MODELLING OF TRANSPORT ACCESSIBILITY FOR MUNUCIPALITIES OF THE CZECH REPUBLIC

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Abstract. An evaluation of public transport accessibility belongs to demanding analysis of local/regional governenment, which monitor the state and propose changes in public transport network. Among various possible data sources and methods of their processing, analysis of time schedule can be applied. Nevertheless, the modelling of the state and progress of transport accessibility requires appropriate parameters setting and way of processing. It is possible to measure the situation by the number of connected targets, time indicators, cost indicators etc.

Results of extended processing of commuting possibilities between pairs of municipalities throughout the Czech Republic are presented using different indicators. The situations in June 2006 and June 2007 are compared. Significant changes are observed mainly in NW Bohemia.

Keywords: transport accessibility, modelling, GIS

1 Introduction

The relative proportion of public transport in the Czech Republic continuosly decreases, but still dominates in the personnal transport. The ratio of people transported by public means in 2001 was 60,2% and since that time it slowly declines to 57,2% in 2005, according to the statistics of Ministry of Transport of the Czech Republic (CR). Futhermore, there is a strong public interest to dicrease a volume of individual transport and support the public transport due to environmental aspects and social issues (mobility of a significant part of the society rely on public transportation).
Unfortunately, in our country irrational reasons for utilisation of cars play the important role (utilisation of car as a important social attribute and a sign of reached social level). Nevetheless, we hope that information about availability, conditions and appropriate restrictive/supporting policy may influence the utilisation of transport means. The following example of transport accessibility analysis may contribute to this goal.

2 Transport Accessibility

The concept of accessibility of geographical objects has been studied since the 1950's. The accessibility is measured by specific indicators, which describe the position of a relevant object in the frame of spatial structure on the basis of connectivity and distance of this object to other objects (Garrison 1959). The practical providing of accessibility analysis is demonstrated e.g. in Bracken (1994) or Burrough et al. (1998).
The accessibility can be divided according to travel means, purposes of travelling, periodicity etc. The determination, what kind of accessibility is intended to be studied, is important for following selection of appropriate methods, sources of data and metrics. Usually distance measures inside a point or line pattern are applied.
The public transport usually creates a network structure, thus the most frequent indicators are based on the length calculation of the path in the graph. According this approach, the best travel accessibility has the location with the smallest value of following indicator (Horak 2006):

$$D_i^C = \sum_j d_{ij}^c$$

DiC indicator of travel accessibility in location i
dijc length of the shortest path from the location i to j
i index of the source
j index of the target

Public transport reflects labour commuting, school attendance and daily/weekly supply/ies, which is important for functional regionalisation. The time accessibility and number of connections to regional centres was used e.g. by Rölc (2001) for a transport regionalization of CR and comparison with socio-geographical and administrative regionalization.

3 Analyses of time schedule

The public transport accessibility can be studied using various sources of data. Usually census data or questionnaires are applied. Our study is concetrated to an evaluation of a capacity of commuting using public transport derived from the analyses of the time schedules. The analyses of the time schedules are provided for various parameter settings according to requested applications.
The extended testing of commuting possibilities cannot be provided without an appropriate automation support.We utilised a DOK programme, which is tailored for searching in the time schedule IDOS (application for travel connection searching). The programme operates with a database, where input parameters of the searched connections are stored as well as the results of processing (parameters of found connection) (Horák et al. 2006).
Among various applications of accessibility analyses we can distinguish examples for local, regional and country level. The basic chararacterization can be found in (Horák et al. 2007 -Brno).
Since 2006 the database of public transport accessibility for Ministry of Social Affairs (MPSV) has been developed. The database includes parameters of public transport connectivity between all municipalities of CR, where the Euclidean distance between municipalities is less than 70 km and the duration of journey is less than 90 minutes. Parameters like the distance evaluated by public transport, number of links in 5 time intervals, prices, duration of journey, number of changes can be utilised for the next processing and the evaluation. Commuting time is limited to several selected intervals (5:00-6:00, 6:00-7:00, 7:00-8:00, 13:00-14:00, 21:00-22:00, 5:15-5:45, 6:15-6:45, 7:15 – 7:45, 13:15-13:45, 21:15 – 21:45), to maximal duration of. 1 hour, maximal number of changes 5.
Due to a lack of computing capacity the analysis is done only for municipal level (not for municipal parts) and only the one-way travel to workplace is tested. Future improvements will overcome these disadvantages.
The database is utilised for searching of vacant job places on the web portal of MPSV under selected conditions (e.g. select vacancies available within 1 hour by public transport).
The searching results stored in the database can be processed and provides the sources of data for evaluation of situation on local, regional and country levels.

The country level of public transport accessibility evaluation enables to understand the commuting conditions, infrastructure used for public transport, regional connections, connections between regional centres, comparison of commuting conditions and its progress in time sequence of analyses.

