

# Analysis of the Variability of the Motorway Impact on Agricultural Land on Example of A1 Motorway Section

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**Abstract.** The innovative method developed for estimating the motorway impact on agricultural land allows determining all the losses associated with the directions of this interaction. The basis for the determination of losses is the analysis of the variability of land use and quality classes and location of access roads to the land along the axis of the planned motorway. An adopted measure of the multi-direction motorway impact on agricultural land is a specified change in the value of land, at which determination only the diversity of the land suitability for agricultural production is taken into account.

The developed method for determining the motorway impact on agricultural land is shown on the example of the planned motorway section.

The construction of one kilometre of the motorway section will reduce the value of farmland amounting to an average of 1.350 cereal units. Taking over the land for the highway construction and its negative impact covers about 85% of the total loss of value of agricultural land. The remaining 15% loss of the land value is associated with an increase in transport and deterioration of land configuration plots.

**Keywords:** the value of agricultural land, the impact of the motorway, farmland layout.

**Conference topic:** Roads and Railways.

## Introduction

Developed by the author method of assessing the motorway construction impact on agricultural land has a simplified character. This approach enables an initial assessment of the impact at the stage of preliminary design of the highway (Harasimowicz 1998; Bacior, Harasimowicz 2002, Bacior, Harasimowicz 2005).

In order to perform the analysis, it is necessary to determine the variability of soil quality on the route the motorway, location of roads and motorway overpasses, agricultural land area, associated with access roads crossing the motorway lane, parameters of the layout of the plots cut by the highway and arrangement of protective green belts. These serve as a basis for determining the variability due to motorway construction of these features of land that determine their production suitability and which are then used in the overall estimation of the impact of motorway construction on agricultural land.

The method of assessment of the motorway impact on agricultural land allows to estimate this impact including all the most important directions of the impact of the motorway on the agricultural land, that is, the loss of land taken over for the road belt, reduction of the production capacity of land located near the motorway and deterioration of the layout of farms cut by the motorway. An adopted measure of the impact of the motorway is the value, determined by taking into account only their production usefulness (Cymerman 1992; Harasimowicz 1996). Therefore, this value is a measure of the valorisation agricultural suitability of land for agricultural production.

Thanks to the simplified nature of the used method, its workload has been significantly reduced, which made it possible to use the method in the evaluation of different variants of the motorway route still at the stage of its preliminary design. The calculation procedure was automated using a program written in the programming language Visual Basic, using Microsoft Excel spreadsheet, which promote dissemination of the method and the possibility of its wide-spread use.

## Characteristics of the tested section of A1 motorway

The developed method of assessment of the highway impact on agricultural land was applied on the road section Stryków-Skoszewy with the length of about 4 km. This area is located in the municipality of Stryków in the Lodzkie Voivodship.

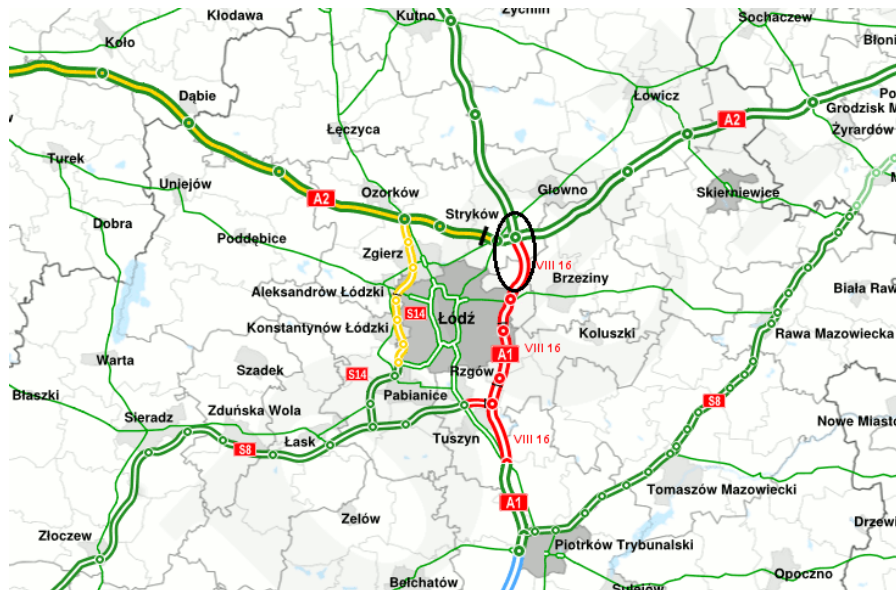


Fig. 1. Location of the analysed A1 motorway section (Source: www.ssc.siskom.waw.pl)

