TRANSPORT HIERARCHY OF CZECH SETTLEMENT CENTRES AND ITS CHANGES IN THE TRANFORMATION PERIOD: GEOGRAPHICAL ANALYSIS

Stanislav KRAFT, Michal VANČURA

Abstract:

The presented paper deals with a geographical analysis of main changes in the transport system of Czechia during the transition period by monitoring changes in the transport hierarchy of main settlement centres. Within the research, our attention is focused on long-term tendencies in the development of transport hierarchy, on main changes in transport hierarchy between 1990 and 2005, and on the relation between transport and complex hierarchy of settlement centres.

Shrnutí

Dopravní hierarchie středisek osídlení Česka a její změny v transformačním období: geografická analýza

Předkládaný příspěvek se zabývá geografickou analýzou hlavních změn v dopravním systému Česka v průběhu transformačního období pomocí sledování změn v dopravní hierarchii středisek osídlení. V rámci tohoto sledování se pozornost zaměřuje na dlouhodobé tendence ve vývoji dopravní hierarchie sledovaných středisek, hlavní změny v dopravní hierarchii středisek osídlení mezi roky 1990 a 2005 a vzájemnému vztahu mezi dopravní a komplexní hierarchií středisek.

Key words: *transport hierarchy, car transport, transition period, transport geography, settlement centres, Czechia*

1. Introduction

Transport is one of the most important national and world economy sectors and at the same time, it is one of the most significant symbols of modernity. The current society in advanced countries may be characterised as highly mobile and from this point of view dependent on transport. As well as other social-geographic systems, the transport system of the Czech Republic is passing through fundamental quantitative and qualitative changes in its spatial organisation, which are related to the post-socialistic transition. These changes are closely interconnected, whereas the actual transport system changes are in a way connected with simultaneous changes in the settlement patterns of the Czech Republic. The most distinctive changes in settlement pattern organisation can be generally characterised by the concentration and deconcentration of population, available jobs and services e.g. Carter, 1995; Giuliano, 1998; Hanson, 2004; Nuhn, Hesse, 2006; Hampl, 2005). It can be expected that simultaneous changes in the geographical organisation of society during the transition period are related to changes in the geographical organisation of the surveyed transport systems on all geographical scales, from local to macro-regional scales.

However, relevant data are missing and main changes in the geographical organisation of the Czech transport system can be therefore studied only implicitly and with certain generalisation. The study focuses on macro-regional changes within the spatial organisation of the Czech transport system. The main objective of this paper is a geographical analysis of changes in the transport hierarchy of Czech centres during the transition period. The purpose of this work is to find suitable indicators, which can characterize these changes and help in their suitable geographical interpretation. The study is focused mainly on the development of the transport system in the Czech Republic in the transition period after the year 1989, which is closely connected with the substantial dynamics of changes in the spatial organisation of society. Concerning the data availability, the study is focused on changes and effects induced by the growing mobility of people, and on changes in the passenger transport system.

The study is focused on the following basic research topics. Firstly, on long-term trends in the development of transport hierarchy, which represent fundamental frameworks for the research. Then, changes of transport hierarchy during the transition period are studied. Finally, the above-mentioned relation between the transport and settlement hierarchies is studied. Some of these issues were studied by Czech transport geographers (e.g. Hůrský, 1978; Řehák, 1994; Marada, 2003; Marada, 2008), but no study dealt with their development, namely during the period of the post-socialistic transition.

2. Transport and spatial organisation

Transport is one of the most important human activities. From a geographical perspective, transport plays a very considerable role both in the society and in the system of national economy, and this is why it is a subject of universal study and interest (Hoyle, Knowles, 1998). Some paradoxes can be seen in transport studies. Transport is mostly referred to as a sector with a relatively great environmental impact on the landscape. At the same time, by its capability to carry goods, people and information it facilitates functioning and sustainable development of settlement and economic structures throughout the world (e.g. Nuhn, Hesse, 2006; Bertolini, 1999). Transport is also a multidimensional activity whose importance is in its historical, social, political, environmental and economic perspectives (Rodrigue et al., 2006). There are two main core concepts in transport geography – accessibility and mobility (Hanson, 2004). Accessibility is in this perspective accepted as a number of opportunities (jobs, shops, transport terminals etc.) available within a certain distance or travel time. The level of accessibility at the same time reflects the existing relations and functional connections of cities, regions and whole countries. Mobility is thus defined as an ability to move between different activity sites (e.g. between home and work place). In the context of actual changes in settlement systems, especially in the context of growing distances between these localities, accessibility is increasingly depending on mobility.

Transport and transport infrastructure also play an important role in regional development and in the integration of regions into integrated economic complexes. Although direct relations between the qualitative transport infrastructure of a certain region and its development is hard to demonstrate, a high- -quality transport infrastructure is one of key factors in the regional development (see e.g. Hoyle, Smith, 1998; Bruinsma, Rietveld, 1997; Gutiérrez, 2001; Viturka et al., 2003; Vančura, 2007). H. Nuhn and M. Hesse (2006) studied the significance of transport for the contemporary society and new types of mobility. They claim that the main role of transport is to overcome distances and physical barriers and in fact, that transport creates new spatial potentials. The growing number of spatial interactions among geographical localities and the increasing speed of mobility come along with globalisation. Recent changes in the global transport system can be considered a demonstration of economic globalisation and a demonstration of global transport relations (see discussion e.g. in: Graham, 1995; Janelle, Beuthe, 1997; Keeling, 2007; Sýkora, 2000).