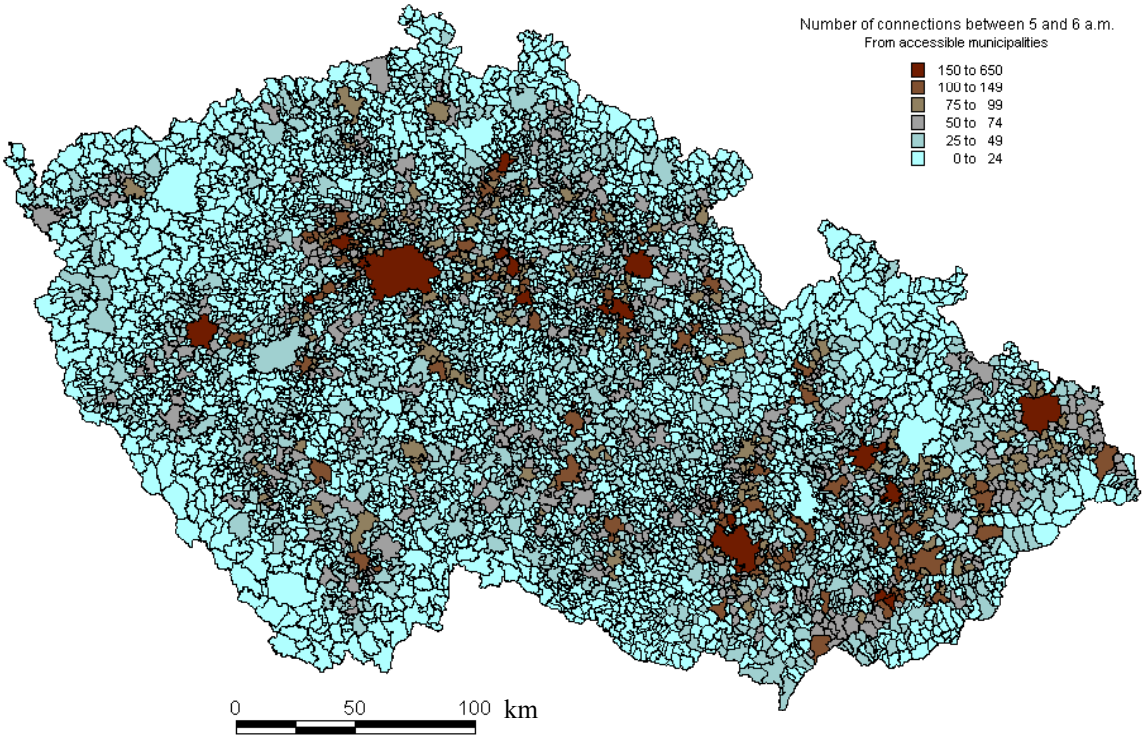

Fig. 1. Number of connections between 5 and 6 a.m. from accessible municipalities in June 2007

Fig. 1 depicts the situation in transport accessibility expressed for any municipality by the number of connections between 5 and 6 a.m. from surrounding municipalities limited by introductory conditions (Euclidean distance to 70 kms, max. duration to 90 minutes).
Naturarly, the best accessibility is in Prague (649 connections), following by Brno (389) and Ostrava (265). Next places are influenced by the municipal size effect – regions with smaller municipalities resulted in "better" accessible measures; see e.g. Central Bohemia or Central and South Moravia. E.g. Unerske Hradiste (5th, 213 connections), Kurim (7th, 201 connections) etc.
The situation can be described similarly by other indicators like number of connections (or ratio of connections to eliminate a border efect and the size of municipalities) available to 8 a.m. (Horák et al. 2007) or other time interval selected according commuting requests.

The analysis was repeated in June 2007. Next, the difference between these states was visualised (relative expression in fig. 2).
The result shows the substantial fall of transport accessibility for many units (red colour), in several cases more than 1000%, which contrasts to the quite small number of municipalities with improved situation (green colour). Deteriorated units can be found in most regions (except of Zlin), but the strong accumulation is indicated in NW Bohemia. The issues with reorganising regional public services in 2006 evidently negatively influence the situation in the accessibility.

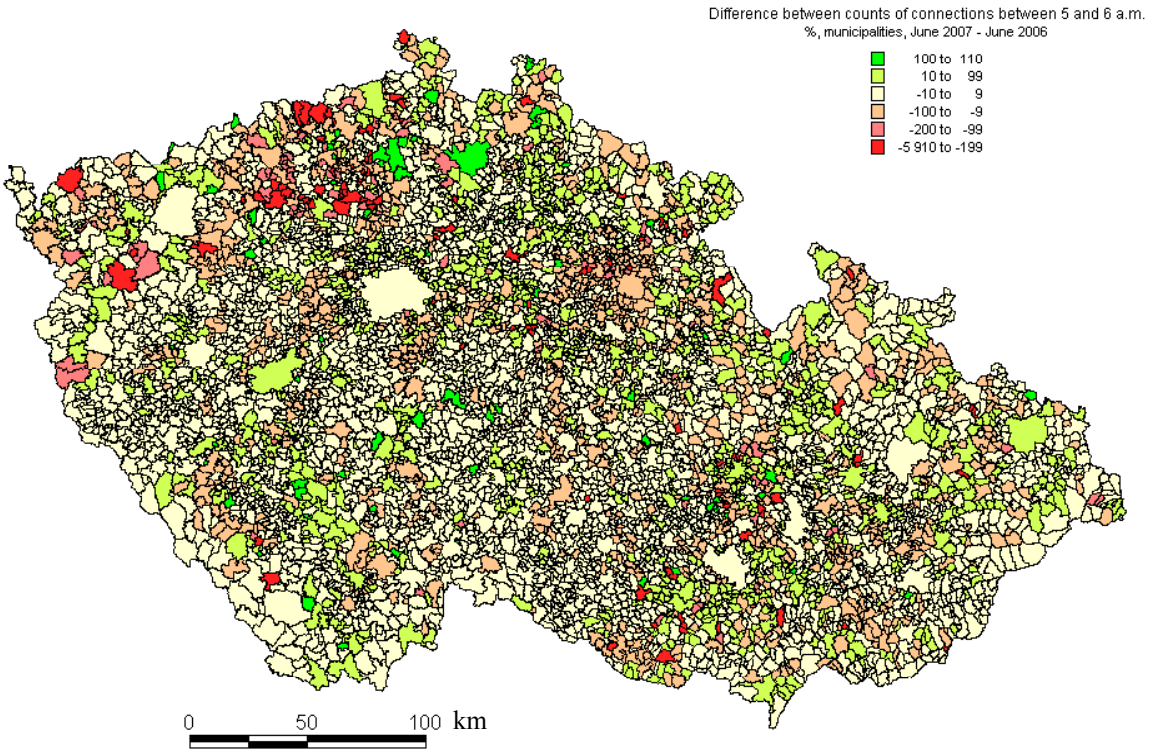

Fig. 2 Difference between counts of connections between 5 and 6 a.m. (June 2007 and 2006), expressed in %

The level of municipalities is quite variable and more influenced by natural variations. The results were aggregated to region units. Testing for various time interval was repeated to evaluate the evolution of regional situation in all situations important for commuting to work (see following figures).
Applied measures are number of accessible municipalities (for 6 a.m., 7 a.m., 8 a.m., 2 p.m., 10 p.m.) and number of transport links (between 5 and 6 a.m., 6-7 a.m., 7-8 a.m., 1-2 p.m., 9-10 p.m.).
Practically all results except of commuting to 10 p.m. approved the strong fall of transport accessibility (57 – 79 %) for Ustecky region (NW Bohemia). Substantial deterioration was recognised also in the Karlovy Vary region (W Bohemia).
The commuting for 3rd shift is influenced by decreasing transport accessibility for 10 p.m. mainly for central part of the country – Pardubice region and Vysocina region. The reason for such regional decreasing is not transparent.

