DELIMITATION OF MICRO-REGIONS IN THE CZECH REPUBLIC BY NODAL RELATIONS

Marián HALÁS, Petr KLADIVO, Petr ŠIMÁČEK, Tatiana MINTÁLOVÁ

Abstract

Spatial interactions express mutual relations among geographical areas or regions at different hierarchical levels, and they are an important factor in the formation of the geographical organisation of space. This paper provides an empirical analysis of labour migration between municipalities and their impact on the formation of nodal regions at a lower regional level and at a local level. The final result of the study is a socio-economic regionalization map and the delimitation of micro-regional systems in the Czech Republic.

Shrnutí

Vymezení mikroregionů v České republice na základě nodálních vazeb

Prostorové interakce vyjadřují vzájemné vazby mezi geografickými areály anebo regiony na různé hierarchické úrovni a jsou tak významným faktorem formování geografické organizace prostoru. Příspěvek přináší empirickou analýzu dojížďky do zaměstnání (pracovních migrací) mezi obcemi a její vliv na formování nodálních regionů na nižší regionální až lokální úrovni. Stěžejním výsledkem studie je socio-ekonomická regionalizace a vymezení mikroregionálního systému České republiky.

Key words: *nodal relations, regionalization, micro-regions, (micro)regional system, Czech Republic*

1. Introduction

Uneven distribution of partial components of the geographic space determines its heterogeneity and variability. Different localization presuppositions of these components also reflect in their spatial differentiation, which means that the components appear with a different intensity in various regions. In most cases, however, there is a natural tendency to balance these differences. Concerning the human-geographical elements, horizontal flows can be found in the social and economic environments; in geography, they are called spatial interactions. Main representatives of these interactions are individuals and their activities whose behaviour and decision-making is influenced by their needs and attempts to optimize their mobility (or location) which provide them with economic and social benefits. All these interactions significantly affect the geographical organisation of the society and characterize interdependence between individual parts of the geographic space (regions) at various hierarchical levels.

Data on migration and namely on commuting for work and school represent basic information on the spatial mobility of population and spatial interactions. Commuting for work and school, which is a basis for regionalization tasks, was firstly surveyed in the former Czechoslovakia within the census in 1961. Since that year, we have been able to work with detailed data on commuting directions, which have been unfortunately gained only in ten-year intervals. Any further information on spatial interactions (e.g. amounts of transported people, attendance of shopping centres etc.) is scarcely available and very often considered a business secret.

The main objective of this contribution is to delimit micro-regions in the Czech Republic on the basis of labour and school commuting data derived from the 2001 census. The theoretical basis is going to focus on the selection and application of appropriate method delimitating micro-regions according to nodal relations. For the practical use of this method (e.g. to delimitate municipalities), the text is also going to outline possible alternative procedures for hinterlands of large cities whose nodal activities generate several times larger area compared to the smallest micro-regions.

2. Theoretical basis and literature overview

Scientific works dealing with standard or more sophisticated regionalization tasks are the main source

of the theoretical basis of this paper. These scientific works mainly use a similar group of input data (labour and school migration) but nevertheless they can be divided into several different categories.

Works discussing the socio-graphical regionalization of the Czech Republic issued by a group of authors led by Martin Hampl (Hampl, Ježek, Kühnl, 1978; Hampl, Gardavský, Kühnl, 1987; Hampl et al., 1996; Hampl, 2005) and by Maryáš and Řehák (1987) belong to the most famous Czech titles on this topic. These works always contain a complex regionalization, which is based on the philosophical concept of region as a territory with relatively closed housing, labour and service functions. A collective led by Hampl delineates service regions by the interaction models (only for the Czech Republic), regional delineation by Maryáš and Řehák (1987) is based on the questionnaire survey on service attraction in Czechoslovakia. On the 2001 census data Hampl (2005) based his regional delineation dominantly on the labour commuting and substituted school commuting (as an auxiliary criterion) for the service attraction. School commuting related only to a relatively small age population group and often has a different flow direction than service attraction. Mulíček, Sýkora (2008), whose regionalization is also based on the 2001 census, defined the local labour systems. The method of the delimitation of regions and their consequent image in the map is similar to Hampl (2005), small differences can be seen only in additional criteria resolving disputed cases of regions' incompactness and unconnectedness.

