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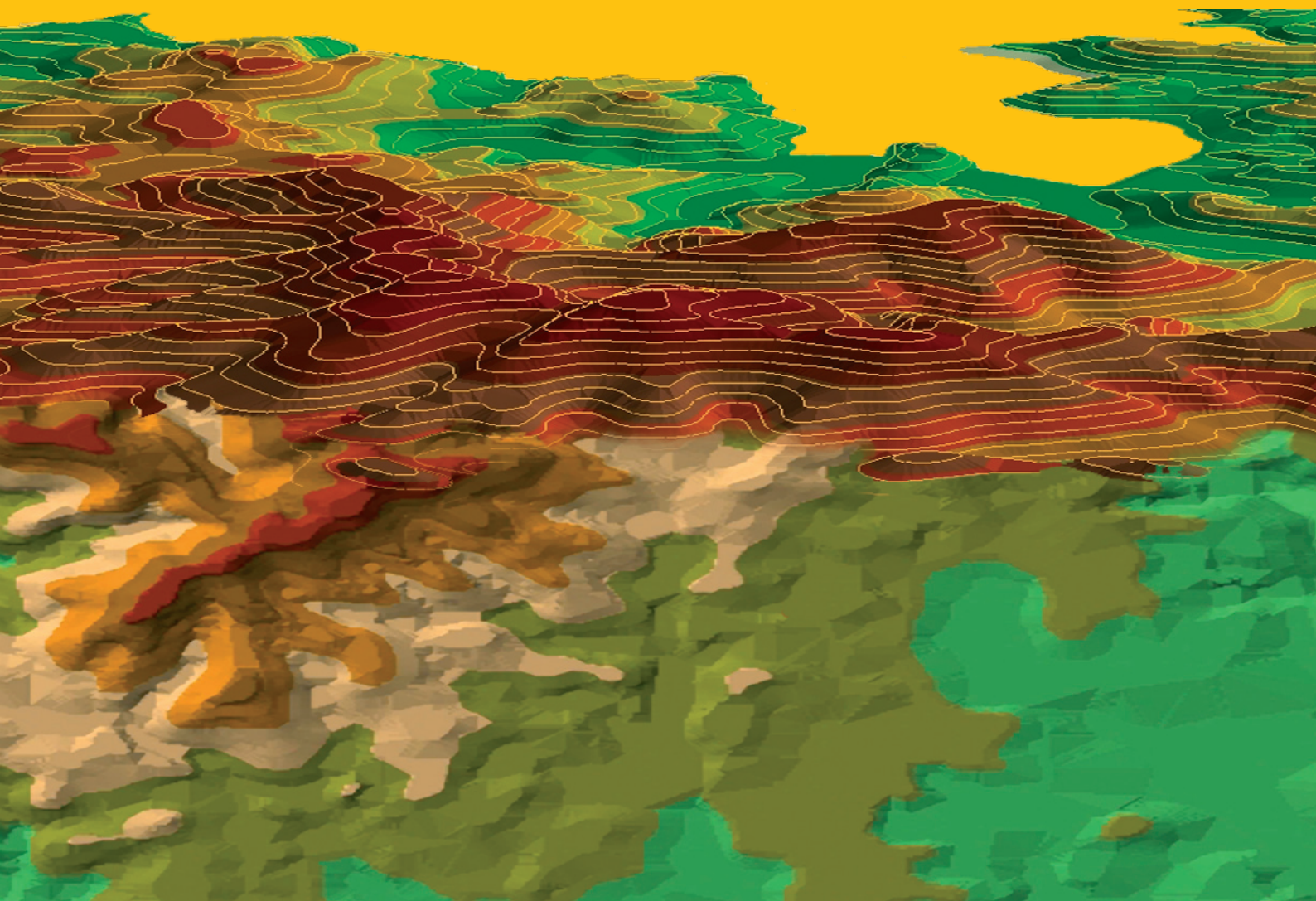

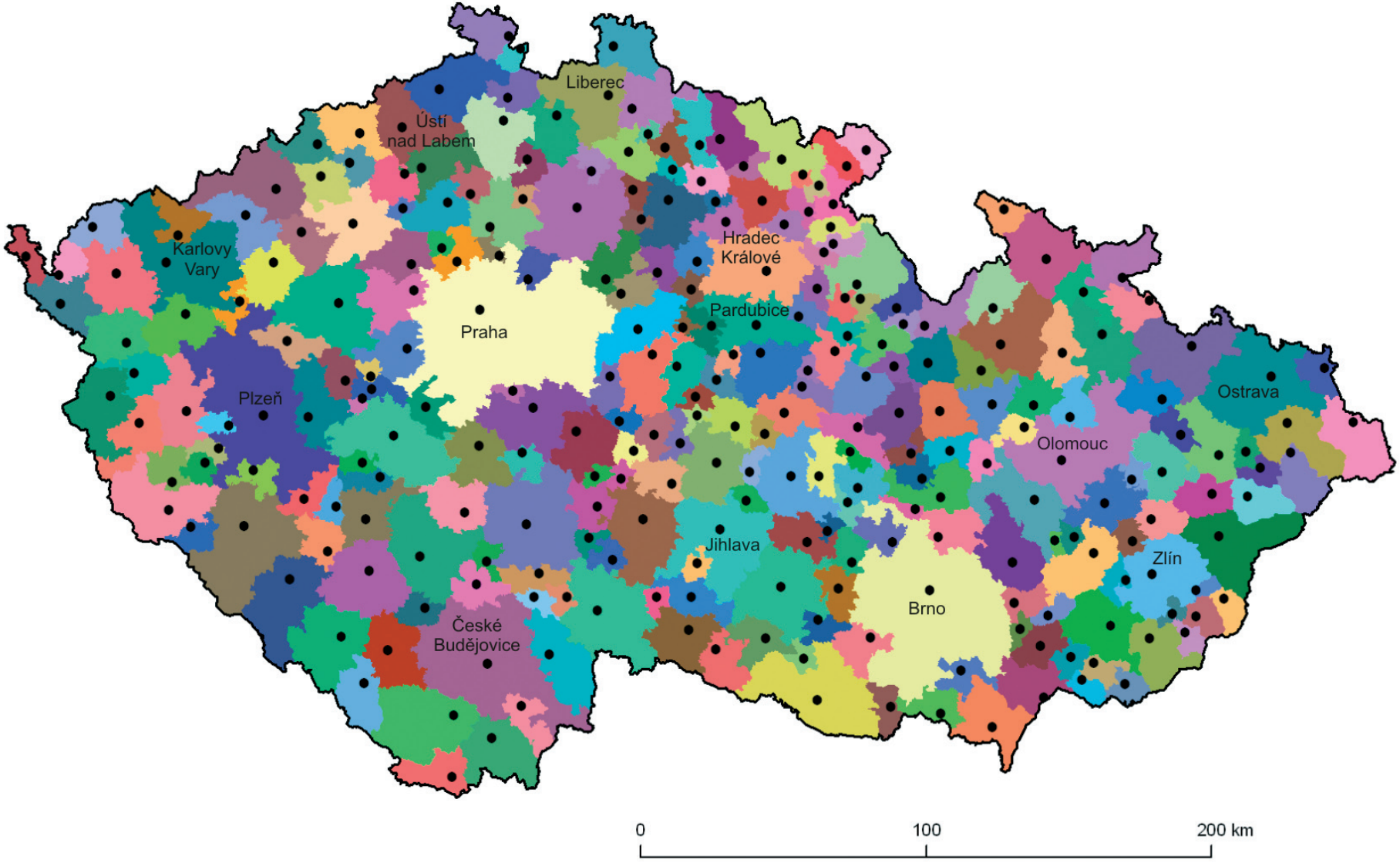

Fig. 2: Nodal regions in the Czech Republic (micro-regional level)
Source: Czech Statistical Office, 2003; own calculations

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

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Articles:

PUBLIC TRANSPORT IN RURAL AREAS OF THE CZECH REPUBLIC – CASE STUDY OF THE JESENÍK REGION

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Abstract

An evaluation of the development of public transport (PT) services in rural areas of the Czech Republic, and the analysis of PT supply level in the Jeseník rural region (NUTS4 – Jeseník District), as well as its dynamics, is the major objective of this paper. The Jeseník Region is one of the less developed Czech regions from many aspects, but an analysis of PT connections, frequencies and connection times in the region, has demonstrated a fairly positive situation during the evaluation of PT local service. The PT service is considered to be a key quality attribute to living in rural areas, mainly because some rural inhabitants, who are more likely to be socially excluded, benefit from the services.

Shrnutí

Hromadná doprava v rurálních oblastech České republiky – případová studie Jesenického regionu

Cílem příspěvku je obecné zhodnocení vývoje dopravní obslužnosti v rurálních oblastech České republiky a současně analýza úrovně dopravní obslužnosti a její dynamiky ve vybraném venkovském regionu Jeseníky (NUTS4 okres Jeseník). Region Jesenicko je jeden z nejvíce zaostávajících regionů České republiky. Analýza spojových frekvencí a dojížďkových dob hromadné dopravy v regionu však ukázala na poměrně příznivou situaci při hodnocení lokální obslužnosti. Dopravní obslužnost veřejnou hromadnou dopravou je považována za jeden z klíčových atributů kvality života na venkově, zejména ve vztahu k vybraným cílovým skupinám obyvatel venkova, jimž hrozí určitá míra sociální exkluze.

***Key words**: rural area, public transport, door-to-door approach, Jeseník Region, Czech Republic*

1. Introduction

The main goal of this paper is the analysis of dynamic changes within the framework of the analyzed area's intra-regional public transport services in the context of general Czech rural transport-geographical problems. The Jeseník Region is for the purpose of this paper defined as LAU1 region (Jeseník District). This region is in many aspects one of the most underdeveloped Czech regions (Rumpel et al., 2009), consisting of 24 municipalities with approximately 41,000 inhabitants. Its unfavourable and disparate development tendencies can be objectively proved even during the transport-geographical evaluation.

In the initial part of the paper, the literature dealing with problematic aspects of transport in the rural areas is discussed. Works analyzing the monitored area from the perspective of Czech transport system (hierarchical perspective, accessibility, transport services, or catchment areas issues) are mentioned as well. The development of PT in Czech rural areas is also briefly characterized, and the methodology selected for the analytical part of the paper is presented. The second part of the paper analyzes the current state and dynamics of the intra-regional transport services in the analyzed area.

2. Literature review

PT services in rural areas are a phenomenon, which has been studied by the geographers since the 1960s (Hůrský, 1969, 1978; Lijewski, 1967; Moseley, 1979; Řehák, 1994; Green and Meyert, 1997). In their research, they have put emphasis on delimitation of the service regions within the state (Hůrský, 1978), or within a lower hierarchical spatial unit, on commuting flows studies within a selected area (Lijewski, 1967; Sandow, 2008), or transport "behaviour" of rural areas' inhabitants (Nutley, 1998). Due to different political and economic conditions in Western Europe and in

socialist countries of Central and Eastern Europe, the object of research was likewise relatively diverse. In Western Europe, the massive increase of cars owned by individuals led to a decrease of PT usage, which resulted, in the conditions of free market economy, in the decrease number of PT connections and led to a social exclusion of certain groups of inhabitants (Gray et al., 2006; Farringhton et al., 1998; Shucksmith, Philip, 2000). This situation resulted in a discussion, whether the assurance of PT services in rural areas should be regarded as a public service.

In countries like the former Czechoslovakia, the role of securing PT services was taken over by the state. Hůrský (1969) remarks that, compared to Poland or Hungary, the ratio of economically active commuters was significant[1]. Therefore, with the low rate of individual car transport, rural areas could face the cities' competition only with sufficiently established network of bus routes – already in the 1950s, the volume of passenger bus transport was higher than in railway transport). Hůrský dealt with the methodology of geographical regionalization according to transport catchment areas in the Czech part of Czechoslovakia, based on the availability of data concerning the number and character of connections. In his work from 1969, he also marginally mentions the issue of quality of travelling by the PT, as well as the necessity to accept walking distance (door-to-door, see further text) into the overall duration of commuting process if this walking distance to the stop (particularly in rural areas) exceeds 15 minutes (Hůrský, 1969). It is proved that in some areas of the Czech Republic, walking distance can exceed this duration quite significantly (Ivan, 2009).

Within complex research works on rural, border or peripheral areas, emerged also transport-geographical works or outputs taking into account transport characteristics of the area when delimiting the peripheral territories (Řehák, 1982). According to Marada (2003), there is a relative agreement between the territorial distribution of peripheral areas and the territorial distribution of areas secluded from the system of public transport. These peripheral areas are affected by their location towards the core areas of the state or region, and they are logically located near administrative borders of NUTS3 regions or the state borders, which is in both aspects the case of the Jeseník Region. On the other hand, the absence of transport demand variance as a consequence of missing competition from the neighbouring districts (LAU1 regions) or micro-regions, is a comparative advantage of the analyzed area (Seidenglanz, 2007). This is due to the border character of Jeseník (working relations with Poland are negligible – see Rumpel, Wilam, 2006) as well as due to the mountain barrier between Jeseník, Bruntál and Šumperk (LAU1) regions. Thus, in the current post-transformation era are guaranteed relatively stable transport directions generating sufficient transport flows with respect to the specifics of the rural areas.

The analysis of PT supply and level in a territory is very important with regard to the possession of cars by households. Ownership of an automobile has still a considerable east-west gradient in the Czech Republic with the lowest numbers in Moravia and a significant difference between rural areas in Bohemia and Moravia (Maryáš et al., 2005).

Řehák (1998), Seidenglanz (2007), Zapletalová (1998), and Perlín (1999) dealt in their works with the general development of transport services in rural areas of the Czech Republic. Among other things, they pointed out the decreasing number of connections to municipalities during the afternoon and evening hours (so-called rationalization of connections). They also drew attention to the low level of interconnections of bus and train transports, which carry out different functions from the level of micro-regions up to the level of districts, which makes their mutual integration difficult from the operational (in particular), and tariffs' point of view. Seidenglanz (2001), in contrast to the earlier hypotheses, did not prove a decreasing supply of PT connections in the analyzed area. With regard to the subject of our research, we can consider his paper as a reference.

3. General problems of PT in Czech rural areas after 1989

Services provided by public transport are considered to be one of the key attributes of the quality of life in rural areas, particularly in relation to selected target groups of rural population, which is threatened by social exclusion in terms of transport accessibility to main services (Kvizda et al., 2007) in the ever more polarized rural space (Moseley, 1978; Nutley, 1998; White, 2001; Woods, 2005). Commuting to work, school or basic services is becoming an important condition for living in the Czech rural areas already at micro-regional level.

[1] There were almost 43% of economically active commuters in Czechoslovakia in 1961. In Poland, the share was 21% (in 1964) and 12.5% in Hungary (Hůrský, 1969).

The historically strong position of PT in the territory of the former Czechoslovakia before 1989 influenced the objective and subjective perception of this issue at the beginning of the 1990s. Rapid decrease of transport performance of PT related with the disintegration of the centrally planned economy, gradual privatization of state-owned bus transport companies and change in financing of this public service, led to an objective worsening of the situation mostly in less populated, peripheral parts of the country, including the inner peripheries (Musil and Müller, 2008). Rapid increase in the level of car possession was a logical result of the new social reality under the conditions of the Czech Republic, where the car represented a social status and independent mobility. On the other hand, it was only just in the rural areas where the possession of car became not only a phenomenon, as we already mentioned, but also a necessity in relation to the decreasing PT supply ensuring the essential travels. Nevertheless, the economic situation of the population in many rural areas did not allow to saturate the desire for independent mobility (i.e. car possession) at the same volume in the similar situation (i.e. the decrease of PT supply), but for different reasons, in some Western European countries. Therefore, we can formulate a not entirely proven hypothesis that under the economic conditions of the first half of the 1990s in the Czech Republic, it was thanks to the inhabitants' insufficient purchasing power that the impact of the so-called "vicious circle of PT" (Fig. 1), as it is referred to by White (2001), Marada and Květoň[2] (2006), and others (Gray, 2001; Perlín, 1999), was at least mitigated.

Insufficient legislation and centralized financing[3] of PT by the Ministry of Transport and delegated district authorities (LAU1) did not allow for the solution of this PT service problem with systematic and transparent approach. On the part of PT providers, the era of privatization and fragmentation of the state-owned enterprise ČSAD[4] was over, occurred a gradual consolidation of the industry, and even several large foreign operators entered the market. General strike on railways in 1997 influenced indirectly some political concepts related to the development of bus PT, which had an impact on the increasing volume of funds for financing provable losses of public bus transport. As for the decrease of transport characteristics of PT, an important role was played by the subjective opinion of the public, too. Their perception of quality and quantity of PT services was largely negative, despite the fact that Seidenglanz (2001) showed in the case of Jeseník Region that the supply of connections was almost unchanged in some regions during the analyzed period (1989/1990 and 1999/2000). That is why another aspect of PT development not only in rural regions has to be mentioned – viz. marketing of sustainable forms of transport mobility. It is the marketing management (Rumpel et al., 2007) and ability to inform people about the real level of PT service, which was heavily underestimated by suppliers and providers of basic or additional transport services. Changes were provoked by extremely competitive pressure on the part of foreign companies, whose service standards and customer care were of high quality standard. The reform of public administration forced the municipalities, or respectively the groups of municipalities, and particularly the Regional Authorities, to a more extensive communication of their measures in providing regional transport services.

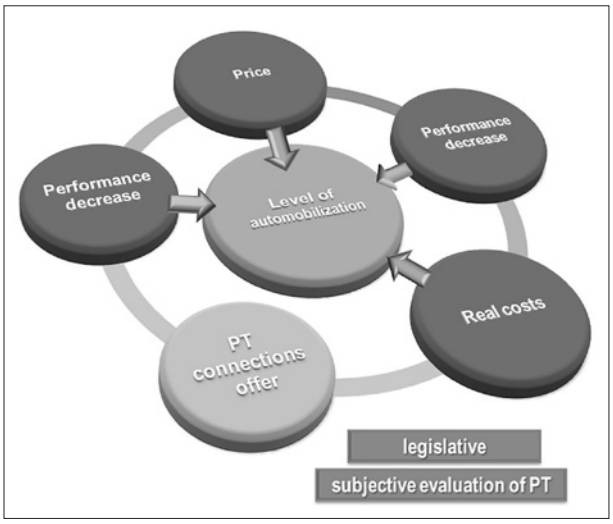

Fig. 1: The "Vicious circle" of PT (drawn by author)

3.1 Institutional changes of PT organization in rural areas of the Czech Republic

The public administration reform can be considered a fundamental change in the system of organizing and financing PT in the Czech Republic. The Regional Authorities took over the responsibility for PT organization (Smítal et al., 2007; Boruta, Ivan, 2008), while the District Authorities ceased to exist as public

[2] Increasing fares supported the shift to the usage of individual car transport, which again decreased the occupancy and economic profitability of PT connections (Marada, Květoň, 2006).

[3] Owing to the influence of mass media and general frustration, the term "funding" was often mistaken with the term of "subsidizing" the PT. However, the subsidy cannot be claimed, while the funds dedicated for the operators can always be claimed if all contractual relations (concerning meeting the commitment of public service) are fulfilled.

[4] ČSAD – Československá automobilová doprava (Czechoslovak Automobile Transport).

administration bodies as of January 1, 2003. The competence to guarantee basic transport services in the region was left in the hands of Regional Authorities and at the same time, the minimum volume of financing which the Regional Authority would have to allocate for PT was not defined any longer. In connection with the preparation for the accession to the European Union, the Czech Republic was bound to adopt a part of EU legislation related to the organization of PT within the Common Transport Policy.

Despite of many uncompleted procedural issues, this fact increased the pressure on a more reasonable financial management, and enhanced transparency (at least in the sector of bus transport) during the quantification of provable losses incurred by operators of specific lines (or even connections). The so-called modal principle of distributing the funds between railways and bus transport was cancelled. Finally, first integrated transport systems started to emerge based on the administrative principle – initially in big cities and their surroundings, and later on also in other, often rural or peripheral areas of the region.

This positive decentralization of competences from the national to the regional level increased the degree of Regional Authorities' emancipation. However, a consequence of this situation is the growth of some regional disparities in the supply of PT services in the territory of the Czech Republic, which is mainly due to the heterogeneous approach to PT organization (economic, spatial, modal, integrated) at the level of NUTS3.

3.2 Walking distance as a negative factor of PT competitiveness in rural areas of the Czech Republic

Travel time by PT (Fig. 2) is an important aspect for inhabitants' decision between the individual car transport and mass transport in case they have the option. With regard to the nature of PT, apart from the travel time, an important role is also played by the walking distance to the PT stop. It is the walking to or from a stop which is commonly not taken into consideration in commuting analyses, even though it often has a significant share in the total commuting time or distance (e.g. to work), namely in rural, peripheral or low-populated areas, and can be a significant factor for the objective preference of individual transport.

This method of analysis is often referred to as a door-to-door approach. Mountain (or more generally rural) areas have a higher percentage (up to 10%) of stops with service radius over 5 square kilometres. In these cases, the distance between the address point (place of residence) and the stop becomes a significant factor putting the PT into disadvantage.

Moreover, not all "nearest" stops are significant for real transport service. There are other factors that can complicate the walking process of commuters such as climate conditions, relief, or the quality of street surface on the way from the place of residence to the access point of PT (the stop), let alone the often high deviations of the connection. The specific Silesian scattered housing is another factor negatively influencing the walking distance – this can result in certain technical and organizational measures (more stops outside urban areas with a minimum number of passengers), which again slows down the travelling time by PT (it is necessary to respect this in timetables etc.). For more information about the door-to-door approach, see Ivan, 2008 or Ivan, 2009.

