

LANDSCAPE CHANGES CAUSED BY THE CONSTRUCTION OF THE POZNAŃ WESTERN RING ROAD – SELECTED PROBLEMS

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Summary. Development of road infrastructure in Poland is becoming more dynamic due to its underdevelopment in comparison to EU countries. This is due to occupation of the increasing number of new sites and a number of consequences in the natural environment. The change of character of the landscape, surface depletion of natural or semi natural landscape, weakening of the natural linkages between valuable natural areas and natural space fragmentation are all unambiguously negative effects of the development of the road infrastructure. The article presents the processes of spatial transformation of the landscape, associated with the phase of the project and the implementation of the Poznań Western Ring Road as part of the S-11. Attention is paid to changes in physiognomy and perception capabilities of the landscape in the context of the emerging ring road, road junctions and numerous engineering facilities connected with the collision-free road line. The important role of mapping and remote sensing materials, as well as the sequence of ground images capturing the processes of landscape transformation were also highlighted.

Key words: processes of spatial transformation of the landscape; perception of landscape; investment line – the city ring road

INTRODUCTION

For the purposes of the road infrastructure development, there is a gradual acquisition of new lands. This process is irreversible and increasingly dynamic due to the retardation of such an infrastructure in Poland, in relation to the European Union. Acquisition of lands, changes in land management, at first the dissection and consequently the fragmentation of ecosystems and larger natural complexes, as well as deforestation, are inseparable elements of the development and the modernization of the transport infrastructure. Much of the road network is formed by taking new land, and the rest by improving the performance of existing routes [Tyszecki 2006]. Consequence of the road infrastructure develop-

ment are many local and regional adverse impacts on the environment, in particular, biologically active areas, forests, wetlands, water relations and living conditions of the population. The direct or indirect impact of these activities will also be positive (growth inhibition of transport emissions in urban areas, improving the acoustic climate) this, however, does not happen in the short term.

New communication systems, particularly freeways which improve connections between metropolitan areas and other areas of the country, making them more attractive for developing different types of functions and locating a variety of investment projects. In consequence, this promotes expanding of urban areas and pressure on areas environmentally valuable or sensitive. In addition, as with the development of the road infrastructure between urban areas, development bands are formed, affecting not only through transport investments but also through other forms of investing money. Therefore, a new road in the landscape is only the beginning of major changes. These phenomena especially occur in emerging metropolitan areas and zones of interaction of large and medium-sized cities.

A clearly negative effect of the road infrastructure development is the change in the landscape character, surface depletion of the natural or semi natural landscape, including sensitive areas (wetlands, peat bogs, river valleys, and environmentally valuable (e.g., area under legal protection), weakening the links between natural areas forming a national or regional system of protected areas and, finally, a series of processes of spatial transformations of the landscape – perforation, dissection, fragmentation, exploitation, loss, merge, hyperplasia [Pietrzak 2010]. First of all, there is fragmentation of the natural space which has adverse effects on the protection of habitats and species, forests and water management, and also has indirect influence on the development of agriculture, recreation or environmental values of the Natura 2000 and other legally protected areas. Note that sites intended for road transport are not in use at present and are basically permanently transformed.

In the context of the above contemplation, the theme of the this article concerning the landscape changes since 2009, caused by the implementation of the linear road investment – the Poznań Western Ring Road. The proposals for the course of the ring road appeared as early as in the 1990s. They have been included in the development plans of the voivodeship and the municipalities. The spatial concept of the designed Poznań Western Ring Road, which was the basis for the Report of the impact of the project on the natural environment to obtain a decision of the zoning and land use (2002), comes from the turn of the 2001/2002.

The purpose of this article is to present the diverse spatial processes of the transformation of the landscape in the planning stage and during the implementation of the road-investment – from the preparatory work until ready to use. Noted changes in the physiognomy of the landscape and its perception caused by the course of the road and the emergence of the landscape elements related to the road are: junctions or engineering objects related to the collision-free course of the road, in relation to the existing and emerging road infrastructure elements.

In addition, the usefulness of the source materials was verified, primarily the remote sensing and ground-based mapping sequence of images.

INVESTMENT CHARACTERISTICS

Western Poznań Ring Road is a part of the S-11 dual carriageway, linking Poznań with Kościan and the S-5 expressway, connecting Poznań with Wrocław. It should „improve the transit traffic, shorten travel time and improve traffic safety and ensure a necessary level of transit traffic on discussed part of the road [<http://www.s11-zlotkowo-rokietnica.pl>].