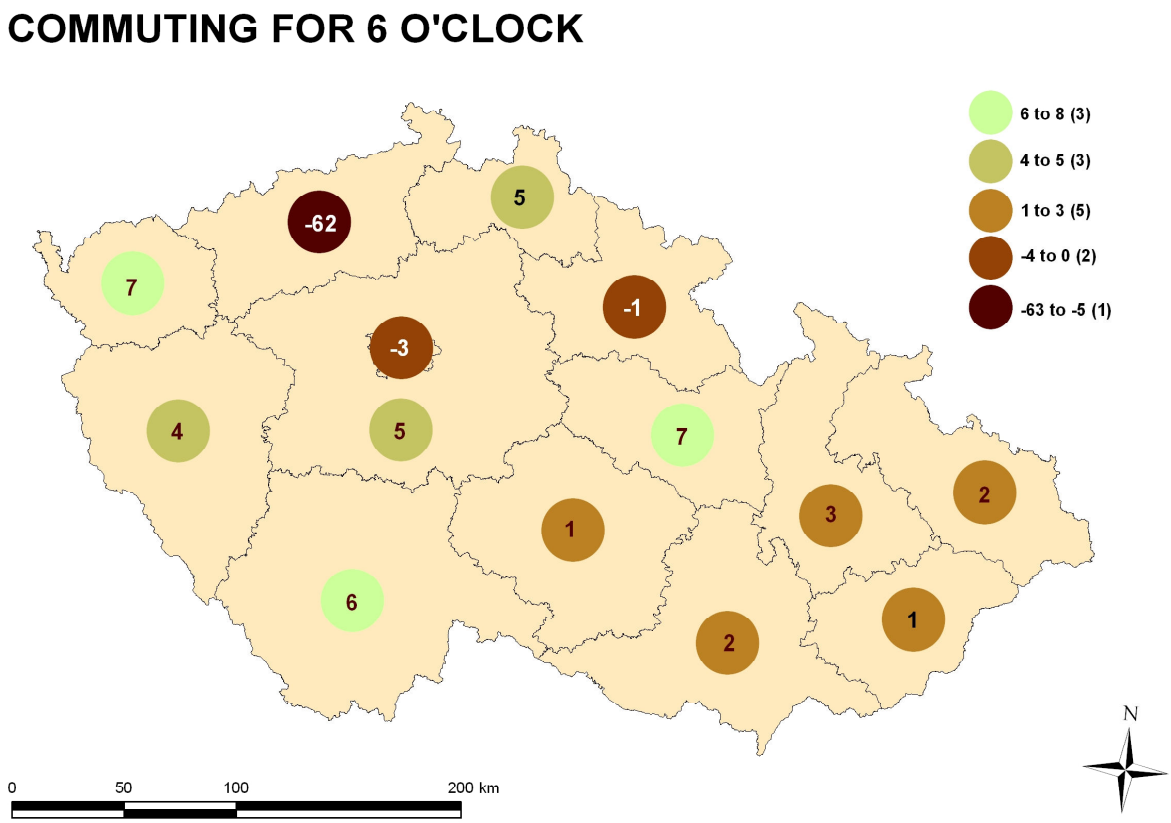

Fig.3 Difference between number of connected municipalities aggregated to region units in year 2006 and 2007 for shift at 6 o'clock