As mentioned above, transport is responsible for the structuring and organisation of geographical space (Seidenglanz, 2007). This thesis is also related to some basic theories and models traditionally used in transport geography. The oldest of them is the Vance model. It is a five-stage mercantile model describing the development patterns in transport networks and related urban hierarchy on the example of trade development between Europe and North America. It points out i.e. the differences between the lengthy development of the urban hierarchy of European cities and the faster hierarchical development of American cities, which are influenced more by the transport networks order. The Rimmer model is an alternative to the previous model, which generalises the process of the rise and development of transport networks in Southeast Asia. In the 1960s, a new sophisticated model called the Taaffe model (Fig. 1) was created by three American authors.

The first phase of Taaffe's model (Scattered ports) is connected with the pre-modern transport networks period. There are a few dispersed seaports with limited hinterlands on the coast, whose importance is approximately equal. The transition to the second phase (Penetration lines and port concentration) is usually evoked by the discovery of new inland raw materials. In an effort to mine these raw materials, access roads are built from selected seaports to new inland localities. The result is a one-way connection from raw material localities to export seaports, emergence of inland distribution centres and growing importance of initially scattered ports connected with inland areas. The third phase (Development of feeders) is characterised by the progressive deepening of settlement hierarchy influenced above all by the spatial layout of transport networks. Other local centres come to existence along the access lines, which fulfil a role of clue-points by connecting seaports and inland centres. The continued growing importance of export-oriented seaports and inland centres is also evident. The growing importance of inland centres is a pre-requisite for transition to the fourth phase (Beginnings of interconnection), when the direct reciprocal connection among the originally isolated inland centres is created. Profitable transport location on all existing connections is the basic development factor for the development of new centre. The high level of transport network connectivity is typical for the fifth period (Complete interconnection). The result of this maximum connectivity is the completion of the settlement hierarchy, whereas the most important centres are reciprocally very well interconnected. In this phase, the expiration of other scattered ports is evident, which were not connected on the incipient transport system and their role is fully assumed by export-oriented seaports. The last phase of Taaffe's model (High priority main streets) is known not only for a high level of connectivity but above all for the existence of hierarchically more important priority connections among the most important centres of the whole transport system. On the other hand, some reductions of poorly used transport links can also be seen. The result of the development is then a comprehensive, high-quality and intensive connection of the most important centres in the whole region. Taaffe's model was modified many times. Its modification to European conditions was made e.g. by J. Brinke, who defines four stages of transport networks development: stage of localized connection, stage of integration, stage of intensification and stage of selection (Seidenglanz, 2008).

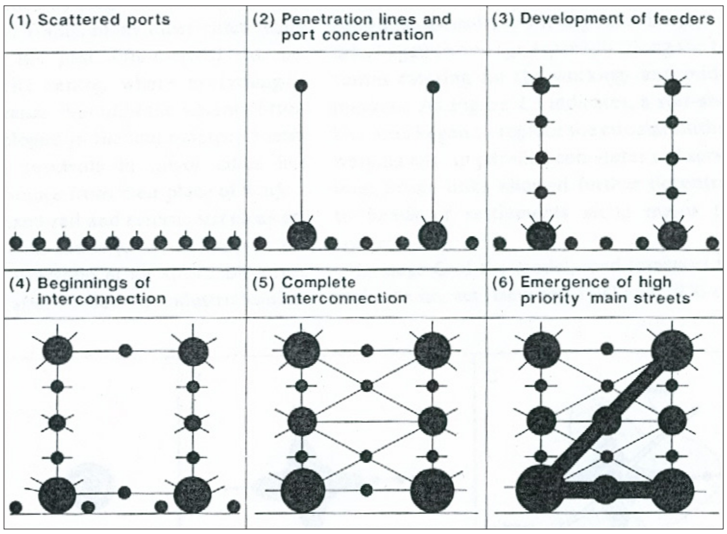

Fig. 1: The Taaffe model
(source: Taaffe, Morrill, Gould, 1963)

All the above-mentioned models are only generalised patterns of real transport network and transport link developments and their relations with settlement systems. The fact, that all these theories were created on the basis of observation in countries with different levels of transport and settlement systems demonstrates that the use of these models in a contemporary transport system is limited. The significance of these models consists above all in demonstrating the historical relations between transport development and settlement systems.

3. Research method

There are two main methodological problems when studying transport hierarchy and its relation to settlement hierarchy. The first one is the representative selection of surveyed centres. There are a few approaches for how to define centres in geographical transport studies. The most common approach is by using the quantitative transport characteristics of particular centres (e.g. Viturka, 1975; Hůrský, 1978; Řehák, 1979; Kozanecka, 1980). These authors argue that only the satisfactory level of transport features (e.g. number of public transport links or road traffic intensity) of surveyed centres is a suitable indicator of transport centres.

The main problem resulting from this approach is, however, the fact, that some centres have a good transport location and subsequently a high level of transport features, but its complex importance is sometimes lower. Conversely, some centres can be situated in a worse transport location and have unsatisfactory transport characteristics but their complex importance is probably higher. Hence, some authors consider comprehensive characteristics as more suitable indicators for the definition of centres in transport geographical studies (e.g. Marada, 2003, 2008). Centres surveyed in this study are taken over from Hampl's socio-geographical regionalisation of the Czech Republic from 2001. Hampl (2005) specified 144 centres of at least micro--regional importance according to their complex size index. The complex size index is an aggregate indicator based on the residential and labour functions of these centres.