This investment is carried out in three stages: I, IIa and IIb. Stage I is already in use (the official opening occurred on June 4, 2012) and runs along the southern part of the Głuchowo junction (A-2 motorway) to the Swadzim junction, with a length of 14.31 km. The expressway and other existing public roads are connected by junctions. Swadzim, at the intersection of the ring road with the 92 national road, Zakrzewo, at the intersection of the ring road with the 307 provincial road, Dąbrówka, at the intersection of the ring road with the 201 powiat road and Głuchowo, at the intersection with the A2 highway. There is no possibility of entering and exiting the Poznań Western Ring Road outside the listed junctions. A service area for travelers is also designed.

Table 1. Designed objects at different stages of ZOP

Object	Stage I	Phase IIa	Phase IIb
Two lanes wide two-lane road crown: ≥ 26.50 m	14.231 km	7.740 km	5.300 km
On-ramp	4 Swadzim Zakrzewo Dąbrówka Głuchowo	2 Złotkowo, Rokietnica	1 Kobylniki
Viaduct road	14	8	no data
Railway bridge	0	1	0
Wharf	0	1	0
Bridge	1	1	no data
Tunnel	0	1	no data
Pedestrian and bicycle crossing	2	0	no data
Emergency passage	5	3	no data
Mop	1	1	0

In addition, on each of these stages there are designed:
internal, municipal and access roads, strengthening the structure of the substrate and surface, acoustic protection, drainage equipment, electrical equipment, reconstruction of water and sanitation machines, telecommunications, drainage, rail and gas networks, demolition of buildings, service areas, fencing on both sides;

Study J. Kijowska on the basis of: <http://www.s11-zo-poznan.pl>, <http://www.s11-zlotkowo-rokietnica.pl> – as of 05/03/2012.

The northern Stage IIa, from the Złotkowo junction to the Swadzim junction with a length of 7.740 km, is in the final stages of construction. This part of the expressway and other existing public roads are connected by Junctions. Złotkowo with the 11 national road and Rokietnica with the Napoleonic Tract municipal road. No possibility of entering and exiting the ring road outside the listed junctions.

Stage IIb, the missing and the most conflicting part of the investment, from the Rokietnica junction to the Swadzim junction, with a length of 5.3 km, with the projected Swadzim junction connecting the ring road with the 184 provincial road, is currently at the stage of obtaining a building permit. The table shows the major objects at various stages of construction of the Poznań Western Ring Road.

AREA AND RESEARCH METHODS

Analysis of the landscape changes has been carried out on the 27 km part of the S-11 section from the Złotniki junction (Suchy Las commune) to Głuchowo junction (Komorniki commune), with particular attention given to section IIb, from the Złotniki junction to the Rokietnica junction, passing through the environmentally valuable Samica Kierska Valley, the ecological corridor on a regional scale, this passage constitutes the Pawłowicko-Sobocki Protected Area, and at the same time the Natura 2000 Samica Valley (PLB300013).

The analyses of landscape changes were made in the context of spatial processes of landscape transformation and therefore mosaic landscape changes, that is landscape composition and configuration, which include perforation („puncture”), dissection („cutting”), fragmentation, exploitation, loss of landscape elements, merge or growth [Pietrzak 2010]. Vertical and oblique aerial photographs were used for this purpose (A. Kijowski), photographs of the investments were made at different times and from different vantage points (J. Kijowska), photographic documentation of the ZOP construction and engineering structure diagrams published on the website of the General Directorate for National Roads and Highways, topographic, zoological and hydrographic maps in the 1:50 000 scale of the study area, the study on the commune land use conditions and development directions where the investment takes place, the Report on the impact of the investment on the natural environment „Western Ring Road of Poznań, within the Koszalin–Katowice 11 National Road”, 2002, and field observations.

LANDSCAPE CHANGES CAUSED BY THE CONSTRUCTION OF THE RING ROAD

At the planning stage, the Poznań Western Ring Road caused perforation, that is „puncturing” in many places on its course due to the exploitation of raw materials – aggregates (Photo 1) and organic materials – peat, as well as archaeological



Photo 1. The aggregate operation in the Samica Kierska Valley before the construction of Poznań Western Ring Road (ZOP) – an example of landscape perforation (24.06.2008, A. Kijowski)



Photo 2. Archaeological conservation works between Sobota and Bytkowo – an example of landscape perforation (23.04.2010, A.Kijowski)

work (Photo 2). In consequence of the exploitation of raw materials, a number of small excavation voids emerged, often with overlapping ground water, which operating time has been restricted to the start of construction work on the line of the designed road. Exploitation of raw materials was purely commercial and was associated with their acquisition before starting the investment. The preparation of the site for archaeological research has resulted in exposures characteristic of arable lands which can be classified as agricultural landscape perforation. This type of perforation, as well as the previous ones, was temporary.

The perforation of the landscape continued during construction works due to soil humus level images in the areas of outflow cavities, river valleys and small streams, and areas for the designed engineering structures, lying in the roadway and related to the replacement of the groundwork for the road lane. This stage, apart from the partial aerial and ground-based photographic documentation, will not be recorded on the topographic maps, and therefore in the context of the future research on the landscape changes based on the cartographic sources, may be omitted completely.

