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The summary of PhD thesis:

"Impact of A1 and A2 highway construction on changes in land development in the communes of Zgierz poviat with GIS"

Since the beginning of the 21st century, there has been a significant increase in the length of motorways and expressways built in Poland. These investments affect the local spatial arrangement and may significantly contribute to changes in development at the local and regional level.

In this thesis, a research hypothesis was adopted: The impact of the motorway construction on changes in the development of the area surrounding the municipalities may be stimulating as well as dissimulating in the studied area. It can be assumed that highway interchanges stimulate land development changes in the municipalities located in the vicinity of the motorway while the axis of the highway is destimulator of these changes. To verify the main hypothesis, three auxiliary hypotheses were put into the work: 1) The impact of the motorway interchanges on land development changes, in particular on the transformation of the functional and spatial structure of the surrounding area, depends on the transport accessibility to the node, (2) The impact of the axis of the highway lane to transform the functional and spatial areas depends on the distance from the axis of the motorway (3) The use of GIS methods and tools for: (a) data integration from various cartographic, statistical and database sources, (b) development of the transport network layer, (c)) assessment of parcel shape, size, property (d) assessment of the land use structure makes it possible to examine the impact of the motorway construction on changes in land development at local scale.

The research was conveyed between 2004 and 2014 and was carried out in 7 municipalities of the Zgierz poviat, located in the Łódź Metropolitan Area (ŁOM). In Zgierz poviat, in the years 2004-2006 and 2010-2012, subsequent sections of the A1 and A2 motorways were completed and commissioned. The socio-economic analyzes were partly referred to the entire ŁOM area in order to compare the changes taking place in the studied area to the transformations occurring in other municipalities.

The research focused on two basic elements of development: the functional and spatial structure of the land based on the land use and the spatial diversity of plots - their size, ownership and

shape. The functional and spatial structure was analyzed based on the author's two-stage classification of the land use. The possibility of harmonization of the adopted classification with the existing spatial data sets, including the Register of Lands and Buildings and the database of topographic objects in the GIS environment, was also examined. Also an original version of the synthetic shape indicator was proposed, verifying the suitability of the shape of the plots for land development changes.

In the spatial structure of the size of plots from 2004, the concentration of smaller plots along A1 and A2 motorways was visible, which resulted directly from the acquisition of land for their construction in the years preceding the analyzed period of research. Apart from one area on the A2 motorway, there were no significant direct relationships between the change in the size of plots and the construction of the motorway. Indirectly, the construction of the motorway can be attributed to the decline in the size of plots within the areas through which the Stryków bypass constructed during the research period. The largest parcel consolidations were connected directly with connecting road plots under the motorway. The indirect impact of motorways on consolidation can be found in the decisions of private investors regarding the connection of plots under the investment areas. These mergers result to a greater extent from individual decisions of enterprises and the location decisions rather than the motorway itself.

The research proved that the motorway junctions and the motorway axis contributed little to changes in the shape of the plots of the studied area in the years 2004-2014. The indirect effect of the motorway's impact was the construction of the Stryków beltway, which contributed to the increase of the compactness of lands occurring in its surroundings and the improvement of their shape. The consequence of the Łódź Północ interchange was "adhering" to it many plots of inferior shape parameters. Summing up, the changes in the shape of plots have resulted to a greater extent from the processes of urbanization and dividing agricultural land into plots than from the very impact of motorways. However, it should be considered whether some of these plots, for example those related to the preparation of industrial and residential development sites located near the road leading to the motorway junctions, did not result from the improvement of accessibility to the motorway junction. Both the size and shape of plots should also be viewed from the perspective of stimulants or destimulants of land development. Most of the plots in the studied area were characterized by good shape parameters. However, these parameters were strongly dependent on the development of settlements and topographical conditions (e.g. occurrence of watercourses). It is possible that plots with inferior shapes (elongated, curved), which occurred especially near the Łódź Północ and Zgierz interchanges

and along the A1 motorway, could limit the possibility of changing their development towards urbanization of space.

