

Transport policy impact on road accessibility – the example of Eastern Poland

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1. Introduction

The purpose of the paper is to identify the impact of transport policy in the years of two European financial perspectives 2004-2006 and 2007-2013 on the road potential accessibility changes in the gminas (LAU 2) in Poland with particular attention to the region of Eastern Poland. The region was characterized by relatively poor road accessibility in the time of the accession of Poland into the EU in 2004. During the first financial perspective of 2004-2006 relatively few big road investments have been carried out in the region. The progress was forecasted in the proceeding perspective of 2007-2013. However, in 2011 some of investments were cut off us as the result of budgetary restrictions.

Studies concerning accessibility are conducted in Europe for many years. Broad analyses on the continental scale were carried out, for instance, within the framework of the ESPON projects. The significance of such studies was quite limited until now in Poland. Accessibility was investigated from the standpoints of geography and economics. In both cases, though, it was conceived in a traditional manner as the appearance (density) of the respective infrastructure on a given territory. Studies of the potential accessibility were undertaken relatively rarely. The situation changed during the last 5-6 years. This is partly due to the restart of the investment projects in transport, these projects having been withheld for roughly 20 years. Such projects, especially when co-financed by the European Union, require broadly conceived evaluation studies, both those carried out *ex ante* and *ex post* with the use of potential accessibility indicator (Spiekermann et al. 2011).

2. Potential accessibility indicator

Accessibility is widely used term and plays an important role in many scientific fields. According to Hansen (1959) accessibility can be defined by “the potential of opportunities for interaction”. Bruinsma and Rietveld (1998) agree that accessibility is an “attractiveness of a node in a network taking into account the mass of other nodes and the costs to reach those nodes via the network”. According to Geurs and Ritsema van Eck (2001) accessibility is determined by some components: land-use component (spatial distribution of activities at destinations and the demand for these activities), transport component (travel time, cost or effort of travelling between the origin and destination), individual component (needs, abilities and opportunities of individual travelers) and temporal component (time restrictions of individual travelers and availability of activities at different times of the day).

There are different approaches to the methodology of measurement of accessibility. On the basis of literature survey one can identify five groups of methods (Komornicki et al. 2010):

- **infrastructure-based** accessibility measure – the regional infrastructure equipment is evaluated by its quantity and quality and the level of congestion,
- **distance-based** accessibility measure (travel-cost accessibility) – distance, time or cost of travel where the activity is sought (a single destination or a set of destinations),

- **isochronic-based** accessibility measure (daily accessibility) – assessment of set of destinations available in particular travel distance, time or cost from the origin,
- **potential-based** (gravity-based) accessibility measure – accessibility is measured by the number of activities (opportunities) which can be reached in a certain distance, time or effort weighted by the travel distance, time or effort to do so,
- **person-based** accessibility measure – analyzing accessibility at the individual level; the models take into account the individual behavior of the transport network user and focus on the person's ability to contribute in activities through space and time.

Potential accessibility indicator. The potential accessibility is based on the negative exponential distance-decay function which produces the well-known potential accessibility indicator. The closer the opportunity (mass of each other region), the more it contributes to accessibility. The larger the opportunity, the more it influences the accessibility (Spiekermann et al. 2011).

The travel time between any pair of transport zones was calculated by applying the method of identifying the shortest travel routes according to Dijkstra's algorithm. Eventually the potential accessibility of a municipality i was calculated using the following index:

$$A_i = M_i \exp(-\beta t_{ii}) + \sum_j M_j \exp(-\beta t_{ij}) + \sum_k M_k \exp(-\beta t_{ik})$$

where:

A_i – accessibility of a municipality i ,

M_i – own mass (population) of a municipality i ,

M_j – mass (population) of a municipality j located in Poland,

M_k – mass (population) of a municipality k located outside of Poland,

t_{ii} – time of an internal trip within a municipality i ,

t_{ij} – travel time between the municipalities i and j .

t_{ik} – travel time between the municipalities i and transport zones k located outside of Poland.

The parameter β determines the slope of the distance decay effect. In this model, the value 0.02 was used for potential accessibility to population measured for short trips and the value 0.005 was used for potential accessibility to population measured for long trips.