In territories with local railways not primarily built for passenger transport (Kvizda et al., 2007; Popelka, 2007; Pavlíček, 2002) or at the time when the walking time to the stop was not considered a relevant aspect for laying out railway tracks (fixed costs of railways construction were more important, because of their primary usage – transport of materials and goods), stops are often located outside the urban areas. Although the number of train stops is two or three times lower in comparison to the bus transport on a specific route[5], technical parameters of railways do not allow to take advantage of this fact for faster travelling times in the rail transport. As a consequence, the railway transport is slow and far away from centres of transport demand. The same situation is in the analyzed area.

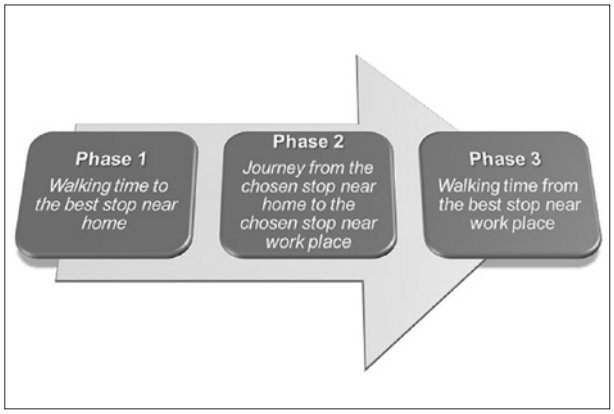

Fig. 2: Door-to-door approach (Ivan, 2009; drawn by author)

[5] This refers to the area analyzed in this paper in case of the existence of both transport modes in the municipality's territory. However, we can formulate a hypothesis that similar findings will be valid for the whole territory of the Czech Republic.

4. Characteristics of the analyzed area

The Jeseník area represents one of five districts (LAU1) of the Olomouc Region (NUTS3). It is located in its northern part near the borders with Poland and consists of four micro-regions (24 municipalities with 41,000 inhabitants in total); its area size is 71,896 km^2. The Jeseník district shows the lowest population density[6] within the Olomouc Region and, based on its structural characteristics; it can be doubtlessly classified as a typical rural peripheral area with many socio-economic problems. It is mostly of mountain (southern part of the territory is a part of a PLA[7]) or piedmont character with eccentric location towards the rest of the Czech Republic and with a significant barrier of the Jeseníky mountain range. The Jeseník district has a typically uniform pattern of towns and villages over the area, which lays high demands on the PT organisation within the region.

The density of road network and the rate of car possession[8] are at the lowest level compared with other LAU1 regions of the Czech Republic (Tab. 1). The lower rate of car possession indirectly increases the demand for PT among the selected target groups (Sandow, 2008; Dijst, 1999). Trunk road is the road I/44 from Šumperk through this region to Poland; from the perspective of E-W connection, trunk road is the road I/60 from Jeseník to Bílý Potok (Fig. 3).

Technical parameters of the trunk road, together with the necessity to get across the mountain saddle under complicated climate conditions during a large part of the year, make the region's transport accessibility towards the regional capital and other regional centres (Šumperk) very difficult. Eventual construction of a tunnel connection between Moravian and Silesian parts of the Jeseníky Mountains is unrealistic (high capital investment with regards to the small population size of this region, concerns of the local environmentalists and significant part of the population about the increase of transit traffic with direction to Poland[9]). Considering the currently minimal transit traffic and the already mentioned characteristics of this region, it is the region with a very low volume of traffic on roads, which are yet in very bad technical condition (Fig. 4). The trunk railroad line is railroad Hanušovice – Jeseník – Mikulovice, crossing the barrier of the Jeseníky Mountains over the Ramzovské sedlo Saddle. To this national railroad[10] are connected local railroads Jeseník – Javorník (with the branch from Velká Kraš to Vidnava) and Mikulovice – Zlaté Hory (Fig. 3).

Order	LAU1	NUTS3	km/100 km^2	Order	LAU1	NUTS3	car/1,000 people
1.	Prague – East	CB	114.8	1.	Prague	PR	510
2.	Kladno	CB	113.7	2.	Prague-City	PR	490
3.	Jablonec n. N.	LB	110.8	3.	Prague-East	CB	490
4.	Beroun	CB	105.2	27.	Český Krumlov	SB	390
5.	Chrudim	PU	101.6	28.	Chrudim	PU	390
	CR		70.4		CR		390
53.	Olomouc	OL	66.4	44.	Jablonec n. N.	LB	370
56.	Šumperk	OL	64.0	67.	Olomouc	OL	320
75.	Český Krumlov	SB	42.9	71.	Šumperk	OL	310
76.	**Jeseník**	**OL**	**41.0**	**77.**	**Jeseník**	**OL**	**290**

Tab. 1: Road network density and rate of car possession in 2005 in LAU1 regions
Note: CB – Central Bohemia Region, LB – Liberec Region, PU – Pardubice Region, SB – South Bohemia Region, PR – Prague Region, CR – Czech Republic
Source: author – according to Maryáš et al. (2005, 2007)

[6] Jeseník District – 58 inhabitants per km^2, Olomouc Region – 122 inhabitants per km^2.

[7] Protected Landscape Area.

[8] The Czech Republic shows a significant east-west gradient concerning this indicator, which until now abnormally influences the rate of car possession in cities and villages in contrast to e.g. Western Europe (where the rate of car possession is nearly always higher in rural areas). In this study is used the rate of car possession according to EUROSTAT, i.e. the number of cars per 1,000 inhabitants of the district (LAU1), while Maryáš et al. (2007) use the number of cars per 10 inhabitants of the district (LAU1), Marada, Květoň (2006) use the number of district's (LAU1) inhabitants per one car. Despite a certain inconsistency in the final interpretation of the term "rate of car possession" is this indicator quite precisely statistically recorded in the Central Register of Cars of the Ministry of the Interior) from which the data for all studies were drawn.

[9] See Šimek, Sýkorová (2001): Sociologický výzkum k rozvoji dopravy Jesenického regionu.

[10] Based on law No. 266/1994 Coll. on railways categorization.

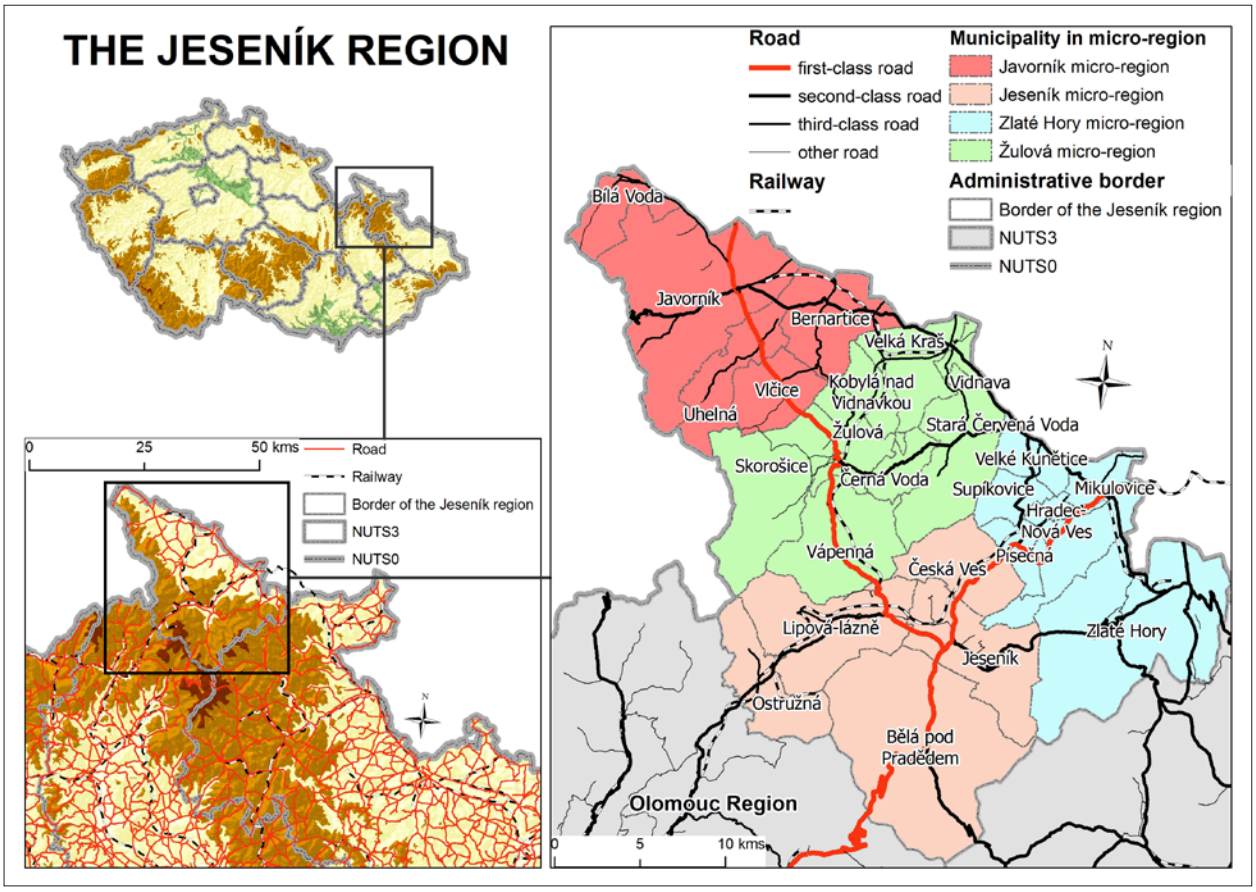

Fig. 3: The Jeseník Region (drawn by author)

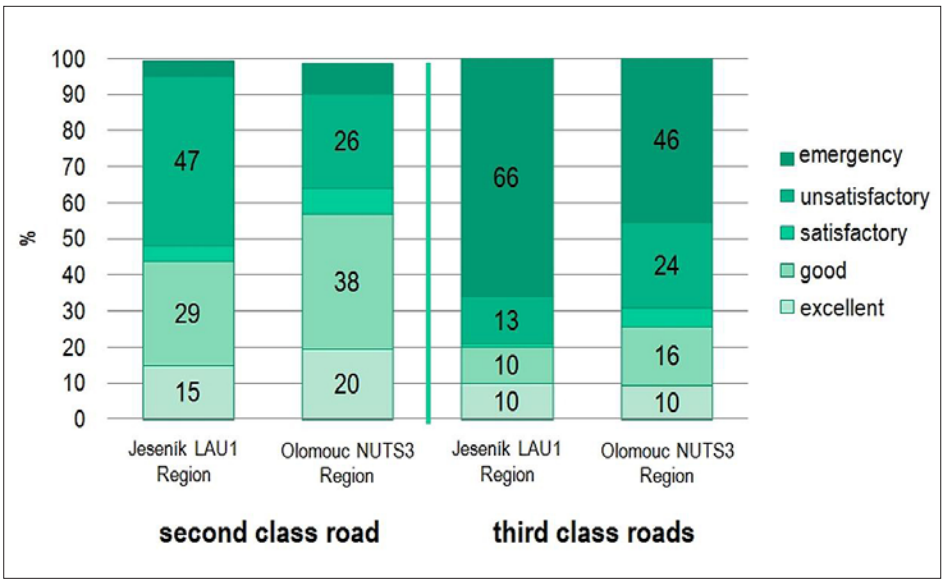

Fig. 4: Technical state of roads in Olomouc NUTS3 Region (2006). Source: drawn by author according to the Concept for the development of road pattern in the territory of the Olomouc Region until 2010 (2006)

The analyzed region is currently a part of the integrated transport system (ITS) of the Olomouc Region (ITSO, since 2003). On the territory of the Czech Republic is applied a so-called administrative principle for the delimitation of the spatial operation of integrated transport systems. That means that integrated transport systems are established under the competence of Regional Authorities (NUTS3), which often, as is the case of the Olomouc Region, take over the role of a so-called ITS coordinator. Implementation and optimization of ITSs is a regionally differentiated process, related to the specific spatial structure of particular regions (White, 2001). Regional Authorities are funding the regional transport in line with the valid

legislation in the mode of basic transport services, while municipalities financially contribute the carriers in the mode of additional transport services. Very important institutional role has the Association of Municipalities of the Jeseník Region (AMJR), mainly in respect of the quality of connections and their supply, especially weekend connections (except for working days). AMJR has played an important role in regional development since 1993; in context of transport agenda, AMJR guarantees additional PT services in the whole Jeseník Region, which helps significantly in the communication and negotiations with PT providers about the volume of financial compensations, number of connections, etc. This complex approach to providing weekend connections makes the planning mechanisms and bureaucratic procedures easier (in some areas of the Czech Republic, the PT provider negotiates separately with individual municipalities). In the Jeseník Region, PT services are provided by two operators – bus (Veolia Transport Morava, Inc.) and train (Czech Railways, Inc.). As to long-distance bus transport, there are some other PT providers involved in the supply of PT services – e.g. Orlobus and ČSAD Ústí nad Orlicí [11]. In 2001, the modal split between individual car transport and PT was approximately 45 to 55%. With respect to general trends in the decreasing share of PT usage in Central European countries (Pucher, 2002), the current modal split can be estimated at 50 to 50% or worse for PT. However, in context of the situation in Western European countries, there is still a significant share of persons using the PT.

The role of intra-regional transport service in the territory is played predominantly by bus transport (UDIMO, 1998); railways are used for travelling over longer distances when commuting destinations are outside the analyzed region. Different roles of bus and rail transport in the region are also influenced by the historical development of the railroad network, which does not suit the today's door-to-door approach in commuting within short and medium distances.

5. Methodology

PT services in the Jeseník region were assessed on the basis of the number of PT connections existing between municipalities of the analyzed region and the city of Jeseník in both directions in particular hours of interest. These time intervals were determined to 6 a.m., 7 a.m., 8 a.m., 2 p.m. and 10 p.m. At these times, transport is most intensively used for commuting to work and school. The NEWDOK application, under development by the Institute of Geoinformatics since 2001 (Fojtík et al., 2009), has been created for searching in PT timetables (CHAPS, Ltd.). This methodology was implemented also in further studies of different regions researches. Therefore, it is suitable for a potential comparison (Horák et al., 2007; Horák et al., 2008). As a valid connection was included every connection, which fulfilled the input criteria:

- maximal duration of PT connection is 90 minutes,
- arrival not sooner than 60 minutes before,
- maximum of 5 changes [12].

The results were subsequently visualized in cartograms.

The method of time accessibility of the city of Jeseník from individual municipalities (in both directions) was chosen as the second type of analysis. Individual connection times were drawn from up-to-date timetables and the representative travelling time between two municipalities was used the fastest of all connections with arrival at 8 a.m.(i.e. between 7 and 8 a.m.). Subsequently, the times were aggregated into three time intervals based on time accessibility of the destination. Green colour marks municipalities from which the fastest PT connection reaches a below-average time (less than 31 minutes) according to the average for the whole Jeseníky Region. In neutral colour are municipalities with the connection within the average duration for the whole region. Red colour marks municipalities, where the length of the fastest connection time substantially exceeds the average length of connection in the Jeseník Region.

The analysis of connections and method of time accessibility was carried out in the time profile 2003/2008. The year 2003 was chosen as the first reference year because of the real impacts of the public administration reform in that year (establishment of NUTS3 regions and their responsibility for the regional PT functioning from January 1, 2003).

Various data sources were used for the evaluation of walking distances to PT stops for commuting to work [13] in the Jeseník Region. PT stops localization was adopted from timetables valid for June 2008 (CHAPS, Ltd.). As a data source concerning buildings was used the Register of census areas (Czech Statistical

[11] These lines are operated on the territory of ITS in the mode of regional transport.

[12] Due to the micro-regional scope of the given survey, extreme values of criteria did not occur.

[13] As the concept of data preparation is specifically oriented on commuting to work (Ivan, 2008), we do not mention any other purposes of commuting although the needs of commuters for reaching a specific stop are changing in such case only minimally.

Office) as of July 1, 2008. For analysis of stops' distribution towards the buildings were calculated the walking distances to the two nearest stops without distinguishing the type of transport. Spatial distances were subsequently converted to time distance with average walking speed being 4.8 kph.

6. Results

The resulting analysis of connections in 2008 (Fig. 5) implies that transport accessibility of municipalities along the railroad No. 292 Hanušovice – Mikulovice, or respectively along the roads No. 369, 60 and 44, was very good. The supply of train and bus connections is also perceived, according to the results of a questionnaire survey in these municipalities, as the best in the whole of the former district (Boruta, Ivan, 2008; Rumpel et al., 2009) – this applies particularly to Lipová-lázně, Česká Ves, and Písečná, i.e. municipalities adjoining to the city of Jeseník. Public transport is operated in this area for commuting at intervals similar to city PT during peak hours. Due to large territories of the municipalities, the following research should be focused also on the actual walking distances of potential passengers to the specific connections (see the preceding chapter). Žulová has confirmed its position of the local transport node, ensuring transport links to and from Žulová and Javorník micro-regions (from and to Jeseník).

The second cartogram (Fig. 5) shows the already mentioned general trend of the rationalization of PT connections during night hours. The used methodology proves problems in the northern (north-eastern) part of Žulová micro-region, Javorník micro-region (Bernartice, Bílá Voda) and Bělá pod Pradědem. Detailed examination outside of the used and frequently sufficient methodology uncovered the existence of one night connection from Jeseník to some of the above mentioned municipalities at 10.30 p.m.

Thus, the PT accessibility to all 23 municipalities during night hours appears to be sufficient from this perspective, particularly in the context mentioned in chapter 2. If we compare the supply of connections with the year 2003 (Fig. 6), it becomes obvious that the total number of connections cumulatively increased by 51. Compared to the year 2003 there was a moderate decrease of PT connections for the morning commuting to Jeseník in 3 municipalities (between 6 and 7 a.m.; Vidnava, Česká Ves, Hradec-Nová Ves). For 11 municipalities we can demonstrate

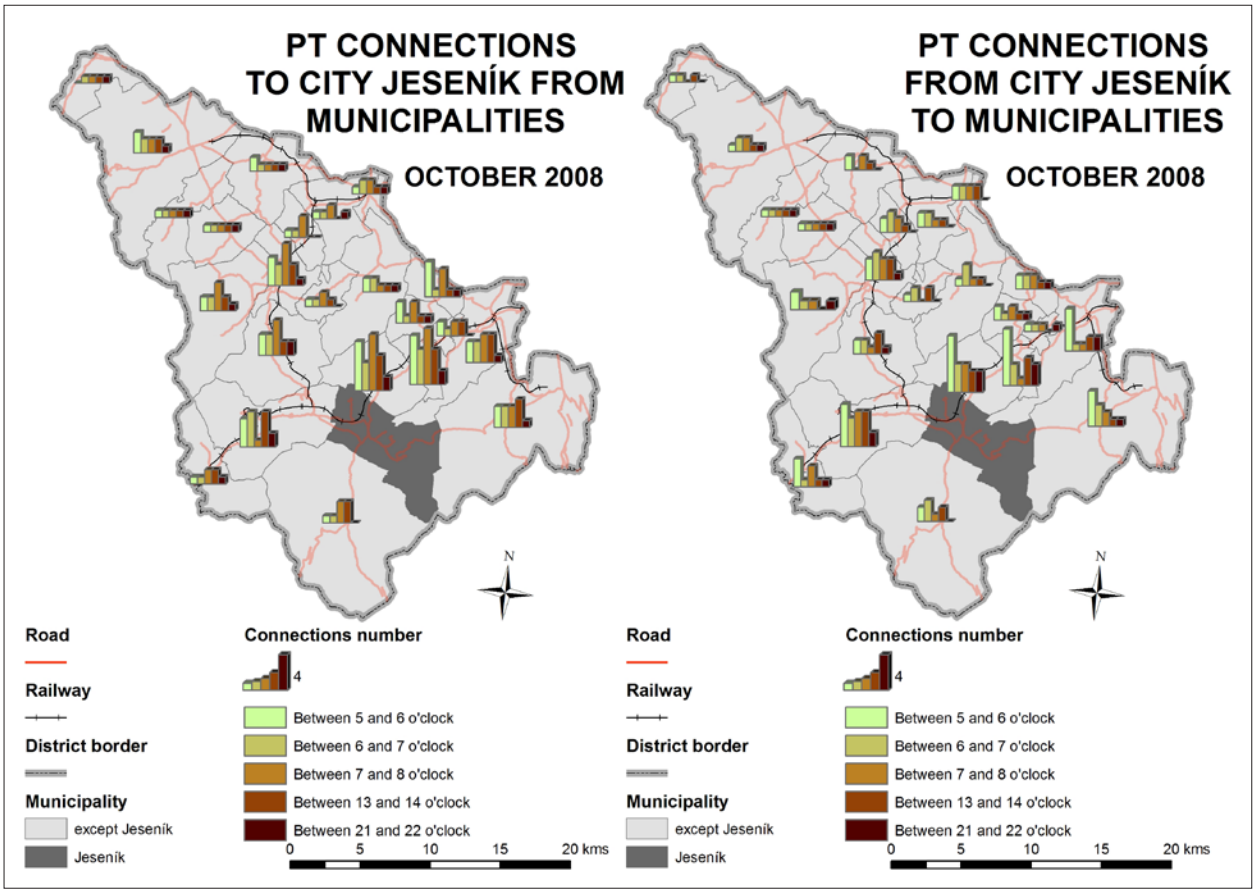

Fig. 5: Number of PT connections to and from the town of Jeseník (Source: author)

a slight increase of "morning" connections to the regional centre, particularly in commuting for 8 a.m. In contrast, the already mentioned rationalization of night connections was proved, which in the concrete territory concerns notably the municipalities with no connection from the city of Jeseník after 9 p.m. on working days (Bernartice, Bílá Voda, Černá Voda, Ostružná, Kobylá nad Vidnávkou and Velká Kraš). Except for Bílá Voda and Černá Voda, these are mostly municipalities through which runs the railroad.