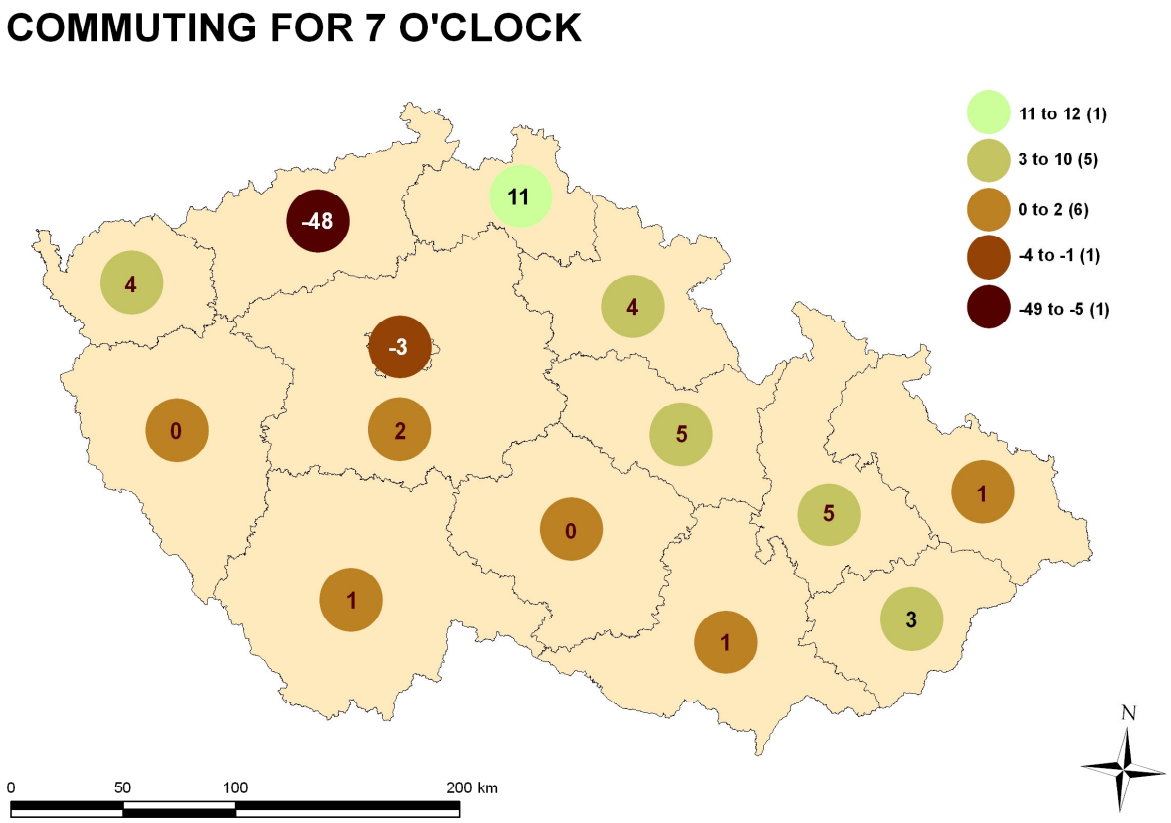

Fig.4 Difference between number of connected municipalities aggregated to region units in year 2006 and 2007 for shift at 7 o'clock

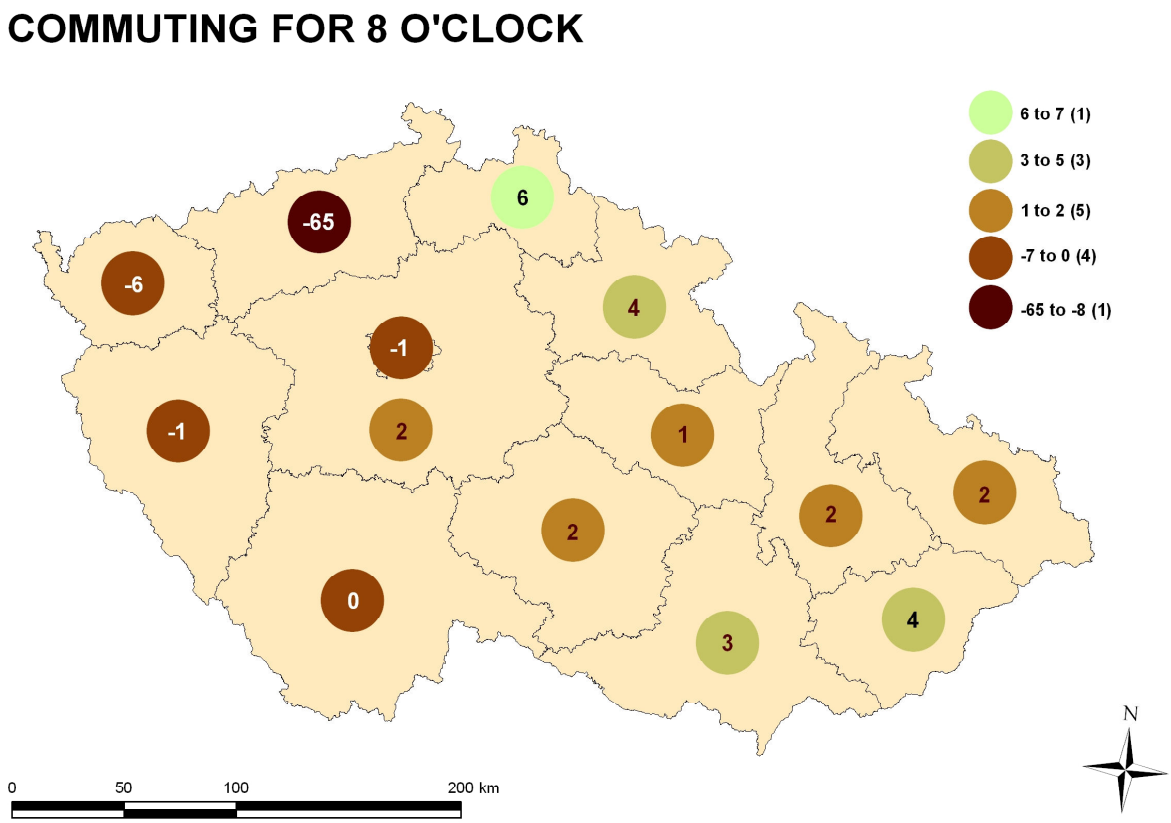

Fig. 5 Difference between number of connected municipalities aggregated to region units in year 2006 and 2007 for shift at 8 o´clock