The second methodological problem results from the above mentioned data availability and data responsibility. The study is focused on the dynamics of passenger transport systems in the Czech Republic in the transformation period and its relation to the settlement system organisation. Unfortunately, there are no deeper and detailed surveys of personal travelling in the Czech Republic (see e.g. National Travel Survey in Great Britain). This is why the transport geographers usually make use of public transport connections (Hůrský, 1978; Řehák, 1979; Marada, 2003; Seidenglanz, 2007) or – less often – of road traffic intensity (Viturka, 1975). Regarding the most important transport mode in the Czech Republic, we use data from the road transport census conducted every five years by the Road and Motorway Directorate of the Czech Republic. These data are the sums of all transport volumes (trucks, private cars, motorcycles) measured at census points situated on a greater part of Czech roads (in this study transport size = average amount of vehicles entering or departing the centre per 24 hour period). Unfortunately, the greatest weakness of this transport census is namely the fact, that there is no direct possibility for how to differentiate what part of total transport volume falls to transit transport and what part falls to "real" local transport between the centre and its hinterland.

Changes in the surveyed centres' transport hierarchy during the transition period and their relationship to the settlement patterns of the Czech Republic are then valuated by using traditional basic characteristics of settlement geography, namely by the rule of size order (size hierarchization of centres), which can serve as a comparative model for distinguishing the level of hierarchization (Marada, 2008). Detailed relations between transport and settlement hierarchy are then evaluated by the Pearson product-moment correlation coefficient, which demonstrates the association of both monitored types of hierarchization. Concentration of transport intensity in the centres is finally expressed by the Lorenz concentration curve.

4. Results

4.1 Long-term trends in the development of transport hierarchy

The analysis of the road transport census in the surveyed centres provides a few basic features of the development of transport hierarchy from a longer time perspective. This research is important for checking the long-term tendencies in transport hierarchy and at the same time for the basic comparison with general simultaneous tendencies in settlement patterns. The analysis included road transport censuses from 1990, 1995, 2000 and 2005. Using data from Viturka's study (1975), it was possible to characterize main tendencies of transport hierarchy in centres before 1990, too (Transport Census in 1973). Long--term trends in the development of transport hierarchy of the surveyed centres are shown in Tab. 1.

As to the size hierarchy of complex and transport characteristics of the surveyed centres, we can see some relevant long-term tendencies in the spatial settlement and transport patterns of the Czech Republic. The most important finding is a continually intensifying hierarchization of centres in both monitored types of studied hierarchies. In the case of complex size, the system of centres naturally shows a much more developed hierarchy than in the case of transport size. The reason is likely the fact that transport flows are much more equably distributed within the space than population or available jobs. The comparison of complex and transport hierarchies further points to other differences of the two indicators. The hierarchization of the complex sizes of centres in both years shows that only the last size category (35^{th}–98^{th} centre) is equivalent to the size of the first centre (Prague). Other size categories have a less developed hierarchy, which results from a longer historical development of settlement patterns in the Czech Republic (see Hampl, 2005). Conversely, the size hierarchization of transport features exhibits different tendencies. Each size category of transport hierarchy surmounts the transport significance of the first centre. Nevertheless, even in these tendencies we can see a certain development of the transport hierarchy during the period of transformation. Evident is the growing importance of the first centre (Prague). A relevant indicator for this assessment is the rate of hierarchization (see notes under Tab. 1). This indicator refers to the growing importance of the biggest centres in the transport hierarchy of the Czech Republic (18.6 for year 1973 and 26.9 for year 2005), which results from the distinctive concentration of transport flows and transport infrastructure in the biggest settlement centres. The transport hierarchy development before and after the year 1989 facilitates

Rank	Relativizated sizes (The 1st centre = 100)						
	Complex size		Transport size				
	1991	2001	1973	1990	1995	2000	2005
1st	100	100	100	100	100	100	100
2nd – 4th	83	74	120	133	129	124	106
5th – 12th	50	49	194	209	208	187	171
13th – 34th	93	85	400	409	385	324	289
35th – 98th	112	104	783	759	668	553	475
Degree of hierarchization	89.3	92.1	18.6	20.0	21.8	25.5	26.9

Tab. 1: Size hierarchization of complex and transport features
(source: Viturka 1975, Hampl 2005, Marada 2008, Transport census ŘSD)
Notes: 1. Degree of hierarchization = 100 times ((size of the 1st–4th centre) / (size of the 13th–98th centre)). The degree of hierarchization indicator demonstrates the size of the largest centres in proportion to the size of medium-size and small centres. Values lower than 100 correspond to a lower degree of hierarchization than presumed by the rank-size rule, values higher than 100 to a higher degree of hierarchization.
2. The data relating to transport census from the year 1973 are borrowed from Viturka's study (1975). This study was made by a different methodology. A possibility to compare the data with other outputs is thus only partial.

a very interesting comparison. The transport hierarchy of the surveyed centres is least developed in 1990. This might have been caused by planned socialist development of settlement centres in the 1970s and 1980s, which suppressed the trends of natural hierarchization in the settlement structure, namely in relation to the development of higher size categories of centres (see e.g. Hampl, Gardavský, Kühnl, 1987). This is why the transport hierarchy status in 1990 rather reflects the previous socialist period in the settlement structure.

A different view of this development provides the evaluation of changes occurring in the transport concentration processes. This phenomenon can be appropriately illustrated in this study by using the Lorenz concentration curve, which allows a comparison between these concentrations in both monitored years (Fig. 2). Transport censuses from the years 1990 and 2005 were analysed. The comparison of both curves points to a conspicuously asymmetrical distribution of transport volumes in the surveyed centres. A half of all transport volumes was concentrated in 29 % of centres in 1990 (23 % of centres in 2005). Thus, the concentration curve for 2005 is more rounded than that for 1990. It again points to the intensifying transport hierarchization of the surveyed centres and to the growing importance of the biggest centres in the spatial distribution of transport flows.