The separate issue is created by more demanding regionalization tasks and the delimitation of daily urban systems, or more exactly functional urban regions. Daily urban systems reflect daily life cycle of the population of a region, they are internally coherent and externally (relatively) closed with regard to the daily movements of the population, either for labour, education, services, recreation and social contacts (Bezák, 2000).

Unlike the nodal regions delimitation, the authors deal with a problem of the overlapping spheres of two or more neighbouring municipalities' influence and the existence of multiple regional cores (Hampl, 2005 and Mulíček, Sýkora, 2008 took it partly into account). However, the greatest difference is in the fact that identification of daily urban systems requires the application of a more demanding algorithm and computational software methods, specifically the testing of the degree of region isolation by a repeated rotation of the input data. The idea of this kind of testing was firstly expressed by the American geographer Brian Joe Lobley Berry (e.g. Berry, 1973) and on the European continent by Peter Hall (e.g. Hall, 1974; Hall, Hay, 1980) who also developed the theory of delimitation of urban regions as daily urban systems. The resulting daily urban systems can be then defined as relatively closed regions considering the daily movement of population, having one or more cores. The daily urban systems or the functional urban regions in different variations were delimited for example in the UK (Ball, 1980), Finland (Hirvonen, 1982), Poland (Korcelli, 1982) or Slovakia (Bezák, 1990, 2000).

The special issue introduces possibilities for the delimitation of nodal regions in the case of the absence of data on daily population flow. In this case several options of geographic modelling of these flows rooted in the works of William Reilly (1929, 1931) can be used. Reilly defined a law of retail gravitation based on the real interactions observed in Texas. This Reilly's model, which is based on Newton's law of gravitation, has often been modified with the tendency of inhabitants to commute for services in selected centres and also to identify the boundaries of the centres' influence depicted in graph schemes of settlement systems (e.g. Huff, 1964; Fotheringham, O´Kelly, 1989; Löffler, 1998). In the Czech literature, Reilly's model is used for standard regionalization tasks by Maryáš (1983), Řehák (2004), Řehák, Halás, Klapka (2009) or by Halás, Klapka (2009).

The human-geographical regionalization is also very useful in practical application. The most typical example is its role in the construction and revision of state administrative organisation. The administrative organisation should take into account the natural belonging to centres and the real daily population flows, which will help to achieve the optimization of a spatial structure and a geographical organisation of society. Outcoming regionalizations by human and regional geographers represent a suitable tool and often of a practical application, such as for a new territorial differentiation of the Czech Republic (see Maryáš, 2003).

All delimitations of nodal regions and daily urban systems mentioned above may be the inspiration for administrative organisations, but the regionalization at a lower hierarchical level should be remarked as well. Here we can mention for example the micro-regions delimitation proposals (Slavík, Bačík, Kožuch, Ragačová, 2005; Slavík, Bačík, 2007) which can be potentially used to revise the spheres of municipal self-governments and their merging into municipalities which include more municipalities (this process took already place in Denmark and is going to be introduced in some other countries).

3. Methodology

This contribution uses the 2001 census data. We are interested especially in the number of people daily commuting to schools and work (their sum) in each municipality of the Czech Republic. The main (i.e. numerically highest) flow of commuting is fundamental for inclusion in micro-regions. The selection of centres is also an important issue.

Since the aim of this contribution is to delimit regions at the lowest (micro) level, a relatively free criterion for the selection of centres was chosen. As the centre of commuting is considered a municipality that contains daily school and labour commuting from at least four other municipalities which practically means that resulting micro-regions must include at least five municipalities. The intention was to capture the natural division of the Czech Republic's geographical space and therefore the catchment areas of the centres will not be regulated by any other means – most important is the main flow. Larger municipalities will of course generate disproportionately larger catchment regions than the smaller (micro-regional) centres.

After the first step, the resulting image in the map is rather fragmented and the resulting regions are not continuous and that is why the second step will include modifications connecting the resulting regions. Two basic cases may appear (Fig. 1). The first case arises when a catchment region of a given centre includes a group of four municipalities at most, whose main flow is directed out of the centre and in this case, the municipalities will be absorbed by the region of which they are a subset (Fig. 1a). In the second case, a group of four municipalities is located within the boundaries of influence of two (or more) catchment centres of commuting (Fig. 1b) and this group is classified into appropriate centre according to the second or the following flow in the order which will give us continuous regions.

