvoje zemědělství a venkova v kraji Vysočina. Sborník příspěvků z mezinárodní vědecké konference Region v rozvoji společnosti 2010. Brno, Mendelova univerzita, p. 263–270.

SVOBODOVÁ, H. (2011): Vývoj zemědělské výroby v České republice pod vlivem společné zemědělské politiky EÚ. Acta regionalia et environmentalica, Vol. 8, No. 1, p. 15–21.

ŠTOLBOVÁ, M., HLAVSA, T. (2008): The impact of the LFA payments on the FADN farms in the Czech Republic. Agricultural Economics, Vol. 54, No. 10, p. 489–497.

VAISHAR, A. ZAPLETALOVÁ, J. (2009): Sustainable development of rural microregions in the Czech borderland. Moravian Geographical Reports, Vol. 17, No. 4, p. 34–43.

VĚŽNÍK, A., BARTOŠOVÁ, L. (2004): Selected regional geographical differences of the Czech Republic agriculture, after the transformation processes. Agricultural Economics, Vol. 50, No. 5, p. 207–216.

VĚŽNÍK, A., KONEČNÝ O. (2011): Agriculture of the Czech republic after accession to the EU: regional differentiation. Moravian Geographical Reports, Vol. 19, No. 1, p. 50–60.

ZELENSKÝ, K. (2002a): Štruktúra rastlinnej výroby Slovenskej republiky 2. časť. Geografia, Vol. 10, No. 1, p. 20–22.

ZELENSKÝ, K. (2002b): Využívanie poľnohospodárskej krajiny. Mapa 1:2 000 000. Atlas krajiny Slovenskej republiky. Ministerstvo životného prostredia, Bratislava, Agentúra životného prostredia, Banská Bystrica, p. 167

Authors' addresses:

RNDr. Jana NÉMETHOVÁ, Ph.D., e-mail: *jnemethova@ukf.sk*
Doc. RNDr. Alena DUBCOVÁ, CSc., e-mail: *adubcova@ukf.sk*
RNDr. Hilda KRAMÁREKOVÁ, Ph.D., e-mail: *hkramarekova@ukf.sk*
Department of Geography and Regional Development FNS CPU in Nitra
Trieda A. Hlinku 1, 949 74 Nitra, Slovak Republic

Initial submission 10 January 2014, **final acceptance** 15 August 2014

Please cite this article as:

NÉMETHOVÁ J., DUBCOVÁ A., KRAMÁREKOVÁ, H. (2014): Impacts of the European Union's common agricultural policy on agriculture in Slovakia. Moravian Geographical Reports, Vol. 22, No. 4, p. 51–64. DOI: 10.1515/mgr-2014-0023.

REVIEWERS OF PAPERS OF THE 2014 VOLUME

The editorial team is grateful for the following scholars who have invested their time and expertise in the peer-review processes during the production of the 2014 Volume (in alphabetical order)**:**

Peter Alexander
Filip Alexandrescu
Helena Bínová
Martin Boltižiar
Patrick Collins
Yassine Charabi
Thomas Dax
Petra Doan
Florescu Elisabeth
Andrew Gorman-Murray
Matthias Groß
Pavol Hurbánek
Vladimír Ira
Igor Ivan
Warren Jochem
Petr Klusáček
Tomasz Komornicki
Jacek Kotus
Stanislav Kraft
František Križan
Bastian Lange
Agnieszka Latocha
Heli Marjanen
Kristýna Meislová
Josef Navrátil
Marco Neubert
Colin Nolden
Robert Osman
John Overton
Martin Perry
Colin Pooley
Ulrike Pröbstl-Haider
Lucyna Przezbórska-Skobiej
David Rudolph
Irena Smolová
Philipp Späth
Zbigniew Taylor
Sergio Tirado-Herrero
Pavel Tomšík
Alexander Tölle
Paul Upham
Jaroslav Vávra

Fig. 2: Agricultural landscape near the village Násedlovice with the valley of the Trkmanka River (Photo M. Havlíček)

Fig. 3: Jarohněvický rybník Pond (Photo: M. Havlíček)

Illustrations related to the paper by M. Havlíček, R. Pavelková, J. Frajer and H. Skokanová