4.2 Transport hierarchy of Czech settlement centres in 1990

Transport hierarchy of Czech settlement centres in 1990 constitutes a start-up phase of detailed research and naturally a reflection of socialistic development. All 144 centres were analyzed by using the indicator of relative transport size (= all vehicles entering and leaving the centre; all centres = 10,000). In 1990, the most important transport centres were the largest settlement centres in the Czech Republic (Praha, Brno, Ostrava, and Plzeň). All these are centres whose position within the transport system is conditioned by their population size and significance of their labour market. The main feature of this hierarchy is at the same time the fact there are also centres of relatively lower complex significance occurring between the most important centres such as Uherské Hradiště, Tábor and Mladá Boleslav. Their transport significance stems out from their good location within the road transport network (similarly for public transport see e.g. Marada, 2003).

Conversely, the centres of relatively greater complex importance, that are situated in less favourable transport locations (e.g. Tachov, Dvůr Králové nad Labem, Uničov) appear at lower levels of transport hierarchy. Good or bad transport locations are thus a key factor influencing the distinctive asymmetry between the transport and settlement hierarchies of the surveyed centres. Tab. 2 presents twenty largest and smallest centres according to their relative transport size in 1990.

The asymmetry between transport and settlement hierarchies causes substantial differences in ranking the centres by transport and complex sizes. Centres with the most favourable transport location are

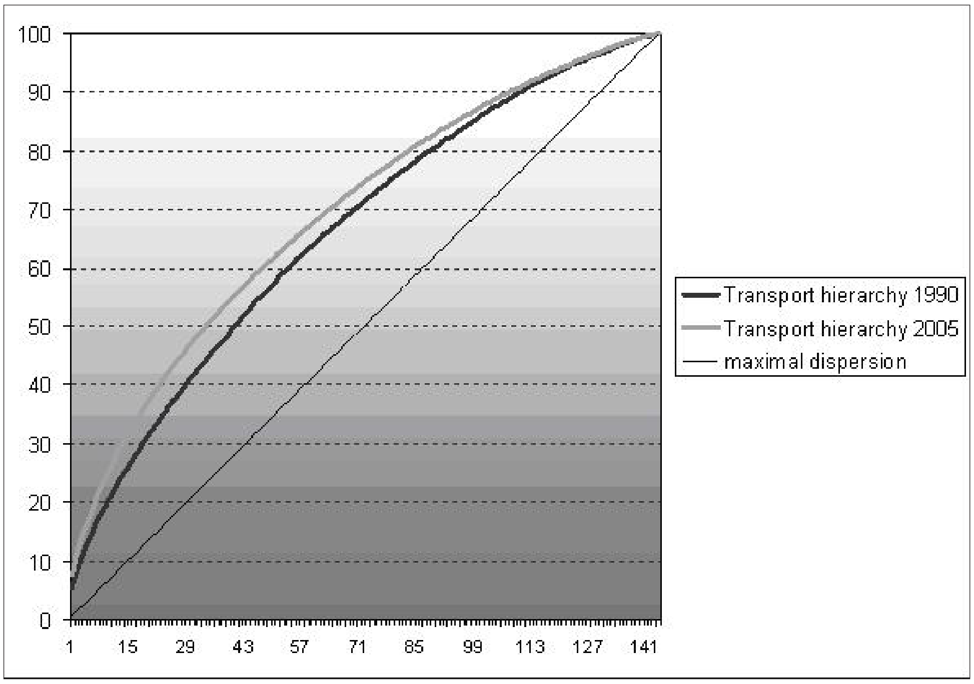

Fig. 2: Lorenz concentration curve for transport hierarchy 1990–2005 (source: Transport census ŘSD)

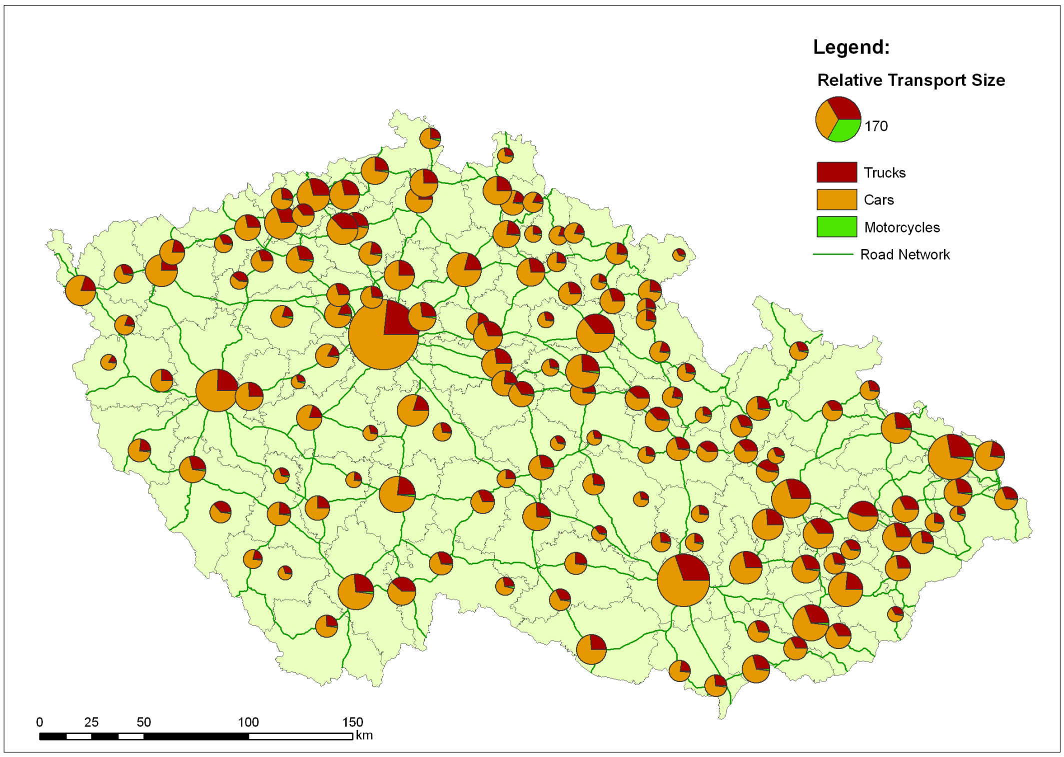

Fig. 3: Transport hierarchy of Czech settlement centres (1990)

