THE ENVIRONMENT AND ROAD INVESTMENT PROJECTS – DO WE NEED TO CHOOSE BETWEEN THE TWO? A CASE STUDY OF THE ROSPUDA RIVER VALLEY IN POLAND

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Abstract

In Poland, many road investment projects are being currently implemented. Regulations require that, when the implementation of investment projects significantly affecting the environment is intended, an environmental impact assessment needs to be carried out. These assessments compare several different variants of the route of the road. The aim of the study is to analyse the variants of the route of the investment project being part of the trans-European through road Via Baltica running through Poland and connecting other Baltic countries with Finland, namely the bypass of the town of Augustów. The project has been completed and put in operation. Its construction, however, did not proceed without complications. The construction was halted due to the protests of the local population and environmentalist circles, primarily because the proposed variants of the route of the road were supposed to cross Natura 2000 sites protected by the Habitats Directive. Currently, the constructed bypass around Augustów is two times longer than the initially proposed variant. The article will analyse the basic indicators describing the variants of the bypass project implementation, and determine a synthetic measure which takes into account the analysed indicators. Results of the study will enable the identification of the optimum variant of the route, taking into account both minimum damage to the environment and most efficiently spent funds for the construction.

Key words: *road investment, roadway, environment.*

Introduction

Societal expectations associated with an improvement to infrastructure raise no doubts. Each community wants to have proper roads, efficient water supply and sewage systems, wastewater treatment plants and other amenities; however, infrastructural projects often interfere with both personal interests of the inhabitants and the environment, which leads to acts of resistance and protests. Road investment projects are such an example as they cross the spatial continuity of land while running as a narrow strip across various areas. The adverse effects of the right-of-way do not only refer to the use of the land for the right-of-way but also to the space surrounding it (KOCUR-BERA, 2010). Each investment project which interferes with protected areas is under special supervision of environmentalists. Under Polish law, investment projects which may always have a significant effect or have a potential effect on the environment may be subject to an environmental impact assessment. Such an assessment is a result of the Act of 3 October 2008 on the provision of information on the environment and its protection, public participation in environmental protection, and environmental impact assessments (AIEP, 2008).
The construction of bypasses around towns and cities is the result of the significant increase in transit traffic. The article analyses the bypass of the town of Augustów, which is a part of the trans-European road Via Baltica. The origins of the project date back to the late 1990's. The choice of the location variant was determined for the first time by a decision taken at a working meeting held on 13 September 1996 at the Voivodeship Office in Suwałki. The decision concerned had not been preceded by an environmental impact assessment for the planned project. In the years 1999–2000, the route of the bypass in the variant crossing the Rospuda River Valley was determined in local area development plans for the municipality of Augustów, the commune of Nowinka, and the town of Augustów, while the reservation of the land for the construction of Via Baltica was taken into account in the area development plan for the commune of Raczki. In 2002, a procedure concerning a decision on building and land development conditions for the Augustów bypass was conducted. At that stage, non-governmental organisations drew attention to the lack of analysis of different variants of the route of the road, the lack of assessments of the impact on

protected species, or the lack of wildlife inventory for the area to be affected. In the years 1997–2005, a number of reports for Augustów bypass were drawn up yet none of them took into account an assessment of the impact on the "Puszcza Augustowska (Augustów Primeval Forest)" Natura 2000 sites in accordance with the requirements of the Habitats Directive applicable in Poland following the accession to the European Union. As a result of the European Commission's intervention, all previously taken decisions concerning the construction of the Augustów bypass were annulled by administrative courts as having been issued unlawfully (SISKOM, 2017).