Among the landscape changes, there were also changes in the natural topography. First of all, new morphological forms emerged – excavation heaps – various aggregates, temporarily obscuring other landscape elements, such as the panorama of the Sobota town from Bytkowo, or the panorama of the Samica Valley from the Sobota town. Mounds emerged in the line of the ring road, especially in the area of the new technical objects: junctions, exits, flyovers, bridges, viaducts.

The dissection occurred at the moment of setting out the roadway and the new system of internal, municipal and access roads. Patches of fields, meadows, forests, but also landscape units such as small ponds, outflow scrubland depressions, woodlots, and other avenues of trees. The dissection process occurred in the regions of Złotkowa, Batorowa, Zakrzewa, Napachanie, Kobylnik, Dąbrówka. In most cases, the consequence was their fragmentation, an example of the outcome can be seen in the Zakrzewo junction area (Photo 6). In this particular case it may be a matter of time that the other isolated sections of forest complexes become exploited and eventually disappear. The analyzed ring road cuts through three river valleys: The Samica Kierska Valley which is a part of the Natura 2000 protected landscape, and the Samica Pamiątowska and Wirenka Valley, as well as 12 valleys of smaller watercourses. This is not a typical dissection of valley landscape because the solution for maintaining ecological continuity are engineering objects: a wharf, bridges and culverts.

The dissection and fragmentation of the landscape units reduce their size and length, which is an obvious symptom of the landscape exploitation (Photo 6). Particularly disturbing processes are those in the case of rare landscape units – orchards, plantations, woodlots, as it will lead to their total disappearance, or forming a coherent part of a larger whole, namely marginal forest zones (ecotone zones), as it leads to their weakening and degradation. The exploitation also applies to roadside avenues of trees which have been broken up (atrophy of the avenue fragments due to their cutting out), in connection with changes in the road system.

The merge processes are slowly gaining momentum in the secondary impact areas of the new investment, as a result of increased communication access they will be managed under different kinds of production functions, services, warehouses, and also of the residential facilities, and therefore will primarily apply to built-up areas. In addition to the obvious changes in spatial terms, a transformation of the landscape composition has been identified as a result of the construction of the numerous engineering objects, inherent in the two new dual-



Photo 3. Removal of the humus layer in the ring road of Poznań – dissection of the landscape
(23.04.2010, A. Kijowski)



Photo 4. Dissection of Natura 2000 Samica Valley (23.04.2010, A. Kijowski)

-carriageways, namely junctions, road and rail viaducts, bridges and flyovers (Photo 5), tunnels, bicycle crossings, which cause the anthropogenization of the landscape.

Therefore, the individual spatial landscape transformation stages have been emphasized [Forman 1995]. And so the process of transformation of the landscape, caused by the construction of the ZOP on the S-11, started from its perforation or „puncture” in the various types of land use, which increases the total length of the borders in the landscape (Photo 1, 2). The process of dissection occurred in the time



Photo 5. Construction of flyovers in Natura 2000 Samica Valley [02.03.2012, <http://www.s11-zlotkowo-rokietnica.pl>]



Photo 6. Zakrzewo node under construction – dissection and fragmentation of the forest complex in Zakrzewo region (23.04.2010, A. Kijowski)

of a planned course of the ZOP road lane, and the new road layout (Photo 3, 4, 6). The consequence of the dissection process is the fragmentation of the landscape. These processes dominate the planning and the implementation of the ring road. While the exploitation of the surface primarily concerns the reduction of the individual patches in relation with the exclusion of land for the construction of the ring road, and the disappearance of smaller patches in the course of the road. The process of merging and growth is a consequence of implementing the investment.

An interesting thread that correlates with the theme of the research paper is the landscape perception of the new linear investment. The Poznań Ring Road undoubtedly limits the perception of the landscape physiognomy of an observer located at a certain distance off the road due to its partial course on the embankment with a height of from a few to a dozen meters, use of acoustic screens or afforestation along the emergency roads. They have become a barrier in the perception of the landscape, and sometimes an anthropogenic background, and the reason for reducing the perspective. It should be noted that the anthropogenic landscape background, through planting the scrubland or implementing natural color screens, in time may become as attractive as the earlier „walls” of the forest, the high wooded areas, areas used for agriculture on the slopes of valleys, and the reduced perspective (due to the lack of comparative scale) will not be felt.

On the other hand, the ring road creates new possibilities for perception of the landscape physiognomy. The previously unnoticed landscapes but currently invisible, are available to the observer. This is connected to the elevation changes of the observer caused by the construction of the road on the embankment, the flyover over the Natura 2000 area, viaducts and bridges which create new opportunities for the observation of the landscape, which broaden the panorama of the low-lying, lacustrine and agricultural landscapes, increase the perspective in valleys, increase in the availability of attractive places in the low-lying landscape such as the view of the Samica Kierska Valley – Natura 2000, the Samica Pamiątkowska Valley, or creating this accessibility to places previously invisible, for example the latitudinal valley of the Lusowskie Lake or the Wirenka Valley.