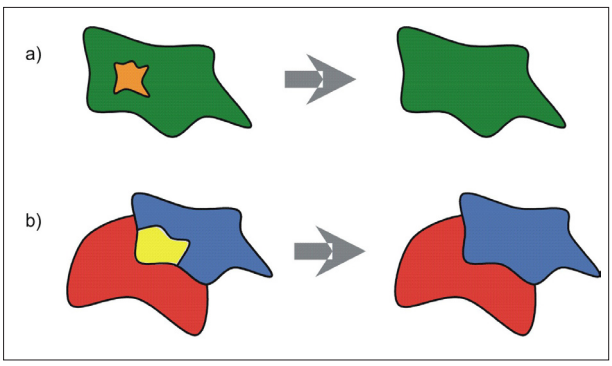

Fig. 1: Assignment of municipalities to centres in the case of region discontinuity

This method sometimes gives a few cases when centres accumulating the main flows of commuting from four (or five) municipalities are cancelled because of their disability to create a continuous region consisting of at least five municipalities. The further inclusion of such a (cancelled) centre and its catchment area is made according to the original procedure and the method described in the first part of this paragraph is also demonstrated in Fig. 1.

This method constructs the final map of the Czech micro-regional system according to nodal relations. The next two maps of micro-regional systems of Prague and Brno hinterlands are constructed by using the same method but the commuting flows to Prague and Brno are not considered (which practically means that we ignored the main flows of commuting).

4. Results

4.1 The micro-regional system of the Czech Republic

The resulting regionalization precisely expresses the spatial differentiation of the Czech Republic's settlement system. It also depicts the natural nodal relations and the range of the influence of macro-, meso- and micro-regional centres. According to the selected method, we identified 271 commuting centres (Fig. 2 – see cover p. 2) in the Czech Republic, which are able to create a continuous nodal region consisting of at least five municipalities.

Position of a centre in the regional and settlement system of the Czech Republic is determined by two main factors: size (population) of a centre (1) and exposition of a centre location (2). The first factor is quite a logical result of principal rules used in the spatial organisation. The second factor can be demonstrated on many specific examples. For instance the town of České Budějovice situated in a less exposed location has more than three times larger catchment region according to its population than Ústí nad Labem which is comparable in its size while the catchment region of Ústí nad Labem (100 thousand inhabitants) is comparable with the catchment region of Jeseník (12 thousand inhabitants).

The largest municipality, which cannot be according to our criteria considered the centre of the nodal micro-region, is Havířov. The Havířov location within the exposed Ostrava agglomeration creates a region with 100 thousand inhabitants (including the centre) but consists only of the centre and three catchment municipalities. In addition to these fundamental factors, the regional and settlement structure is also influenced by many secondary factors, e.g. by

the position of the centre in respect of transport infrastructure (especially rail and road networks), location of the centre with regard to the state borders, functional orientation and specialization, or more exactly diversity of centres. Basic characteristics of the largest nodal regions and the province of the most significant centres are presented in Tab. 1.

The smallest nodal micro-regions consist of five municipalities (which was the criterion of minimum size) and have approximately 2–3 thousand inhabitants. In most cases, they are rural regions with a worse access to midsized or large regional centres (e.g. the northeast and northwest Vysočina). From the social and economic points of view, they are considered peripheral regions (mainly inner peripheries) with a low population density. They are often located near district boundaries, which is in accord with the delimitation of peripheries in the Czech Republic (Musil, 1988; Musil, Müller, 2008) where the most peripheral regions are areas with bad transport accessibility to regional capitals (on the influence boundaries of regional capitals). In this area, there are also many small nodal micro-regions of rural character consisting of a few (from five to ten) municipalities.

