

SELECTED LAND MARKETING TOOLS. PART TWO: APPLICATION OF THE PROPOSED METHOD OF ASSESSING IMPACT OF A MOTORWAY ON ARABLE LANDS

Stanisław Bacior, Anna Pietraszek

Summary

The second part of the paper analyses the method of assessing impact of motorways on arable lands, proposed in the first part. The method can be used to determine all the losses resulting from different directions of this impact. The losses are determined in an analysis of variations in land use, soil quality class, layout of access roads leading to lands situated along the axis of a planned motorway. The method is especially useful at the initial planning of a motorway or at evaluation of its routes' variants, because it is simple and helps to determine a negative impact of a motorway on arable lands with adequate accuracy.

The impact of a motorway on arable lands is exemplified by a Tarnów – Rzeszów section of an existing A4 motorway. The section is 7.136 km long and it runs through Borowa, Wewiórka and Góra Motyczna villages. The outcomes were compared with an alternative variant of the motorway's route in this section.

Keywords

value of arable lands • motorway impact • farm's layout • marketing of arable lands

1. Introduction

The ever-increasing use of cars and the resulting need to increase road safety and efficiency of international transport meant that building a network of motorways and express roads proved necessary. Today there are 3050 km of express roads and the number is still growing, and the construction stage is not yet over. To determine negative impact of a motorway on farms situated in its vicinity, many popular methods of assessing value of arable lands are used. But most of these methods require a detailed analysis of particular farms, which makes the procedure labour-intensive. And yet assessment of changes in value of farms is necessary to correctly determine the amount of compensation for the losses resulting from the construction of a motorway. The study should be carried out after a detailed project of a motorway is prepared or even after its construction is completed. However using the proposed

simplified method, when preparing an initial project of a motorway or evaluating proposed variants of its route, is more convenient and it allows to determine a negative impact of a motorway on arable lands with much less work and with sufficient accuracy [Bacior 2012].

The proposed simplified method of a motorway impact on arable lands allows to determine all directions of losses related to the investment, such as:

- loss of lands reserved for the construction of a motorway,
- decrease in value of lands located in the vicinity of a roadway,
- increase of expenditure on agricultural transport and worsening of land plots layout.

The losses are determined in an analysis of variations in land use, soil quality class, layout of access roads leading to lands situated along the axis of a planned motorway. The analysis shows the change in value of arable lands, while taking into account the diversity of their usefulness for agricultural production. The value serves as an indicator of usefulness of lands for agricultural production.

2. Characteristics of a studied section of the A4 motorway

The developed method of assessing a motorway's impact on arable lands has been used in the study of a 7.136 km Borowa – Góra Motyczna section of A4 motorway, and then the results have been compared to an alternative proposal of the motorway's route of 6.766 km. The existing section runs through Borowa, Wiewiórka and Góra Motyczna villages, in Dębicki district (Figure 1).

A properly designed motorway route should go along a village borders and be located as far possible from larger settlements. This way one can minimize the increase in length of agricultural transport resulting from cutting lands off from settlements. The actual motorway route in the discussed section largely meets these requirements.

The studied section of the A4 motorway intersects 23 roads, 3 of which was fitted with motorway flyovers. In an alternative variant, however, the motorway was to be intersected by 29 roads, 3 of which were to be fitted with flyover. The distances between flyovers are one of the output parameters used in the assessment of motorway impact on increase of agricultural transport. The greater the number of flyovers and the shorter distance between them, the lesser the impact of the motorway on the transport to lands.

In the analysis of the studied section impact on arable lands it was assumed that its width is 70 m. In both considered cases there are no protective greenbelts of 30 m width.



Source: authors' study based on: https://pl.wikipedia.org/wiki/Autostrady_i_drogi_ekspresowe_w_Polsce