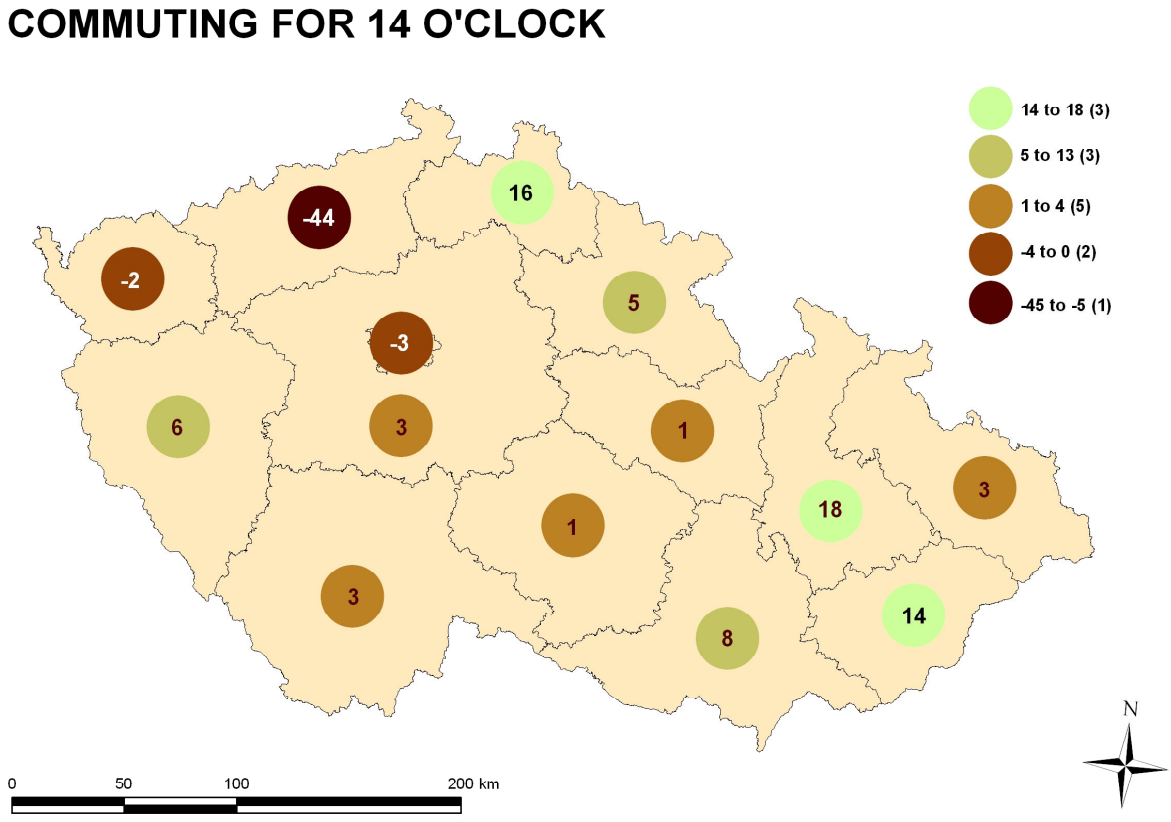

Fig.6 Difference between number of connected municipalities aggregated to region units in year 2006 and 2007 for shift at 14 o´clock

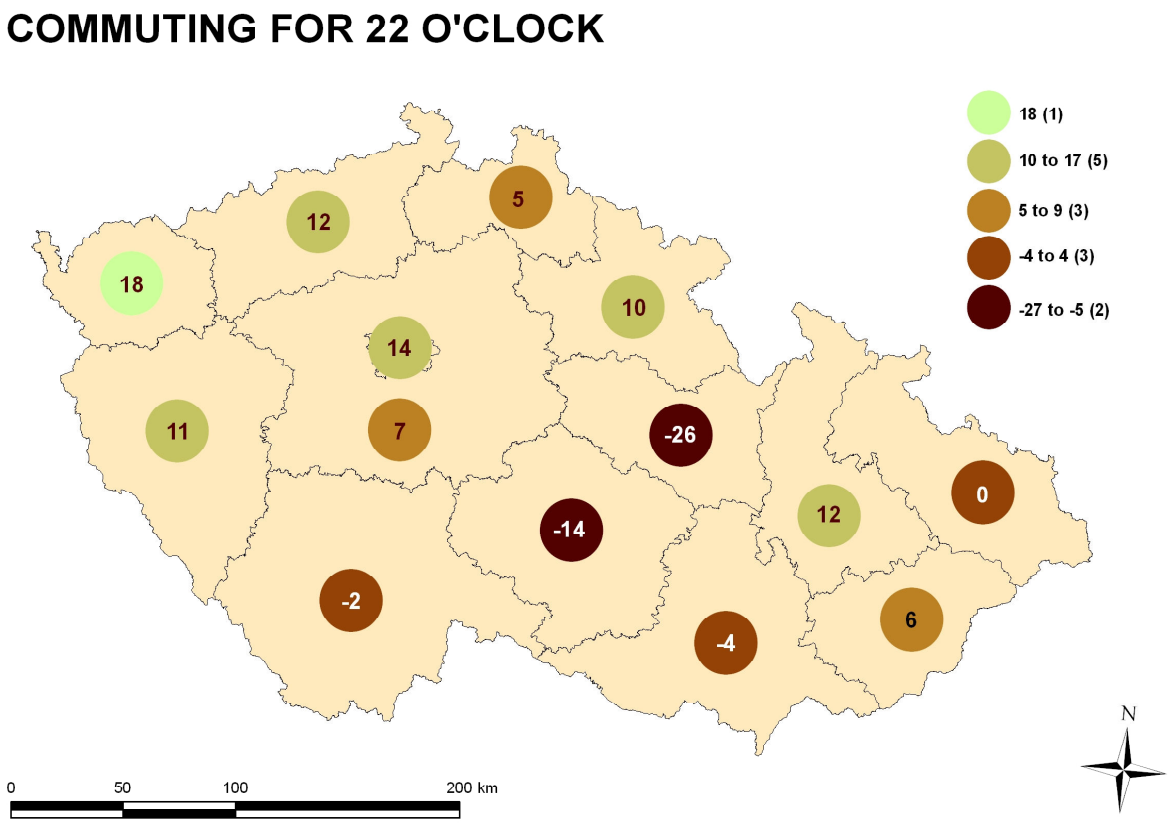

Fig.7 Difference between number of connected municipalities aggregated to region units in year 2006 and 2007 for shift at 22 o´clock

