

## ENVIRONMENTAL CONDITIONING OF SETTLEMENTS DEVELOPMENT IN THE NADWIEPRZAŃSKI LANDSCAPE PARK (SE POLAND)

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**Summary.** This paper presents the relationship between spatial structure of settlements and the natural conditions in the region of Nadwieprzański Landscape Park. In the first part the relationship was characterized between these two elements in the overall scale – i.e. the impact of individual components of the environment on the location of each village. The analyses carried out at this stage in the first place revealed a significant role of the river network and the distribution of fertile soils for the shaping of settlements.

The second part examines similar relationships in the detailed scale – i.e. for individual residential buildings. The results are presented separately for the three periods (years: 1936, 1985, 2004), thus showing the trends in the development of building and change of the significance of individual elements of the environment for its distribution. In this case, the relationships were less pronounced and associated with the cumulative impact of several factors. In all the cases, however, during the investigated period a decreasing importance of natural factors was found out.

The determination of the role of the considered environmental components allowed for an identification of the characteristics of each of the components which were optimal for the development of settlements. On this basis, in the last part of the paper the areas are presented with the natural conditions favorable for the rational development of residential housing.

**Key words:** natural conditions for settlement, Nadwieprzański Landscape Park, rural landscape, urban planning

### INTRODUCTION

The Nadwieprzański Landscape Park is an area with rich environment. For centuries the area has been intensively populated and now it has a clearly shaped spatial structure of settlements. The purpose of this paper is to present the importance of the natural conditions of settlement in this area as well as the changes taking place in the relations between the environment and the development of building. A detailed analysis of these relationships will not only allow to learn

about their range but also to determine the causes and also to indicate how the natural conditions should be included in the planned land use of the area.

## STUDY AREA

The study was conducted in the area of Nadwieprzański Landscape Park and its buffer zone. In the case of analyses conducted in the overall scale also the wider environment of the park was taken into account, within the radius of 5 km from the buffer zone border. The park is located at the crossroads of the Lublin Upland, Western Polesie and Volhynia Polesie as well as the Południowopodlaska Lowland [Kondracki 2002]. The total area of the park is 4432 hectares, but the buffer zone is more than three times larger and covers 13 059 ha.

The park is heavily extended on the south-east and north-west line along the river Wieprz, constituting its main hydrographic, natural and landscape axis. In the northern part the Wieprz valley is narrow, winding, of a breakthrough character, with clearly marked, steep edges, deeply cut ravines and gorges. Fertile plateau areas extend beyond the valley. The southern part of the valley is broad, strongly swampy and the edges are slightly marked. It is surrounded by the lake accumulation plain and the river – periglacial accumulation plain with a few areas of dune accumulation. The main aquifer refers to the bottom altitudes of the main river valleys, and it is sloping from the watershed to the river [Janiec and Rederowa 1992, Chmielewski 1993, Chrzanowska *et al.* 2006].

## MATERIALS AND METHODS

This paper is based on two main methods. The first of these was the method of comparative cartometric analysis at the interval of several decades. This method served to carry out an analysis of the spatial development processes of settlement in the present area of the Nadwieprzański Landscape Park and its buffer zone against the natural conditions. The second method was ecophysiological studies involving the determination of natural conditions affecting the spatial organization of the area.

All the work was divided into three stages:

1. Analysis of the natural conditions of settlement in the overall scale.
2. Analysis of the natural conditions of settlement in the detailed detail.
3. Determination of areas with the most favorable conditions for the development of settlements.

The initial cartographic materials used were:

- WIG topographic map, scale 1 : 100 000 from 1936,
- topographic map, scale 1 : 100 000 from 1985,
- map of soil – farming, scale 1 : 100 000,
- aerial photo from 2004.

The analyses were carried out in the MicroStation V8 XN on academic license.

On the basis of cartographic materials and information available in the literature a series of maps was worked out that characterized the different environmental components such as: terrain relief map, water conditions map and soil – farming map as well as physiographic units map acc. to the division by Kondracki [2002] designed for the analysis of settlement in the overall scale.

The distribution of villages or residential development in the analyzed periods was imposed on the above-mentioned maps in order to obtain the density of buildings in areas with different environmental features as well as the changes of this density in different periods.

In the last stage of the work, attempts were made to identify the most suitable areas for development in terms of natural conditions. These areas were determined by the superimposition of the selected sites with beneficial characteristics of the terrain, water conditions and soil.