The time interval above 45 minutes can be considered inconvenient and inattractive as to the use of public transport by inhabitants (Fig. 7). The resulting disadvantageous position of the Javorník outlet (administratively the Javorník micro-region) only proves it as a geographical periphery even within the Jeseník region (cross-border commuting relations are not significant at this moment). Interesting situation exists in the case of the significant transport node of Žulová municipality (Žulová micro-region). Due to manipulation times at the main stop in the municipality (changing of connections, correction of delays, etc.), this stop belongs to the average (neutral) interval from the perspective of travel time, although its real PT service is sufficient in terms of commuting time and the frequency of connections (synchronous operation of several lines from other municipalities).

The second map field in Fig. 7 shows worsening possibilities to reach the region's municipalities on requested time in the opposite direction, i.e. from the town of Jeseník to 23 region's municipalities. This is mostly because a lower demand for these connections and that means logically no existence of the second pair of connections on these routes.

The tabular output (Tab. 2) is a result of the walking distance analysis, where the walking distances to the two nearest PT stops from all buildings in municipalities of the Jeseník Region are shown both in metres and in minutes. For metric distances are stated values of arithmetic average and median. Median is in all cases below the average, which is mainly due to the fact that the value of average was influenced by the extreme values of walking distances from some remote buildings. Time distance is described with arithmetic average and maximum. Red colour saturation highlights cases (municipalities) with very long walking distances and blue colour saturation highlights cases with the shortest walking distances. The longest walking distance to the closest stop is in Ostružná where people

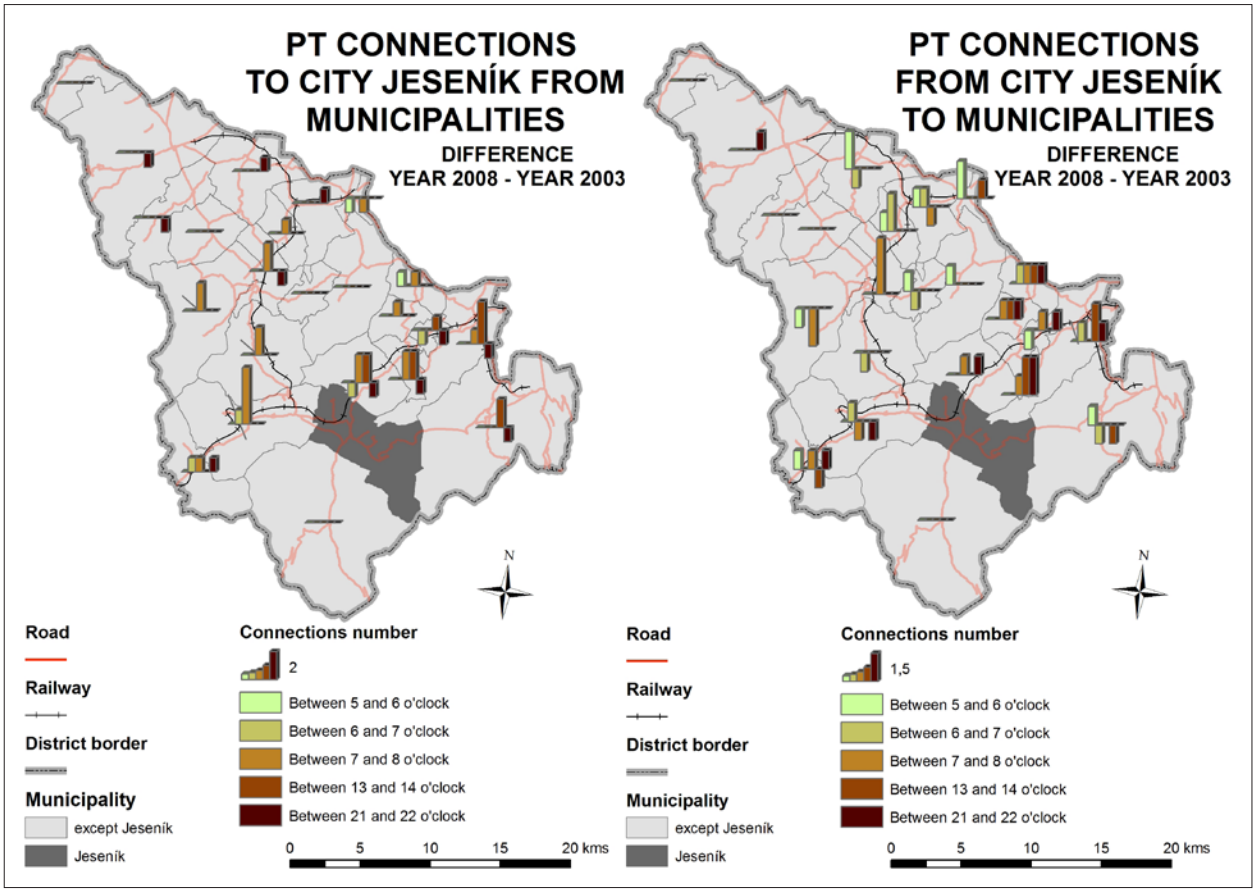

Fig. 6: Difference in the number of PT connections to and from the town of Jeseník in 2003–2008 (Source: author)

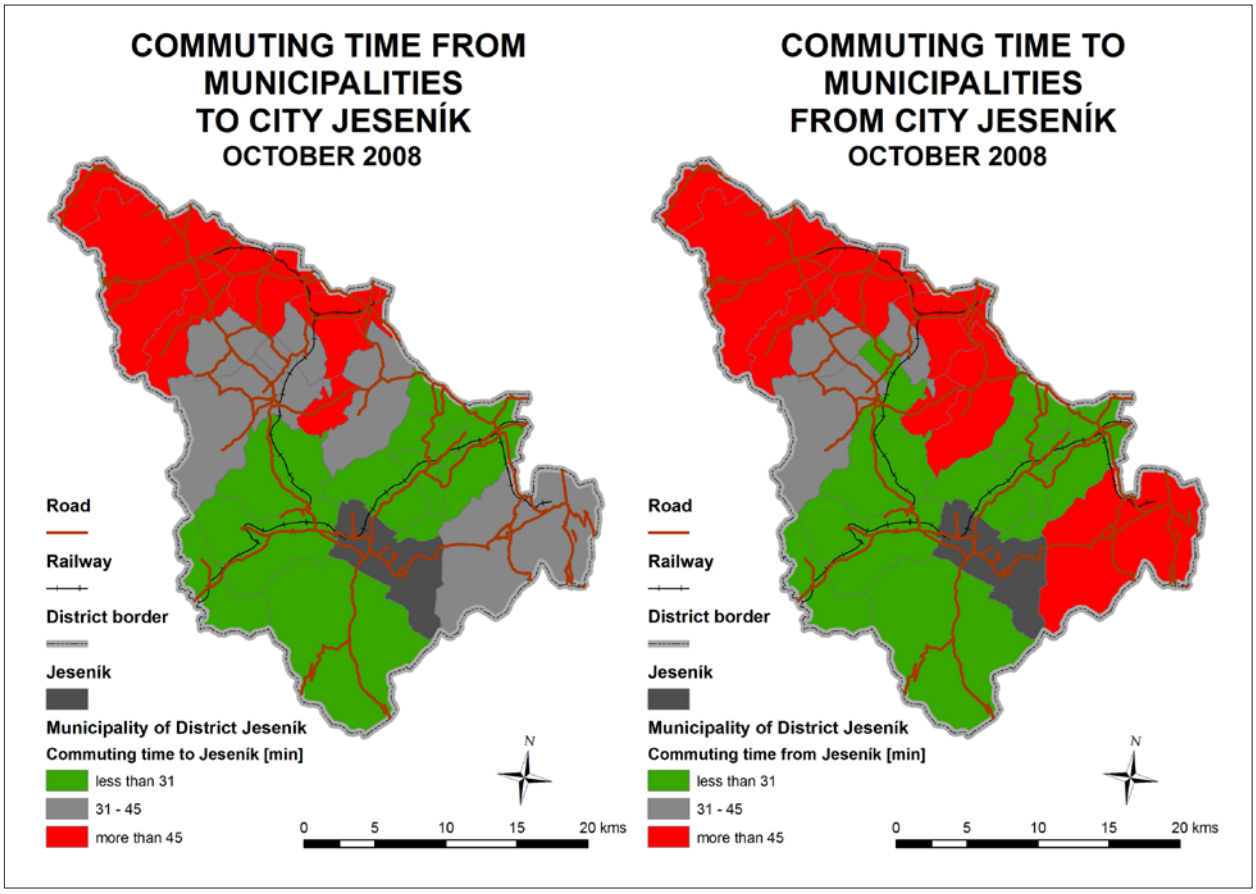

Fig. 7: Commuting time of PT connections to and from the town of Jeseník (Source: author)

have to walk up to one kilometre (almost 12 minutes), but the average distance to the second nearest stop is only about 150 metres longer, which is the smallest difference among all municipalities of the analyzed region. On the contrary, the longest distance to the second nearest stop is in Bílá Voda, where inhabitants must walk a distance of 1.5 km. This municipality also has the highest difference of walking distance between the first two nearest stops. The average walking distance to the closest stop is more than 500 metres for the whole Jeseník Region and to the second closest stop is the distance about 400 metres longer. In time space, it means that the walk to the nearest stop takes almost 7 minutes and in case of the second stop, it is almost 12 minutes. Worth noting is also the maximal walking time in individual municipalities – the most time demanding walk to the nearest stop is in Javorník and Bělá pod Pradědem, whose inhabitants will maximally walk for more than one hour. Average walking time to the nearest stop for the whole region is a little over 30 minutes, and 5 minutes longer to the second nearest stop.

7. Conclusions

From the analyses of intraregional PT services in the Jeseník region, we can draw the following conclusions:

- In spite of the necessary rationalization (particularly at night hours), the aggregate supply of PT connections has not worsened,
- There is an evident move of morning peak hours (considering the number of connections) towards 8 a.m. (commuting to schools and work in the service sector, in contrast to the absence of three-shift operation),
- Environment-friendly rail transport does not offer shorter travelling times in the door-to-door approach than bus transport. The travelling time of train (second phase of door-to-door approach) is not more attractive than the travelling time of the bus connection – with only one exception. Moreover, the walking distances to train stops are longer,
- Walking distances to PT stops are long within the whole region, and thus protract the total time of commuting, which decreases PT attractiveness compared to individual car transport. Due to the character of the territory, the climate (weather) plays an important role in the walking process, as well as the relief profile of the given walking stage and its character (sidewalk, road), and utilities of the particular stop (roof, street furniture, bike rack, tidiness etc.),
- The quality of local institutions has an important participation in providing additional PT services

Municipality	Distance of walk [m]				Time of walk [min]			
	Average		Median		Average		Maximum	
	1.	2.	1.	2.	1.	2.	1.	2.
Bělá pod Pradědem	435.24	1023.22	392.68	865.58	5.44	12.79	64.28	66.68
Bernartice	581.13	1000.09	602.77	1026.35	7.26	12.50	31.70	31.83
Bílá Voda	635.90	1580.17	502.06	1425.51	7.94	19.75	52.52	57.02
Černá Voda	617.13	797.76	361.70	527.60	7.71	9.97	29.66	31.05
Česká Ves	409.16	715.82	355.82	661.88	5.11	8.94	46.57	47.54
Hradec-Nová Ves	440.47	758.91	423.95	732.07	5.50	9.48	14.21	19.33
Javorník	762.56	1253.58	416.34	681.13	9.53	15.66	73.92	81.46
Jeseník	498.01	781.63	423.41	767.67	6.22	9.77	26.71	37.65
Kobylá nad Vidnavkou	353.16	697.49	337.84	646.66	4.41	8.71	12.28	16.87
Lipová-lázně	411.86	770.22	283.02	462.29	5.14	9.62	31.28	39.33
Mikulovice	535.57	931.53	472.67	890.81	6.69	11.64	31.87	41.54
Ostružná	946.74	1114.57	764.05	945.16	11.83	13.93	32.68	35.08
Písečná	637.54	1032.26	472.90	994.97	7.96	12.90	44.78	47.92
Skorošice	632.39	1165.74	564.16	1052.64	7.90	14.57	33.15	40.64
Stará Červená Voda	499.45	817.04	396.97	733.28	6.24	10.21	23.00	24.27
Supíkovice	489.66	1033.91	471.89	1062.12	6.12	12.92	17.39	23.68
Uhelná	575.10	1256.95	423.31	1144.25	7.18	15.71	40.27	46.83
Vápenná	627.77	970.69	432.50	850.36	7.84	12.13	33.96	38.18
Velká Kraš	496.42	799.95	381.76	713.19	6.20	9.99	26.15	32.85
Velké Kunětice	565.24	985.01	574.32	920.98	7.06	12.31	20.87	25.06
Vidnava	455.46	871.40	418.33	823.63	5.69	10.89	17.35	26.64
Vlčice	678.74	1136.46	510.28	1030.06	8.48	14.20	33.09	33.30
Zlaté Hory	470.61	742.04	333.23	533.90	5.88	9.27	49.16	64.79
Žulová	385.19	656.59	298.68	514.48	4.81	8.20	24.54	25.36
Jeseník Region	**547.52**	**953.88**	**442.28**	**833.61**	**6.84**	**11.92**	**33.81**	**38.95**

Tab. 2: Distance to the two nearest PT stops (Source: author)

and sustaining supply of basic PT services. The public administration reform has generally led to significant disparities between particular NUTS3 regions in the supply of PT services,

- PT supply is stabilized and the size of demand, despite a moderate regression corresponding to trends (respectively lower than the national average), can be considered as a success. However, this positive situation of the PT level is not at all exploited for marketing by the service contractor (regional authority, AMJR) or by the operators. Generally negative opinion of the public concerning the PT quality changes very slowly or not at all, particularly in the case of individual car users (and potential PT clients).

A comparison with other structurally similar (at least partly) regions will be carried out within the framework of further research with emphasis on analyses in the context of the door-to-door approach to commuting. For this future research, we can consider as inspiration also the issue of the inclusion of rural and peripheral areas into integrated transport systems, as well as a definition of the position of local railways in these systems.

In this context, it is also necessary to mention the prepared changes in legislation in the field of public services for passenger transport. These changes will be mandatory (valid since December 2009) for all EU Member States and from the perspective of the Czech legislation they will significantly modify the

institutional view on the assurance of PT services in regions (Drdla, 2009). For example, this European Directive counts with a possibility to implement the public service commitment apart from the home state also in a foreign country, which can be in the future good opportunity for border regions like Jeseník; in addition, a multinational bus operator provides PT also in Poland. The Directive also counts with a significant legislative (and directly even financial) discrimination in favour of rail transport in case the territory can be serviced by this type of transport.

In case of the analyzed region, there is a question whether the railways (particularly the Velká Kraš – Vidnava and Mikulovice – Zlaté Hory railroads) are able to function at full in everyday local commuting to school or work, and if it is at all – considering all economic and environmental parameters – ecological.

All previously mentioned railway routes in the Jeseník Region were severely damaged by floods, which struck the region at the beginning of July 2009. Unlike the similar situation in 1997 when the railway operator and owner – České dráhy a.s. (Czech Railways, Inc.) decided to shut-down the operation[14], an intention to repair all damaged sections was immediately declared. This shows a certain progress in transport policy of the state and regions.

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

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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.

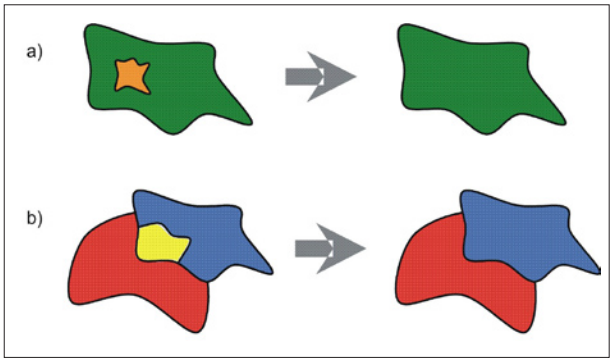

Fig. 1: Assignment of municipalities to centres in the case of region discontinuity

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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PROBLEM AREAS IN POLISH REGIONAL POLICY

Paweł CHURSKI

Abstract

The notion of problem areas is strictly related to selecting (based on regional research) rich and poor, growing and stagnant, strong and weak as well as crisis-generating and expansive regions. The need for selecting these areas is directly associated with one of the principles of regional policy: the rule of concentration. Contents concentration (connected to the policy's goals) and spatial concentration (related to the selected areas). The change in the regional policy paradigm (which seems to be a foregone conclusion for years to come) consisting in the departure from the compensatory model in preference for the polarization-diffusion model justifies the change of the name of problem areas to strategic intervention areas which has become a reality in some OECD countries. The goal of this article is to analyze and evaluate the changes in Poland's regional policy in the area of selecting problem/strategic intervention areas in 2000–2009, followed by recommendations on the financial prospects for 2014–2020.

Shrnutí

Problémové oblasti v polské regionální politice

Pojem problémové oblasti se úzce vztahuje k výběru (jako výsledku regionálního výzkumu) bohatých a chudých, rozvíjejících se a stagnujících, silných a slabých regionů nebo regionů procházejících krizí či expandujících. Potřeba vymezení těchto oblasti přímo souvisí s jedním z principů regionální politiky: pravidlem koncentrace. Obsahový aspekt koncentrace je spojený s politickými cíli, zatímco její prostorová dimenze se vztahuje na vybraná území. Změna v paradigmatu regionální politiky, která se jeví jako předběžný závěr pro nadcházející roky, spočívá v opuštění vyrovnávacího modelu a preferování polarizačně-difusního modelu, přičemž dále opravňuje změnu názvu problémové oblasti na strategicky intervenované oblasti, což se již stalo skutečností v některých zemí OECD. Cílem tohoto článku je analyzovat a zhodnotit změny v polské regionální politice v oblasti výběru problémových/strategicky intervenčních oblastí v období let 2000–2009, doplněné doporučením ohledně finanční perspektivy pro léta 2014–2020.

***Keywords**: problem areas, regional policy, regional development, Poland*

1. Introduction

Regional policy is a common form of state interference in social and economic processes. Contrary to popular opinion, the origins of this type of intervention measures exceed the time horizon of the Old Continent and the European Community. Regional policy is believed to have started in the 1930s, after the Great Depression of 1929–1933 when President Franklin D. Roosevelt enacted the New Deal in the United States of America. The New Deal was based upon the federal government's control over the economy (cf. Szlachta, 1990). From the very beginning, intervention as part of regional policy in Europe, and other regions of the world alike, has gone hand in hand with the need of identifying the spatial range of activities directly related to the necessary delimitation of this policy's problem areas.

The notion of problem areas is strictly associated with selecting (on the grounds of a regional research) rich and poor, growing and stagnant, strong and weak as well as crisis-generating and expansive regions. The need for selecting these areas is directly linked with one of the principles of regional policy: the rule of concentration. Contents concentration (related to the policy's goals) and spatial concentration (associated with the selected areas) of intervention are necessary mainly when accompanied by moderate funds the dispersion of which diminishes the activities' effectiveness. Despite the popular reference to the notion of problem areas an unambiguous and universal definition thereof has not been coined to date. When defining problem areas in literature on the subject, authors either indicate that the specific feature(s) is non-existent, or define them for the sake of a specific publication. Problem areas are nevertheless most frequently defined as underdeveloped areas with poor growth dynamics and plagued by the negative social effects of the transformation process (cf. Bański, 1999;

Churski, 2004d). Hence the notion of problem areas has a pejorative overtone and is directly linked with regional policy based on the compensatory model, accounting for the need of supporting the weakest regions for the sake of regional convergence.

The change in the regional policy paradigm (which seems to be a foregone conclusion for years to come) consisting in the departure from the compensatory model in preference for the polarization-diffusion model justifies the change of the name of problem areas to strategic intervention areas[1] which has become a reality in some OECD countries (cf. Reshaping Economic…, 2009; Barca, 2009).

The goal of this article is to analyze and evaluate the changes in Poland's regional policy in the area of selecting problem/strategic intervention areas in 2000–2009, followed by recommendations on the financial prospects for 2014–2020.

The author of this article was to a large extent inspired by his involvement in the Expert Team on Problem Areas/Strategic Intervention operating between January and May 2009 within the Ministry of Regional Development (cf. Identification and delimitation…, 2009) as well as by his previous research-related experience (cf. Churski, Hauke, 2002; Churski, 2002; Churski, 2003a; Churski, 2003b; Churski, 2003c; Churski, 2004a; Churski, 2004b; Churski, 2005c; Churski, 2004d; Churski, 2005).