In comparison with the regionalization classifications by Hampl (2005) and Mulíček, Sýkora (2008), we have delimited other 127 or 121 smaller nodal regions (rem. in both cases mentioned above the authors used

Region (centre)	Population (thous.)	Out of which centres	Out of which hinterland	Proportion of a centre (%)	Number of municipalities	Area (km^2)	Population density
Praha	1 453,0	1 169,1	283,9	80,5	315	2 857,4	508,5
Brno	616,0	376,2	239,9	61,1	235	2 324,0	265,1
Ostrava	567,9	316,7	251,1	55,8	63	949,2	598,3
Plzeň	263,5	165,3	98,3	62,7	128	1 690,8	155,8
České Budějovice	179,9	97,3	82,5	54,1	110	1 530,6	117,5
Olomouc	176,8	102,6	74,2	58,0	65	1 046,2	169,0
Hradec Králové	145,0	97,2	47,9	67,0	88	731,0	198,4
Liberec	135,1	99,1	36,0	73,3	29	585,7	230,8
Zlín	134,1	80,9	53,2	60,3	61	631,0	212,5
Pardubice	125,3	90,7	34,6	72,4	74	500,0	250,6
Opava	123,9	61,4	62,5	49,6	50	708,4	174,8
Karviná	121,7	65,1	56,5	53,5	9	173,1	702,9
Ústí nad Labem	121,6	95,4	26,1	78,5	27	475,5	255,6
Kladno	108,9	71,1	37,8	65,3	35	345,4	315,4
Třinec	106,7	39,0	67,7	36,5	26	454,9	234,5
Teplice	105,4	51,1	54,4	48,4	25	334,4	315,3
Mladá Boleslav	102,2	44,3	57,9	43,3	106	918,0	111,3
Frýdek-Místek	96,4	61,4	35,0	63,7	29	427,0	225,9
Prostějov	95,0	48,2	46,8	50,7	73	560,0	169,6
Uherské Hradiště	91,0	26,9	64,1	29,5	43	480,9	189,2
Karlovy Vary	89,0	53,4	35,7	59,9	38	966,3	92,1
Chomutov	86,8	51,0	35,8	58,7	29	607,6	142,9
Jihlava	86,4	50,7	35,7	58,7	78	848,5	101,8
Sokolov	82,1	25,1	57,0	30,6	31	509,1	161,2
Jablonec n. Nisou	79,5	45,3	34,3	56,9	26	365,6	217,5
Děčín	79,4	52,5	26,9	66,1	31	509,9	155,7
Přerov	78,5	48,3	30,2	61,6	56	365,2	214,9
Most	77,9	68,3	9,6	87,6	16	241,1	323,1
Tábor	77,8	36,6	41,3	47,0	76	963,2	80,8
Znojmo	77,6	35,8	41,8	46,1	84	924,1	84,0

Tab. 1: Main characteristics of the largest nodal regions in the Czech Republic
Source: Český statistický úřad, 2007; own calculations

the bigger size criteria (approximately 15 thousand inhabitants per region) to define a separate region. In more than 90% of cases, these smaller regions are located between the spheres of influence of regional centres defined by Hampl (2005) and Mulíček, Sýkora (2008). The remaining 10% is represented by smaller regions situated near the state border; special examples can be found in the "hooks" of the Czech Republic (e.g. Aš, Varnsdorf, Javorník etc.).

For the statistical documentation of the size range of delimited nodal regions the following data may be used – 27 nodal micro-regions, whose total population density is 46.9 inhabitants per square kilometre, have less than 5 thousand inhabitants and 85 nodal micro-regions, with the total population density 55.3 inhabitants per square kilometre, have less than 10 thousand inhabitants. On the other hand, heavily populated nodal regions and regions with the exposed location have the opposite characteristics. These midsized and large regional centres would be also the centres of regions in the regionalization at a higher hierarchical level. 44 nodal regions, whose total population density is 204.4 inhabitants per square kilometre, have more than 50 thousand inhabitants and 17 regions, with the total population density 282.2 inhabitants per square kilometre, exceeded the number of 100 thousand inhabitants.

4.2 Micro-regional systems of Prague and Brno hinterlands

If the resulting regionalization proposal should be used in practice, it would require several modifications. We are interested in micro-regions, especially in their formation and existence. Anyway, the establishment and the activity of micro-regions should be initiated by lower authorities (self-governments' effort to cooperate) and the recommendations may deal only with a degree of naturalness and economic efficiency of the micro-regional system.