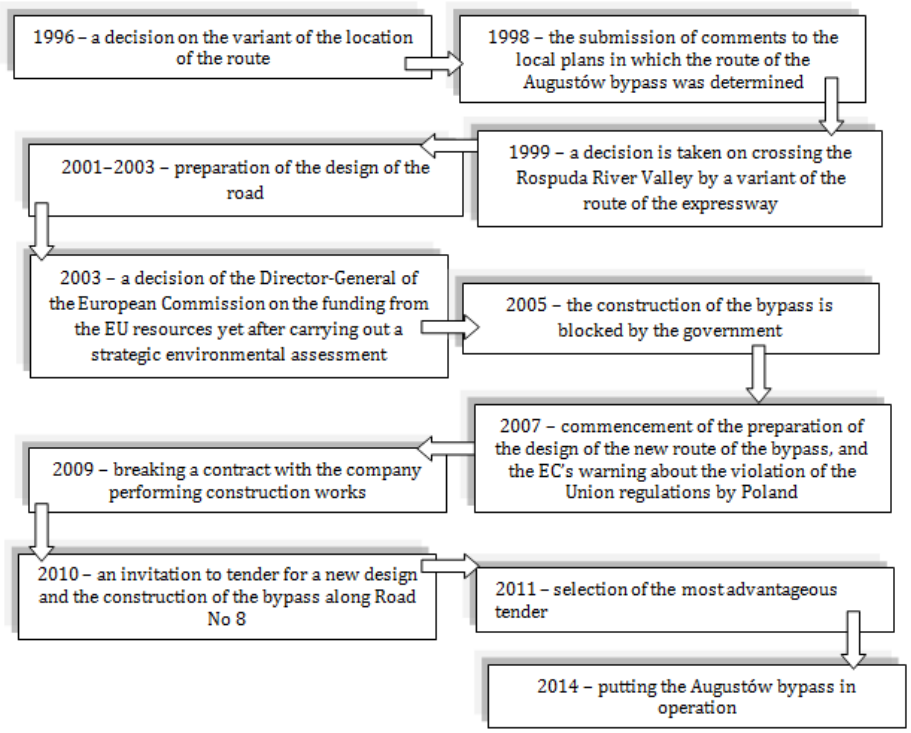

Fig. 1. Timeline of the construction of the Augustów bypass. *Source: own study.*

The aim of the study is to compare the proposed variants of the route of the Augustów bypass i.e. a part of *Via Baltica*, a trans-European road linking the Baltic countries with Finland. To this end, an aggregate synthetic measure was used; it took into account a number of features describing particular variants of the route of the road. These variants were analysed, and the final part of the article indicates a variant which, in the researcher's opinion, is optimal.

Methods

Complex phenomena such as a choice of a variant of the route of a road within the space may be described using more than one feature. Multidimensional data cause problems during their analysis as they cannot be presented in the form of a simple graphic illustration, and it is not possible to observe intuitively certain regularities to be later described numerically in a relatively simple manner (SOKOŁOWSKI, 2014). Therefore, in such cases, a multi-dimensional analysis is applied. This is a tool which allows one to organise and classify objects described with numerous features. Many synthetic measures exist, yet for the study, a measure proposed by Sokołowski (2014) was used. The selected measure is clear when interpreted, and enables the presentation of a number of spatial and environmental determinants occurring within the area under study in the form of an aggregated indicator. In addition, the proposed measure is relatively simple in calculation, therefore it can be calculated using a simple calculation and spreadsheet software.

The synthetic vulnerability index (IS) is expressed as a mean value of all standardised and reduced attributes describing space (SOKOŁOWSKI, 2014; ZELIAŚ, 2006; KOCUR-BERA, 2016). It is expressed by a general formula (1).

$$IS = \left(\frac{\sum_n^i W_{iu}}{n}\right) * 100 \quad (1)$$

where:

w_{iu} – unitarised value of the variable with the use of formulas (2) and (3);
n – number of features.

The unitarisation was performed according to formulas (2) and (3):

For stimulants $\Longrightarrow$ $$x_{ij} = \frac{xij - \min\{xij\}}{\max\{xij\} - \min\{xij\}} \quad (2)$$

For destimulants $\Longrightarrow$ $$x_{ij} = \frac{\max\{xij\} - xij}{\max\{xij\} - \min\{xij\}} \quad (3)$$

where:
i – number of the entity;
j – number of the feature.