Třeboň (difference between transport hierarchy and complex hierarchy is 87 points), Lovosice (82 points), Poděbrady (72 points), Nový Bor and Čáslav (55 points). This discrepancy can be caused by other reasons too (e.g. spatial differentiation of road transport intensities in the Czech Republic or public transport quality), but the factor of transport location can be considered the most important of all. By contrast, centres with the most unfavourable transport location are Sokolov (74 points), Blansko (71 points), Kadaň (58 points), Dvůr Králové (55 points) and Litvínov (53 points). All these centres display a substantially lower relative transport size than their complex size is. These centres are situated aside important transit communications and we can suppose that they are relatively least affected by transit or irregular transport.

4.3 Transport hierarchy of Czech settlement centres in year 2005

The transport hierarchy of Czech settlement centres in 2005 was evaluated analogically, i.e. at the time of the last transport census conducted in the Czech Republic. This year can be considered a final stage of the transformation period. The most important transport centres were again the largest settlement centres of the Czech Republic (Praha, Brno, Ostrava and Plzeň), but their dominance over other centres is notably lower. In this respect, the declining transport size between the four largest centres and the other centres is much more continual. The above-mentioned asymmetry between the transport and settlement hierarchies can be once again documented by the fact, that there are also centres of lower complex significance among the most important transport centres (Prostějov, Mladá Boleslav, Frýdek-Místek and Hranice). These centres are advantaged by their good transport location again; they usually serve as the most important road transport crossings in the Czech Republic. On the other hand, there are the smallest centres according to their relative transport size here too (Chotěboř, Prachatice, and Broumov). The main feature of the two studied hierarchies consists in significant qualitative changes in the relative transport size of all surveyed centres. The relative transport size of the first centre (Praha) was 527.3 in 1990 while in 2005 it was only 757.2. By contrast, the relative transport size of the smallest centre (Broumov) was 16.8 in 1990 but only 13.0 in 2005. Thus, the studied system of settlement centres shows a growing variation interval between the maximum and minimum relative transport size. Among other things, this points

Rank	Centre	Relative transport size	Rank	Centre	Relative transport size
1.	Praha	527.3	125.	Polička	31.3
2.	Brno	290.7	126.	Semily	30.7
3.	Ostrava	218.0	127.	Uničov	29.5
4.	Plzeň	191.5	128.	Lanškroun	27.6
5.	Olomouc	161.9	129.	Nový Bydžov	27.1
6.	Hradec Králové	155.2	130.	Milevsko	27.0
7.	Uherské Hradiště	139.6	131.	Blatná	26.6
8.	Tábor	139.0	132.	Tachov	26.5
9.	České Budějovice	133.8	133.	Frýdlant	26.3
10.	Zlín	126.1	134.	Dvůr Králové nad Labem	26.2
11.	Mladá Boleslav	124.6	135.	Valašské Klobouky	25.5
12.	Pardubice	124.2	136.	Velké Meziříčí	25.5
13.	Most	118.8	137.	Frýdlant nad Ostravicí	25.1
14.	Teplice	115.5	138.	Sedlčany	25.0
15.	Vyškov	111.8	139.	Bystřice nad Pernštejnem	24.3
16.	Karlovy Vary	110.3	140.	Hlinsko	23.6
17.	Lovosice	106.3	141.	Chotěboř	23.1
18.	Benešov	105.0	142.	Hořovice	21.1
19.	Prostějov	103.8	143.	Prachatice	20.0
20.	Opava	98.6	144.	Broumov	16.8

Tab. 2: The largest and smallest centres according to their relative transport size (1990)
(source: Transport census 1990, ŘSD)
Note: Relative Transport Size = all transport volumes entering or departing the centre; all centres = 10,000

to the growing significance of the first centre. Twenty largest and smallest settlement centres according to their relative transport sizes in 2005 are presented in Tab. 3.

Similarly as in the previous evaluation, the above documented differences in the order of centres according to their complex and transport size is evident. Centres that are advantaged by good transport locations are namely Lovosice (by 69 points), Mohelnice (by 65 points), Litomyšl (by 60 points), Čáslav (by 59 points) and Hranice (by 53 points). The most distinctly growing dynamics can be seen in centres situated on the R35 or I/35 road (Olomouc, Mohelnice, Litomyšl, Vysoké Mýto, Hradec Králové), which is an alternative communication to the most exploited expressway D1. Conversely, the most disadvantaged centres due to their transport location are Sokolov (by 63 points), Litvínov (by 59 points), Dvůr Králové (by 54 points), Příbram (by 51 points) and Kadaň (by 50 points). Although the disproportions are considerable, a certain convergence between the two types of hierarchy during the transformation period is evident.