The motorway route, when designed correctly, should run near the village borders and if possible bypass the larger concentrations of buildings. Thanks to such routing of the highway it is possible to limit the increase in agricultural transport due to cut-off the land from habitats and reduces the nuisance of the harmful impact of the highway for residents. As for the course of the test section of the highway – it is possible to state that largely it meets the above requirements. The part of the planned motorway A1 presented in this paper crosses five roads, three of which will be equipped with motorway overpasses, the other two will be intersected by the highway, so the access to the plots that they handled would have to take place by a roundabout route (Fig. 1). The motorway overpasses are distant from each other by an average of 1313 m. The distance between the viaducts is one of the output parameters, which will be used to assess the impact of the motorway on the growth of agricultural transport. High density of overpasses, and hence a small distance between them, leads to the conclusion that, the impact of the construction of the motorway on the access to land will be small.

The average distance between roads intersected by the motorway is 788 m.

While estimating the impact of the test section of the highway on agricultural land, it was assumed that its width would be 70 m without taking into account the protective green belts, while the width of the protective green belts was estimated to be 30 m. The total width of the motorway lane will vary from 70 to 130 m depending upon the occurrence of protection belts on one or both sides of it. Through the adoption of these assumptions, it will be possible to estimate the relatively high cost of wide motorway lane buyout, which can be adequately reduced to the actual width of the lane.

In the case of the test section, its width over the entire length is 70 m, this is due to the fact, that protective green belts have not been provided for it.

## Methodology

### A. Determination of initial parameters used to assess motorway impact on agricultural land

In order to determine the parameters, it is necessary to draw the axis of the planned motorway on cadastral map.

Along the highway axis, it is a need to select and number points, in which classification or use of land changes. Intersections of the highway axis with access roads to land should be taken into account as well as all access roads to the land including those, which have been classified as agricultural land and are necessary for the local transport.

The resulting sum of the road sectors lengths running through highlighted land and their quality classes allow estimating the differences in the type and quality of land along the lane motorway.

An essential element is to estimate the lengths of the areas supported by the given road, which can be accessed through the highway. The product of the length and width of the area is equal to the area, to which access requires crossing the motorway lane. In this column should be omitted determination of considered sections of roads that will be equipped with the highway overpasses. The number of plots cut by the axis of the highway and the characteristics of their layout enables to estimate the impact of the highway on the shape and size of plots.

An important issue is also to determine the presence of protective green belts. The assumed width of the belt is 30 meters on each side. On the basis of information about the presence of the protective green belts the area occupied by the construction is calculated as well as the scale of reduction in the value of the land near the motorway.

### *B. The area and quality of land taken over for the construction of the motorway*

The area of land taken over for the construction of the highway is most often determined by its measurement on the map bearing the motorway project. The size of these areas can be estimated by on the basis of lengths of the segments running through emphasised types of land use and quality classes measured along the axis of the highway. The total width of the motorway lane on farmland usually ranges from 70 m to 130 m.

The surface of the land is determined as a sum of the products of lengths of the segments measured on the axis of the motorway and its width over a given section.

By the study of the variability of the quality of land located along the highway axis, one can estimate the value of land located in the zone of influence of the highway. The area of land exposed to the harmful effects of pollution caused by automobile traffic includes two strips of land adjacent to the highway with a width of 50 m to 100 m located on its both sides (Curzydło 1997; Wilkowski 1995).

The area of land located in the zone of the negative impact of the motorway is calculated as the sum of the products of the length measured along the axis of the sections of the highway and the width of the impact lane of the highway, which is dependent on the presence of the protective green belts, and their width ranges from 15 to 30 m. In places where there is protective green belts impact of the motorway decreases from 90 m to 50 m (Bacior, Harasimowicz 2002; Bacior, Piech 2013).

The decrease in quality and production and profit capacity of land located in the zone of motorway influence is estimated at half or one class of land valuation, this corresponds to the reduction in the point quality of territory of 20 to 40% (Curzydło 1997; Wilkowski 1995; Bacior 2010; Bacior 2012).