One of the main issues in the micro-regions delimitation is quantitative regulation of the influence sphere of the largest cities. This process is quite demanding and it would require an extensive statistical testing. This problem is evident in the catchment regions of Prague and Brno whose generated area is not the micro-region. In case of these (and some other) municipalities, we recommend to delimitate the micro-regional nodal system without the municipalities themselves.

As to Prague (example of Prague-East and Prague-West districts: Fig. 3) and Brno (example of Brno-Province district: Fig. 4), we tried to delimitate it without the main commuting outflow (i.e. the flow to Prague and Brno). The whole process followed the methodology described above with a slight difference that we did not focus on the first but rather on the second most significant flow and the third and following flows of commuting were used as an additional criterion.

The results are satisfactory and they can be used as a proposal for the natural delimitation of micro-regions in the hinterlands of large cities. Regarding the Brno hinterland, some of (secondary) centres overlap the

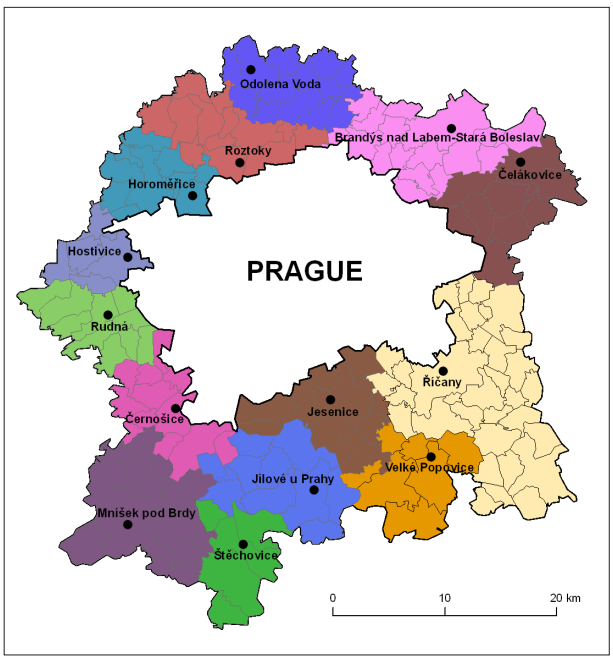

Fig. 3: Micro-regional system in Prague's hinterland (according to the 2nd flow of labour commuting, without flow to Prague)
Source: Czech Statistical Office, 2003; own calculations

Fig. 4: Micro-regional system in Brno's hinterland (according to the 2nd flow of labour commuting, without flow to Brno)
Source: Czech Statistical Office, 2003; own calculations

Brno-Province district boundaries, i.e. the catchment regions do not follow the district boundaries and continue in the neighbouring districts. The micro-regions in the Prague hinterland (not shown in the picture) do not respect the district boundaries either and continue out of Prague-East and Prague-West areas but their centres can be found in both of these districts.

5. Conclusion

According to Bezák's (1993) classification of regional taxonomies, the presented regionalization task can be ranked in hierarchical problems of functional regionalization with disjunctive regions. The resulting regionalization of the Czech Republic follows the regionalization procedures of Hampl (2005) and Mulíček, Sýkora (2008), corroborating their results and providing new data. The aim was not to gather the information for the delimitation of alternative districts (neither MEA nor deputed municipality areas) and thus we do not have to limit the size level of the smallest nodal (micro) regions or sphere of influence of the largest nodal regions. Therefore, it was not necessary to follow the rule of spatial justice (i.e. comparable size of regions) which is one of the criteria of a correct state administrative organisation.

The resulting map shows the natural stratification of the Czech Republic area and the province of the large, midsized and small regional (or micro-regional) centres. The localization identification and the spatial range of the smallest catchment centres is the added value of this contribution because it has not been mentioned in any of the Czech Republic's regionalizations. These smallest centres and their catchment regions can be found in sparsely populated and rural areas within the influence boundaries of large and midsized regional centres.

The resulting regionalization aptly reflects the coexistence of dominant Prague with other major cities (Plzeň, České Budějovice, Liberec etc.), meso- and micro-regional centres in Bohemia. It also expresses spatially more contrastive relations, which are typical of Moravian-Silesian centres. For further data processing, used in the proposed delimitation of micro-regions, it is necessary to eliminate the spheres of influence of the biggest centres. Prague and Brno have the most evident spheres of influence and therefore we delimited nodal regions in their hinterlands by the elimination of flows going into these two municipalities.