2. Problem areas in Polish regional policy

For an analysis of the modes of identifying the problem areas in Poland's regional policy we need a definition of the stages of the related changes which have occurred in Poland since 2000. In general, three major stages should be distinguished:

- Regional policy of the pre-accession period 2000–2004
- Regional policy of the initial accession period 2004–2006
- Regional policy of the 2007–2013 financial perspective

2.1 Problem areas of regional policy in the pre-accession period 2000–2004

Poland's regional policy of the pre-accession period was hitherto the only time in the country's national regional policy executed with relative independence from EU regulations[2]. This was facilitated by the inclusion of pre-accession programmes from the instruments of national regional policy. Yet this was frequently attributed to the inefficiency of the measures in place due to the very limited funds. The rules for identifying problem areas in Poland's regional policy of that time were stipulated in the National Strategy for Regional Development for 2000/1–2006 presented in greater detail in the government's Support Programme 2001–2002/3. It set out five priorities to be carried out, three of which were intended to cover the whole country, while the remaining two were referred to in territorial terms:

PRIORITY A – Extension and upgrading infrastructure for enhancing regions' competitiveness.

Activities within this PRIORITY could be pursued all over the country.

PRIORITY B – Restructuring voivodships' economic foundations and creating conditions for their diversification.

Activities within this PRIORITY could be pursued all over the country.

PRIORITY C – Development of human resources

Activities within this PRIORITY could be pursued all over the country.

PRIORITY D – Supporting areas necessitating activation as they are threatened by marginalization

Activities within this PRIORITY could be pursued in problem areas[3] selected with respect to at least one of the following criteria:

1. per capita GDP in the voivodship (NUTS2) below 80% of the average national per capita GDP (as of 1998),
2. unemployment rate in poviats (NUTS4) exceeding (in each of the past 3 years) 150% of the average unemployment rate in Poland (as of 31 March or 31 December in 1998, 1999 and 2000, adopting a variant allowing to qualify the poviat as a support area[4]).

Bearing in mind the above criteria, 161 poviats were selected (NUTS4) as problem areas within this priority (Fig. 1). The selected areas encompassed the whole

[1] The polarisation-diffusion model relies on intervention as part of regional policy in economically robust regions (to boost their development) and in under-developed areas in order to bridge the gap between them and the central areas. It would be therefore groundless to continue using the notion of problem areas with its pejorative overtones.

[2] The basis for the new model of regional policy was the Act of 12 May 2000 on the principles of supporting regional growth. O.J. No. 48/2000 item 550.

[3] The term used was "support area".

[4] With the stipulation that the time frame for defining the unemployment rate in 1999 needs to be the same as the time frame adopted for 2000.

of Poland's eastern and north-eastern voivodships, the so-called "eastern wall": Subcarpathian, Lublin, Podlasie, Warmian-Masurian and Świętokrzyskie voivodships. This priority's problem areas included also numerous poviats of the Pomeranian, West-Pomeranian and Kuyavian-Pomeranian voivodships marked by proprietary structure of agriculture dominated by former state farms, areas affected by depopulation and high concentration of the negative effects of industrial restructuring in the Lower Silesian, Opole and Lubusz voivodships as well as individual poviats in the Łódź and Masovia voivodships. The resulting spatial distribution is to a great degree due to the arrangement of peripheral areas surrounding three core regions of Poznań, Warsaw and Silesia selected in an analysis of Poland's regional diversification conducted by T. Czyż (2002).

PRIORITY E – Encouraging cooperation between regions

Activities within this priority could be pursued in problem areas selected with respect to the criterion of adjacency of statistical units NUTS3 to the country's land or sea borders. With the above criteria in mind, 17 sub-regions were selected (NUTS3) as well as certain poviats (NUTS4) of the Opole sub-region which are considered problem areas within this priority as listed in the annex to the Support Programme for 2001–2003 (Fig. 2). In line with the above criterion, this priority's problem areas formed a dense ring of borderline sub-regions (NUTS3) along the entire national border. The Opole sub-region formed an exception as three poviats – Namysłów, Kluczbork and Olesno – were excluded. This arrangement should be deemed mistaken for two reasons:

1. it introduced an imbalance to the border sub-regions by limiting their opportunities for support in the three poviats of the Opole sub-region,
2. it diversified the basic units whose arrangement served to determine the support areas for this PRIORITY (sub-regions NUTS3 and poviats NUTS4). On the other hand, the right decision was made while amending the Support Programme which removed Łosice poviat in Masovia voivodship from the list of problem areas. If the poviat had remained on the list of support areas, it would have reinforced the differentiation of basic units the arrangement of which is used for the determination of these areas. It would have also contradicted the adopted requirement of the statistical unit adjacency to the state border, a condition the Łosice poviat failed to fulfil.

The subsequent Support Programme 2004 did not account for the identification of problem areas. Due to Poland's accession to the European Union its regional policy became subordinated to EU regulations which treated the whole of Poland as one intervention area.

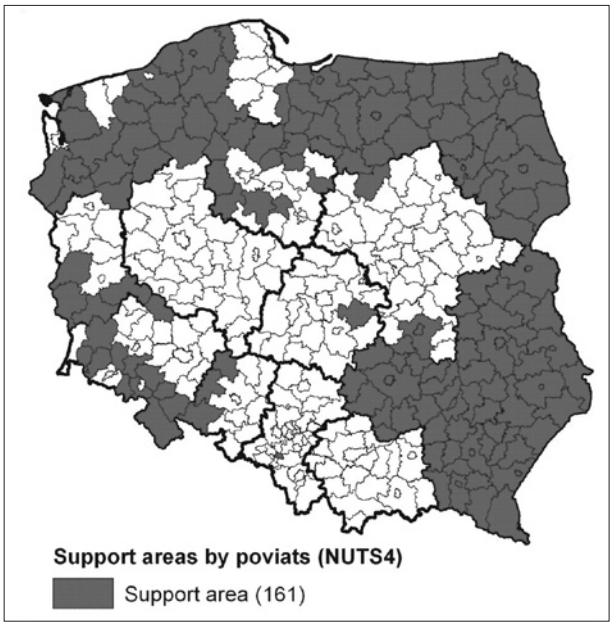

Fig. 1: Support areas within the priority: supporting rural areas in need of activating and under the threat of marginalization
Source: author's own compilation based on Support Programme 2001–2003; Official Journal No. 39/2001, item 460 as amended

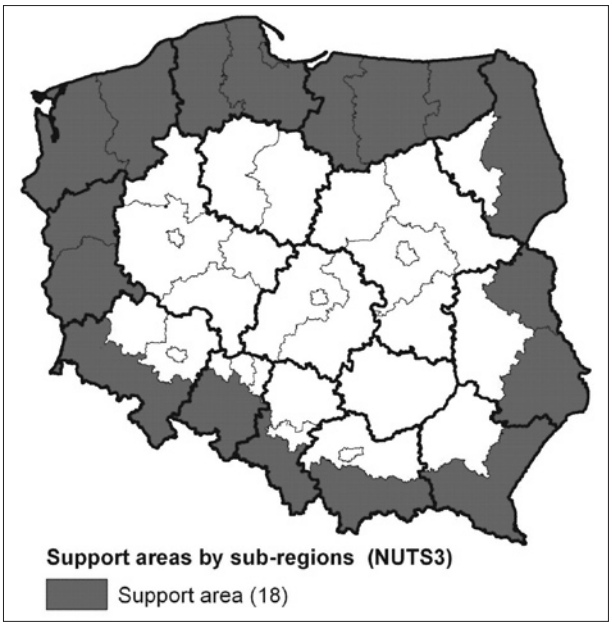

Fig. 2: Support areas within the priority: development of cross-border cooperation
Source: author's compilation based on Support Programme 2001–2003; Official Journal No. 39/2001, item 460 as amended

It is worth noting that on top of the foregoing rules of identifying problem areas as part of Poland's regional policy the national budget in the pre-accession period allocated within the Support Programme was divided in an indicative way on a regional basis. Together with the specification of the problem areas it was another element of the spatial diversification of the financial

support granted as part of the inter-regional policy administered by the state in the regions. The following criteria adopted in the National Strategy for Regional Development 2001–2006 were employed to this end:

- demographic criterion: 80% of the funds divided pro rata among all the regions with respect to the number of inhabitants,
- economic criterion: 10% of the funds divided in proportion to the number of inhabitants in voivodships where per capita GDP was below 80% of the country's average per capita GDP,
- social criterion: 10% of the funds divided in proportion to the number of inhabitants in poviats where in each of the past three years the unemployment rate exceeded 150% of the national average.

This division resulted in a distribution where the state granted the greatest assistance to the most populated and relatively highly developed voivodships: Masovian, Silesian and Lower Silesian. The aid was weakest in regions with the smallest populations: Opole and Lubusz. The calculation of these shares per capita however introduced a completely different spatial distribution of assistance granted by the state. In this case, the most under-developed voivodships in areas suffering from the accumulated negative social effects of the transformation resulting in high unemployment rates were at the top of the list (cf. Stasiak, Horodeński [eds.], 2005; A.Stasiak [ed.], 2006). These were the "eastern wall" voivodships and West Pomerania (Fig. 3). In all of these voivodships the per capita share of assistance from the state budget granted as part of the Support Programme 2001–2003 exceeded the national average, while in the case of the Warmian-Kuyavian region it accounted for massive 161% thereof.

2.2 Problem areas of regional policy in the first membership period 2004 – 2006

Poland's integration into the European Union dramatically changed the model of the country's regional policy. Even before the act on the National Plan of Development[5] was introduced, this document was already drawn up and all the sector and region-related operational programmes were developed in compliance with the European Commission's guidelines for member states in force in the 2000– 2006 financial period. In line with the valid EU regional policy at the time it was assumed that entire Poland would be considered a problem area of Goal 1 Activating under-developed areas in social and economic growth. This was due to the fact that not a single Polish region enjoyed per capita GDP (PPS) exceeding 75% of the then EU average (i.e. $15,159.8 per capita). The inclusion of all voivodships in the support programme as part of Goal 1 of the EU's regional policy was equivalent to their exclusion from applying for support in the remaining Goals.

The most significant instrument of Poland's regional policy in the initial years of EU membership was the Integrated Regional Operational Programme (IROP) that secured sector programmes and regions access to structural funds. The IROP 2004–2006 budget, in support of structural funds, was divided with respect to the criteria included in the National Strategy for Regional Development 2001–2006; the funds served the adoption of the strategy in the pre-accession period of 2001–2003. As a result the share of voivodships embraced by this budget closely resembled the regional division of the governmental Support Programme 2001–2003 budget.

In the first period of Poland's membership the existing governmental Support Programmes were abandoned within the scope of the regional policy financed from domestic funds and administered by way of Voivodship Contracts. It is worth noting that the central budget dedicated to regional policy intervention measures was so meagre that, apart from ensuring the actual contribution to the absorption of structural funds, its impact on the developmental processes was insignificant. These measures had nothing in common with the identification of the problem areas.

2.3. Problem areas in the regional policy of the initial EU membership period 2007 – 2013

The 2007–2013 financial period is the first complete EU budget period that included Poland. The model of Polish regional policy in this period was established in the Act on administering a development policy, as amended[6]. According to this model subordinated to the Community Strategic Guidelines, the National Cohesion Strategy (National Strategic Reference Framework) is the most important instrument of regional policy, substituting the National Development Plan administered by Operational Programmes of

[5] Poland's accession to the European Union involved obligatory changes to the model of regional policy. The scope of these changes was defined in the New act replacing the regulations from 2000 – Act of 20 April 2004 on the National Development Plan. O.J. No. 116/2004, item 1206 and its amendment – Act of 13 July 2006 on changes to the act of the National Development Plan and cerain other acts. OJ. No. 149/2006, item 1073.

[6] Act of 6 December 2006 on the rules of administering the development policy. O.J. no. 227/2006, item 1658 Act of 7 November 2008 on changes to certain acts with relation to implementing structural funds and the Cohesion Fund. O.J. no. 216/2008, item 1370.

sectoral or regional character. Measures applied as part of the NCS (NSRF) are in full compliance with the new goals of EU cohesion policy. Due to the fact that the Polish regions have failed to achieve per capita GDP equal to or above 75% of the EU average, the whole country became incorporated into intervention measures in Goal 1 of the EU's Convergence cohesion policy as a problem area of that Goal. In line with that Poland has not seen the implementation of Goal 2 Competitiveness and employment in regions. In contrast with the period of 2004–2006 and despite the fact that all Polish regions are treated as problem areas some areas also receive assistance from Goal 3 of the European Territorial Cooperation cohesion policy of the EU. The obvious asymmetry in the size of structural funds that can be disposed in Goal 1 and Goal 3 should be emphasized: 98.8% and 0.8% of the total allocation for Poland, respectively.

Ventures launched to execute Goal 1 of the Convergence cohesion policy NCS (NSRF) were implemented with respect to five Operational Programmes and 16 Regional Operational Programmes. This is an indication that the number of Operational Programmes remained more or less the same like in the period of 2004–2006 and that IROP 2004–2006 was replaced with 16 Regional Operational Programmes. It is worth noting that on top of the Regional Operational Programmes, the Operational Programme Development of Eastern Poland has regional characteristics and refers to special interventions launched at the level of NUTS 2 (Fig. 4). The origin of this measure that is linked to the financial assembly of structural funds together with an extra pool of state funds shows the government's determination to include the national goals of the regional policy in the execution of the European cohesion policy in Poland. Nonetheless the aid addressing the problem areas at hand disposes funds in addition to the Regional and Sectoral Operational Programmes from the lowest-value Operational Programme budget (3.4% of the total allocation). The very fact of launching the programme should be nonetheless appreciated as an important breakthrough in the administration of Polish regional policy. It should focus more on the internal goals and consequently on the internal discrepancies and the resulting distribution of problem areas. It also needs be stated that the remaining Operational Programmes set numerous priorities at a regional level. This is a clear evidence of the fact that effort was exerted at decentralizing regional policy and managing the EU funds with a greater inclusion of internal goals. Chief support is granted to measures undertaken within the scope of regional policy in Poland between 2007 and 2013 by implementing Regional Operational Programmes and replacing the Integrated Regional

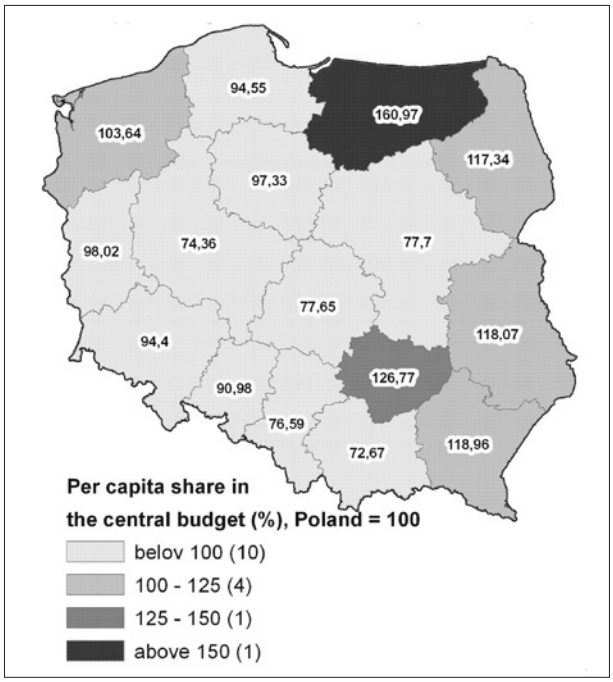

Fig. 3: Per capita distribution of the country's central budget: Support Programme 2001–2003 by voivodships Source: Support Programme 2001–2003. Official Journal no. 39/2001, item 460 as amended

Fig. 4: Problem areas: Operational Programme – Development of Eastern Poland 2007–2013 Source: author's own compilation

Operational Programme in the new financial period. The governmental allocation of the EU funds to the regions proved most controversial in light of the Regional Operational Programmes produced by regional authorities. Out of the three proposals the method reminding of the pre-accession period and IROP 2004–2006 was opted for on the basis of social consultation and very strong pressure from regional authorities. It relied on demographic, economic and social criteria without impacting the distribution.

Activities launched to accomplish Goal 3 of the European Territorial Cooperation cohesion policy have been implemented with respect to two territorial cooperation programmes: Cross-Border Cooperation Programme and Transnational Cooperation Programme supported by the Interregional Cooperation Programmes (INTEREG IVC). While the latter two programmes have international implications and may be executed in all Polish regions, the first one is dedicated to problem areas selected at the level of NUTS 3 located in member states along internal borders, several external borders and on coasts to the distance of below 150 km. In Poland this includes sub-regions the borders of which are concurrently state borders. Assistance was additionally allocated to all coastal sub-regions which distinguished it from the 2004–2006 period (Fig. 5). This had nevertheless no impact on the areas situated within 10 km from the border (e.g. the communes of Sarnaki and Stara Kornica in the sub-region of Ostrołęka and Siedlce) which were not eligible for support, while other areas located further than 100 km from the border still qualify (e.g. Byczyna commune in the sub-region of Opole and Wschowa commune in the sub-region of Zielona Góra).

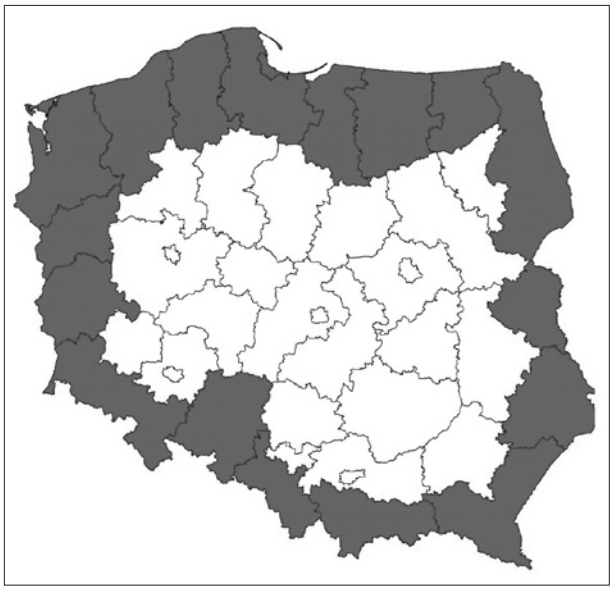

Fig. 5: Problem areas: Goal 3, European Territorial Cooperation 2007–2013
Source: author's own compilation

The regional policy measures funded from domestic sources maintained the Contract instrument which however tends to be applied chiefly to the allocation of structural funds to the regions and redistribution of the state's highly limited budget. These funds tended to be targeted grants (e.g. focusing on the upgrade of the educational infrastructure and healthcare, construction of sports grounds etc.). These measures, just as was the case between the years 2004 to 2006, fail to identify the problem areas.

3. Problem areas vs. planned changes to regional policy

The change to the regional policy paradigm consists in channelling intervention to support the regions' competitive edge in global rivalry by applying their internal resources and to prevent marginalization of the peripheral areas and of those accumulating the negative effects of transformation. The change has triggered a discussion on the future of the Polish regional policy. The fact that in late 2008 the Parliament adopted an act introducing acute changes to the existing regional policy model [7] was conducive to the discussion. In the face of the numerous new regulations the Minister for Regional Development assumed the task of identifying and delimiting the problem areas; at the same time another approach to the denomination was adopted by the new system of strategic documents – the Long-Term and Medium-Term National Development Strategy and the National Strategy for Regional Development. During the preparation stage launched at the Ministry of Regional Development it was assumed that the term "problem areas" should be replaced by "problem areas/ strategic intervention areas" – PA/IS referred to as "[...] areas selected with respect to the territory and domain which are not successful in properly managing and benefiting from their resources important with regards to the country's growth and which encounter substantial growth barriers. In order to establish how these areas should develop in an optimum manner respecting their specificity, a dedicated strategic intervention on the part of the state is required at observing the rule of subsidiarity" (cf. Identification and delimitation..., 2009, p. 23). Let us note that the work on the aforementioned documents and amendments thereof has not yet reached completion. It is however true that PA/IS will become a very important element of Poland's new regional policy. Its significance was confirmed by proposals presented in draft strategic documents and the relevant analyses. Three related studies were analysed:

- The Expert Project of the National Zoning Plan by 2033 prepared by the Scientific Expert Team re. the National Zoning Plan appointed by the Minister of Regional Development (cf. the Expert Project of the National Zoning Plan, 2008),

[7] The Act of 7 November, 2008 on changes to selected acts with relation to implementing structural funds and the Cohesion Fund. O.J. No. 216/2008, item 1370.

- Identification and delimitation of the problem areas and strategic intervention in Poland developed by the Ministry of Regional Development and the Structural Studies Institute in cooperation with the Expert Team (cf. Identification and delimitation of the problem areas and strategic intervention in Poland, 2009),
- Project of the National Strategy for Regional Development 2010–2020 elaborated by the Ministry of Regional Development which will become the basis of Poland's future regional policy (cf. Project of the National Strategy for Regional Development, 2009).

The timelines of all of the analysed documents exceed the present period of cohesion policy programming (2007– 2013). One can thus assume that their conclusions will largely affect the definition of the role of problem areas in Poland's regional policy after 2013. This approach is very likely to diverge from the existing one: in addition to the superior goal of absorbing structural funds as part of the EU's cohesion policy the national regional policy goals will also be pursued. O concern is however the fact that these documents use varying definitions of the problem areas.