Description of the area under study

The area of the study comprised the implemented construction project being part of the trans-European through road Via Baltica running through Poland and connecting other Baltic countries with Finland. Via Baltica serves the role of the most important road link between the Baltic countries, and along with Rail Baltica, it is a part of the trans-European transport corridor. The analysed construction project is situated within the area known as the Green Lungs of Poland covering an area of 63 235 km^2, which accounts for approx. 20.0% of the area of Poland, and inhabited by almost 4.0 million people (9.7% of the country's population) The region comprises Warmińsko-Mazurskie and Podlaskie Voivodeships as well as parts of Mazowieckie, Kujawsko-Pomorskie, and Pomorskie Voivodeships. Within the region, the largest system of protected areas on the national level has been established, consisting of 4 National Parks: Białowieski National Park (entered into the UNESCO World Heritage List), Biebrzański National Park, Narwiański National Park, and Wigierski National Park, as well as 13 Landscape Parks, more than 270 Nature Reserves, and approx. 5 700 natural monuments; in total, approx. 43.7% of the area of the Green Lungs of Poland is covered by various forms of legal protection (EIA, 2009). The area under study is partially situated within the Augustów Primeval Forest, and one of the variants of the route of the road crosses the Rospuda River Valley. The Augustów Primeval Forest, along with its parts situated in Lithuania and Belarus, is the largest compact forest complex of the primeval forest nature in this part of Europe. High natural values of the Rospuda River Valley have been recognised relatively recently (SOKOŁOWSKI, 1996). The Rospuda River Valley is the largest in Poland, and certainly one of the largest in Europe. The Rospuda River has its beginning several kilometers to the south of the boundaries of Romincka Primeval Forest, and flows into Rospuda Lake situated north-west of the town of Augustów. In the southern part of the Rospuda Valley, surrounded by coniferous forests of the Augustów Primeval Forest, vast, mossy, and treeless lowmoor and transitional moor are situated, which provide a refuge for numerous rare plant and animal species. The rich flora of the moors includes 4 plant species listed in an Annex 2 to the EU's Habitats Directive, 15 plant species listed in Polish Red Data Book of Plants, and 50 species of protected plants. Moreover, the moors are the only refuge in Poland for an orchid that is rare on the European level, namely the musk orchid (Herminium monorchis). The landscape structure of the area clearly indicates great pressure from human action, namely the agricultural use of the land (EIA, 2009). Forests cover only 24% of the area, and most of the land is still used for agricultural purposes. Despite this, researchers of the valley indicate that the Rospuda River Valley is an important ecological corridor linking three neighbouring Primeval Forests: Augustów, Romincka, and Borecka (JĘDRZEJEWSKI et al., 2004).

Fig. 2. Location of the area under study. *Source: own work based on (NW, 2017; FZPP, 2017).*

Table 1. The description of variants of the route of the Augustów bypass

Variant	DESCRIPTION
Variant I – *Via Baltica* through Białystok	Modification of variant IVL, a section of the bypass was accepted along the existing Road No 8, and, further on, along the designed bypass of the city of Suwałki; the entire designed section of the Road S8 Augustów – Suwałki will be situated within the road corridor of Via Baltica;
Variant IA – *Via Baltica* through Łomża and Ełk	was accepted as a modification of the construction design of the Augustów bypass; a section to the end of the bypass was accepted along the existing Road No 8, and, further on, along the designed bypass of the city of Suwałki; the designed section of Road S8 Augustów – Suwałki will not be situated within the road corridor of Via Baltica;
Variant II – *Via Baltica* through Białystok	was accepted in order to reduce clashes between Variant I and the Natura 2000 site "Puszcza Augustowska" by making use of the narrowing in the width of this area, occurring in the village of Chodorki; the entire designed section of the Road S8 Augustów – Suwałki will be situated within the road corridor of Via Baltica;
Variant IIA – *Via Baltica* through Łomża and Ełk	was accepted in order to reduce clashes between Variant I and the Natura 2000 site "Puszcza Augustowska" by making use of the narrowing in the width of this area, occurring in the village of Chodorki; the designed section of the Road S8 Augustów – Suwałki will be situated within the road corridor of Via Baltica only along the section from Raczki to Suwałki;
Variant III - *Via Baltica* through Białystok	was accepted in order to avoid clashes between Variants I and II and the Natura 2000 site "Puszcza Augustowska" by making advantage of the lack of protection of a short section of the Rospuda Valley near the village of Raczki under the Natura 2000 network; the entire designed section of the Road S8 Augustów – Suwałki will be situated within the road corridor of Via Baltica;
Variant IIIA - *Via Baltica* through Łomża and Ełk	was accepted in order to avoid clashes between Variants I and II and the Natura 2000 site "Puszcza Augustowska" by making advantage of the lack of protection of a short section of the Rospuda Valley under the Natura 2000 network near the village of Raczki; the designed section of the Road S8 Augustów – Suwałki will be situated within the road corridor of Via Baltica only along the section from Raczki to Suwałki;

Source: own work based on (SISKOM, 2017).