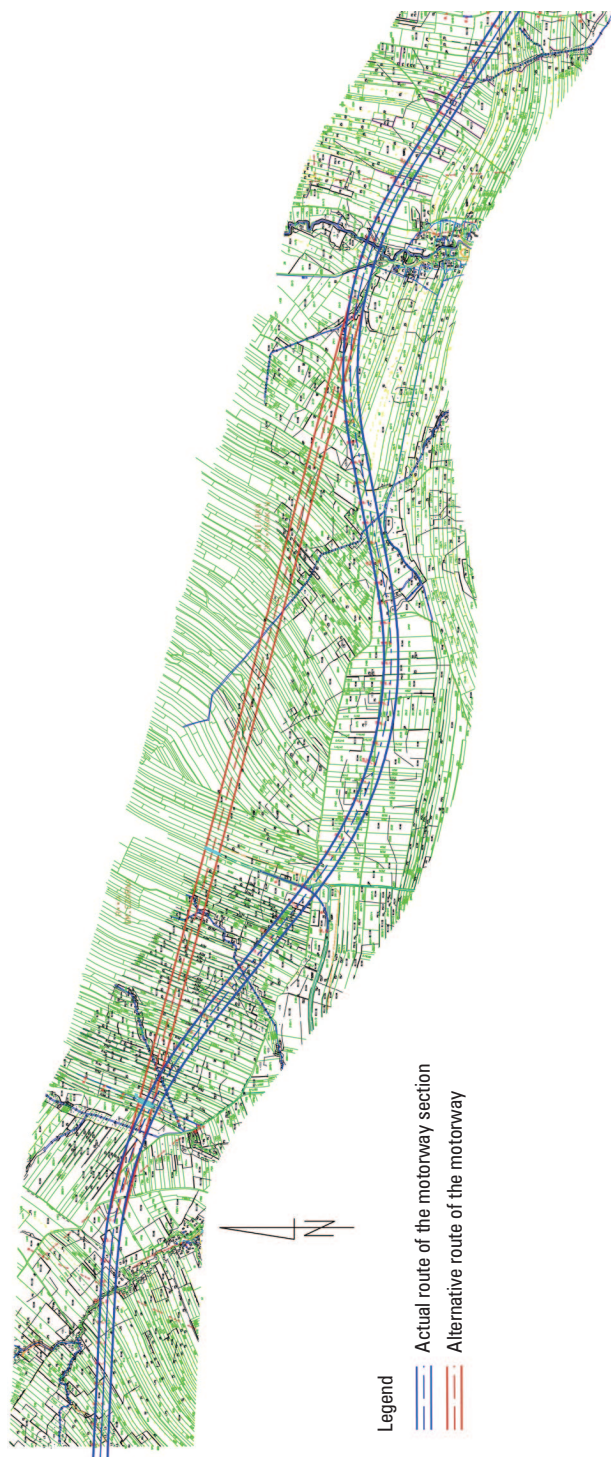
Fig. 1. The A4 motorway with a marked section between Borowa and Góra Motyczna

3. Changes in the features of arable lands caused by the construction of a motorway

3.1. The size of lands taken over for the construction and situated within the motorway's impact

The size of lands taken over for the purpose of the motorway construction in the studied section is around 45.76 ha, whereas in the alternative variant – 43.19 ha. This is a relatively small area, mainly because there are no protective greenbelts.

The areas designated for the motorway construction and situated within the zone of its negative impact consist of various kind of lands, but arable lands are decidedly the largest. Their share in the size of lands taken over by a motorway in the studied villages is 91.6%, and in the second variant – 91.2%. If the share of arable lands is small it usually means that the area reserved for a motorway construction is mainly



Source: authors' study

Fig. 2. Cadastral map with actual and alternative route of the motorway Borowa – Góra Motyczna section

a wooded one. This explains why arable lands have the largest share in the total area taken over for the construction of a studied motorway section.

The areas of arable lands taken over for a construction of 1 km of a motorway in the studied section are 6.58 ha, and arable lands situated within the zone of its harmful impact are 19.92 ha. In the alternative route variant the values are 6.66 and 17.12 respectively.

In both cases the area of lands situated within the zone of detrimental impact of the studied section is almost three times as large as the area taken over for its construction. The width of impact belt of a motorway on arable lands and its size depend on whether protective greenbelts are designed. If there are no greenbelts along the motorway, the significant impact of a motorway reaches up to 90 m from its edge and the quality of arable lands in that area drops on average by 40% [Curzydło 1997, Siuta 1992, Wilkowski 1995]. In that case the width of the motorway impact zone is 180 m, while the motorway is 70 m wide.

Protective greenbelts on one side of a motorway widen it to 100 m, and its impact on arable lands then is 140 m, which means that the area under detrimental impact of a motorway is 1.5 times as large as the area taken over for the construction of a motorway. The protective greenbelts present on both sides of a motorway widen it to 130 m, which means that the total area of its impact decreases to about 100 m. Sometimes the area taken for the construction of a motorway is larger than the area of its negative impact on arable lands.

The parameters discussed earlier concerning the area of lands taken over for construction and situated within the negative impact zone of a motorway referred to the premises of cross-section profiles of a motorway and its scope of impact on arable lands. The parameters were established in the way to emphasise the motorway impact and for this reason the values may be slightly overstated. For example, it was assumed that the motorway would be 70 m wide, though the minimal width of a three lane motorway can be reduced to 50 m. In the developed software one can easily change the main parameters of a motorway profile and the scope of its impact, such as width of a motorway or width of protective green belts.