This accessibility involves three potentials in the form of the so-called **own potential**, i.e. $M_i \exp(-\beta t_{ii})$, **internal potential**, i.e. $\sum_j M_j \exp(-\beta t_{ij})$ and **external potential**, i.e.

$$\sum_k M_k \exp(-\beta t_{ik})$$

Spatial range. The spatial range of the study can in short be defined as the area of the European continent. Yet, from the methodological standpoint one ought to split the spatial ranges concerning the origins and destinations of travels. It is namely assumed in the study that the origins are uniquely located on the territory of Poland, while the destinations – across the entire continent. For this reason all the maps, showing the results of the analysis, have been limited to the area of Poland. In the case of road transport, 2 321 transport districts (travel origins) have been distinguished in Poland at the municipal level.

The spatial reach of the travel destinations is, naturally, much broader than that of the travel origins. The latter encompasses not only the subset of the travel destinations in Poland – identical with the set of travel origins (each travel origin is at the same time also a travel destination), but also a subset of travel destinations, located outside of Poland across the territory of entire Europe. This territory of Europe, outside of Poland, was divided into 212 transport zones.

Travel times and speeds. The speeds assumed were adjusted down for driving impediments. The model includes 14 categories of road in Poland. Then logit functions were used and in this way the average speed in Poland was calculated for parts of the road network taking account of traffic regulations and some other variables influencing the speed of vehicles such as, for instance, the number of inhabitants in a buffer zone of five kilometres around that part of the network and the topographic features of the area. For each road category and for each variable influencing the speed of travel different parameters were applied in the logit functions producing the appropriate speed-limit-related reductions of the travel speed. In general duration of travel with road transport in Poland was estimated on the basis of the traffic velocity model for more than 12 000 road segments, including local – county and municipality – roads. Travel times within the transport districts were estimated by equating the area of the district with that of an equivalent circle and assuming that the average distance travelled inside the transport district is equal half of the radius. Therefore the approximation of self-potential when calculating the potential accessibility indexes is based on the internal travel time. The internal travel time is calculated on the basis of the following previous studies (e.g. Rich, 1978; Gutiérrez *et al.*, 2011) with the use of the formula:

$$t_{ii} = \frac{0,5\sqrt{S}}{v_{ii}} \times 60 \quad ,$$

where t_{ii} stands for an internal travel time, S – for a surface of unit i and v_{ii} – for an average travel speed within a unit i , which is assumed to be 20 km/h.

3. Eastern Poland characteristics

Five provinces were assumed to constitute the area of Eastern Poland, namely: Warmińsko-mazurskie (Warmian-Masurian), Podlaskie, Lubelskie, Świętokrzyskie and Podkarpackie (Subcarpathian) provinces. These provinces were included in the macro-regional Operational Program of the European Union under the name of Development of Eastern Poland.

Eastern Poland is a macroregion, which is situated peripherally both on the national and on the European scales. The provinces, which compose the macroregion, belong among the poorest areas in the European Union. In this context, development of transport infrastructure is being mentioned as one of basic instruments of the regional and spatial policy, which may accelerate the development of the area and diminish the negative consequences of its peripherality. The effectiveness of investment projects is increasingly frequently assessed in the perspective of changes in spatial accessibility. This concerns all the geographical scales, from the local to the European one. From the point of view of transport-wise accessibility the specificity of Eastern Poland is reflected, in particular, through:

- a) the neighbourhood of the poorly permeable outer boundary of the European Union,
- b) high share of the transit traffic, both intra-Union (in the direction of the Baltic states) and the external one,
- c) low – even as for Polish conditions – availability of the modern transport infrastructure (very low share of the motorways and expressways, and simultaneous lack of fast train lines and of airports – the latter except for Rzeszów),
- d) large share of areas under various forms of nature protection, which makes investment projects in transport more difficult,
- e) historically conditioned underdevelopment of the settlement network, one of the essential objectives of the regional policy in this region consisting in the support for the viability of the settlement network.

Due to the abovementioned circumstances, the transport accessibility of the region is low (for a comparison with other parts of Poland).

4. Programming period 2004-2006

After 2000, most of the major road projects in Poland was carried out on the basis of the EU financial aid. Poland joined the European Union in the course of the financial period 2000-2006. This had an impact on the scale and structure of investments co-financed by the EU in this period. Major road projects already started earlier and were supported by the pre-accession fund ISPA. Some of these investments were implemented in 2004. They were then taken over by the Cohesion Fund and the Sectoral Operational Programme Transport. Moreover, there were also implemented highway investments, which were private contractors concessionaires, for example sections of highways built in 2007-2008 - A1 (Gdańsk-Grudziądz) and in 2004 - A2 (Komorniki-New Tomyśl).