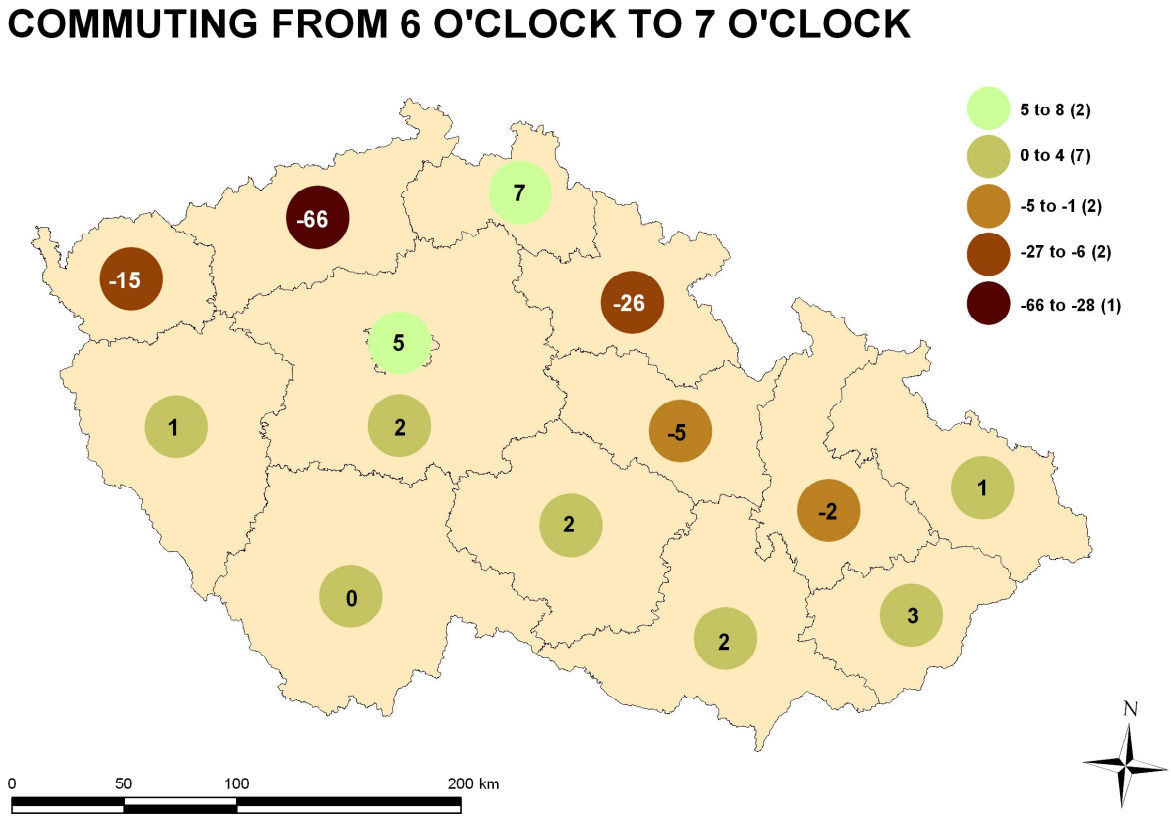

Fig.8 Difference between number of connected municipalities aggregated to region units in year 2006 and 2007 for 6 - 7 o'clock

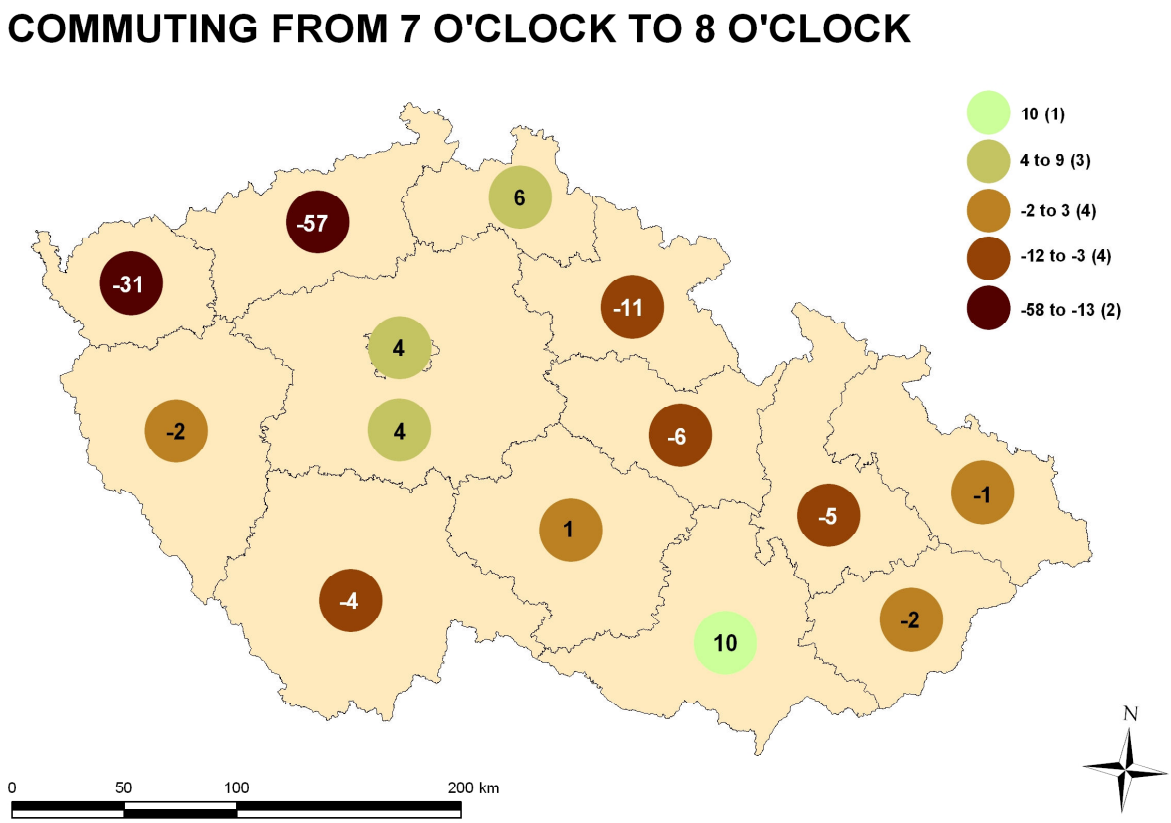

Fig.9 Difference between number of connected municipalities aggregated to region units in year 2006 and 2007 for 7 -8 o'clock