Regarding the analysis of the ownership structure of registration plots, especially in the areas of motorway junctions, land ownership fragmentation was observed, which may prove the impact of construction and operation of the motorway on the ownership structure of the property. It is worth noting that along the motorway on land with better accessibility, i.e. in the region of the junctions, there was a clear spatial concentration of land owned by commercial law companies and other business entities, among which property development and real estate management dominated. However, no regularity was observed determining the dependence of the number of property owners on the location relative to the motorway.

The analysis of socio-economic features of the analyzed communes against the background of the Łódź Metropolitan Area (ŁOM) showed that the motorway could contribute to the redistribution of population and the increase in settlement in the Parzęczew municipality. This phenomenon can be attributed to the increase of transport accessibility (location of motorway junctions) and not to the course of the motorway axis. However, the above conclusions should be approached with caution. In the vicinity of motorways, a higher rate of wage growth was also observed, smaller consequences of the economic slowdown and a slightly larger increase in the number of enterprises in rural municipalities located near A2 compared to other rural municipalities of ŁOM, as well as greater development of enterprises that employ more than 100 employees.

Studies on changes in land use in relation to transport accessibility to motorway entries revealed that motorway junctions are a stimulus for the development of service, industrial, communication and wasteland areas. It is therefore a stimulant mostly for the urbanization of space. However, the motorway is not a sufficient factor for the development of logistics and industrial areas. It is necessary to conduct an appropriate spatial policy by municipalities. Evidence of this is the uneven distribution of housing development around particular nodes. For residential areas, access to the motorway (represented by motorway interchanges) is a stimulus for development from a certain distance. Due to legal and planning restrictions, smaller increases in residential areas in the immediate vicinity of the motorway have been observed. On the other hand, there was no major impact of transport accessibility to nodes for green areas and recreation, water areas, farmland and areas for farming, breeding and agriculture. In the case of forests, small increases in the share of their area around nodes were observed, which resulted from secondary succession of set-aside land.

In case of the Euclidean distance from the motorway axis, it was found that this method is only valid for the immediate surroundings of the motorway, but it is not suitable for testing impacts over greater distances. Based on the empirical studies carried out, it was found that the motorway axis is a stimulus for the development of non-urbanized areas, in particular, seminary wasteland and forest areas. In the immediate area it is also a destimulator for the development of residential areas. In 2004-2014, higher shares of industrial and logistic areas were observed in the vicinity of the motorway, but they occurred only in the immediate vicinity of the interchanges. For the rest forms of land use, the relationship between the distance from the motorway axis and the size of their function changes couldn't be found.

The presented research results only partially confirm the first two auxiliary hypotheses adopted in the dissertation. Based on the conducted research, it was found that transport accessibility to motorway junctions, in addition to the process of acquiring land for construction, only slightly influences the size and shape of plots. Mainly this impact results from the implementation of transport-related investments related to the motorway, i.e. the construction of new roads or the modernization of existing ones. In case of parcel properties, clear relationships between land ownership and node accessibility were observed. Such dependencies weren't sought for distance to the axis. The impact of motorways on socio-economic transformations was clearly visible, but the transport accessibility, and thus the accessibility of interchanges, could be entirely attributed to them. In the case of land use, it was found that the motorway junction is a stimulus for the development of spatial urbanization processes, while in the immediate vicinity it may be considered as a development destimulant (e.g. residential areas). The distance to the motorway axis is a barrier to the development of residential areas, at the same time a stimulant for the development of forests and wasteland. For most of the methods and tools used in the dissertation, the Geographic Information System (GIS) played a central role. This paper underlines the usefulness of GIS in studies on the impact of motorway construction on land development changes, which confirms the third hypothesis.

Taking the above into account, it should be stated that the main hypothesis of the work has been verified positively in part - the nature (direction) of the motorway construction impact depends on the individual directions of land use and the scale of spatial impact.