## RESULTS AND DISCUSSION

### **Analysis of the natural conditions of settlement in the overall scale**

In a separate area of Nadwieprzański Landscape Park and its buffer zone as well as in the designated area within the radius of 5 km from the Park buffer zone, villages distribution and the chronology of their formation was presented [Wieczorek 1968, Horocha 1989, Chrzanowska *et al.* 1996, Gajos 2010, [www.ludwin.powiatleczynski.pl](http://www.ludwin.powiatleczynski.pl), [www.trawniki.hg.pl](http://www.trawniki.hg.pl), [www.fajslawice.info](http://www.fajslawice.info), [www.dorochucza.republika.pl](http://www.dorochucza.republika.pl)] against the background of physiographic units [Kondracki 2002]. The drawn-up map clearly shows the relationship of settlements development with the natural conditions of the area (Fig. 1). First of all, the highest density of villages can be observed on the Swidnicki Plateau – the area of natural conditions most conducive to the development of agriculture (the best soils, relatively unvaried relief, a small proportion of wetlands).

But if you examine the chronology of the emergence of villages in the area, it can clearly be seen that the river network played a dominant role in the shaping of the spatial structure of settlements. Almost all of the oldest villages (93%), settled in this area by the end of the Middle Ages (from the Xth to XVth c.), are located in the immediate vicinity of the rivers (up to 2 km from the trough). And the same applies both to the Wieprz and to its small tributaries. Also, the farther from the river, the younger the settlements, with the earliest inhabited top terrains of the Świdnicki Plateau, and the latest inhabited areas of the Łęczyńsko-Włodawska Plain and the Dorohuckie Depression, which are far away from the rivers.

So here we are presented with the overlap of two major environmental features crucial for the development of settlements. They are the distance from the rivers and the natural suitability of land for cultivation. Throughout the historical period under review, there is a clear gradual decline in the importance of the first of these factors.