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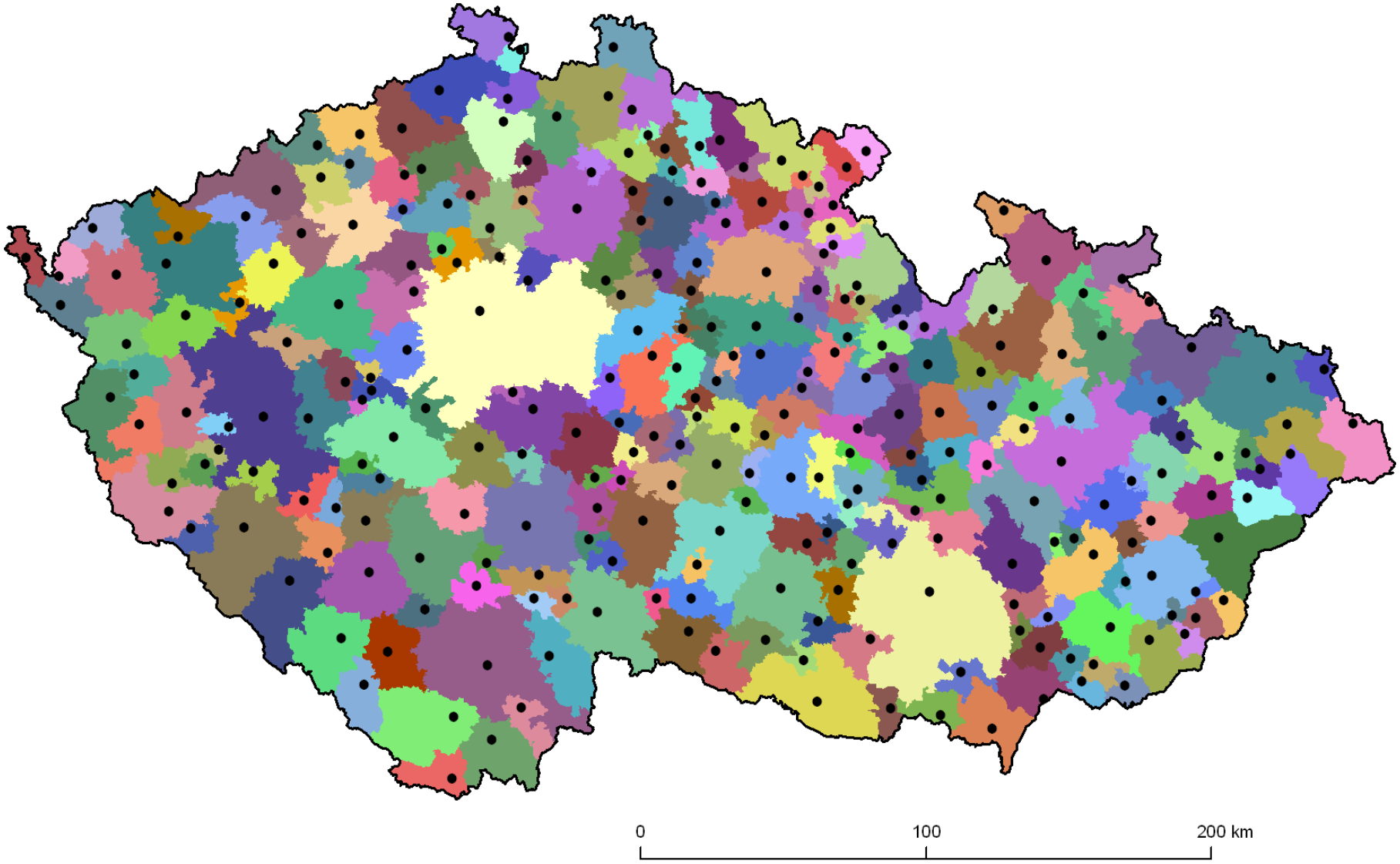

Fig. 2: Nodal regions in the Czech Republic (micro-regional level)
Source: Czech Statistical Office, 2003; own calculations

Illustration related to the paper by M. Halás et al.