4.4 Correlations between the transport and settlement hierarchies

The correlation between the transport and settlement hierarchies can be documented also by using basic statistical methods. The goal of this evaluation is to demonstrate the mutual dependence of the two studied hierarchies and the development of this correlation during the transformation period. The assessment includes both all components of the complex hierarchy (complex size, labour size and population size) and components of the transport hierarchy (volumes of trucks, cars and motorcycles). The Pearson product-moment correlation coefficient is used to monitor which component of transport hierarchy is more closely associated with the complex hierarchy and which component of complex hierarchy is most associated with the transport hierarchy.

Rank	Centre	Relative transport size	Rank	Centre	Relative transport size
1.	Praha	757.2	125.	Sušice	28.9
2.	Brno	377.9	126.	Dačice	28.8
3.	Ostrava	230.1	127.	Uničov	28.7
4.	Plzeň	191.2	128.	Nový Bydžov	27.4
5.	Olomouc	190.6	129.	Vlašim	27.4
6.	Hradec Králové	185.8	130.	Lanškroun	27.2
7.	Prostějov	183.2	131.	Hořovice	26.5
8.	Mladá Boleslav	159.5	132.	Vimperk	26.3
9.	Frýdek-Místek	155.6	133.	Sedlčany	25.7
10.	Pardubice	148.3	134.	Dvůr Králové nad Labem	25.4
11.	České Budějovice	142.8	135.	Semily	23.2
12.	Hranice	129.2	136.	Blatná	22.8
13.	Teplice	122.8	137.	Hlinsko	22.6
14.	Uherské Hradiště	122.4	138.	Frýdlant	22.5
15.	Ústí nad Labem	122.1	139.	Tachov	21.4
16.	Zlín	120.0	140.	Podbořany	20.5
17.	Kolín	115.9	141.	Bystřice nad Pernštejnem	20.2
18.	Liberec	112.8	142.	Chotěboř	18.9
19.	Vyškov	110.8	143.	Prachatice	17.4
20.	Tábor	107.5	144.	Broumov	13.0

Tab. 3: The largest and smallest centres according to their relative transport size (2005)
Source: Transport census 2005, ŘSD
Note: Relative Transport Size = all transport volumes entering or departing the centre; all centres = 10,000

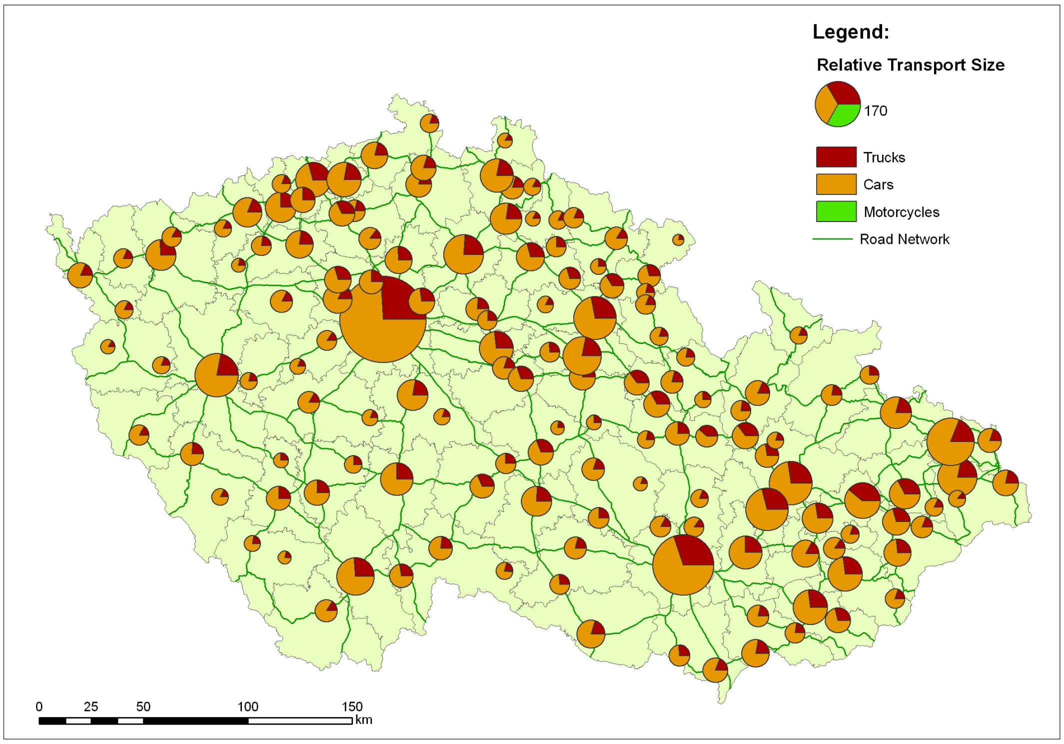

Fig. 4: Transport hierarchy of Czech settlement centres (2005)

In terms of previous evaluations, we can suppose the existence of a higher association between complex and transport indicators for the passenger-car transport, which shows the highest spatial dispersion in all studied years. Lower association can be expected in the indicators of truck transport, which is more oriented to long-distance (transit) transport. The absolutely lowest correlation can be expected in motorcycles; this transport mode is not markedly concentrated and represents only a minor share of all transport volumes. In respect of assessing the dynamics of these relations, a higher association among all monitored categories can be expected in 2005 than in 1990.

In terms of monitoring the whole set of settlement centres in 1990 (Tab. 4), a relatively close dependence can be seen among all components of transport and complex hierarchies. A very tight dependence (0.889) is characteristic of relation between the main components of both types of hierarchy ("CS" and "ATV"), which demonstrates a distinctive interconnection between the two monitored systems. The closest dependence on the components of complex hierarchy (CS, LS, PS) is typical for passenger-car transport (analogical values 0.900; 0.902; 0.897). Thus, the individual car transport is the most important component of transport hierarchy in relation to the settlement system organisation. A lower correlation is then seen between the complex characteristics and truck transport, which is a consequence of the above-mentioned orientation to the transit transport of this transport mode. On the other hand, the evaluation demonstrates a close relation among all transport indicators and labour size of settlement centres. This indicator is thus the most significant component of complex hierarchy in relation to transport characteristics.