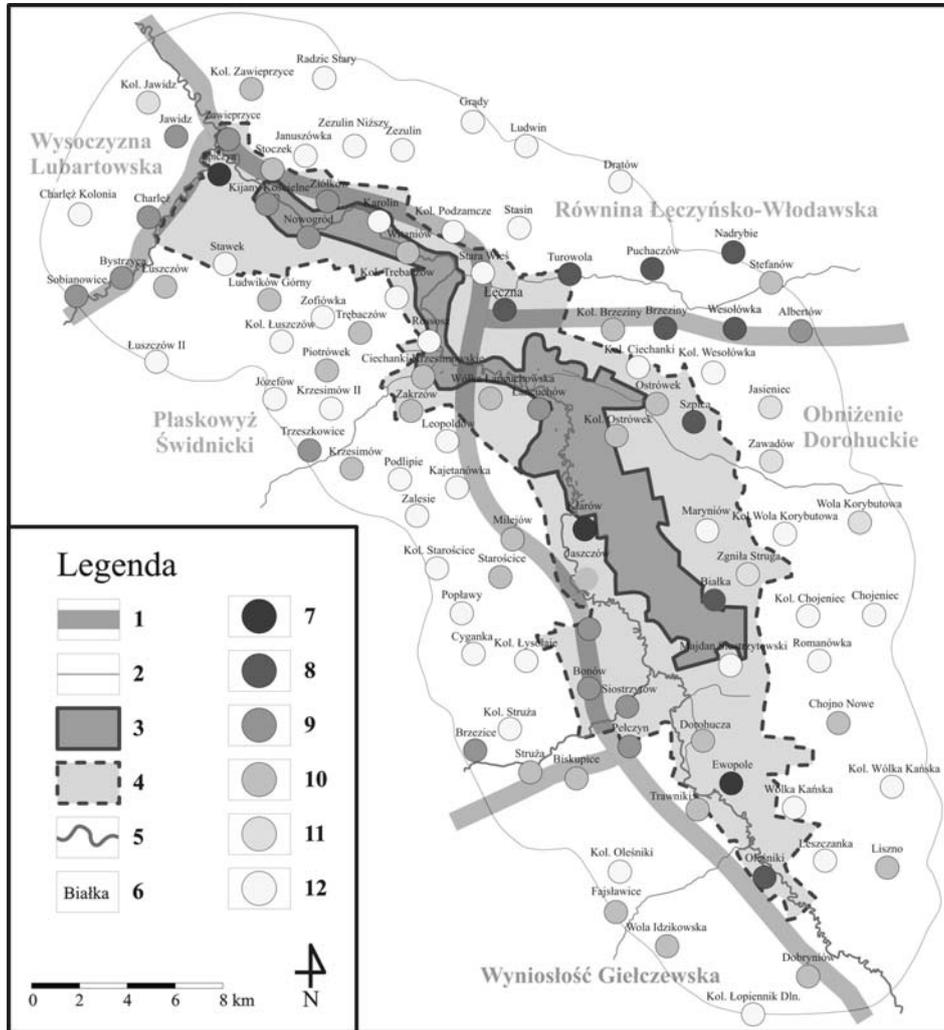


Fig. 1. The development of settlements in historical times in the region of Nadwieprzański Landscape Park on the background of physiographic division [acc. to Kondracki 2002]: 1 – the boundaries of physiographic units; 2 – the boundary of the area under review – the radius of 5 km from the Park’s buffer zone, 3 – the boundary of NLP, 4 – the boundary of NLP buffer zone, 5 – the network of rivers, 6 – the names of villages. Periods of village settlements: 7 – until the Xth c., 8 – XIth–XIIth c., 9 – XIIIth–XIVth c., 10 – XVth–XVIth c., 11 – XVIIth–XVIIIth c., 12 – XIXth–XXth c.

### Analysis of the relationship between water conditions, terrain relief and the location of buildings from 1936 to 2004

To clarify the issue of natural conditions of the settlement, within the studied area the detailed analyses were carried out of the impact of selected components of the environment on the distribution of residential housing. In the first place, the key environmental feature for the settlements was considered, namely the terrain relief [Leszczycki 1932, Ciołek 1952, Soszyński *et al.* 2006, Wiśniewska 2007]. It was analyzed jointly with the water conditions. The analyses were performed for the years: 1936, 1985 and 2004.

In the Nadwieprzański Landscape Park and its buffer zone there are a considerable variety of relief forms, at the same time characterized by different water conditions. It is possible to distinguish three main groups of forms there. The first is the bottoms of river valleys constituting the fill terraces (28.1% of the park and buffer zone) and the strath terraces (1.8% of the area) as well as the extensive peat swamp areas of varied degree of wetness (10.9% of the area). The second group is the slope forms divided in this paper into steep slopes (3.04% of the area) and gentle slopes (3.06% of the area).

They usually represent a relatively narrow strip of land between the bottoms of valleys and hilltop areas. Often these are dry areas, creating the conditions for the development of xerothermic vegetation. The third group is the accumulation plains (5.9% of the area). And, the dominant in the Park and buffer zone, hilltop areas (47.2%). Both the accumulation plains and hilltops are located away from rivers. Typically, wetlands do not occur within these areas.

Given the density of buildings for particular forms of terrain relief in the three analyzed periods (years: 1936, 1985 and 2004), in each case the highest density of buildings in the area occurred on the steep slopes, gentle slopes, and then alternatively: the accumulation plain, corrugated and flat hilltop.

Table 1. Changes in the number and density of buildings in various forms of terrain relief in selected years

The form of relief	Area	N 1936	Bd 1936	N 1985	Bd 1985	N 2004	Bd 2004
Flat hilltop	2722.5	190	<b>0.07</b>	214	<b>0.08</b>	683	<b>0.25</b>
Corrugated hilltop	6082.5	385	<b>0.06</b>	532	<b>0.09</b>	1323	<b>0.22</b>
Fill terrace	5236.7	175	<b>0.03</b>	140	<b>0.03</b>	328	<b>0.06</b>
Strath terrace	329.8	4	<b>0.01</b>	0	<b>0</b>	4	<b>0.01</b>
Steep slope	567.3	49	<b>0.09</b>	80	<b>0.14</b>	122	<b>0.21</b>
Gentle slope	571.9	54	<b>0.09</b>	81	<b>0.14</b>	186	<b>0.32</b>
Accumulation plain	1100	95	<b>0.09</b>	81	<b>0.07</b>	209	<b>0.20</b>
Peat area	2029.3	87	<b>0.04</b>	42	<b>0.02</b>	69	<b>0.03</b>

Bd – density of buildings within a particular type of relief, house/ha,  
 N – number of buildings (homes/farms) within a given type of relief,  
 Area – surface of area occupied by a given type of relief, ha.

The lowest density can be observed on the fill and strath terraces as well as between the boundaries of peat areas. It should be noted that in 2004 the number of buildings within the various forms of relief was almost twice as high in relation to the previous periods analyzed, and often even three times higher, compared with the year 1936, in the case of hilltops and gentle slopes (Tab. 1).