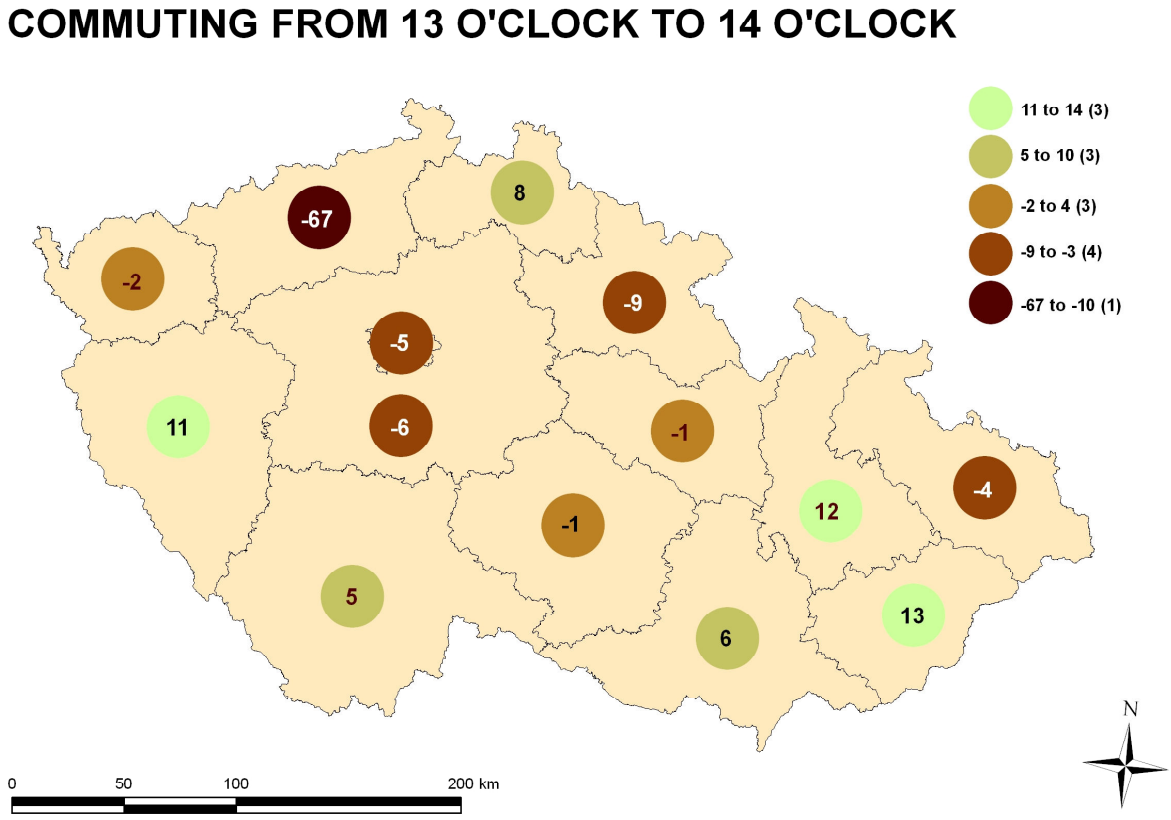

Fig.10 Difference between number of connected municipalities aggregated to region units in year 2006 and 2007 for 13 - 14 o'clock

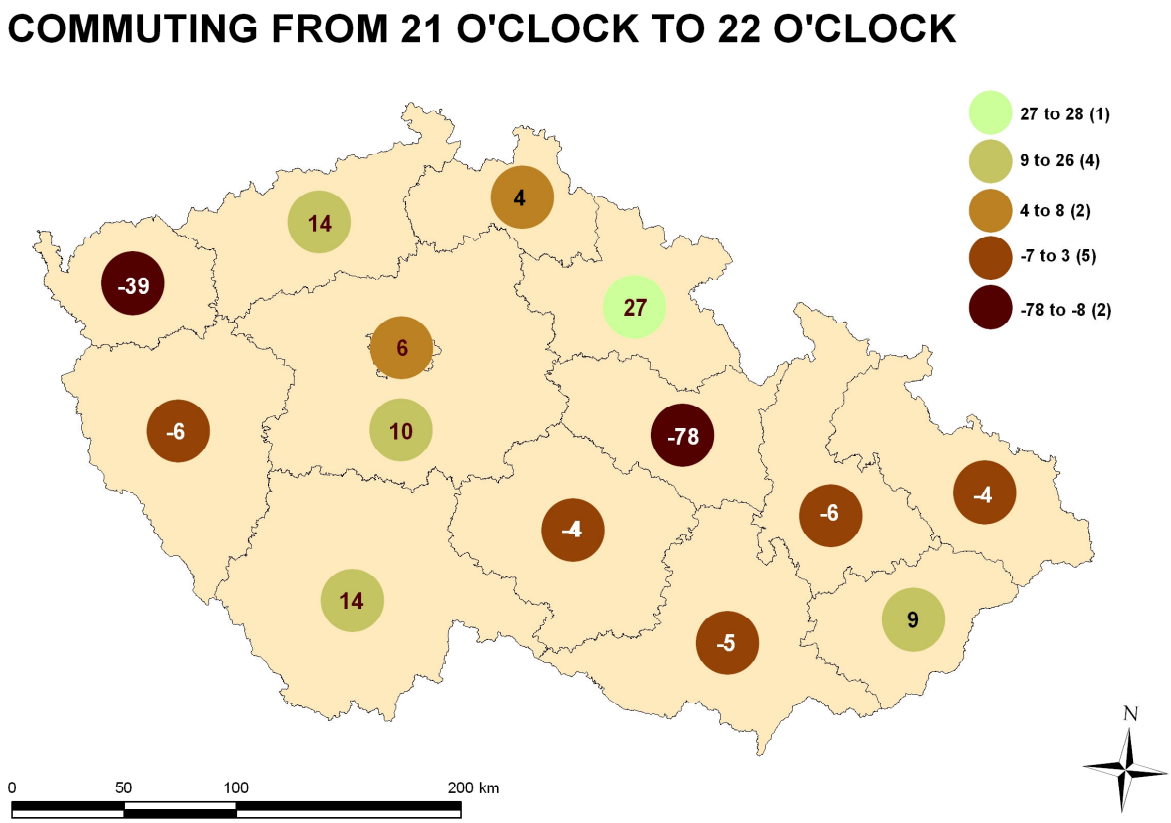

Fig.11 Difference between number of connected municipalities aggregated to region units in year 2006 and 2007 for 21-22 o'clock

Comparison between averages of connected municipalities in region by using scatterplot (see following graphs). The red boxes show dropping regions and the blue boxes show accumulating regions.