The basis for accessibility analysis for 2004-2006 are all motorway and expressroad projects completed in this period (regardless of funding source). Analysis of accessibility changes of both national and international (European) level has been made for changes in relative terms, both for short and long trips. For short trips difference between national and international accessibility changes is low. A high accessibility growth in 2004-2006 is visible in particular around the important motorway nodes, especially around the new sections of the A2 and A4 motorways, and selected sections of expressways (such as S1). The main cause of small accessibility changes is a relatively small number of investments compared to 2007-2013, the next perspective (fig. 1).

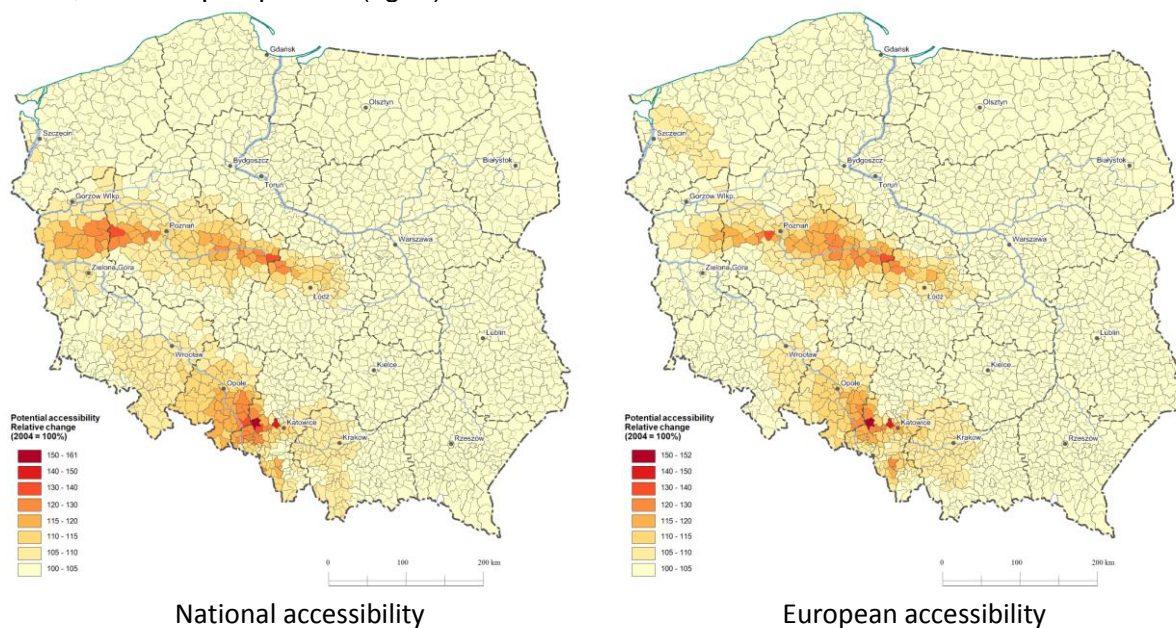


Fig. 1. National and European accessibility. Relative changes 2004-2006 (short trips; $\beta=0,02$)