In 1936, the average density of buildings amounted to 0.06 houses/ha. The highest density (0.9 houses/ha) occurred within the three types of forms: steep slopes, gentle slopes and accumulation plains. The lowest density of buildings in this period was observed for fill and strath terraces as well as for peat areas. It should be noted, however, that the absolute number of buildings in the fill terraces areas during this period was very high and amounted to 17% of all the residential buildings in this area. The high density of buildings within the slope forms and especially on the steep slopes can be explained by the previously-mentioned trend of settlements localization near a river.

Due to the threat of flooding, the valley slopes are thus the most convenient (the nearest safe) place to build a farm. The slopes of valleys, located between the meadow areas in the valley bottoms and areas of arable land on the hilltop, are also an ideal location for farms, since this location allows for an easy handling of fields belonging to the farm, while allocating the least useful for cultivation part of the land for buildings.

In the next period, namely in 1985, the average density of buildings amounted to 0.07 houses/ha, and so there was a slight increase relatively to 1936. Compared to the previous period, the increase in building density was observed on steep and gentle slopes – until about 0.05 houses/ha. In these areas the density was also the highest. The average increase by 0.02 houses/ha was recorded on the corrugated and flat hilltops. On the other analyzed terrain relief forms the density of buildings decreased.

In the last period considered (2004) the average density of buildings was 0.16 houses/ha, i.e. by about 0.09 more than in 1985 and by 0.10 relatively to 1936. The greatest density of buildings was reported, as in the previous periods, on gentle slopes (an increase by 0.18 houses/ha in comparison with 1985 and by 0.23 in comparison with 1936).

A significant increase can be observed on both hilltops, where the density was the highest, just after a gentle slope. On the flat hilltop, the density increased by 0.17 houses/ha, and on the corrugated hilltop by 0.13 relatively to 1985 and by 0.16 relatively to 1936).

The upward trend was also found out on the accumulation plain and, to a lesser extent, on a steep slope. Within other forms of relief, i.e. fill and strath terraces as well as peat areas, no clear trends were observed.

In the analyzed period from the 30s of the twentieth century to the first decade of the twenty-first century, we can observe first of all a clear decline in the significance of rivers for the development of the spatial structure of settlements. Therefore, there was no significant increase in the building intensity in the immediate vicinity of rivers (the bottoms of valleys). However, there was

a definite increase in the share of buildings localized away from rivers, on hilltop areas. The analysis of cartographic materials has clearly demonstrated that this was determined primarily by the growing role of roads – usually placed within the hilltop areas. Important role in this increase, played property conditions changes (parcelling out the landowners property) or technical progress (facilitations in a well digging). In recent years the increasingly more important is the fact that most newly emerging buildings are of non-agricultural character. Therefore the position near grassland and arable land is losing importance – and the vicinity of roads is getting more significant.

The continuing, after all, significant proportion of all buildings placement on the fluvial terraces can be explained by the growing importance of landscape in choosing residential location. The Nadwieprzański Landscape Park is one of the most attractive scenic areas in the vicinity of Lublin and it has become an area of increasing settlement of city inhabitants. On the other hand, the localization of building on fluvial areas is often the result of the randomness of investment process associated with the causes of economic and ownership nature.

#### **Relation between farming suitability of soils and location of settlements**

The next element of environment often indicated as a crucial one for the shape of settlements are soils [Leszczycki 1932, Róžański 1979, Wiśniewska 2007]. The importance of soil quality for settlement development in general is presented in one of previous chapters of the article. Location of residential buildings in connection with farming suitability complexes of soils has been analyzed in order to determine importance of this influence in a local scale. Analyses, as is the case of relief and water, were conducted for the area of the Park and its buffer zone in three periods: in 1936, 1985 and 2004.

There is typical for Poland mosaic of types of soils, and therefore its farming suitability in the area of the research. The biggest soil complex in the area of the Park is wheat complex – very good and good one (27.9% of the area), which is the most favorable for agriculture. There are medium grasslands in the valley of Wieprz and its inflows, as well as weak and very weak ones to a lesser degree (they take 26.03% of a total area). A smaller area is dominated by very good rye complexes (6.2% of the area) and good rye complexes (7.7% of the area), situated in the northern and east-central part of the Park. The eastern part of the buffer zone is covered by weak rye complexes (6.8%) and very weak rye complexes (4.9%). A small part is covered by grain-fodder complex (4.6% of the area) situated in the central and southern part of the area. Forest lands, for which farming suitability has not been defined are 15% of the described area. They are situated mainly in its central and southern parts.