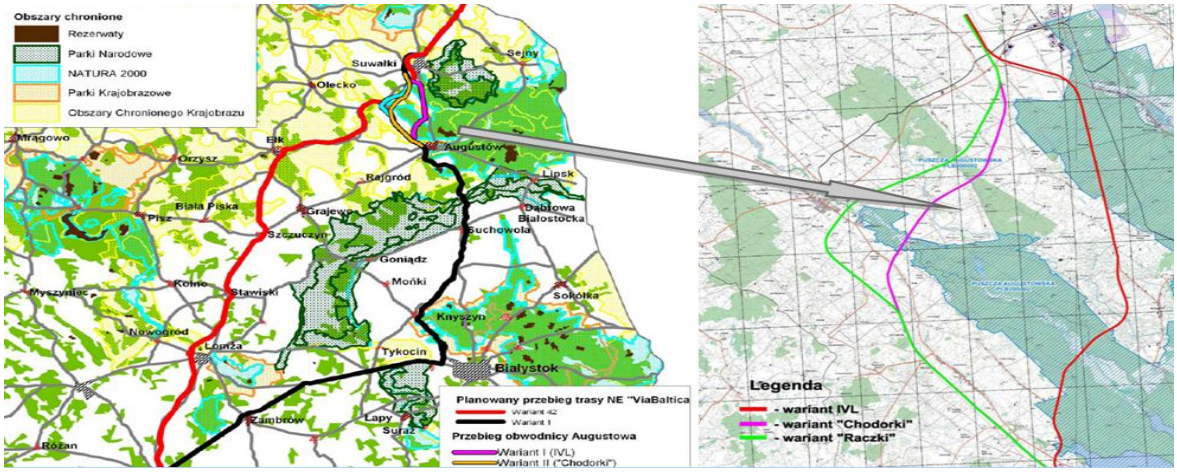

Fig. 3. Detailed location of the route of the analysed Augustów bypass. *Source: own work based on (SISKOM, 2017).*

In order to determine the synthetic indicator, the main spatial indicators which are taken into account while analysing the selection of a variant of the route of the road were put together. They are listed in Table 2, including the value of the indicator for each of the analysed variants. All the analysed variables belong to the group of destimulants, which means that an indicator with the highest value is the worst variant, while the one with the lowest value is the best one.

Table 2. A compilation of particular features of the analysed variants of the construction of the Augustów bypass

Symbol of the variable	Variable name	Number of the analysed variant of the route of the road					
		I	II	III	IA	IIA	IIIA
X1	Length [km]	32.252	32.990	34.531	32.551	33.453	35.090
X2	Extension [%]	19.0	21.7	27.4	20.1	23.4	20.5
X3	Occupancy of the area [ha]	404	439	450	407	446	448
X4	Number of buildings to be demolished	11	8	6	14	10	7
X5	The area of habitats of Community Importance N200 within the right-of-way (within a distance of 2 km) [ha]	163.24	33.19	49.94	163.24	33.19	163.24
X6	Total of all habitats [ha]	3889.11	4069.00	4261.31	3889.11	4069.00	4261.31
X7	The area of habitats included in the right-of-way of Community importance to be eliminated [ha]	17.68	0.30	0.00	17.68	0.30	0.00

Source: own work based on (EIA, 2009).

Results and discussion

The aim of the study was to analyse variants of the route of the Augustów bypass, in relation to which various possible routes thereof were indicated. 6 variants numbered I, IA, II, IIA, III, and IIIA were analysed; a detailed description of the route of particular variants is provided in Table 1 and 2. For further analyses, besides the length (X1) of each of the proposed variants, the following features of the space and the designed road were taken into account: extension (X2); occupancy of the area (X3); buildings to be demolished (X4); the area of habitats (X5) of Community importance located within Natura 2000 sites, which are situated within the right-of-way, and within a distance of 2 km from the designed right-of-way, where adverse effects of the road are anticipated; the total area of all habitats within the right-of-way and within the buffer zone of 2 km from the designed right-of-way (X6), and the area of Natura 2000 sites which would need to be eliminated during the construction process (X7). The choice of features to be analysed was based on the choice indicated by both the institutions involved in environmental protection and units concerned with the management and construction of roads.