### *C. Lengthening access roads to the land*

The motorway crosses many local roads causing major disruptions in access roads to land, which usually a circuitous route must carry out by overpasses built on local key roads.

In order to determine the change in agricultural transport due to the construction of the motorway, it is necessary to define for each road cut by the highway area of land, access to which runs through the highway, as well as the increase in the length of the access road to the area.

The increase in distance to land requiring passing the motorway can be estimated in a relatively simple manner using the average distance between the intersecting roads. This area is determined for roads cut by the highway lane, which does not have overpasses. The length of the area access to which is associated with crossing the motorway is in the range of 100 to 600 m (Gilbert, Steinherr 1994; Harasimowicz 1998). To correctly estimate the width of the strip of land that requires passing through highway, it is necessary to know the rules of the organization of agricultural transport (Harasimowicz 1997; Harasimowicz 2002). The detailed analysis of the distribution of habitats, the system of agricultural transport roads and the borders of the area, are required.

The area of land, access to which will require crossing the motorway lane, is the product of the length of the tested motorway section and the average width of the area.

### *D. Deterioration of the plots layout*

The motorway through the intersection of the real actual plots system causes in the vast majority the deterioration of their layout. Plots that were cut by the highway are usually shorter, and they reduce their areas. The deterioration of the land layout can be assessed by determining the number of plots, which layout was changed and the average range for this change. The proposed method of estimation of the layout changes under consideration requires an estimate of the number of plots, which were cut by the axis of the motorway and their lengths and widths.

### *E. Deterioration of reduction in the value of agricultural land in the zone of motorway influence*

The presented method of estimation of the agricultural land value and their changes caused by the construction of the highway takes into account only the production suitability of the land (Harasimowicz 1996).

This method includes all the essential directions of the highway impact on agricultural land, namely:

- taking over of land for the construction of the highway,
- an increase of expenditures on the farm transport and the deterioration of the layout of plots,
- the deterioration in the quality of land near the highway.

The value of land calculated using this method does not apply to its market value; it is also not the value specified for the purchase of land for development. It should be treated as an indicator of production suitability of agricultural land, which has been determined by the features of the plot and the farm. The subject of interest is the extent of change in this value caused by the construction and the adverse effects of the highway.

The decrease in the value of land that follows the construction of the motorway is directly related to the change in their features, which have a particular influence on suitability for agricultural production. It is estimated on the basis of the difference between the value of the farm land before the construction of the motorway and after the investment (Harasimowicz 1998; Quinet 1997).

### Decrease of the value of farmland as result of motorway construction

Table 1 shows the reduction in value of farmland due to the construction of the test section of the highway split into four considered directions of its impact for the tested section. The obtained values reflect both changes in the unit value of land as well as the corresponding areas of land under a particular direction the motorway impact.

Table 1. Decrease of the income value of land due to motorway construction (source: own work)

No	The cause of lowering the value of the land	The value of one hectare of land [cereal unit/ha]		The area covered by the change [ha]	Reduction of income value				
		Before the change	After the change		In the village [cereal unit]	Structure [%]	Per kilometer of motorway [cereal unit/ha]	Per kilometer of motorway section going through agricultural land	Structure [%]
1	The takeover of land for the construction highway	81.94	–	27.07	2218.1	100.0	563.1	564.3	41.8
2	Deterioration in the quality of land located near the motorway	81.94	49.17	69.61	2281.5	102.9	579.2	580.4	43.0
3	The increase in distance of land from the farm due to changes in the communication system	81.94	73.76	19.34	158.2	7.1	40.2	40.3	3.0
4	Deterioration of layout of plots cut by the highway lane	81.94	63.34	34.92	649.5	29.3	164.9	165.2	12.2
Total		–	–	150.93	5307.4	239.3	1347.4	1350.1	100.0

The overall losses in the value of agricultural land in the test section of the motorway length of about 4 km are 5307.4 cereal units. For the construction of the highway the land worth, 2218.1 cereal units will be taken over. The land will be entirely bought out by the investor. Purchase of land occupied by the road lane covers usually covers about 40% losses on agricultural land, which will be the result of the motorway construction (Bacior, Piech 2013). Reduction of the usefulness of agricultural land leading to a decrease in their value related to the damaging effects of the motorway, cutting off the land from habitats and deterioration of the plots layout is not covered by the payment of compensations, despite the fact that the law on highways and protection of land imposes on the investor warrant pay any damages related to his activities. If take into account the similar value of land and other assets of agricultural production on the farm, the actual loss of farms due to the creation of the highway can be estimated as twice as big as the decline in the value of agricultural land. Based on the survey can thus be concluded, the land buyout for the construction of the motorway covers only a quarter of the losses incurred by farms in connection with the construction of the highway. In practice, however, the buyout price of the land under the highway is 3 to 4 times higher than the average price of agricultural land (Zak 2002).