The Expert Project of the National Zoning Plan by 2033 relies on highlighting problem areas as those which can be identified not only in line with the borders of territorial units but also in compliance with the geographic range of certain phenomena. The approach to the definition is derived from the compensatory concept and it is marked by a pejorative overtone. It is assumed that the problem areas suffer from the accumulation of certain negative social, economic and natural phenomena and that attempts at their solution or elimination call for governmental intervention. The delimiting process relies on an expert approach, i.e. on intuitive activities without the application of a ratio analysis. Two national areas and nine inter-voivodship areas have been selected (Fig. 6). Eastern Poland is regarded as the most serious problem area; it is plagued by accumulated negative results of the social and economic transformation and unfavourable historical conditioning. Its location along the external border of the European Union further aggravates the adverse growth conditioning. On top of that, attention was paid to the need for channelling intervention to areas of extremely poor transport infrastructure, areas of spatial conflicts (e.g. Ełk – Suwałki) and areas of special natural attractions which need to be continually protected. The problem of eastern Masovia was also highlighted. Despite its location in Poland's most affluent region, the Siedlce – Ostrołęka sub-region tends to be under-developed. Another problem area of national significance is the Upper Silesia conurbation, one of the most urbanized areas in the European Union together with the Krakow conurbation and the Ostrava-Karviná Coal Basin in the Czech Republic. The issues regarding environmental protection, development of post-industrial areas, decapitalization of the housing stock, worsening demographic trends and accumulating social pathology evidently call for extraordinary intervention. While the national problem areas are defined as coinciding with the borders of administrative units, all the remaining problem areas of inter-voivodship nature are defined in terms of their geographic range. This is bound to be a serious impediment to practical application. Diversified spatial conflicts necessitate external intervention. For example: the seaside belt, climatic changes, protection of the sea shore, urban architecture pressure, production of wind energy, the Odra River Valley and the Vistula Valley, development of flood areas, construction of bridge crossings, restoration of sea navigation, solution to the problem of dams and protection of areas of natural value.

The document Identification and delimitation of problem areas and areas of strategic intervention in Poland developed as a response to the changes in Poland's regional policy adopts an altogether different concept of problem areas. First, it treats them as PA/IS in line with the polarization-diffusion model of growth. The methodology of the hitherto completed work aimed at delimiting PA/IS is based on an objectified and scientifically sound methodology of quantitative research recommended by OECD and the European Commission. This ensures the transparency and neutrality of the results and the definition of spatial distribution of PA/IS in accordance with various statistical criteria. Importantly, a study produced for the purposes of the Project of the National Strategy for Regional Development recommends the division of intervention into two categories – areas of strategic intervention and problem areas – taking into account the regional policy implementation in Poland in compliance with the concept of polarization and diffusion-based growth; this view is fully supported by the author. The former group centres on the cities – capitals of the Polish regions – and it is concurrently internally diversified by them (Tab. 1).

It is assumed that intervention accounting for the internal diversification of the metropolitan areas, enhancing the quality and structure of human and social capitals, ensuring more innovation, higher productivity and spatial cohesion as well as bettering the natural environment will ensure optimum leverage of resources which will in turn affect the environment by diffusion processes. The other group includes

Fig. 6: Problem areas in the Expert Project of the National Zoning Plan by 2033
Source: Experts Project of the National Zoning Plan…, 2008 – p. 81

Category	Area	Reasons and directions of intervention
1	Warsaw	metropolis aspiring to MEGA class
2	Krakow, Wrocław, Poznań, Three Cities (Gdańsk, Gdynia, Sopot)	potential metropolises
3	Łódź, Szczecin	Growth hubs requiring a boost of their metropolitan function and resistance to marginalization
4	Bydgoszcz – Toruń sub-region	Specific situation in Toruń and Bydgoszcz as centres of intense cooperation; however, due to a relatively low level of development they cannot be included in categories 1–3
5	The Upper-Silesia conurbation (sub-regions: Rybnik, Gliwice, Katowice, Sosnowiec, Tychy).	Unique needs in the realm of natural environment reclamation and revitalization of the degraded housing stock
6	The remaining voivodship cities: Zielona Góra, Gorzów Wielkopolski, Opole, Olsztyn, Białystok, Lublin, Rzeszów, Kielce	Important regional growth centres necessitating assistance

Tab. 1: Strategic intervention areas recommended for the Project of National Strategy for Regional Growth
Source: Identification and delimitation of the problem areas and strategic intervention in Poland, 2009, p. 97

areas where developmental challenges accumulate. Areas of low educational quality, poor transport infrastructure and low levels of computerization are considered priority areas. This decision resulted in the arrangement of problem areas encompassing Eastern and Northern Poland as well as groups of sub-regions in the remaining voivodships (Fig. 7). Effective intervention in these areas requires detailed identification of the internal potentials of the selected diffusion areas. It seems however that the intervention should focus on enhancing infrastructure, developing human capital, enhancing business environment and improving spatial and social cohesion. Bearing in mind all the benefits of the suggested distribution of the problem areas let us not forget one drawback resulting from the application of sub-regions (NUTS3) as benchmarks for the delimitation. The large size and rich internal diversification of the sub-regions (NUTS3) prevents the adoption of this arrangement as the best option for the potential channelling of spatial concentration of regional policy intervention. The available public statistics in Poland unfortunately fail to provide a complete set of data for the poviats (NUTS4) and hence do not allow for a more detailed analysis.

The Project of the National Strategy for Regional Development is a document of great importance, confirming the trend of the changes occurring in Poland's regional policy. It is assumed that following consultation with social partners it will become adopted by the government and will form the basis for programming and executing regional policy in Poland by 2020. The strategy is based upon the polarization-diffusion related model of development. The identification and delimitation of PA/SI were conducted by way of the ratio method. Three strategic goals are planned to be achieved. Goal 1 Enhancing competitiveness is to be implemented in all voivodships by means of the arrangement of strategic intervention areas as presented in the previous document, i.e. cities, capitals of voivodships. It is assumed that strengthening the metropolitan functions of these areas, while creating conditions for the diffusion of developmental processes from voivodship centres and their absorption

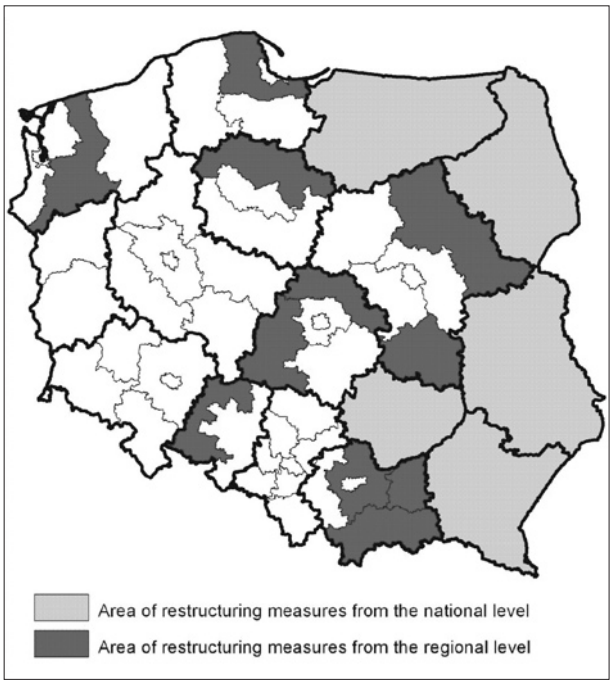

Fig. 7: Areas with the lowest levels of social and economic growth in the Project of the National Strategy for Regional Development
Source: Project of the National Strategy…, 2009, p. 74

in peripheral areas, will contribute to the enhanced competitiveness of the voivodships. Creating the basis for regional competitiveness will also be supported by horizontal activities targeted at the development of human and social capitals facilitating conditions for (chiefly external) investment, enhancing opportunities for the absorption of innovative solutions, development of business environment institutions and sustainable use of natural resources, including energy resources. The difference in approach comes down to an external classification of these areas which distinguishes three classes generalizing the formerly presented recommendation (Tab. 2).

As suggests the name itself Goal 2 Building territorial cohesion and countering marginalization in problem areas directly relates to the spatially concentrated intervention in the weakest areas. The following five classes of areas are expected to be identified:

Areas with the lowest levels of social and economic growth, including Eastern Poland, are to be offered special support by the continuation of the currently implemented Operational Programme Eastern Poland Development (regions with the lowest per capita GDP both in Poland and European Union member states) and sub-regions in other voivodships with per capita GDP below 75% of the national average or with the intervention allocated via Regional Operating Programmes.

Rural areas in the gravest social and economic situation and with the poorest access to services and goods which condition their growth opportunities were selected in the poviat arrangement with respect to coexistence of the following social and economic phenomena: large share of inhabitants employed in agriculture, small share of employment in non-market services, poor availability of healthcare and education, low levels of education and effectiveness of education, poor infrastructure and unfavourable demographic trends. The identified areas tend to be concentrated in Eastern Poland. They also occur in lower concentrations in other regions, particularly in West Pomerania and Kuyavian-Pomeranian voivodships (Fig. 8).

Cities and other areas losing their existing social and economic functions are areas which have lost or are to lose their basis for social and economic growth in near future despite their relative affluence due to poor economic situation or, for example, depletion of resources. These areas will be selected in the NUTS5 arrangement provided that at least five ratio criteria are fulfilled (Tab. 3).

Border areas, especially on the external borders of the European Union, were selected as a continuation of the currently implemented Goal 3 of the European cohesion policy, European Territorial Cooperation, encompassing all sub-regions (NUTS3) one border of which coincides with the national border.

Areas with the poorest spatial access to regional centres have been selected with respect to the identified isochrone of 120 min, calculated as the commuting time to the voivodship's capital. These are primarily peripheral areas located along the country's external borders, especially in upland and hilly areas and in Eastern Poland. A special subtype of this area is constituted by the border between the Pomeranian and West-Pomeranian voivodships.

Intervention in the selected problem areas will be focusing on boosting employment, enhancing access to goods and services fostering development, countering negative demographic trends and enhancing spatial access. Goal 3 – enhancing the processes of planning and executing public policies affecting territorial development of the Project of the National Strategy for Regional Development is no longer related to selecting PA/IS and assumes the form of institutional activities defining the scope of changes which need to be introduced to the Polish public administration in

Category	Area	Reasons and directions of intervention
1	Warsaw	The country's chief metropolitan centre
2	Kraków, Wrocław, Poznań, Tricity: Gdańsk-Sopot-Gdynia, Upper Silesia conurbation, Łódź, Szczecin, Lublin, Bydgoszcz, Toruń	The largest metropolitan centres
3	The remaining voivodship cities: Zielona Góra, Gorzów Wielkopolski, Opole, Olsztyn, Białystok, Rzeszów, Kielce	Regional centres with the roles of capitals of voivodships

Tab. 2: Strategic intervention areas in the Project of National Strategy for Regional Growth
Source: Project of National Strategy for Regional Growth, 2009

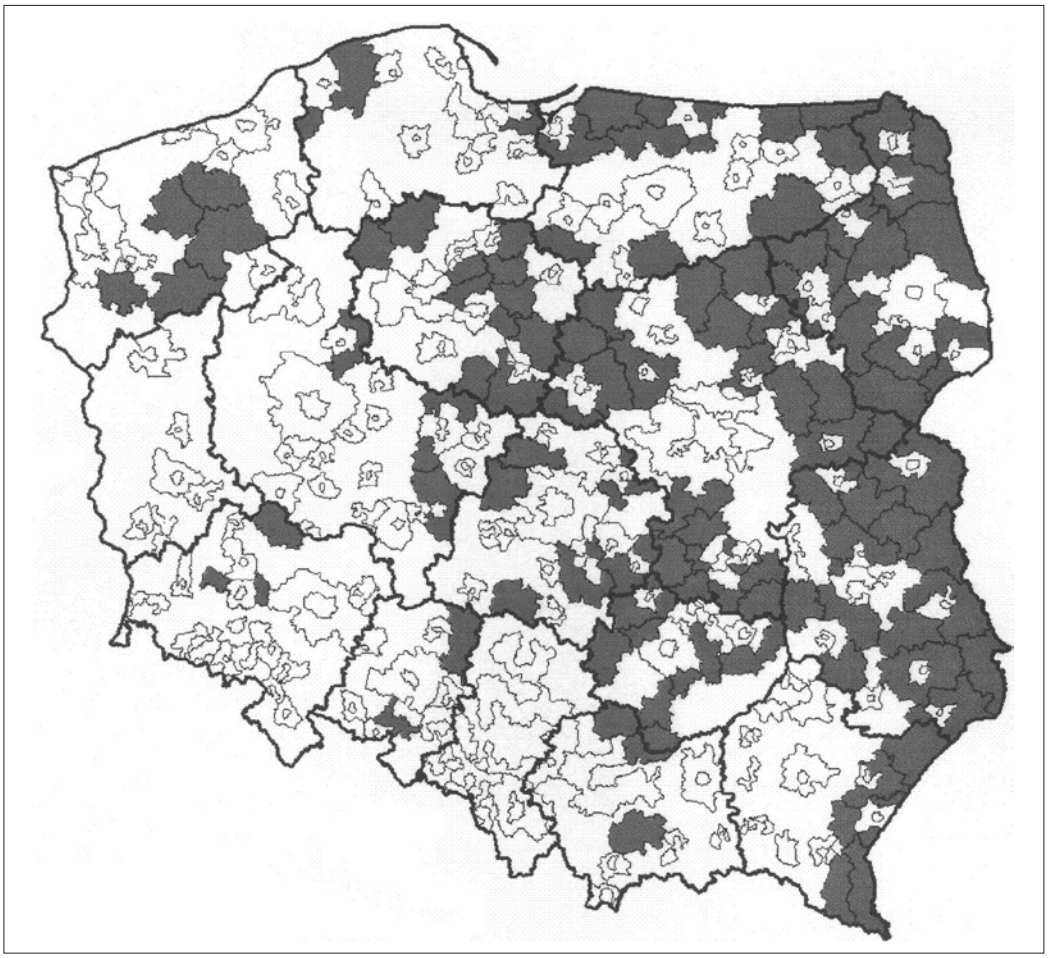

Fig. 8: Problem rural areas with the lowest levels of social and economic growth and the inhabitants´ poorest access to services and goods conditioning growth opportunities in the Project of the National Strategy for Regional Development
Source: Project of the National Strategy…, 2009, p. 75

Criterion
GDP dynamics at least 30% below the national average
Above-average reduction in population size (150% above the national average)
Number of individuals collecting compensation benefits per 1,000 inhabitants 50% higher than the national average
Percentage of individuals employed in traditional, low-productivity sectors 50% higher than the national average
Number of discontinued business operations per 10,000 inhabitants 50% higher than the national average.
Vocational activity ratio among individuals at working age 50% lower than the national average
Share of long-term unemployment in working-age individuals 50% higher than the national average
Percentage of individuals prematurely leaving school 25% higher than the national average (%)
Number of crimes per 1,000 inhabitants 25% higher than the national average
Number of registered national economy entities per 100 inhabitants 50% lower than the national average
Proportion of buildings without water supply/sewerage in the total number of buildings 25% larger than the national average

Tab. 3: Problem areas selection criteria: cities and other areas losing their former social and economic functions in the Project of National Strategy for Regional Growth
Source: Project of National Strategy for Regional Growth, 2009, p. 82

order to boost the efficiency of intervention measures. The Project of the National Strategy for Regional Development is, in short, a very important step in the reformation of the Polish regional policy. As the Strategy implies, the reforms will take into account the European trends as far as the change in the regional policy paradigm is concerned. They will equally express the need for including the goals of the national regional policy on a larger scale as reflected in the spatial concentration of internal domestic activities, including PA/SI.

4. Conclusions

Several main conclusions can be drawn on the basis of the conducted analysis:

- Regional policy has used problem areas as an instrument of spatial concentration of financial support to ensure better efficiency of the undertaken activities.
- Modifications in the regional policy paradigm reflect in this instrument's mode of usage. Once the problem areas become an element within the policy of polarization-diffusion, they cease to be an instrument of compensatory policy. Identification of problem areas in socially and economically marginalized regions is thus accompanied by the determination of strategic intervention areas in relatively better developed regions. This is aimed at overcoming the areas' growth barriers and creating conditions where the resources could be fully exploited ensuring more effective diffusion in the environment and improved competitiveness.
- Polish regional policy in the first years of the country's membership in the EU was completely subordinated to the goals of European cohesion policy, including the identification process of problem areas. This led to limited diversification of the intervention that did not match the complexity of the country.
- The existing programming period 2007–2013 and the preparation of the new frameworks of Polish regional policy which will enter into full effect in the next EU budget period 2014–2020 clearly indicate that the problem areas are newly attributed higher importance in the realm of intervention. The delimitation of a problem area relies on mathematical and statistical estimation and problem areas are then defined in compliance with the polarization-diffusion model of growth.
- The problem areas in the program-preparation and execution stages of Polish regional policy have played an increasingly significant role, especially at the time of its nation-wide implementation. This is an unambiguously positive phenomenon.

One should bear in mind that decisions regarding the selection of PA/SI will always have political overtones. The instruments of regional policy shall not replace decision makers or lead to any political speculations. The task of this policy's instruments is the optimum presentation of information concerning spatial disproportions in growth and recommendation of how these disproportions can be reduced. The importance of spatial analyses rests in their function of a basis for decisions regarding the determination of problem areas/strategic intervention.

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SOCIO-ECONOMIC DISPARITIES AND MIGRATION IN SLOVAKIA

Anton MICHÁLEK, Peter PODOLÁK

Abstract

Despite well-known regional disparities, which have increased and in general represent relevant factors determining migration, the rate of interregional migration remains at a comparatively low level in Slovakia. In this paper, an attempt is made to observe the effects of unemployment and wages on the level of interregional migration in the years 1996–2007. The anticipated movement of population from economically weaker to economically stronger regions remains relatively restricted in Slovakia. Potential migration is limited by the action of other factors, which can be classified in the group of liquidity constraints.

Shrnutí

Vybrané sociálně-ekonomické disparity a migrace na Slovensku

Přes dokázané zvyšující se regionální disparity, které všeobecně představují relevantní faktory podmiňující migrace, zůstává míra meziregionální migrace na Slovensku stále na relativně nízké úrovni. V tomto příspěvku jsme se pokusili o sledování vlivu nezaměstnanosti a výše mzdy na úroveň interregionální migrace v období let 1996–2007. Předpokládaný přesun obyvatelstva z ekonomicky slabších do ekonomicky silnějších regionů se zatím na Slovensku projevuje jen v omezené míře. Potenciální migrace je výrazně limitovaná působením jiných faktorů, které je možno zařadit do skupiny tzv. „likviditních omezení“.

***Key words**: unemployment, wages, migration, regional disparities, Slovakia*

1. Introduction

The relationship between migration, wages and unemployment stands in the focus of experts from various fields. By the end of the 1960s, several studies involved with the research into these phenomena appeared. Simultaneously, some originally simple, later more complicated models studying relationships and dependencies between emigration and wage rates in regions, emigration and unemployment rates but especially those studying all three phenomena at the same time were presented (Todaro, 1969). The majority of migration models assumed that an individual or a household would profit from the migration from a poorer region to a richer one by obtaining a better job and higher wages which would mean a better life for the individual and his/her family. Apart from that, models were based on two basic assumptions: Firstly, if the inequity between the rich and poor region diminishes, the migration rate will decrease and secondly, the higher probability of obtaining a job in a richer region will increase the migration rate. These simple models were later elaborated in depth and gradually improved namely in connection with the often observed low migration level in spite of the pronounced regional disparities. Most authors tried to incorporate factors in models, which could help to find and explain the low rate of interregional migration.

Banerjee and Kanbur (1981) and Hatton (1983), for instance, explicitly modelled the “aversion to risk”. High aversion to risk generally lowers the migration rate. Other theoretical and empirical studies specified the ideas of incomplete information about the developments in an alien region (Stark, 1991; Burda, 1993; Faini, 1993) and they found out that the lack of information distinctly lowered the willingness to migrate. Wyplosz (1993) incorporated into the model uncertainty in expectations either concerning the living cost or further development of the region what leads to a lowered migration as well. Faini and Venturini (1994) introduce the term of “liquidity constraints” as a special case of transaction cost[1]. It is a barrier for the poorest because they find the cost

[1] Liquidity constraints in this study refers to a spectre of important disincentives of demographic, social and material nature existing in Slovakia

of moving too high (it comprises the moving cost itself, search for and price of a new dwelling, which is normally more expensive, as it is located in a richer region, and the like). Precisely these liquidity constraints reduce most the expected high out-migration from the poorest regions. The result is a non-linear dependency between wages and the emigration rate from economically weaker regions. Many experts assert that the interregional migration rate is largely determined by the housing market. Inaccessibility of dwelling was and still is a very important factor hindering labour mobility. Shields and Shields 1989, Stark 1991, Andrienko and Guriev 2004 and others tried to include into the model some additional important aspects such as infrastructural amenities with a number and quality of hospitals or schools, accessibility and quality of transport, size of green areas, number of parks, etc. that are useful not only for individuals but for households as well. As far as the geographical mobility of labour in "transition economies" is concerned, the greatest number of studies focused on the search for migration rate determinants.

Authors of such empirical studies, e.g. Erbenová (1997), Burda (1995), Fidrmuc (2004), Horváth (2006) and others, attempted to confirm or deny the hypothesis about the relationship existing between migration, wages and unemployment rates in Slovakia. The aim of this paper is to observe the effects of regional unemployment and wage levels on the migration rate. Unemployment rates and average nominal wages were selected as the most relevant characteristics used by comparative regional analyses. The applied meaning of such analysis of geographical mobility of labour provides an opportunity to identify the flexibility of the Slovak labour market and to point out the principal factors restraining such flexibility. It is quite important in the present period of financial and economic crisis calling for any ways and possibilities to keep jobs and to support the population's mobility (migration) in pursuit of work. Annual migration data (1996 to 2007) from 72 districts of Slovakia were used in this study, with urban parts of the cities Bratislava and Košice being summed up into one unit for the sake of geographical relevance.