Table 5 shows an increasing level of association between the components of transport and complex hierarchies. The closer dependence between the main components of both hierarchies (0.930) results especially from the above-mentioned convergence between transport and complex characteristics. Thus, transport indicators correspond with actual changes in the settlement systems more in 2005 than in 1990. The closest correlation for the components of complex hierarchy (CS, LS, PS) is again typical for passenger-car transport (analogical values 0.937; 0.937; 0.935). The relatively closer dependence is then characteristic for truck road transport (0.890; 0.893; 0.881) and for motorbikes (0.867; 0.897; 0.858). The closest correlation of all studied characteristics is that between transport indicators and labour size of settlement centres (0.893; 0.937; 0.897 and 0.931).

5. Conclusion

Results of our analyses showed that the transport system of the Czech Republic went through relatively distinctive changes in its spatial organization during

	CS	LS	PS	TV	CV	MV	ATV
CS	*1.000*	*0.999*	*0.999*	0.818	0.900	0.648	0.889
LS	*0.999*	*1.000*	*0.999*	0.821	0.902	0.649	0.892
PS	*0.999*	*0.999*	*1.000*	0.813	0.897	0.645	0.886
TV	0.818	0.821	0.813	1.000	0.936	0.730	0.966
CV	0.900	0.902	0.897	0.936	1.000	0.758	0.996
MV	0.648	0.649	0.645	0.730	0.758	1.000	0.764
ATV	0.889	0.892	0.886	0.966	0.996	0.764	1.000

Tab. 4: Paired correlation among components of complex and transport size hierarchies (1990) (source: Hampl, 2005 ; Transport census 1990; ŘSD)
Note: CS – complex size; LS – Labour size; PS – Population size; TV – trucks volume; CV – car volume; MV – motorcycles volume; ATV – all transport volume

	CS	LS	PS	TV	CV	MV	ATV
CS	*1.000*	*0.999*	*0.997*	0.890	0.937	0.867	0.930
LS	*0.999*	*1.000*	*0.994*	0.893	0.937	0.897	0.931
PS	*0.997*	*0.994*	*1.000*	0.881	0.935	0.858	0.926
TV	0.890	0.893	0.881	1.000	0.969	0.903	0.984
CV	0.937	0.937	0.935	0.969	1.000	0.927	0.998
MV	0.867	0.897	0.858	0.903	0.927	1.000	0.927
ATV	0.930	0.931	0.926	0.984	0.998	0.927	1.000

Tab. 5: Paired correlation among components of complex and transport size hierarchies (2005) (source: Hampl, 2005; Transport census 2005; ŘSD)

the transformation period. The synthesis of all surveyed issues can be summarized in the following conclusions:

1. In terms of monitoring the long-term tendencies in development of the transport hierarchy of settlement centres, a deepening of hierarchization tendencies occurred in the transformation period and a certain convergence between the development of the given hierarchy and general trends in the geographical organization of the society. The most conspicuous change is the increasing transport significance of the largest settlement centre (Praha), which is typical especially for the transport hierarchy of year 2005.
2. The transport hierarchy of Czech settlement centres experienced considerable quantitative and qualitative changes between 1990 and 2005. The most substantial changes can be characterized by the growing variation interval between the maximum and the minimum value of relative transport significance, which indicates the increasing transport significance of the largest transport/settlement centres and the decreasing transport significance of the smallest centres. The convergence of transport hierarchy to general trends in settlement patterns results at the same time in the decreasing asymmetry between the transport and settlement hierarchies.
3. As to the monitoring of correlation between the transport and settlement hierarchies, a relatively close link was demonstrated between all components of the settlement and transport hierarchies. The development of this correlation was closer in 2005 than in 1990. The closest links between the settlement and transport hierarchies were shown to exist in the volume of car transport and in the labour size of centres, which demonstrates a close relation between the two components.

In conclusion, we point out that the character of used data is problematic because the data illustrate the studied issue only implicitly and with a certain generalization. Previous analyses elucidated some aspects of relations between the transport and geographical organisation of the society. Therefore, the authors will focus their follow-up research on other geographical scales (meso- and microregional), which however call for different research methods.

References:

BERTOLINI, L. (1999): Future of Transport? – Future of Cities. Promet-Traffic-Traffico, Vol. 11, No. 2–3, p. 89–95.

BRUINSMA, F., RIETVELD, S. (1997): Is Transport Infrastructure effective? Berlin – Heidelberg, 383 pp.

CARTER, H. (1995): The Study of Urban Geography. 4th edition, John Wiley & Sons, New York, 420 pp.

GIULIANO, G. (1998): Urban Travel Patterns. In: Knowles, R., Hoyle, B. [eds.]: Modern Transport Geography, Wiley and sons, Chichester. p. 115–134.

GRAHAM, B. (1995): Geography and Air Transportation. John Wiley, New York, 288 pp.

GUTIÉRREZ, J. (2001): Location, Economic Potential and Daily Accessibility: an analysis of accessibility impact of high-speed line Madrid–Barcelona–French border. Journal of Transport Geography, Vol. 9, p. 229–242.

HAMPL, M., GARDAVSKÝ, V., KÜHNL, K. (1987): Regionální struktura a vývoj systému osídlení ČSR. Univerzita Karlova, Praha, 255 pp.