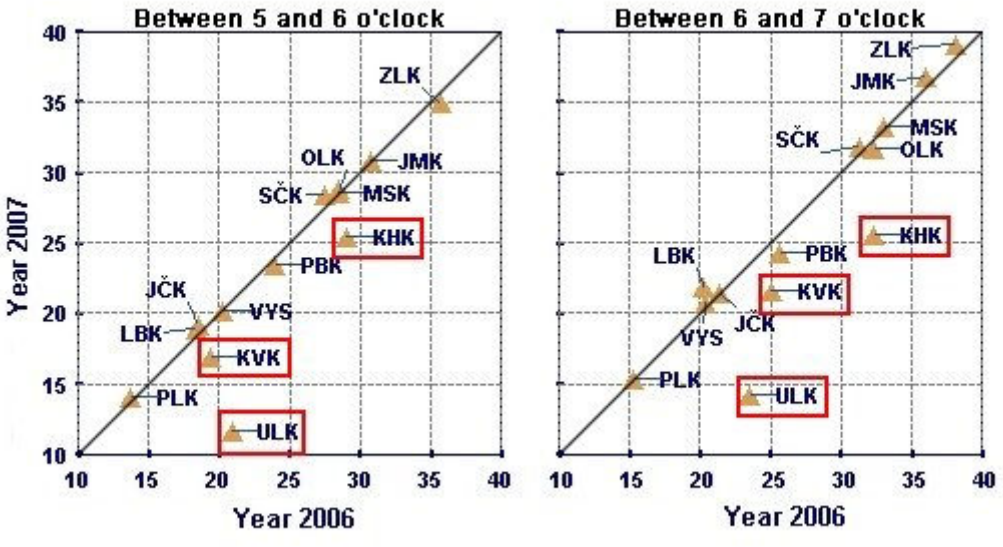

Fig.12 Average counts of accessible municipalities in regions for shifts between 5 - 6 a.m. and 6 - 7a.m. (June 2006 and 2007)

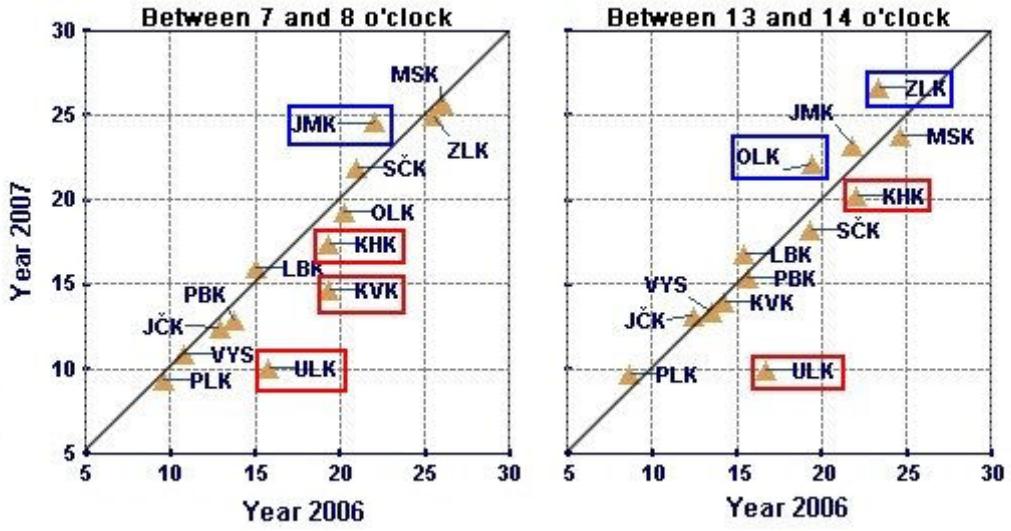

Fig.13 Average counts of accessible municipalities in regions for shifts between 7 - 8 a.m. and 13 - 14 a.m. (June 2006 and 2007)

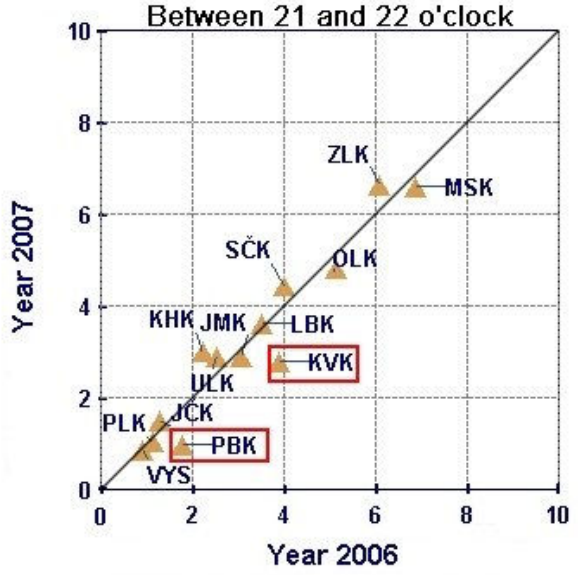

Fig.14 Average counts of accessible municipalities in regions for shifts between 21 - 22 a.m. (June 2006 and 2007)

4 Conclusion

The evaluation of public transport accessibility based on time schedule analyses can be applied to local, regional and country levels. They can contribute to our understanding of not only commuting situations and conditions but also for a recognition of infrastructure conditions influencing constitution of territorial relationships and social structures.

The situation in public transport accessibility was compared between June 2007 and 2006.

The result for municipalities shows the substantial fall of transport accessibility for many units (in several cases more than 1000%). Deteriorated units can be found in most regions (except of Zlin), but the strong accumulation is indicated in NW Bohemia, where issues with reorganising regional public services in 2006 evidently negatively influence the situation.

The changes were also tested for the regional level. Practically all results except of commuting to 10 p.m. approved the strong fall of transport accessibility for Ustecky region (NW Bohemia). The significant deterioration was recognised also in the Karlovy Vary region (W Bohemia).

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