2. Unemployment and regional disparities

The Slovak labour market underwent distinct changes in the course of the 1990s. At the beginning of transition, the market was controlled by several systemic but also non-systemic economic changes accompanied by an abrupt drop of the GDP and increase of unemployment which went on increasing after the right assumed power in 1998. It was due to the onset of economic reforms. The unemployment rate culminated in 2001 reaching the astounding 19.2% (30% in some regions) and Slovakia ranked among European countries with the highest unemployment rates. However, it quickly dropped after 2001 reaching the historic minimum of 8.0% (UPSVaR, 2008) at the end of 2007. The rate of long-term unemployment started to drop from 2005 as well (Tab. 1). The Slovak labour market slowly drew closer to labour markets in advanced economies. Unfortunately, the financial crisis and the distinct deceleration of the economy by the end of 2008 have caused the unemployment rate to shoot up again.

year	Unemployment rates (in %)	Number of long-term unemployed (in thousands)	Nominal wages (in Sk)	Real Wages Index* (in %)
1997	12.5	149.5	9 226	106.6
1998	15.6	160.7	10 003	102.7
1999	19.2	195.4	10 728	96.9
2000	17.9	261.6	11 430	95.1
2001	18.6	282.8	12 365	101.0
2002	17.5	291.4	13 511	105.8
2003	15.6	280.9	14 365	98.0
2004	13.1	291.2	15 825	102.5
2005	11.4	291.2	17 274	106.3
2006	9.4	258.2	18 761	103.3
2007	8.0	121.8	20 146	104.3

Tab. 1: Development of unemployment and wages in Slovakia (1997–2007)
** Real Wages Index was computed as a ratio of the Nominal Wages Index and the Consumer Price Index*
Source: Štatistický úrad SR, 2008

It must be born in mind that these national numbers dissimulate a great regional variability. While the lowest registered unemployment rate was 1.6% in Bratislava (2007), the highest unemployment rate was observed in the district of Rimavská Sobota amounting to 37.4% in 1999. The following data confirm that disparities among regions in unemployment rates (UR) dramatically increased during the transition: 3.1% UR in Bratislava was the lowest, while that in the Rimavská Sobota district reached 25.4% in 1997 which means a difference of 22.3%. In 2007, this difference increased to 25.5%, while the same districts reached the extreme values; URs in Bratislava and Rimavská Sobota were 1.6% and 27.1% respectively. Values of the standard deviation and variation coefficient illustrate the increasing regional disparities even better. While the 1997 standard deviation and variation coefficient were 5.4 and 29.0, in 2007 these values reached 5.8 and 33.6.

Figure 1 presents the chronological order of unemployment disparities. Inequality in regional unemployment is expressed by variation coefficients (I and II) for each year while their values were normalized (normalized value for 1997 is 1). The normalized variation coefficient I captures the development of variability in URs and always compares the value of the quoted year with the same period of the preceding year. The curve makes it possible to follow the increase of regional disparities in unemployment in 2001, 2002, 2005 and 2006. The variability distinctly increased at the beginning of the millennium and was observable namely in years of the highest UR or with a slight delay following such years. These results confirm the validity of theories asserting that the unemployment increase is accompanied by deepening regional differences. Comparison of the dynamics of regional disparities on the basis of a standardized variation coefficient II, which compares changes in each year with the initial year 1997 shows that 2000 was a break-through year because before 2000, regional UR disparities were decreasing while they were almost steadily increasing after 2000.

3. Wages and regional disparities

Wages in Slovakia were and still remain among the lowest in the EU (apart from the new member countries Bulgaria and Romania). According to the scale published by the FeEE in 2004, Slovakia ranked 35th among 48 compared countries. The source asserts that mean wages in Slovakia in 2004 represented only 11% of mean wages in Denmark. The high unemployment rate, surplus of labour, inadequate departmental structure, lack of funds, restrictions on the part of government and other factors affected the development of wages in Slovakia. In respect of purchasing power, mean wages were several times lower than in the "old" EU member countries (Michálek, Podolák, 2004). Moreover, they only reached about 50–60% of national average in some regions of Slovakia. The upturn came only in 2005 (Tab. 1). The situation in

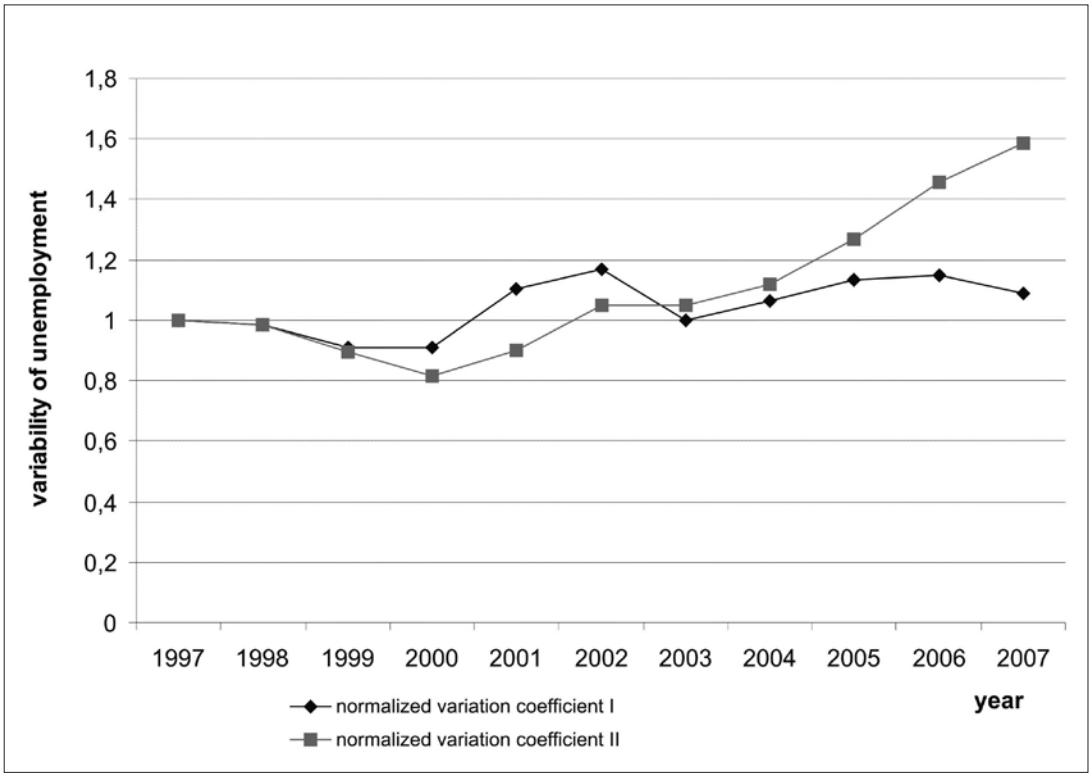

Fig. 1: Dynamics of regional unemployment disparities

wages improved and actual wages started to increase with the arrival of foreign investments, restructuring and diversification of industry, introduction of new technologies, etc. Since 2004, the index of actual wages has been at a comparatively stable level which indicates a favourable development.

Figure 2 presents the chronological order of inequalities in wages. They are expressed in the same way as in unemployment, namely by variation coefficients (I and II) for the given year. Values of the standardized variation coefficient I slightly dropped in 2002 and since then they have maintained a relatively balanced level with a slightly oscillating level of regional wage disparities.

Values of the standardized coefficient II were slightly increasing during the concerned period at an almost balanced curve, which demonstrates a permanent increase of the regional wage differentiation level.

In the first phase of transition, spatial distribution of wages was almost balanced. In the course of transition, disparities between districts appeared and grew. In 1997, mean wage in Bratislava (which was the richest) was Sk 11,638.00, which is 1.7 more than in the poorest district of Medzilaborce, while in 2007, the difference amounted to 2.3 times the wage in the poorest district (when the highest wage in Bratislava and the lowest wage in Medzilaborce were Sk 31,717.00 and 13,984.00 respectively). The available data reveal that disparities in wages between the districts in the studied period increased more rapidly than disparities in unemployment between the districts.

4. Internal migration

A period of extensive urbanization with the concentration tendencies of internal migration and a massive movement of population to cities were observed in Slovakia for several decades. Between the mid-1980s and about 2000, a phase with a distinct drop of migration mobility is evident. At the beginning of the third millennium, some new trends begin to appear in the migration behaviour of the population.

The marked regional differentiation of basic demographic characteristics such as the population age structure and the level of natural reproduction between the northern and eastern regions on the one part and the western area of Slovakia on the other part has been evident for quite a long time. Demographic differences involving differences in the level of social and economic development have also existed for long decades. However, they gained a new dimension with several specific traits after 1989. This is the background of polarization concerning the economic, social and demographic development in Slovakia with some extreme differences between the south-west and other parts of the country. One of possible consequences of such disparity is a considerable

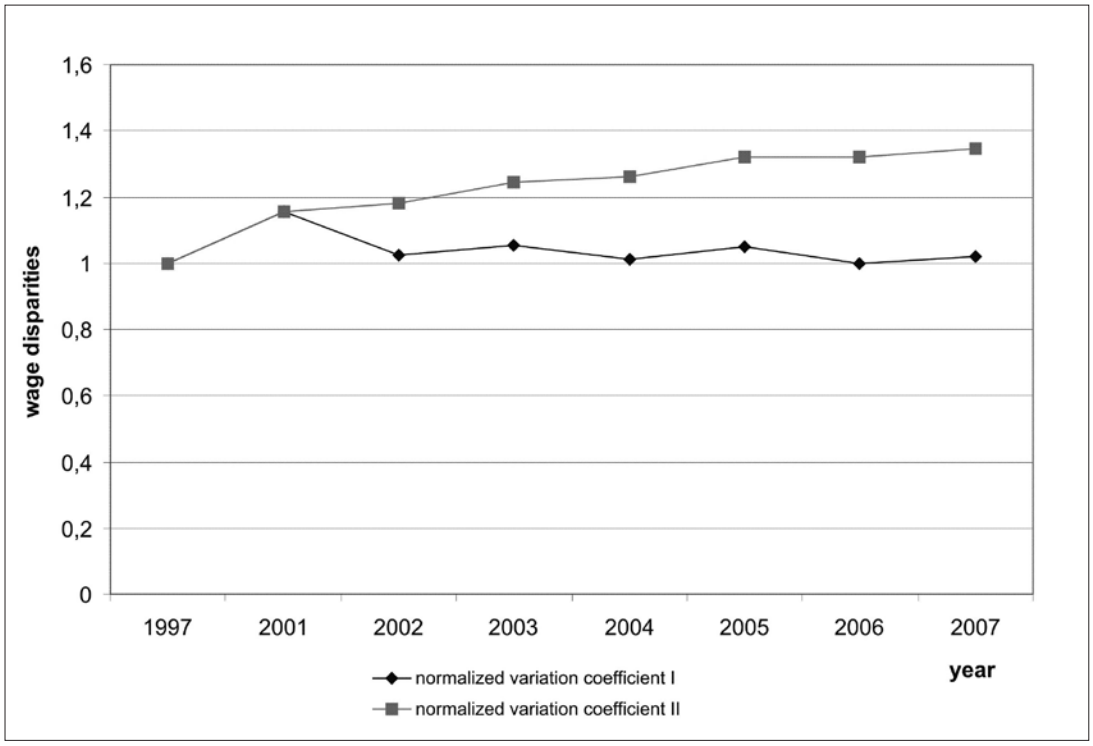

Fig. 2: Dynamics of regional wage disparities

mobility of population from regions belonging to one part of the country to regions in another part of the country motivated by economic, demographic, social and other reasons.

Political, economic and social changes that took place in Slovakia after 1989, along with a significantly changed demographic behaviour of the population determined the nature and spatial arrangement of internal migration. The second half of the 1990s witnessed aftermath of the rapid drop in the volume and intensity of internal migration; from 1996–1999, the average annual number of internal migrations was 81 thousand (compared to 100 thousand recorded by the end of the 1980s). The gross annual migration rate was around 15‰ compared to 19‰ at the end of the 1980s. The decreasing trend stopped after 2000 and the volume and rate of internal migration values started to increase up to the present 89 thousand (16.6‰, Tab. 2). However, in the same period, the migration structure displays a drop in the % share of interregional migration in the total volume of internal migration. Migrations within regions (districts) still represent almost a half of internal migration; their share increased after the mid-1990s obviously due to the ever more pronounced suburbanization and deconcentration of population.

5. Migration efficiency

One of possible and in the world often applied ways of achieving a more detailed identification of the role that migration plays in redistribution of population are the rates of migration efficiency (for instance, Plane, 1984, Brognan, 1984; Podolák, 1995, 2006 and many others). Migration efficiency rates were used in this part to characterize the main trends in the development of the migration of population between regions in Slovakia in the period from 1996–2007.

Migration efficiency of a region is expressed as

$$E_j = 100 \times N_j / T_j$$

where E_j = migration efficiency of region j, N_j = difference between immigration and emigration of region j, T_j = volume of migration in region j.

Migration efficiency values will be positive if immigration outnumbers emigration and negative if emigration outnumbers immigration. If the efficiency value considerably differs from zero, a high redistribution of population exists in the region with respect to total migration. On the other hand, low efficiency values suggest that immigration and emigration eliminate each other and the result is a low spatial redistribution.

In the second half of the 1990s, positive values of migration efficiency prevailed in 26 districts (36.1% of total districts) and the same happened in 2004 – 2007 in 27 districts (38.4% of total districts). In 1996–1999, the highest migration efficiency values were observed in districts of south-western Slovakia, particularly in the wider hinterland of Bratislava (Senec, Pezinok, Malacky, Dunajská Streda and Galanta). The most negative values were observed in the northern and eastern districts of Námestovo, Čadca, Stará Ľubovňa, Svidník and Medzilaborce. Distribution of migration efficiency values in 2004–2007 at a district level remained more or less stabilized while positive values changed into negative and vice versa only in six and seven districts respectively. In the spatial pattern after 2000, a concentration of districts with the most positive values in the south-west of the country is conspicuous. Northern and eastern districts kept the negative values of migration efficiency. At the same time, absolute differences between positive and negative values are more distinct at present than in the mid-1990s.

The resulting values of migration efficiency reflect a reversed effect of hierarchic and positional components. Suburban mobility leads to migration loss in the biggest cities, but this type of migration occurs in their closer or wider hinterlands, so that it is migration within districts. On the other hand, the hierarchic position of big cities at a higher economic level determines the

Average of years	1996–1999	2000–2003	2004–2007
Total internal migration (in thous.)	81.6	82.7	89.4
Total internal migration in ‰	15.1	15.4	16.6
Interregional migration (in thous)	45.8	44.4	47.8
Interregional migration in ‰	8.5	8.3	8.9
% of interregional migration from total internal migration	56.1	53.8	53.5

Tab. 2: Characteristics of internal migration in Slovakia (1996–2007)
Source: authors' calculations based on data publicized by the Statistical Office 2001, 2008

migration attractiveness of corresponding regions with contribution of the effect exerted by the positional factor: migration attractiveness of economically advanced districts in the south-west and west of Slovakia.

The resulting values of migration effectiveness also reflect another property of interregional migration: a comparatively high degree of reversed flows, which have already appeared for some time between the districts of Prešov and Košice and in some other cases as well. Positive values of migration efficiency in some districts with a high unemployment level and a low mean wage level is also determined by such specific factors and events as the organized transfer of Romanies from the districts of Poprad and Kežmarok (the effect of which is manifested in negative migration efficiency values in these districts) to Rožňava and Levice.

Summarized characteristics were applied in order to describe the whole system of interregional migration (Tab. 3). The variance indicates an increasing difference between the minimum and maximum migration efficiency values in time between the beginning and end of the studied period. The increase of standard deviation values also suggests the increasing level of regional differentiation in the studied migration system from the mid-1990s until present, while this increase was more conspicuous between the end of the 1990s and the beginning of the third millennium. Certain stabilization came after 2003 when the increase of the summarized characteristics became a lot more moderate.

Another characteristic is the total net migration rate, which summarizes the overall effect of migration on redistribution of population within the whole regional system. It is expressed as a quotient of the sum of absolute values representing migration balances and an average population number in the relevant period. A high level of the index indicates that migration is an efficient mechanism of population redistribution and in turn low values indicate the balance between the migration flows that do not significantly contribute to population redistribution. This characteristic can then be interpreted as a rate of symmetry and balance in the studied system of interregional migration flows and its increase presumably means an increased role of migration as an efficient tool of population redistribution at a regional level. The level of disparities increases in the migration system: the total contribution of migration to redistribution of population becomes more important, the values of all quoted summarized characteristics of migration system indicate a slightly increased role of migration in redistribution of population in the relevant period.

The all-system characteristics of interregional migration only provide summarized information about the migration system that may disguise some distinct differences in migration between individual regions, which are undoubtedly determined by socio-economic disparities as well. Anticipation of a population shift from the economically less favoured regions into advanced ones would be only natural. Although the data about the reasons for interregional migration should be considered with caution (regarding the scale of options and other factors which play a role in quoting reasons for moving), the values are unreasonably low. Change of working place and drawing closer to the working place is quoted as a reason for moving only by 4–5% of respondents who moved, namely at a longer distance (moving from one administrative region to another). The migration situation at a level of districts has not taken the definite shape yet. Statistical data about internal migration in the SR have not yet confirmed the thesis about the population's movement from spatial units with higher levels of unemployment and low numbers of vacant jobs to those with more favourable conditions.

Average of years	1996–1999	2000–2003	2004–2007
Variance	59.700	74.900	82.900
Standard deviation	12.521	14.294	15.046
Total net migration rate	0.134	0.155	0.156

Tab. 3: Migration efficiency characteristics (1996–2007)
Source: authors' calculations based on data publicized by the Statistical Office 2001, 2008

6. Unemployment and migration

Figure 3 shows the mutual dependence of unemployment rate and migration efficiency in the period 2004–2007. Theoretically, the relationship between migration efficiency and unemployment should be negative. As long as the unemployment rate in a given region is above average, a tendency to higher emigration and lower immigration is expected. However, the graph demonstrates the fact that districts with the top rate of unemployment are far from displaying the most negative migration efficiency values. Rimavská Sobota, Revúca and Veľký

Krtíš with the highest unemployment rates are more positive than districts like Stará Ľubovňa, Snina, Tvrdošín or Čadca in terms of migration efficiency values. The negative values of migration efficiency in Poprad are not related to high values of unemployment but rather to the movement of Romany groups from the region to other regions of Slovakia. On the other hand, in the case of districts with the most positive migration efficiency values (Senec, Malacky, Pezinok and Dunajská Streda) the dependency characterized by low unemployment rates is much more distinct. The fact did not change over the studied period and it is also true both for the second half of the 1990s and 2004–2007.

As the graph shows, economic factors such as unemployment do determine the willingness of individuals to migrate, but only to a certain extent. Above all, in the case of troublesome and unemployment stricken regions, the labour force does not move to economically advanced regions namely for the financial reasons (inaccessible dwelling, cost of moving etc.) and such regions remain in what is referred to as a poverty trap. As it is obvious from literature, a poverty trap may be fairly resistant to any attempts to escape.

7. Wages and migration

Figure 4 shows dependence between wage disparity and migration efficiency in 2004–2007. Theoretically, the relationship between migration efficiency and wage inequality should be a positive one. As long as the wages in a particular region are above average, immigration should prevail over emigration. In this case, expected logical linkages (migration from regions with lower average wages to economically more advanced regions) appear more distinct, again particularly in districts with the highest migration rate (Senec, Pezinok, Malacky), which are also characterized by relatively high average wages. In districts with the lowest average wages, the highly negative migration efficiency values cumulate with the values of negative migration efficiency less frequently but still more expressively than in the case of the mutual dependence between the values of migration efficiency and the rate of unemployment. Typical (and logically expected) cases in this context are the districts of Stará Ľubovňa, Snina and Bardejov, where low average wage cumulates with the highly negative values of migration efficiency. This indicates an increased number of citizens moving to economically advanced regions. It is evident from the diagram that disparities of regional wages have a somewhat greater effect upon the level of migration of population between districts than regional disparities in the unemployment rate.