HAMPL, M., MÜLLER, J. (1996): Komplexní organizace systému osídlení. In: Hampl, M. et al. [(ed.]: Geografická organizace společnosti a transformační procesy v ČR. Univerzita Karlova v Praze, Přírodovědecká fakulta, katedra sociální geografie a regionálního rozvoje, Praha, p. 53–59.

HAMPL, M. (2005): Geografická organizace společnosti v České republice: Transformační procesy a jejich obecný kontext. Univerzita Karlova v Praze, Přírodovědecká fakulta, katedra sociální geografie a regionálního rozvoje, Praha, 147 pp.

HANSON, S. (2004): The Context of Urban Travel – Concepts and Recent Trends. In: Hanson, S., Giuliano, G. [eds.]: The Geography of Urban Transportation. The Guilford Press, New York, p. 3–29.

HORŇÁK, M. (2006): Identification of Regions of Transport Marginality in Slovakia. In: Komornicki, T., Czapiewski, K. [eds.]: Regional Periphery in Central and Eastern Europe, Europa XXI, Vol. 15, p. 35–41.

HOYLE, B., SMITH, J. (1998): Transport and Development: Conceptual Frameworks. In: Knowles, R., Hoyle, B. [eds.]: Modern Transport Geography, Wiley and sons, Chichester, p. 13–40.

HŮRSKÝ, J. (1978): Regionalizace České socialistické republiky na základě spádu osobní hromadné dopravy. Studia Geographica, 59, Geografický Ústav ČSAV, Brno, 182 pp.

JANELLE, D., BEUTHE, M. (1997): Globalization and research issues in Transportation. Journal of Transport Geography, Vol. 5, pp. 199–206.

KEELING, D. (2007): Transportation Geography: new directions on well-worn trails. Progress in Human Geography, Vol. 31, No. 2, Sage publications, p. 217–225.

KNOWLES, R., HOYLE, B. [eds.] (1998): Modern Transport Geography, Wiley and sons, Chichester, 374 pp.

KOZANECKA, M. (1980): Tendecje rozwojowe komunikacji autobusowej v Polsce. Studium geograficzno – ekonomiczne. Prace monograficzne WSP w Krakowie, Vol. 36, Krakow, 240 pp.

MARADA, M. (2003): Dopravní hierarchie středisek v Česku: vztah k organizaci osídlení. Disertační práce. Univerzita Karlova v Praze, Přírodovědecká fakulta, katedra sociální geografie a regionálního rozvoje, Praha, 116 pp.

MARADA, M. (2008): Transport and geographic organization of society: Case study of Czechia. Geografie – Sborník ČGS, Vol. 113, No. 3, p. 285–301.

NUHN, H., HESSE, M. (2006): Verkehrsgeographie – Grundriss, Allgemeine, Geographie. Paderborn, 379 pp.

RODRIGUE, J.-P., COMTOIS, C., SLACK, B. (2006): The Geography of Transport Systems, Routledge, New York, 296 pp.

ŘEHÁK, S. (1979): Prostorová struktura obslužného systému hromadné osobní dopravy. Kandidátská disertační práce. Geografický Ústav ČSAV, Brno, 88 pp.

ŘEHÁK, S. (1994): Hromadná osobní doprava ve výzkumu prostorové struktury státu (na příkladu někdejšího Československa). Habilitační práce, Masarykova univerzita, Přírodovědecká fakulta, katedra geografie, Brno, 75 pp.

SEIDENGLANZ, D. (2007): Dopravní charakteristiky venkovského prostoru. Disertační práce, Masarykova univerzita, Přírodovědecká fakulta, Brno, 170 pp.

SEIDENGLANZ, D. (2008): Geografie dopravy. In: Toušek, V., Kunc, J., Vystoupil, J. [eds.]: Ekonomická a sociální geografie. Aleš Čeněk, Plzeň, pp. 231–270.

SÝKORA, L. (2000): Globalizace a její společenské a geografické důsledky. In: Jehlička, P., Tomeš, J., Daněk, P. [eds.]: Stát, prostor, politika. Univerzita Karlova v Praze, Přírodovědecká fakulta, p. 59–79.

TAAFFE, E., MORRILL, R., GOULD, P. (1963): Transport expansion in underdeveloped countries: a comparative analysis. Geographical Review, 53, pp. 503–529.

VANČURA, M. (2005): Foreign direct investment in the countries of Central Europe with the emphasis on the Czech Republic. In: Michalski, T. [ed.]: Geographical Aspects of Transformation Process in Central and East-Central Europe, Wydawnictwo Bernardinum, Pelplin, pp. 171–181.

VITURKA, M. (1975): Střediska silniční dopravy v ČSR. Rigorózní práce, UJEP v Brně, Přírodovědecká fakulta, Brno, 66 pp.

VITURKA, M. (1981): Vztah sídelní struktury a silniční dopravy. Sborník Československé geografické společnosti, Vol. 86, No. 1, p. 28–37.

VITURKA, M. et al. (2003): Regionální vyhodnocení kvality podnikatelského prostředí v České republice. Masarykova univerzita, Brno, 141 pp.

ZAPLETALOVÁ, J. (1998): The issue of traffic remoteness in South Moravia on the example of the middle Dyje river Basin. Moravian Geographical Reports, Vol. 6, No. 1, pp. 1–13.

Authors' addresses:

Mgr. Stanislav KRAFT, *e-mail: kraft@pf.jcu.cz*
Mgr. Michal VANČURA, Ph.D., *e-mail: vancura@pf.jcu.cz*
Department of Geography
Pedagogical Faculty, University of South Bohemia,
Jeronýmova 10, 371 15 České Budějovice, Czech Republic