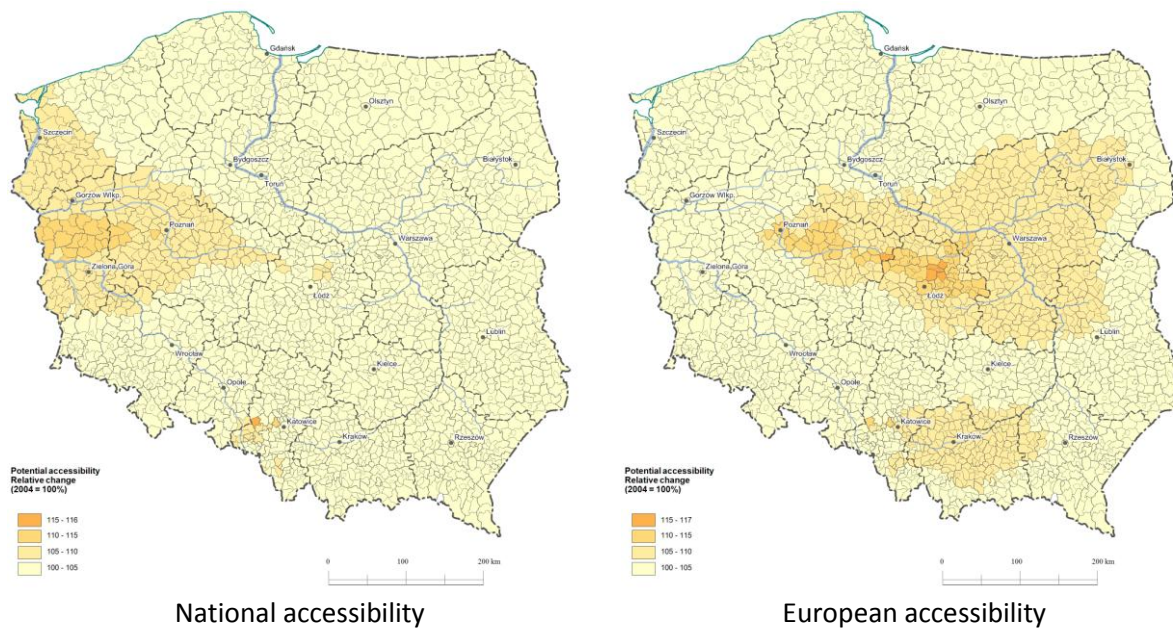


Fig. 2. National and European accessibility. Relative changes 2004-2006 (long trips; $\beta=0,005$)

Relative accessibility changes for long trips are even lower than for short trips and rarely exceed 15%. In the case of the national accessibility highest changes can be seen in peripheral areas, especially in Lubuskie voivodeship, which is the greatest beneficiary of the new western A2 motorway section. Accessibility changes in this area form a shape of fan to Zachodniopomorskie province. On the other hand, opening of the potential accessibility model to destinations across Europe (European accessibility) leads to the highest accessibility changes on the area of the east of the new sections of A2 and A4 motorways. Particularly interesting, taking into account Eastern Poland, looks the northeastern part of the country where major changes are the result of the opening of the A2 Konin-Stryków motorway section located in central Poland (fig. 2).

5. Programming period 2007-2013 (2015)

After 2007 Poland has become the main beneficiary (at the scale of organization structure) of the structural aid provided by the European Union. Hopes were high that in this period significant investment projects should be carried out. Also, this period overlapped with the decision by UEFA to entrust Poland and Ukraine with the joint organization of the European Football Championship. Large-scale transport investment projects (motorways and expressways) were implemented (some of these projects are still in progress) utilizing the resources within the framework of the largest Operational Programme Infrastructure and Environment. Simultaneously it is financed with the funds of the European Fund of Regional Development as well as the Cohesion Fund.

As regards the Operational Programme Infrastructure and Environment, a list of key projects was drawn up. In the subsequent years, this list was updated several times, mainly by reducing the number of envisaged investment projects. As of the end of 2010, as the environmental decision-making process was in progress, invitations to tenders were issued (the majority of them using the design-and-build system). This process was halted in January 2011, when, by a decision of the Minister of Infrastructure, owing to growing budgetary problems related to financial crisis, field of investment operations was curtailed. Independently from investments supported with the resources of the European Union, in the financial perspective 2007-2013, two motorways were constructed according to / based on a

concession system. These were the routes A1 (Gdańsk – Toruń) and A2 (section Świecko – Nowy Tomyśl).

Obviously, changes in accessibility in the years 2007-2013 (2015) are proportionately higher than in the years 2004-2006, due two reasons: firstly, incomparable length of these two periods, and secondly incomparable investment effort made in the years 2007-2013 (2015) which was unprecedented in the history of Poland.

As far as short trips are concerned, the main beneficiaries of development of transport infrastructure in the years 2007-2013, both in terms of national and international accessibility, are gminas (communes) located within the belt running alongside the newly constructed sections of motorways (A1, A2 and A4) and expressways (mainly S8). Concerning the international accessibility, a crucial element that made it considerably easier to travel to Germany, Czech Republic, Slovakia and Lithuania was abolishing of the internal borders within the Schengen zone, thus giving the right to free and unrestrained travel between Poland and the abovementioned countries (for instance, it is attested to by changes in international accessibility which took place in gminas lying at the Polish-Lithuanian border) (fig. 3).