Having compiled and unitarised the analysed indicators, the synthetic indicator was calculated using formula (1), and the results are provided in Fig. 4. An analysis of the value of the synthetic indicator reveals that the worst variant of the route is Variant I, despite the shortest length of the bypass section, and the least occupancy level of the area. However, this variant takes into account a high number of buildings to be demolished (11) as well as the large area of Natura 2000 sites which would need to be eliminated. Another, equally unfavourable variant is Variant IA which is characterised by similar features.

Variant No	Synthetic measure (IS)
I	62.50
IA	52.84
II	35.27
IIA	59.14
III	43.83
IIIA	24.86

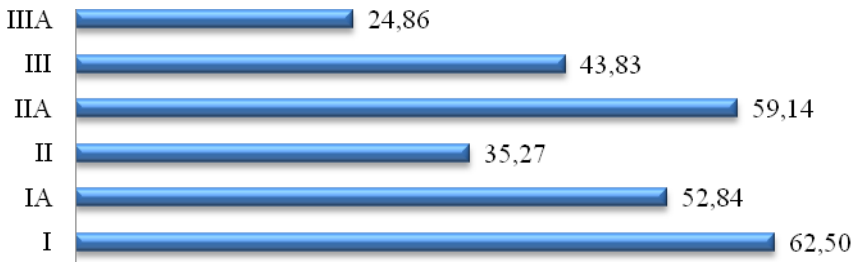

Fig. 4. Results of calculations of the synthetic measure for particular variants of the route of the road. *Source: own study*

According to calculations, Variant IIIA is by far the best proposed variant. This is the longest of the proposed variants; it has an effect on the largest area of natural habitats yet its route does not require the elimination of Natura 2000 sites of Community importance. Another alternative variant to be chosen is Variant II. This is one of the shortest variants in terms of the length, which in general leads to the conclusion that it is the cheapest, its occupancy of the area is medium, only 8 buildings would have to be demolished, and it would contribute to the loss of only 3 000 thousand m^2 of Natura 2000 sites. The indications for the choice of the best variant by the authority carrying out the environmental impact assessment concerned Variants III and IIIA. According to the report, these variants have the least impact on the environment. Eventually, Variant IIIA was constructed. This variant route completely bypasses

protected areas of the Natura 2000 network, yet it interferes with the largest area of the remaining natural habitats (see Fi. 3 i 5). Therefore, a few questions arise: should we only protect the areas indicated by European Directives (i.e. those included in the Natura 2000 network)? What about other species? Can they be eliminated with impunity? The generally heard opinion is that the costs of the construction of 1 km of a road in Poland are among the highest in Europe. Is it not one of the reasons for such a situation? While extending the route of a road, we face the risk of the need to build more additional structures increasing the costs of the construction (bridges, flyovers, and viaducts)? Will the longest variant of the bypass, if constructed, serve its role? Will drivers be more willing to choose this direction of the passage, bypassing the town? So far, these questions have remained unanswered. In the researcher's opinion, Variant II of the route of the road was the optimum choice in terms of both the protection of habitats and the other analysed parameters.

Fig. 5. Images of the constructed Augustów bypass. *Source: (GDDKiA, 2017)*

Conclusions

People's expectations about infrastructure are obvious. We would like to drive on proper roads constructed most economically, and, at the same time, we would like to dwell in an area surrounded by greenery, without noise, vibrations, or exhaust gases? Can these wishes be fulfilled?

The article presents results of the analysis of the variants of the route of the already built road, namely the bypass of the town of Augustów, which is a part of the designed trans-European road *Via Baltica*. The timeline of the construction of the bypass dates back to 1998 when first steps were taken in order to build it, which means that the project was much needed, and had been requested for for a few decades. In the opinion of authorities carrying out the environmental impact assessment, the best variants of the route were Variants III and IIIA, the route of which did not contribute to the elimination of valuable Natura 2000 sites. In addition to the above-mentioned feature, the conducted study also took into account other features, *inter alia* the impact on all natural habitats (not only Natura 2000 sites), occupancy of the area, the buildings to be demolished, or the length of the constructed road. In the researcher's opinion, the optimum variant was Variant II, as it took into account the minimisation of the area of habitats (both Natural 2000 sites and the others) to be destroyed, and its length of the constructed bypass was one of the shortest. The presented method enables taking into account also other spatial factors during the selection of a variant of the route of the road.

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