3.2. Cutting of lands from settlements by a motorway section

The motorway axis in both studied variants crosses a large number of roads, and consequently a large area of lands would be accessed through flyovers.

The total area of lands, to which the road distance will increase after constructing the motorway, in the existing variant is 88.01 ha, whereas in the alternative variant it would be 98.94 ha.

The area of lands cut off by the motorway from the settlements was also assessed, and the values were expressed per 1 kilometre of a motorway crossing the arable lands. The adopted procedure eliminates two factors: the impact of the length of a given motorway's section on these areas and the frequency of occurrence of arable lands within the section in question. The factors provide the most accurate information

about the size of lands cut off by the motorway from the rural settlements and enable a direct comparison of the studied motorway sections running within the borders of a village. The 1 kilometre long section of the motorway running through arable lands cuts off 12.66 ha of lands from the settlements, the road distance to which will increase, whereas in the alternative variant the area in question would have 15.25 ha.

The studies confirmed that an increase in distance to lands resulting from the motorway construction is related to distance between adjacent flyovers and the number of roads intersected by the motorway studied section. The road distance to lands increases with the increase of distance between flyovers and if there is large number of roads intersected by a motorway the increase is by half of the distance between flyovers.

Increases in road distances to lands related to the distances between flyovers lead to a significant rise in expenditures on agricultural transport, if there are large areas of lands that can be accessed by roads not fitted with flyovers. The considerable increase in distances to lands due to the construction of a motorway shows that there are large distances between flyovers. The correctness of a motorway route can be assessed on the size of land plots cut off from their settlements [Bacior 2013].

3.3. Changes in layout of land plots intersected by a motorway

The studied motorway sections, the existing and the alternative variant, cross respectively 244 and 234 agricultural land plots. In both cases the motorway intersects land plots crosswise, dividing them in two parts.

The mean area of land plots intersected by a studied motorway section is around 0.62 ha, whereas in the alternative variant – 0.48 ha.

The total area of land plots, the layout of which got worse after they were intersected by the motorway, is 224.45 ha and 223.34 in the alternative option. The size of area depends mostly on the length of intersected land plots, the length of the considered motorway section and the size of arable lands in the structure of land use in the studied area.

The size of land plots intersected by the motorway expressed in terms of 1 km of a motorway crossing the arable lands is the measure of deterioration of land plots layout. The diversity of these lands is not significant, because it depends only on features of the intersected land arrangement. In the studied section the area of land plots with worse layout per 1 km of a motorway crossing arable lands is 32.28 ha in case of the existing section and 34.43 in the alternative variant of the motorway route.

4. Decrease in value of agricultural lands due to the construction of a motorway

In the existing section the value of lands taken over for the construction of a motorway is 777.7 of cereal units · ha⁻¹ per 1 km of a motorway passing through arable lands, an in the alternative variant it is 789.1 corn units · ha⁻¹. The lands are purchased

by an investor. The amount of money from the purchase would cover around 48% of losses of arable lands due to the construction of a motorway [Bacior 2013].

The losses in agricultural lands resulting from their lower productivity can be related to the fact that farms do not fully use their means of production, such as live-stock buildings and agricultural machinery. It can cause additional losses incurred by farms due to the construction of a motorway. The decrease in the area of farms can be the cause of less intensive livestock husbandry. That is why, taking into account the value of lands and fixed assets of agricultural production, the losses of farms can be twice as large as the drop in value of arable lands.

The studies lead to the conclusion that purchase of lands for the construction of a motorway covers only relatively small part of the losses incurred by farms in relation to it. However the sale price of lands for the purpose of motorway is in fact 3 or 4 times higher than the average price of arable lands [Žak 2002].

The losses in value of arable lands per 1 km of an motorway are lower when the share of arable lands in the total area of lands taken over for a motorway is low. The variations in value decrease of arable lands resulting from the construction of a motorway are related mainly to changes in the quality of their soils.

In the two studied cases, in the existing and the alternative variant, the takeover of lands for the construction of lands is responsible for, respectively, 35.0% and 33.8% of total decrease in lands' value. These values are the result of absence of protective greenbelts, which is why the takeover of lands for the construction of a motorway have such a low share in the total decrease in value of arable lands related to this investment.