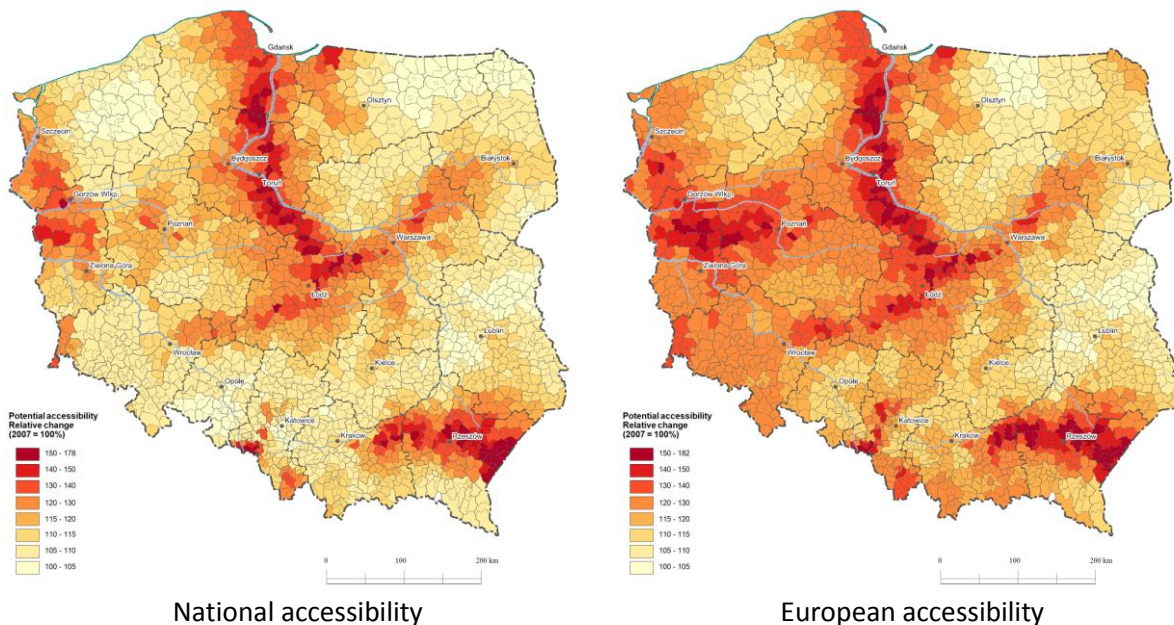


Fig. 3. National and European accessibility. Relative changes 2007-2013 (short trips; $\beta=0,02$)

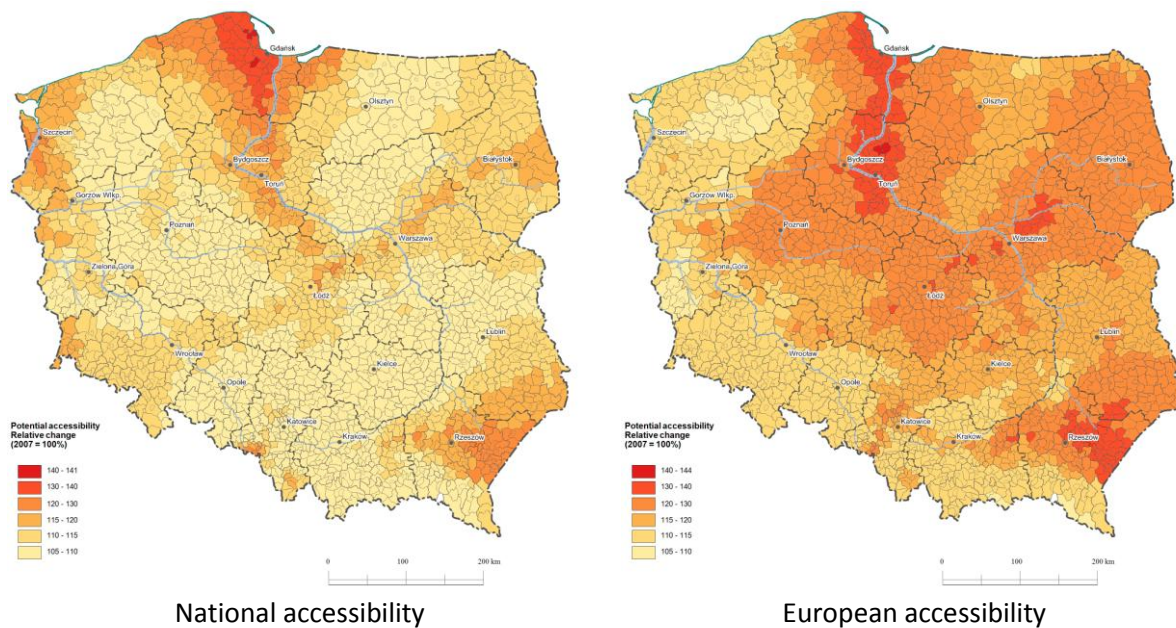


Fig. 4. National and European accessibility. Relative changes 2007-2013 (long trips; $\beta=0,005$)