In spite of some cases, the presumed implications between out-migration from economically weaker to economically stronger districts are confirmed only to a limited extent. Probable reasons are economic problems and cost of new dwellings in advanced districts as well as the strong bond to the original place of living. The level of population mobility in Slovakia (in spite of a certain revival after 2000)

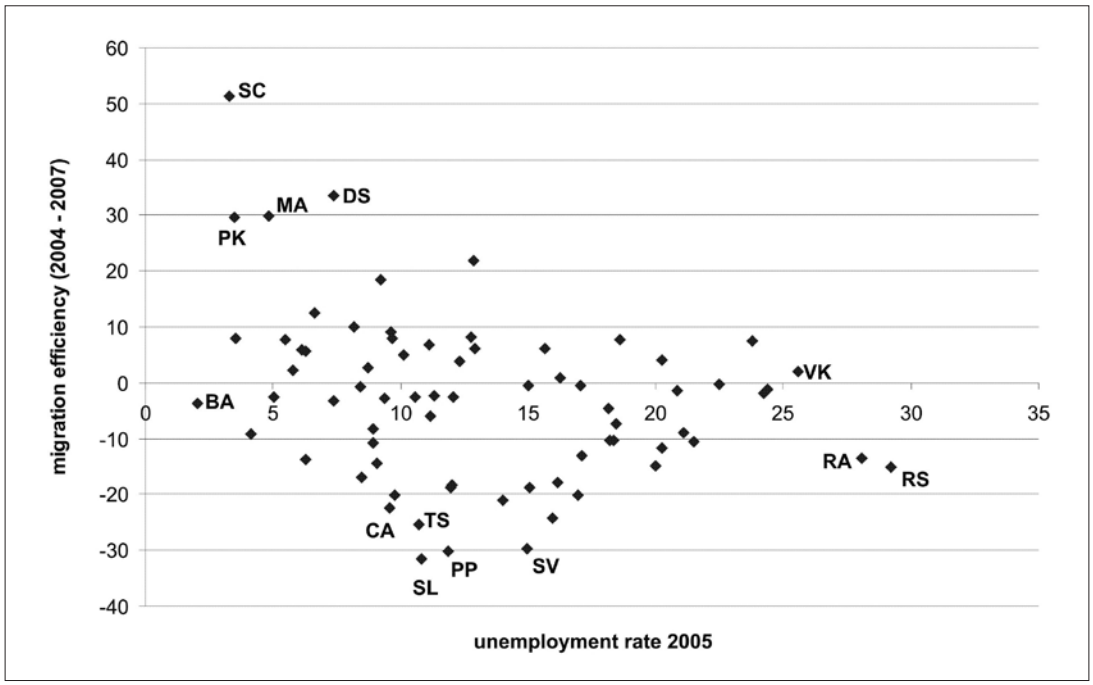

Fig. 3: Unemployment and migration (2004–2007)
BA – Bratislava, CA – Čadca, DS – Dunajská Streda, MA – Malacky, PK – Pezinok, PP – Poprad, RA – Revúca, RS – Rimavská Sobota, SC – Senec, SV – Snina, SL – Stará Ľubovňa, TS – Tvrdošín, VK – Veľký Krtíš

lags behind many countries, for instance the Czech Republic (Horváth, 2006; Vaňo, 2005). Presumably, the cotemporary migration to advanced EU countries, which in many cases compensates for the financial inaccessibility of new dwellings in main centres of economic development, plays a certain role. A lower level of education of the population characterizes regions with lower, prevailingly negative values of migration efficiency. The generally valid dependence, which is manifested in the world, was also confirmed in Slovakia: because of financial reasons it is not the poorest who move but those who can afford it.

The results suggest that the low migration efficiency is greatly influenced, especially in problematic districts (apart from the considered economic factors) by additional factors: liquidity constraints. It seems that most probably the stronger such constraints, the lower the level of population mobility of the region. Distance also plays an important role and combined with cost means that if the economically advanced centres are remote then the level of emigration from the problematic regions is low in spite of their attractiveness.

In districts which should theoretically (estimating from unemployment rate and level of wages) exhibit increased emigration, but in reality the level of migration is below average, the effects of additional reasons should be considered. Factors like unavailable or deficient information, uncertain expectations, aversion to risk (increasing with the population's age) professional orientation and qualifications regarding the market offer, age composition, family bonds associated with mutual help, options of self-supply (share of family houses), price inaccessibility of housing or lack of flats for rent may be mentioned. Commuting options are also important especially if they are time- or cost- effective. However, conditions of an individual, such as having a family, capacity to adapt, to learn, his/her communicativeness and fixation to the region, primary profession in industry, agriculture or services, if he/she lives in a city or in a village and many other factors must also be considered. These aspects (personal prerequisites) and the associated circumstances concerning migration are studied by other human sciences, which is why they were not given more detailed attention in this paper.

8. Conclusion

In our study, we analyzed one of indicators of labour market flexibility – geographical mobility of labour force. On the basis of two key determinants of migration (unemployment and wages) in Slovak regions, an attempt was made to estimate whether the regional unemployment rate and the amount of wages determine the willingness of population to move in searching for jobs. In Slovakia, as in other economies in transition, the rate of the geographical mobility of labour in the studied period dropped or stagnated while the regional disparities increased. This situation is contradictory, because the increasing regional differences should have been accompanied

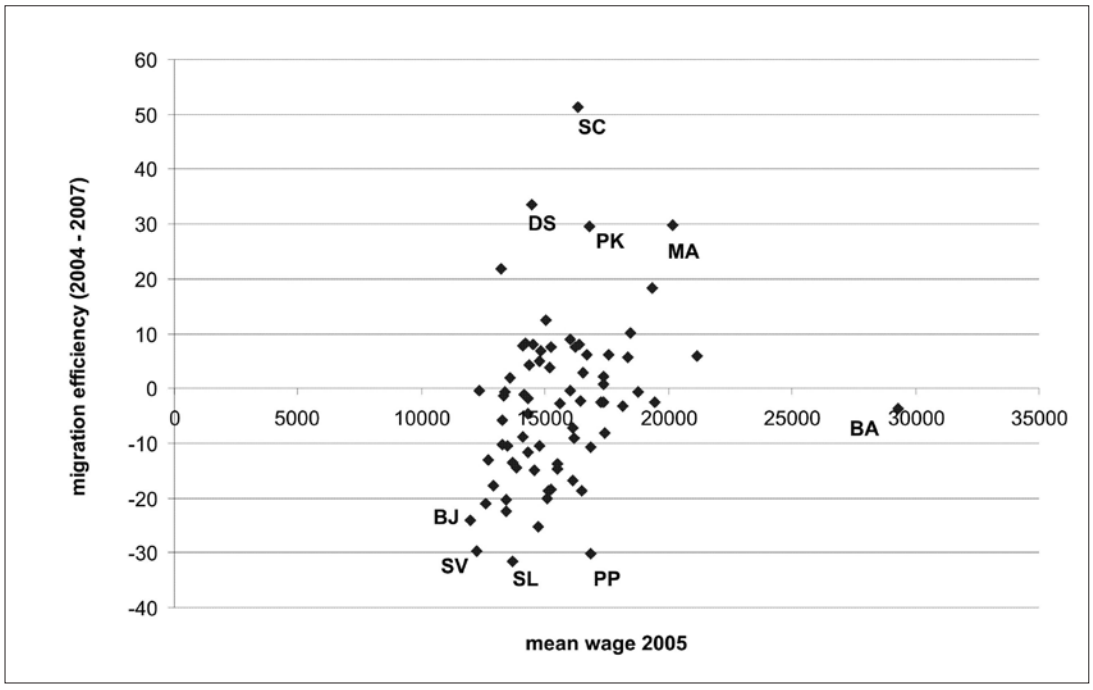

Fig. 4: Wages and migration (2004–2007)
BA – Bratislava, BJ – Bardejov, DS – Dunajská Streda, MA – Malacky, PK – Pezinok, PP – Poprad, SC – Senec, SV – Snina, SL – Stará Ľubovňa

precisely by an increased emigration from the stricken areas to richer regions. In the empirical part of the study, the authors concluded that differentiation of the unemployment rate in regions of Slovakia determine the population mobility and flows of labour only to a limited extent. This fact may be due to the increased uncertainty associated with the gradual transition to a market economy. In this sense the obtained results represent a follow-up to the study of Fidrmuc (2004), who also confirmed the low rate of migration in four Central European economies (Czechia, Hungary, Poland, and Slovakia) while the regional disparities are only partially balanced by the development of wages and unemployment. Explanation of this evident contradiction can be seen in the action of other factors of a diverse nature. The migration behaviour of population in Slovakia is determined by deconcentration and suburbanization processes on the one hand and by the increasing marginalization of some regions on the other hand. Moving from one region to another is connected with a considerable cost which leads to abidance in a poverty trap (population cannot afford moving to a prospering region). The cost connected with migration is a result of the condition of the Slovak financial market (difficult access to loans for households with lower income or to those threatened by loss of job). An important factor, which affects population's mobility, is the housing market and price inaccessibility of dwellings in rich regions. The analysis also indicates the significance of liquidity constraints for population mobility. The greater are the constraints, the lesser is the tendency of real convergence between individual regions. The natural question is whether the economic, wage or regional policies are able to mitigate the negative effects of such constraints on population mobility. In this context, questions connected with improving the conditions on the labour market and greater demand for labour, changes in housing policy by making the dwellings more accessible associated with adjustment of loan conditions with regard to low-income and young households, etc. seem to be significant.

Acknowledgement

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PERIGLACIAL FEATURES IN THE KRUMGAMPEN VALLEY, ÖTZTAL ALPS, AUSTRIA

Ondřej MARVÁNEK

Abstract

Different types of patterned ground are present in the Krumgampen Valley, Ötztal, Austria. The periglacial environment includes small to medium scale features. Small scale periglacial forms were mapped and some genetic cross-sections were made to study the environmental influence on its spatial distribution. Also the monitoring of ground temperatures during the autumn season revealed frequent freeze-thaw cycles. This thermal regime supports recent development of patterned ground features. The spatial distribution of patterned ground in the Krumgampen Valley is affected not only by the altitude. The topography in association with other factors related to the morphology of the valley floor determines the appearance of patterned ground mainly by the changes in the parent regolith properties and soil moisture.

Shrnutí

Periglaciální tvary v údolí Krumgampen, Ötztálské Alpy, Rakousko

V údolí Krumgampen (Ötztálské Alpy, Rakousko) se nacházejí četné formy strukturních půd. Periglaciální prostředí je představováno tvary malého a středního měřítka. Malé periglaciální tvary byly zmapovány a pro určení mechanismu jejich vzniku byly provedeny kopané sondy na vybraných tvarech. Během podzimu 2006 byly také měřeny půdní teploty na třech lokalitách s výskytem strukturních půd. Po zmapování strukturních půd byla provedena prostorová analýza jejich rozmístění. Rozmístění strukturních půd v údolí Krumgampen není ovlivněno pouze nadmořskou výškou, ale také morfologií a z ní vyplývajícími vlivy.

***Key words**: periglacial, patterned ground, needle ice, sorted nets, solifluction, Ötztal, Austria*

1. Introduction

The Krumgampen Valley, an east-facing side valley of the Kauner Valley, falls within the alpine periglacial environment. Rock glaciers and some small-scale periglacial landforms occur above the timberline. Since numerous studies concerning rock glaciers were carried out by Berger and others (2004) in Kauner Valley, this study aims to collect information on the small-scale periglacial landforms in the Krumgampen Valley focusing mainly on patterned ground morphology and distribution.

Studies on patterned ground have been conducted since the beginning of the 20th century. At that time most of the studies surveyed permafrost related patterned ground in high latitude regions. During last decades, however, the periglacial environment in the mountains of central Europe has seen increasing interest (Jaesche, 1999). Primarily the changes of mountain permafrost in the Alps have raised the importance of evaluating the high-alpine environment and preventing the effects of natural hazards (Etzelmüller et al, 2001) caused by different climate change consequences such as rock avalanches, increase in slope instability and other processes linked with the degradation of mountain permafrost. It particularly applies to the Alps that the natural hazards endanger people as well as the local economy. Kauner Valley could represent a conflict between the changing environment and the demands for local economic development.

Although the Czech Republic has no mountain permafrost and thus is not threatened by any similar natural hazards which would drive a research of the periglacial environment, studies on periglacial patterned ground are in progress here. The analysis of distribution, morphometry and relation to the environment are the main topics of these studies (Treml et al., 2010). The data from recently active areas could provide valuable information for the evaluation of relict patterned ground phenomena in the Czech Republic.

2. Study area

Kauner Valley is located in Tyrol, Austria. It constitutes a part of the main mountain ridge along the border to Italy. The Krumgampen Valley is a tributary of the Kauner Valley and it reaches the main valley at an altitude of approximately 2,400 m (Fig. 1). The valley has alpine environment featuring steep scree slopes and rock walls. Two remnants of the retreating Krumgampen glacier are present in the upper part of the Krumgampen Valley (Krumgampenferner S and N). The highest point of the area and of the ridge surrounding the Krumgampen Valley is the Glockturm peak (3,353 m a.s.l.). The valley is oriented E-W and declines to the east in a slightly bended shape.

2.1 Geology

The bedrock of Kauner Valley is identified as paragneiss and schists with intercalated orthogneiss, amphibolite, eclogite and meta-carbonates (Hausmann, 2005). The area belongs to the poly-metamorphic Ötztal-Stubai metamorphic complex of the austro-alpine unit.

2.2 Geomorphology

The morphology of the Krumgampen valley is of a noticeably alpine character. The vertical difference between the highest and lowest points of the valley is nearly 1,000 meters. The valley is of glacial origin and is currently subject to periglacial transformation. The most conspicuous periglacial features in Kauner Valley are rock glaciers located beneath some rock walls (e.g. Innere Ölgrube – Berger et al., 2004). The floor of the Krumgampen Valley is dissected by rock steps and bars the surface of which is occupied by roches mountonnées. The retreating glaciers have formed three small lakes. The lowest one is located in a depression in front of the rock glacier at 2,674 m a.s.l., the second and the largest one is dammed by moraines in the central part of the formerly glaciated area. The third one is located in a small cirque on the eastern flank of the Glockturm mountainside that deglaciated during the last 30 years. There are two more lakes in the Furmentekar cirque located on the northern side of the Krumgampen Valley.

Lower parts of the valley feature various periglacial forms reflecting different environmental conditions. The valley sides are formed by rock walls and adjacent talus. A few rock glaciers with typical ridge and furrow topography are also present. The upper part of Krumgampen Valley comprises remnants of the retreating glaciers and its moraines. The most distinct moraines originated at the end of the Little Ice Age (LIA, 1600 – 1850 AD). The valley is drained by two main streams and by subsurface flow through the gravelly Quaternary deposits. The drainage of the Kauner Valley catchment area is influenced by the complex glacial morphology of the valley and by permafrost. Alternating steep and flat parts affect the erosion and sedimentation rates of streams. In addition to that, solifluction lobes reaching the valley floor increase water retention by infilling the lowest parts with solifluction deposits. Wet patches formed by deposits with fine grained sediment represent localities of patterned ground features.

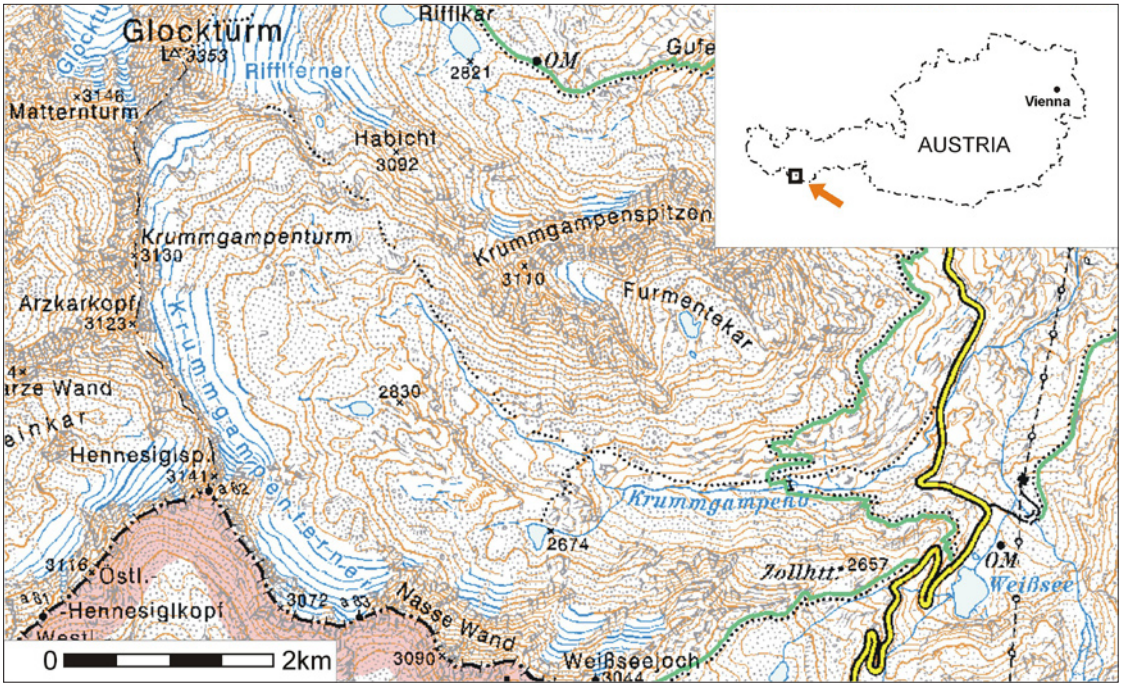


Fig. 1: Topographic map of the Krumgampen Valley (source: AMAP 3D WEST, BEV)

2.3 Climate

The Mean Annual Air Temperature (MAAT) at Feichten – Kauner Valley (1,280 m a.s.l.) is 4.6 °C and the mean annual precipitation amounts to 848 mm. The coldest and the warmest months of the year are January (– 4.6 °C) and July (14 °C), respectively (http://tirolatlas.uibk.ac.at). Using the vertical gradient of 0.7 °C/100 m, the MAAT for Krumgampen is approximately – 3 °C. There are nevertheless some meteorological phenomena like the "föhn" modifying the winter temperature and thus possibly increasing the annual value. The tree-line in Kauner Valley approaches 2,245 m a.s.l. (Nicolussi et al., 2005).

Figs. 2a, b, c: Frost-affected earth hummocks on glacifluvial and lacustrine sediments (top), solifluction sheet (middle) and on frozen upper part of the mound (bottom)
(Photo author)

2.4 Permafrost

The lower limit of sporadic permafrost in the Alps is 2,000 m a.s.l., the limit of discontinuous permafrost lies at 2,500 m a.s.l. and the limit of continuous permafrost ranges between 3,000 and 3,500 m a.s.l. (Hausman, 2005; Rączkowska, 2007). According to these values all of the zones are to be expected in the Krumgampen Valley.

2.5 Land use

In the summer season the area of the lower Krumgampen Valley is presently used for grazing. Grazing of cattle occurs up to "Die Gumsnitl" rock steps and bars in the middle part of the valley at an elevation of roughly 2,600 m. The upper part of the valley is hardly accessible for the cattle and offers only sparse vegetation. Despite the vicinity of the Kauner Valley skiing area on the Weissseeferner glacier and some marked trails, only a handful of visitors come to the Krumgampen valley in the summer.

3. Mapping and determination of periglacial features

Since most geomorphological studies focus on rock glaciers, this study aims to deal with small-scale periglacial landforms. Large landforms, such as talus, protalus ramparts or rock walls, are distinguishable on aerial photographs but their distribution does not form part of this study.

Mapping was conducted using GPS (Garmin 76S) and the topographical map of the Austrian Alpine Club (OEAV – 1:25000). To determine the patterned ground features, cross-section profiles were dug through some of the forms. Temperature was also recorded for several weeks using the Optic Stove Away Temperature Logger (Onset Corp.).

3.1 Small periglacial forms

3.1.1 Earth hummocks

Earth hummocks occur mainly in the lower, vegetated part of the valley floor (French, 1996; Washburn, 1979). These features are slightly to distinctly elevated mounds or a few tens of centimeters high formations with diameters of a similar range. Mounds occur in groups. The mound material consists of silty sand with a humus rich horizon on top of it affected by cryoturbation revealed in almost all of the cross-sections (Figs. 2a, b, c). The underlying silty sand penetrates into the upper humus horizon, sometimes reaching the surface of the mound.

3.1.2 Ploughing blocks

On the slopes with an inclination ranging from approximately 20 to 40° there are numerous boulders showing traces of movement, such as furrows and ramparts in front of the block (French, 1996). Ploughing blocks occur mostly on vegetated ground but bigger ploughing blocks also appear on bare ground. The "b" axis of the boulders ranges from tens of centimeters to over one meter in boulders lying on bare ground, which tend to be bigger. The furrows are several meters long and the "b" axis of the stones inclines downslope.

3.1.3 Sorted patterned ground

Sorted patterned ground in the Krumgampen Valley occurs in diverse forms. Nets, circles and stripes (Washburn, 1979) are present in this area in different topographical positions with varying moisture, exposition, slope angle and vegetation cover. The scree slopes are marked by debris islands.

Ground temperatures were recorded on patterned ground sites S1, S2, S3 (Fig. 12 see cover p. 4) at depths of 5, 15 and 30 cm (Figs. 4a, b, c). The monitoring (October 13rd–November 20th, 2006) revealed diurnal freeze-thaw cycles mainly at depth of 5 cm at site S3. At the depth of 15 cm the diurnal freeze-thaw cycles are almost missing and at 30 cm the soil did not experience any diurnal freeze-thaw cycles during the monitoring period. Thus the diurnal shallow thaw-freezing cycles along with the differential frost heaving and particle sorting may take place in the shallow subsurface layer in which miniature patterned ground features of a few centimeters in diameter originate (Matsuoka, 2003).

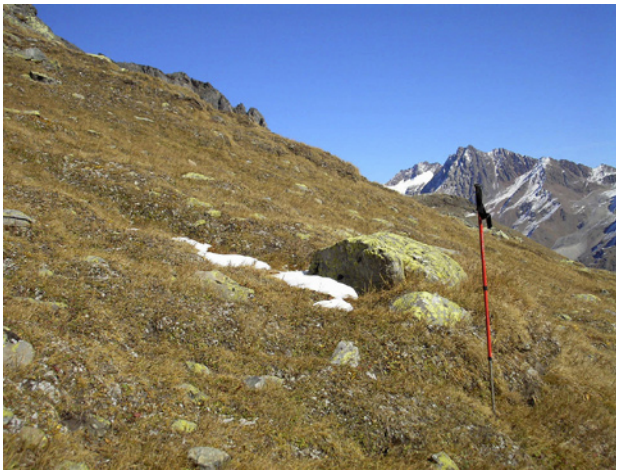
Sorted nets and circles

Sorted nets (Figs. 5a, b) can be divided into two types. The first type developed on the solifluction lobes with their surface covered by vegetation, such as lichens, moss and some resistant seed plants. The first type pattern is not as distinct as the second one on bare ground. The centers are often elevated above the coarse border formed by large stones the axis of which measures several tens of centimeters. Solifluction lobes reaching the valley bottom form an obstacle for the flowing water. The solifluction deposits are supposed to gain more water which results in a more likely formation of patterned ground. The diameter of nets is higher than 1.5 m and some forms of over 4 m in diameter are also present. The morphometry of sorted nets, circles and steps is shown in Tab. 1.