These new possibilities of perception are an unintended consequence of the interference in the low urbanized area of investment.

CONCLUSIONS

The analysis of the available cartographic and remote sensing materials, and field observations supplemented by the ground-based photo documentation during the preparatory stage of the construction and during the construction of the S-11 section (ZOP) has allowed for capturing a wide range of changes in the landscape. The analysis stage of the planning and implementation of the investment allowed for capturing changes in the landscape not registered in the cartographic materials (the effects of landscape perforation: archaeological „pits”, excavation voids, the felling sites in the course of the road the registration of the individual spatial transformation stages of the landscape (e.g. from perforation to atrophy).

The value of widely available remote sensing and photographic materials creates opportunities for analyses of the spatial processes changing the landscape and its dynamics, using a specific idea or research methods.

It should be noted that the presented spatial processes which find diverse consequences in the operation of the landscape, undoubtedly lead to different

systems (sequences) of the landscape mosaic. A separate problem, requiring wider exposure, are the spatial ecological changes in the landscape, for which the evaluation of particular importance is the size of the patch, density and length limits of the landscape [Forman 1995]. Through a multi-faceted study of the transformation of the landscape, we enter into its management process, covering diagnosis, planning and decision-making, implementation, and the monitoring and control system.

The undeniable advantages of the new road infrastructure, particularly in the metropolitan area are: improving and increasing the capacity of transport, shortening travel time, good road connections of national and international importance or reducing vehicle emission and noise levels in the city. Yet, this is done at the expense of increasing changes. They are moving towards landscape anthropogenization, which is primarily associated with the exclusion of the current agricultural, forestry and meadow usage, often environmentally valuable, and channeling them into a network of roads, triggering numerous changes. In Poland, between 2007 and 2013, there were 250–300 km² excluded, it is predicted that by 2020 about 400 km² will be excluded [Tyszecki 2006], and in the later perspective, subsequent sites will be excluded, which is currently difficult to estimate in terms of size.

Currently, we are witnessing revolutionary transformations of the landscape. Never before in the history of civilization, did human activities cause such drastic and enormous changes in the sense of planning. The process of „consuming” the landscape begins to take on a massive scale and is a sufficient reason to take action in relation to the objectives of the sustainable development and the sustainable management of the landscape, in the interest of its harmonious development as a natural human environment [Myga-Piątek 2010].

A new road in the landscape is only the beginning of its great changes.

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**ZMIANY KRAJOBRAZOWE WYWOLANE BUDOWA
ZACHODNIEJ OBWODNICY POZNANIA – WYBRANE PROBLEMY**

Streszczenie. Na potrzeby rozwoju infrastruktury drogowej zajmowane są stopniowo nowe tereny. Proces ten jest nieodwracalny i coraz bardziej dynamiczny, ze względu na niedorozwój tego rodzaju infrastruktury w Polsce w stosunku do krajów Unii Europejskiej. Konsekwencją rozwoju infrastruktury drogowej są różnego rodzaju lokalne i regionalne niekorzystne oddziaływanie na środowisko przyrodnicze oraz warunki życia ludności. Jednoznacznie niekorzystnym skutkiem rozbudowy infrastruktury drogowej jest zmiana charakteru krajobrazu, uszczuplenie powierzchni o naturalnym lub quasi-naturalnym krajobrazie, osłabianie powiązań przyrodniczych pomiędzy obszarami tworzącymi krajowy bądź regionalny system obszarów chronionych, czy fragmentacja przestrzeni przyrodniczej.

W artykule przedstawiono różnorodne procesy przestrzenne przemian krajobrazu na skutek realizacji inwestycji – zachodniej obwodnicy miasta Poznań (S-11), począwszy od etapu planowania i prac przygotowawczych do budowy, przez etap jej budowy, do momentu oddania drogi do użytku. Zwrócono uwagę na zmiany w fizjonomii krajobrazu oraz aspekt zmian percepji krajobrazu w kontekście nowej drogi i poszczególnych elementów z nią związanych, m.in. węzłów drogowych, obiektów inżynierskich związanych z bezkolizyjnym przebiegiem drogi, w stosunku do istniejących i nowo powstających elementów infrastruktury drogowej. Ponadto podkreślono ogromną przydatność materiałów źródłowych, przede wszystkim kartograficznych, teledetekcyjnych i sekwencji zdjęć naziemnych.

Slowa kluczowe: procesy transformacji przestrzennej krajobrazu, percepja krajobrazu, inwestycja liniowa – obwodnica miasta