As far as long trips are concerned, the Kaszuby region (NW Poland) is an interesting case in point because its inhabitants are the main beneficiaries of road infrastructure that is being developed in 2007-2013 (2015) timeframe (primarily as a result of construction of A1 motorway). The other area which has improved its situation considerably is the northern Podkarpackie (Subcarpathian) province (development of A4 motorway towards in the direction of the Polish-Ukrainian border). In both these cases, this can be attributed mainly to the low-base effect, that is a low starting point of national accessibility that was a factor characteristic of these areas as of 2007.

Concerning longer trips in the international context, great changes in accessibility (above 20%) are clearly visible over the much larger area of Poland (effect of shortening journey times in international travel due to the accession of Poland into the Schengen zone). Only the provinces like Zachodniopomorskie, Lubuskie, Dolnośląskie and Opolskie are the ones where, in the majority of gminas (communes), these changes do not exceed 15%. The Podlaskie province located in eastern Poland provides an interesting example of the region which is simultaneously deriving benefits both from opening-up the borders between the countries belonging to the Schengen zone as well as from development of transport infrastructure; on the one hand, the development of the subsequent sections of S8 expressway contributes greatly to improving regional accessibility to Warsaw and central Poland, and, on the other hand, the northern part of the province can enjoy a benefit of quicker and easier travel to Lithuania (fig.4).

6. Conclusions and recommendations

The results indicate that the accessibility of the region of the Eastern Poland has improved significantly after the accession of Poland into the EU. The process of improving transport infrastructure is unprecedented in the modern history of Poland. However, the lack of major road motorway or express roads is still an obstacle for Polish peripheral regions and Baltic countries and reduces its road European accessibility.

Although the accessibility of the Eastern Poland has significantly improved, the most crucial is that there are still major regional centres which have no direct motorway or express road connection with the capital of Poland. European Cohesion Policy proved to be more effective

in the central and western Poland. The lack of tools to preserve the key investment priorities for remote areas is easily seen. The implication is that the aim of next financial European perspective should be to support the construction of road connection between Warsaw and major regional centres in the Eastern Poland. The impact of investments made during the next perspective of 2014-2020 should be also better evaluated ex ante (with the usage of potential accessibility indicator for both short and long trips).

Potential accessibility constitutes an important indicator characterising the spatial units of regional and local levels in the perspective of their development capacities. The analyses and simulations conducted demonstrated that the indicators considered are characterised by a significant spatial differentiation. Therefore, these indicators are a useful tool, alternative with respect to the classical indicators (the macroeconomic ones, such as the GDP, but first of all the transport-related ones, such as, for instance, network density, or even the density or magnitude of traffic). The classical transport indicators show, first of all, the level of satisfaction of demand for infrastructure. They do not account for the information content, associated with the role of infrastructure as the element stimulating development (and, simultaneously, demand for infrastructure). That is why, in the context of regional development, the results obtained may be interpreted in several different ways:

- low level of transport accessibility ought to be perceived as a barrier to development; identification of strong connections in space with simultaneous low accessibility provides the evidence for the existence of bottlenecks in the transport system and the need of undertaking investment activity; it may, though, also be interpreted as the premise for the decongestion of definite functions (e.g. public service outlets to be established in better accessible locations);
- high level of accessibility is an important development premise; if, in conditions of good accessibility definite interactions do not take place, this situation can be treated as an indication for undertaking other regional policies stimulating spatial interactions (like, e.g., finding the hinterland for the emerging outlets and institutions); good accessibility might also be interpreted as the justification for concentration of certain functions;
- comparison of the results of simulation of changes in the values of the potential accessibility indicators after the implementation of definite investment projects gives the basis for the assessment of rationality of the concrete development-oriented plans; inclusion of the economic element in the simulations (like, e.g., investment cost) allows also for the comparison of the potential outlays needed to achieve the assumed improvement in accessibility through construction of transport infrastructure or, alternatively, decongestion of services.