After converting per one kilometre of the motorway lowering of the value of the land caused by the construction is 1347.4 cereal units/km. Slightly bigger value shows the indicator determining the reduction in value of agricultural land per one kilometre of the motorway running exclusively by agricultural land because it amounts to 1350.1 cereal units/km. The decline in the value of farmland due to the construction of the motorway mainly relates to the changes in their quality classification. Greater soil quality results in a proportional decrease in land value caused by the impact of the highway.

The takeover of land for the construction of the motorway includes, in the present case, 41.8% of the total loss of value due to its construction. This value depends mainly on the presence of the protective green belts, and these are not designed for the described section of the motorway (Bacior, Harasimowicz 2000).

Deterioration of land located in the belt of toxic influence of the highway is 43.0% of the total reduction in the value of agricultural land associated with the investment. As in the case of takeover of land for the construction of the motorway, this proportion is dependent on the prevalence of protective green belts. The lack of these protective belts causes that less land is taken over for the construction of the motorway. So the losses associated with the direction of the highway impact are smaller. However, in this case, the reduction of the value of land subjected to adverse influence of the highway is bigger. The combined influence of land take over for the construction of the highway and its harmful influence on land situated in its vicinity is about 85% of the total motorway impact on agricultural land. After analysing the above data, it can be concluded, that the losses associated with the design of the protective green belts are equivalent to the reduction of the harmful impact of the motorway on agricultural land. This is an important argument for the use of protective green belts because they significantly reduce the environmental pollution near the highway. However, a

common practice among investors is to avoid designing these belts or possible their construction only in cases where it is necessary because they increase the amount of land that is subject to take off. Increased losses associated with the lack of protective green belts related to the harmful effects of the highway are not paid to victims, and thus, they are not charged to the owners of the motorway.

The deterioration of the spatial structure of villages and farms caused by the construction of the highway, which consist of adverse changes in plots layout an increase of their distance from farms leads to the decrease in the value of agricultural land covering about 15% of the total of its impact on the land. Total losses associated with the deterioration of the spatial structure of farms caused by the construction of the motorway are usually relatively small. However, there are cases when they are equal to the decrease of the land value resulting from their taking over for the construction of the motorway.

Reduction in the value of agricultural land due to the change of the layout of plots crossed by the highway is equal 12.2% of the total impact of the motorway on the land. Even smaller impact on reducing the value of agricultural land has the increase in the distance due to their being cut off from habitats by the motorway lane. Reduction in value of farmland caused by the highway impact about the total its impact on the value of the land is only 3.0%.

### Decrease of the value of agricultural land as result of motorway construction

A simplified method for assessing the motorway impact on agricultural land takes into account all the main motorway influences on the land and presents impact in a measurable way and equivalent units. The advantage of the method is small workload, what is the effect of the simplifications in the assessment of the motorway impacts, limiting the scope of initial data collection to the analysis of the highway axis and automated calculation process using the developed computer program. This method can be applied especially during the preliminary estimation of the impact of the highwayway construction on agricultural land, which is carried out at the stage of making decisions about the route of the motorway and may be helpful in assessing the considered variants of the planned motorway sections.

The decrease in the value of land caused by the construction of the highway on the test section is equal 5307.4 of cereal units. For the section of motorway one kilometre long it is equal 1350 cereal units/ha. The quality of land located on the route of the highway has the biggest influence on the size of the reduction in the value of land per length unit.

The total impact of taking over of land for the construction of the highway and its harmful effects on land situated in its vicinity is equal about 85% of the total motorway impact on agricultural land. While the deterioration of the spatial structure of villages and farms due to the construction of the highway, which includes adverse changes in the layout of plots and increase of their distance from habitats leads to the loss of the value of agricultural land including about 15% of its impact on the land.

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