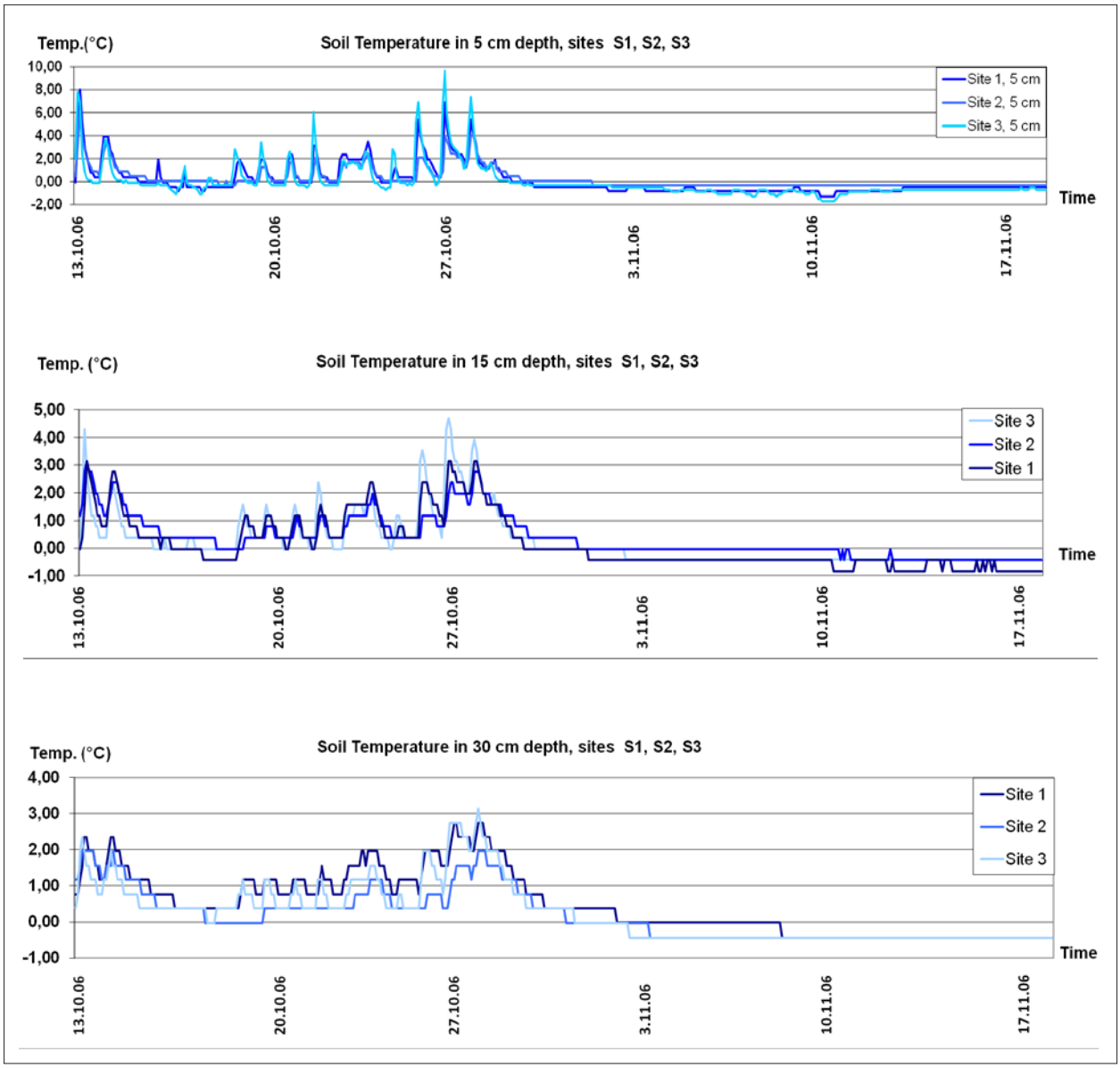
The second type occurs on flat ground with glacilacustrine and glacifluvial sediments close to water streams or lakes. In such locations the water table is shallow and it sometimes drops to the surface of the stony borders of sorted nets. Compared to the patterned ground on the solifluction sheets the fine centers are muddier and smaller, vegetation is sparse or missing and liquefaction can take place. When frost sets in, needle ice of a few centimeters in length develops. Needle ice causes stone uplift and displacement due to bending of ice crystals. After the needle ice melts the upper soil moves downslope as a result of micro-solifluction. The stone belt system of the sorted patterned ground makes the discharge flow easier (Hodgson, Young, 2001).

Sorted steps

Sorted steps were found at an elevation of 3,051 m on the scree slope above the small cirque lake on the flank of Mt. Glockturm. The flat fine domain of sorted steps is bounded downslope by the stony rim forming the step shape. The average diameter of the flat fine domain is 343 cm which is the highest value for sorted features in the study area. It must have been developed during the last three decades according to the OEAV map 1:25000 which shows the area glaciated al least until 1969.



Figs. 3a, b: Ploughing boulder on bare ground (left) and on vegetated ground (right) (Photo author)



Figs. 4 a, b, c: Ground temperature at Site 1 – 2,674 m a.s.l., SITE 2 – 2,740 m a.s.l., Site 3 – 2,806 m a.s.l. at different depths (5 cm – Fig. 4a, 15 cm – Fig. 4b, 30 cm – Fig. 4c). The effect of snow cover from October 30th is apparent

Figs. 5a, b: Cross-section through the sorted net (left), net pattern pointed up by snow cover (righ) (Photo author)

3.1.4 Stone belts

Some features resembling sorted stripes can be found in the valley. Elongated stone accumulations occupy the lowest parts of some small terrain depressions that are surrounded by mainly vegetated solifluction cover (Figs. 6a, b see cover p. 3).

The stony belts could originate asthe frontal sections of solifluction lobes were pushed together when the solifluction lobes met (Stingl, 1969). After the fine soil was washed away, the stones in the shape of stripes became exposed. The stones were originally part of the moraine material but it seems that its formations were disturbed by the movement of solifluction lobes.

3.1.5 Needle ice features

Intensive needle ice action takes place where bare ground with sufficient fine-grained regolith and moisture occur. In clear weather conditions the radiation causes the ground to cool down below the freezing point with a subsequent formation of needle ice. The most suitable conditions occur in spring after the disappearance of the snow cover and in autumn before the arrival of snow and before the temperature drop to below zero levels at night and early in the morning. Stones and fine particles become vertically lifted from the surface by several centimeters and then they move downslope and bend the needle ice when it melts. Sometimes the particles are grouped in clumps or stripes (Figs. 7a, b).

Locality	**SITE 0**	**SN 11**	**SN 3**	**SN 2 (SITE 1)**	**SN 8 (SITE 3)**	**SC 2**	**SN 13**	**SS 1**
altitude	2,645	2,656	2,668	2,674	2,806	2,880	3,036	3,051
slope aspect	-	SE	SE	SE	-	E	-	SW
slope angle	0–1°	0–1°	1–5°	1–5°	0–1°	0–1°	0–1°	15–30°
appearance of water	yes	yes	yes	yes	no	no	no	no
type of patterned ground	SN	SN	SN	SN	SN	SC	SN	SS
vertical profile of the landform	transition	transition – high centred	high-centred	transition – high centred	transition	transition	transition	transition
vegetation cover	sparsely vegetated center	sparsely vegetated center + lichens in border	sparsely vegetated center + lichens on the fringes	vegetated center	unvegetated	unvegetated	unvegetated	unvegetated
No. of cells	2	6	8	10	5	1	7	2
elongated/rounded morphometry (cm)	2/0	2/4	4/4	6/4	4/1	0/1	3/4	1/1
a	138.5	99	526	246.8	375.5		186.7	709
as	82	57	385.25	153.8	284		112.7	609
b	96	71.5	346.5	177.3	286		136.0	464
bs	64.5	37.5	199.75	89.2	179.75		65.3	294
o		169.25	331	140.8	184	190	148.3	372
os		73	228	74.0	45	110	61.0	236
u	12.5	12.2	24.3	23.2	15.225	13.6	13.9	19.8

Tab. 1: Characteristics of sorted patterned ground in the Krumgampen Valley. SN – sorted net, SC – sorted circle, SS – sorted step, a – longer axis of the elongated cell including the stone border, as – the longer axis of the elongated fine centre, b – axis perpendicular to a-axis, bs – axis perpendicular to as-axis, o – axis for the rounded cell including the stone border, os – axis for the fine centre of the rounded cell. The values given are average values for a single site, u – average diameter (b-axis) of the stones in the border. The dimensions are given in cm. For each site 30 clasts were measured. The measurements involved the total of 41 features of sorted patterned ground.

3.1.6 Stone tongues

In stone pavement localities an unusual tongue-shaped stone form was discovered (Fig. 8). Elevated rim of smaller stones surrounds a lower inner part composed of bigger stones. The tongue stretches from the glacially molded outcrop to the stone pavement cover. The „b"-axis length of stones of fine and coarser parts was measured. The average value for the rim is 6.9 cm and for the coarser infill 12.5 cm, respectively. Thirty stones from each part were measured. The tongue shape indicates that the feature was formed by some flow-like movement. The fine matrix is missing and the slope angle is gentle and therefore the origin is unclear. The flow-like movement mechanism could be produced by the melting snow mixed with soil and stones sliding on the surface of the stone pavement. Afterwards the soil was washed away. More detailed studies are still necessary to determine the genetic mechanism.

3.1.7 Stone pavement

Stone pavements occur mainly in shallow depressions where the outflow takes place and where snow accumulates (Fig. 9 see cover p. 4). The pavement is less than 10 m wide and several tens of meters long. The pavement is often delimited by glacially molded steep bedrock outcrops. Stones the size of the stone tongue, with the flat side up, sank into the underlying sandy sediment. Sometimes sorting occurs when the underlying sandy material is expelled towards the surface at the formation of sorted circles or nets. In some parts the distribution of allochthonous stones indicates the solifluction movement. The stone pavement area is located in the altitude of above 2,600 m a.s.l. and the surface is bare of vegetation.

3.2 Spatial distribution of the patterned ground features

The dissected glacial morphology of the Krumgampen Valley caused a high diversity of the local environmental factors, changing the hydrological properties, insolation, slope angle and exposition to the prevailing wind, which are all important for the patterned ground distribution and development (Van Vliet Lanoë, 1998; Křížek et al., 2007; Treml et al., 2010; Janásková, 2008).

Different patterned ground sites thus reflect the spatial diversity of the environmental conditions. Simply put, in terms of patterned ground the Krumgampen Valley is distinguished by two types of areas: vegetated and unvegetated. But in the middle part of the valley these areas become merged. The lower part and the south-facing valley sides are generally more vegetated in contrast to the upper part and north-facing sides covered by bare scree of talus slopes, moraine covers and ridges and rock glaciers.

3.2.1 Earth hummocks

Earth hummocks appear predominantly on flat (0–2 °) or gently inclined slopes (2–5 °) covered with fine-grained alluvial sediments or soils with higher organic content and vegetation cover. In the upper parts of Krumgampen Valley frost mounds occur on solifluction lobes (2,630 m a.s.l.) and/or on glacifluvial and glacilacustrine sediments (2,670, 2,735 m a.s.l.).

3.2.2 Sorted patterned ground

Sorted patterned ground sites are located in the central and upper parts of the valley above the altitude of approximately 2,600 m with flat and gentle sloped topography in its middle part. Patterned ground sometimes also develops on steeper slopes in the upper part up to the elevation of 3,100 m creating step-like forms, miniature sorted circles, sorted stripes or debris islands in the scree (Figs. 10a, b). The environment of sorted patterned ground in the middle part is wet and the ground contains fine-grained as well as coarse materials (solifluction deposits, till, glacilacustrine material covered by coarse debris). In contrast to the sites located in the middle part of the Krumgampen Valley, the sites situated in its upper part are drier. Also the bedrock is close to the surface or emerging. Sorted patterned ground is represented by nets or stripes, rarely by step circles or polygons.

4. Morphometry of sorted patterned ground

Some morphometric properties were measured at selected sorted patterned ground sites. The processing of the data is difficult since many of the patterned ground sites present only few features due to the limited area marked by suitable conditions. The sites include only a handful of patterned ground forms which are difficult to incorporate into some form of analysis. The diverse terrain morphology renders the creation of several patterned ground forms with equal conditions impossible. For a summary of morphological data refer to Tab. 1, Fig. 12 (see cover p. 4) presents spatial distribution of patterned ground features.

5. Conclusion

The distribution of fine periglacial features in the Krumgampen Valley is affected by many factors. In mountain areas the altitude together with other environmental settings is of great importance (Stingl, 1969). The glacial morphology of the bottom of Krumgampen Valley with varying environmental properties allowed the constitution of diverse periglacial forms even in limited areas. The effect of deposition of fine-grained sediments enabled the formation of patterned ground forms. The water discharge from flat reaches is slowed down by the

Figs. 7a, b: Clumps of fine material. Folding Meter for scale (ca. 20 cm – left), miniature sorted stripes formed by needle ice (right) (Photo author)

Fig. 8: Tongue-shaped form on the stone pavement. Snow in the middle part points out the tongue-like shape (Photo author)

Figs. 10a, b: Sorted stripes at site 1 (left) and sorted steps on recently deglaciated surface (right) (Photo author)

sediment deposits which results in waterlogging of the site Pronounced variations in discharge were observed which affected the ground along the flat reaches where sorted nets are present. The diurnal discharge cycles showed minimum discharge with the lowest water level in the morning and maximum discharge with the highest water level in the evening hours. The irrigation of the patterned ground site therefore occurs during the day soaking the sediment. During the night and in the early morning, when frost sets in, the locality has sufficient moisture content but it is not inundated. Consequently needle ice and frost heaving occur as a result of segregated ice formation (Figs. 11a, b). The frost action rate is impacted by the exposition of the valley sides on a day with clear weather. Because the orientation of the valley is E-W, the slopes have southern and northern aspects. The effect of "cold and warm" slopes is obvious from Tab. 1. Chiefly at times of a thin snow cover in the "warm" part of the valley the snow melts and exposes the ground to frost action, while the "cold" part remains insulated by snow. During spring and autumn the shaded north-facing side remains frozen and the southward exposed slopes are subject to numerous freeze-thaw cycles. In contrast to the expression "warm and cold", the "cold" north-facing side is less affected by frost action than the "warm" south-facing side (see the needle ice features in Fig. 7). The frequent freeze-thaw cycles in the snow-free season, as an important factor for differential frost heaving development, are a consequence of the high altitude. The patterned ground features can develop within few decades. The valley morphology along with the wind action affects the snow distribution and thus a different level of soil insulation against the frost. Van Vliet Lanoë (1998) maintains that this effect is evident primarily in the earth hummocks.

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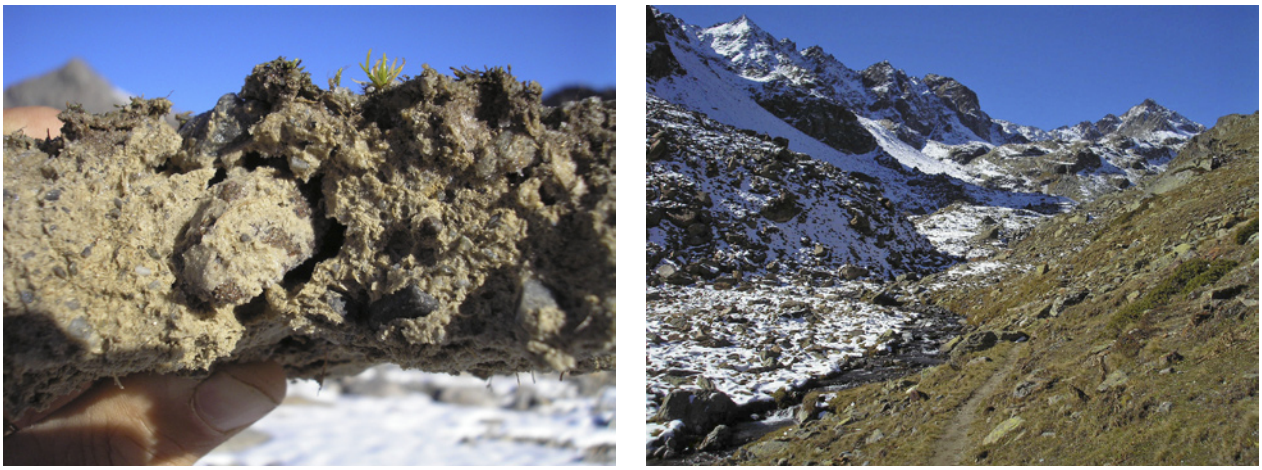

Fig. 11a, b: Upfreezing of stones during the regelation (left) and the exposition effect (right) (Photo author)

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Fig. 6a: Stone belts in Krumgampen Valley (Photo: author)

Fig. 6b: Another example of stone belts in Krumgampen Valley (Photo: author)

Illustrations related to the paper by O. Marvánek

Fig. 9: Stone pavement (Photo author)

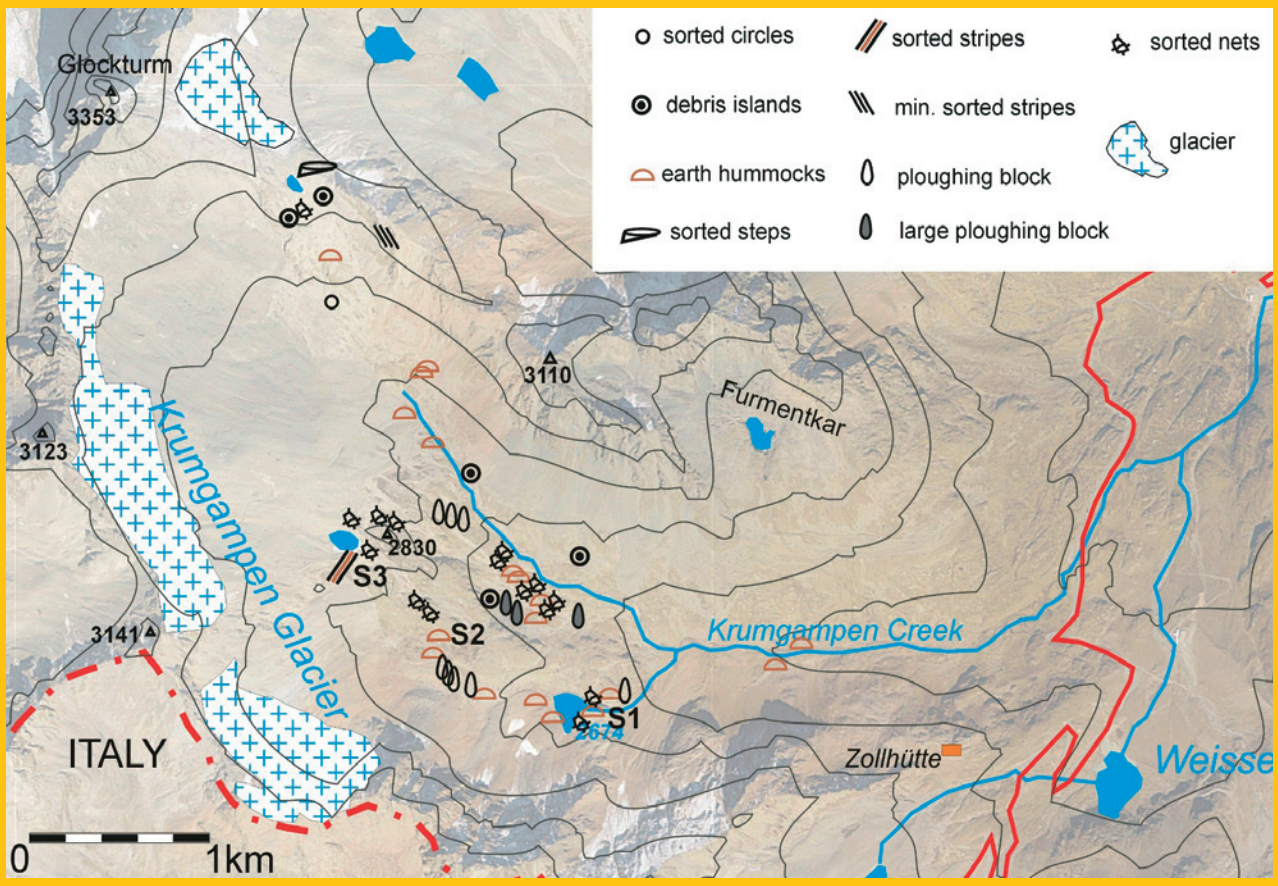

Fig. 13: Spatial distribution of small-scale periglacial landforms in the Krumgampen Valley, Ötztal, Austria

Illustrations related to the paper by O. Marvánek