In conditions of the here considered macroregion of Eastern Poland the most important direction of interpretation is the identification of the zones of low accessibility, as the barriers to development, including, first of all, the barriers for: (a) development impulses between central and eastern Poland (linking up of the eastern provincial centres to the network of the largest cities); (b) development impulses between the provincial capitals and their outer zones.

The analysis of potential and cumulative accessibility yields solid prerequisites for formulation of recommendations for the transport policy in the context of setting the stages and priorities in the planning of respective activities on the territory of Eastern Poland. The fundamental conclusion from the analyses performed is the confirmation of the need to improve the accessibility of the area in question, first of all through construction of transport routes of high speed, linking main centres of Eastern Poland, that is – Białystok, Lublin, Rzeszów, Olsztyn and Kielce, with the biggest cities in Poland, primarily with Warsaw, Cracow and the Tri-City (Gdańsk, Gdynia, Sopot). In this perspective the natural priorities are associated with the finalisation of the motorway A4 up to the Polish-Ukrainian border, of the expressway S7 over its entire length from the Tri-City to Rabka, as well as the construction of

two expressways, linking Warsaw with Białystok (S8) and with Lublin (S17). The study confirmed also quite clearly the significance of the investments into new bridges over Vistula, this river remaining one of the barriers limiting the accessibility of Eastern Poland.

Conform to the argumentation of the proponents of the so-called new economic geography, owing to the improvement of transport infrastructure of interregional character, there follows the drainage of resources from the poorer regions. This proposition, though, must be treated – in Polish conditions – as debatable, to say the least. The drainage of resources, especially in the form of migration (of population, and hence also of the micro-businesses) from the provinces of Eastern Poland to Warsaw or Cracow, and to other cities of central Poland, has already been taking place for some time and constitutes a natural, hardly controllable process. This process results from the very differences in the levels of economic development, the differences in the capacities of the labour market, and the differences in wages. In the conditions of serious underinvestment and poor spatial accessibility, the improvement of the state of infrastructure might rather act against the course of these processes. It constitutes a necessary (although, naturally, not sufficient) condition for stimulating the external investments. It also causes some migrations to be replaceable by job commuting (sometimes in the flexible work settings, supported by telework), which allows for the preservation of numerous services (including the market-oriented ones) in the locations of residence of the commuters. Besides, development of infrastructure would enable the inhabitants of the areas considered to take advantage of the effects of knowledge diffusion and exchange of experiences, while the entrepreneurs from the territory of Eastern Poland, producing under relatively lower costs would expand, owing to improved infrastructure, the geographical sales markets for their products. The key issue, though, is to strengthen the most important centres of the region by linking them up to the national and European networks. This is the condition for the development of the metropolitan functions in these cities, and thereby – for attaining the competitive positions by them (in the domains of both migrations and commuting) with respect to Warsaw and Cracow.

An important conclusion, resulting from the analyses conducted, is also the observation that improvement of accessibility within the area of Eastern Poland may be realised by implementation of investment projects located in other regions, and in particular – in central Poland. This is demonstrated by the high indicators of effectiveness (in terms of improvement of accessibility in the five provinces considered) for the construction of the motorway A2 between Warsaw and Lodz, and for the finalisation of the Warsaw road node. This observation has its consequences of institutional character and may be translated into the principles of allocation of means in the framework of the cohesion policy in the consecutive programming periods. Adoption of the principle of conditionality, based on the effectiveness of the activities undertaken may signify that the condition for granting direct support is not constituted by investing on the territory receiving the support (as this is the case nowadays), but investing that secures a definite effect on the area receiving the support.

Summing up, current mechanisms of the macro-scale planning, as well as the manner in which the European cohesion policy is being implemented, are not fully conducive to the overcoming of these negative circumstances. Experiences from the first, and partly also from the second programme perspective of the EU demonstrate that the cohesion policy, despite important financial transfers, also in the transport sector, is not capable of resolving the most important problems of the region, and in particular – its infrastructural separation from the rest of the country. In this situation the need arose of a more in-depth analysis of the problems of the region in question concerning spatial accessibility and the envisaged changes in the accessibility due to the execution of the transport-related investment projects.

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