The reduction in value of lands situated near the motorway is 799.9 cereal units · ha⁻¹ per 1 km of a motorway, which is 36.0% of the total reduction in value of arable lands, and 811.7 cereal units · ha⁻¹ per 1 km of the motorway (34.8%) in the second variant. As in the case of taking the lands over for the construction of a motorway, the share can vary in relation to the frequency of occurrence of protective green belts. If they are not present, the lands reserved for the motorway construction are smaller, and consequently the losses related to that impact direction of a motorway is limited. In this case, however, the loss in value of lands subjected to negative impact of the motorway is greater. In both analysed cases the combined influence of taking over of lands for the motorway and its harmful impact on lands in its vicinity makes up for about 70% of the total impact of the motorway on arable lands.

Deterioration of the spatial structure of a village and farms due to the construction of a motorway, including the negative changes of land plots layout and the increase of distance of lands to settlements, in the studied cases meant that the value of arable lands was reduced by 326.6 cereal units · ha⁻¹ per 1 km of a motorway (14.7% of its total impact on these lands) and 385.8 cereal units · ha⁻¹ per 1 km of a motorway (16% of its total impact) in the alternative version. The losses related to the worsening of spatial structure of farms are usually insignificant. Sometimes, however, they equal the loss in value resulting from the fact they were taken over for the construction of a motorway.

Table 1. Drop in income value of arable lands due to the construction of the motorway in the existing Borowa – Góra Motyczna section

| No | Cause of reduction in land value | Value of 1 ha of lands [cereal units · ha ⁻¹] | | Area subjected to change [ha] | Drop in income value | | | | |
|----|---|---|------------------|-------------------------------|-----------------------------|---------------|---|---|---------------|
| | | Before the change | After the change | | In a village [cereal units] | Structure [%] | Per 1 km of motorway [cereal units · ha ⁻¹] | Per 1 km of a motorway crossing arable lands [cereal units · ha ⁻¹] | Structure [%] |
| 1 | Taking over of lands for the construction of a motorway | 118.17 | - | 45.76 | 5407.5 | 100.00 | 757.8 | 777.7 | 35.0 |
| 2 | Reduction in value of lands located near the motorway | 118.17 | 70.90 | 117.67 | 5562.0 | 102.9 | 779.4 | 799.9 | 36.0 |
| 3 | Increase of distance from the settlements due to changes in the communication network | 118.17 | 93.10 | 88.01 | 2206.3 | 40.8 | 309.2 | 317.3 | 14.3 |
| 4 | Worsening of layout of land plots intersected by the motorway | 118.17 | 108.05 | 224.45 | 2271.2 | 42.0 | 318.3 | 326.6 | 14.7 |
| | Total | - | - | 475.88 | 15446.9 | 285.7 | 2164.6 | 2221.6 | 100.0 |

Source: authors' study

Table 2. Drop in income value of arable lands due to the construction of the motorway in the alternative Borowa – Góra Motyczna section

| No | Cause of reduction in land value | Value of 1 ha of lands [cereal units · ha ⁻¹] | | Area subjected to change [ha] | Drop in income value | | | | |
|----|---|---|------------------|-------------------------------|-----------------------------|---------------|---|---|---------------|
| | | Before the change | After the change | | In a village [cereal units] | Structure [%] | Per 1 km of motorway [cereal units · ha ⁻¹] | Per 1 km of a motorway crossing arable lands [cereal units · ha ⁻¹] | Structure [%] |
| 1 | Taking over of lands for the construction of a motorway | 118.51 | - | 43.19 | 5118.4 | 100.00 | 756.5 | 789.1 | 38.8 |
| 2 | Reduction in value of lands located near the motorway | 118.51 | 71.11 | 101.06 | 5264.6 | 102.9 | 778.1 | 811.7 | 34.8 |
| 3 | Increase of distance from the settlements due to changes in the communication network | 118.51 | 95.84 | 98.94 | 2243.4 | 43.8 | 331.6 | 345.9 | 14.8 |
| 4 | Worsening of layout of land plots intersected by the motorway | 118.51 | 107.30 | 223.34 | 2502.6 | 48.9 | 369.9 | 385.8 | 16.5 |
| | Total | - | - | 476.53 | 15129.0 | 295.6 | 2236.0 | 2332.6 | 100.0 |

Source: authors' study

Similarly, the increase of distance, due to cutting off lands from settlements by the construction of a motorway, plays a minor role in a drop in value of arable lands. It is responsible for 317.3 cereal units · ha⁻¹ per 1 km of a motorway in the existing variant (14.3% of the total impact) and 345.9 cereal units · ha⁻¹ per 1 km of a motorway (14.8%) of the total impact in the alternative version (Tables 1, 2).

5. Conclusions

The presented method takes into account all major directions of motorways impact on arable lands, which is expressed in measurable and comparable units. The great advantage of this method is that it is not very labour-intensive, which is the result of simplifications in the assessment of motorways impact, limiting the scope of gathered output data for the analysis of the motorway axis, and automatic calculations made by the developed software [Bacior 2003].

The method can be used in initial assessment of a motorway construction impact on arable lands, carried out at the stage of taking decision as to the motorway route, and in the assessment of alternative motorways routes when designing motorways sections [Bacior 2003].

The study of two versions of a motorway route (existing and alternative) aims at showing usefulness of this method in verifying different variants of realizing this investment.

Due to the construction of the motorway the value of lands in the studied section dropped by 2221.6 cereal units · ha⁻¹ per 1 km of a motorway and in the alternative version – by 2332.6 cereal units · ha⁻¹. For all main directions of motorway impact the decrease is less significant in the existing section. The outcomes lead to the conclusion that in the studied area the motorway was designed optimally.

References

- Bacior S.** 2001. Uproszczony szacunek oddziaływania autostrady na wartość gruntów rolnych. Wydział Geodezji i Inżynierii Środowiska AGH, Komisja Geodezji i Inżynierii Środowiska Krakowskiego Oddziału Polskiej Akademii Nauk – Sprawozdanie z posiedzeń komisji naukowych. Tom 44/1, Secesja, Kraków, 183–185.
- Bacior S., Harasimowicz S.** 2002 Metoda oceny wpływu autostrady na wartość gruntów rolnych, dokładność oszacowania powierzchni użytków i klas gruntów. Materiały Konferencji organizowanej przez Polskie Towarzystwo Inżynierii Rolniczej – Komitet Techniki Rolniczej PAN, Warszawa, 8 (41), 107–120.
- Bacior S.** 2010. Oddziaływanie autostrady na grunty rolne na przykładzie odcinka Borek Mały – Boreczek. Infr. Ekol. Ter. Wiej., 3, 5–15.
- Bacior S.** 2012. Oddziaływanie autostrady na grunty rolne na przykładzie odcinka Brzozówka – Nowa Jastrzębka. Acta Sci. Pol., Admin. Loc., 5–14.
- Bacior S., Piech I.** 2013 Oddziaływanie inwestycji liniowych na grunty rolne na przykładzie odcinka autostrady A4 Żyraków Paszczyzna. Acta Sci. Pol., Geod. Desc. Terr., 12 (1), Wrocław, 19–28.

- Curzydło J.** 1994. Drogi i autostrady a skażenie motoryzacyjne. *Aura*, 5, 7–8.
- Cymerman R.** 1992. Urzędzeniowo-rolna metoda wyceny obszarów rolniczych. *Wycena* nr 1, 12–13.
- Harasimowicz S.** 1997. Główne kierunki oddziaływania autostrady na możliwości dochodowe gospodarstw rolnych. *Metodyka oceny oddziaływania autostrady na grunty rolne i leśne. Sesja naukowa, AR w Krakowie. Szkoła Wiedzy o Terenie*, 57–62.
- Harasimowicz S.** 1998. Ocena oddziaływanie autostrady na grunty rolne. *Prz. Geod.*, 6, 6–12.
- Harasimowicz S.** 2002. Ocena i organizacja terytorium gospodarstwa rolnego. *Wyd. AR w Krakowie, Kraków*.
- Wilkowski W., Kłopociński W., Potasznik W.** 1993. Szacowanie gruntów, budynków i lokali. *Stowarzyszenie Geodetów Polskich, Warszawa*, 25–38.
- Wilkowski W.** 1995. Wielokryterialna metoda oceny wpływu autostrady na gospodarstwa rolne, *Pr. Nauk. Polit. Warsz. Geodezja*, 33, 5–19.
- Żak M.** 2002. Problematyka wyceny nieruchomości położonych w pasie budowy sieci autostrad. *Zesz. Nauk. AR w Krakowie*, 396, 17–22.

Dr inż. Stanisław Bacior
Uniwersytet Rolniczy w Krakowie
Katedra Geodezji Rolnej, Katastru i Fotogrametrii
30-198 Kraków, ul. Balicka 253a
e-mail: rmbacior@cyf-kr.edu.pl

Anna Pietraszek, MBA, MA
Florida International University
Department of Marketing
11200 SW 8th Street – RB 304, Miami, FL 33199
e-mail: pietrasa@fiu.edu