Taking into consideration the density of buildings as regards farming suitability complexes of soils, the greatest density in 1936 was within the following complexes: good wheat complex, weak rye complex, and very weak rye complex.

In the area of other farming suitability complexes the density of buildings was smaller, however the differences were not significant.

Similar, equal values were observed in 1985. Minor decrease was observed only regarding medium grasslands. Concentration of buildings increased in very good and good wheat complex.

In the last period that has been analyzed, in the year 2004, a significant increase of a density of buildings was observed within all complexes. That concerns the most: good and very good rye complexes, weak grain-fodder complex as well as good wheat complex. As in the case of previous periods differences among certain complexes were not significant. However, a kind of regularity is the fact that smaller values were recorded within the lowest farming suitability complexes.

Table 2. Changes in the number and density of buildings within certain farming suitability complexes of soils in chosen years

Complex of soils	Area	No. 1936	Db 1936	No. 1985	Db 1985	No. 2004	Db 2004
Forest	2956.8	58	<b>0.02</b>	45	<b>0.01</b>	58	<b>0.02</b>
Very good wheat complex	1767.9	113	<b>0.06</b>	142	<b>0.08</b>	327	<b>0.18</b>
Good wheat complex	3428.8	231	<b>0.07</b>	281	<b>0.08</b>	682	<b>0.20</b>
Medium grasslands	3500.9	252	<b>0.07</b>	230	<b>0.06</b>	538	<b>0.15</b>
Weak and very weak grasslands	1347.8	85	<b>0.06</b>	83	<b>0.06</b>	181	<b>0.13</b>
Very good rye complex	1154.6	55	<b>0.05</b>	77	<b>0.06</b>	263	<b>0.23</b>
Good rye complex	1439	86	<b>0.06</b>	87	<b>0.06</b>	361	<b>0.25</b>
Weak rye complex	1260.6	98	<b>0.07</b>	100	<b>0.08</b>	265	<b>0.21</b>
Very weak rye complex	915.8	68	<b>0.07</b>	74	<b>0.08</b>	152	<b>0.17</b>
Grain-fodder complex	867.8	51	<b>0.06</b>	51	<b>0.06</b>	90	<b>0.11</b>

Db – density of buildings within certain complex of soils, house/ha,

No. – number of buildings (houses/farms) within certain complex of soils

Area – area covered by certain complex of soils, ha.

In general, in case of farming suitability complexes of soils, on the basis of conducted analyses, it is difficult to talk about clear tendencies regarding preferences for placing residential buildings because of specific complexes of soil. Decrease in density of buildings in the area of grassland should be associated with the decrease of the importance of rivers in localization of colonization, that has already been mentioned. Increase of density of buildings mainly within higher farming suitability should be associated with previously mentioned development of building complexes on top parts of the upland, that is a result of increase of importance of roads in location of settlements. An important fact regarding the discussed territory is that the area covered by farmyards connected with farming has been decreasing lately. On the other hand, the number of residential and summer buildings is increasing. This results in usage of good soils for settlements build up. From economic point of view this residential function is more beneficial than agricultural one.

**Indications regarding settlements location on the basis of spatial diversity of natural conditions**

Described relation between settlement development and natural conditions has indicated a number of rules that follow from importance of chosen features of environment for location of settlements. These days, natural factors often lose their importance for economic factors or communication facilities. A great part of settlement, especially these days (but also in previous periods) is developed against rules of rational natural conditions usage. An example might be investing into so called threshold areas [Kozłowski 1990], which are flooded areas, steep slopes or boggy areas. Concerning arable farming, development of settlement on the most fertile soils that causes their loss for agriculture is also concerned as irrational. Advantages of settlement for certain elements of environment have been indicated and presented in the map in order to indicate areas in which development of settlement would be rational because of natural conditions. Areas, in which advantages cover each other has been identified as the most favorable regarding natural conditions for settlement development.

Concerning relief and water conditions, the most favorable areas for development of settlement are: flat and undulating top parts of the upland, gentle slope, alluvial plain. These areas meet conditions conducive to human settlement, which are: inclination of the area, humidity of the ground or flood hazard.

Concerning soil conditions the following areas have been identified as favorable for settlement: very good, good, weak and very weak rye complex, grain-fodder complex as well as medium, weak and very weak grasslands. These are all complexes that can be found in the analyzed area, with the exception of good and very good wheat complexes that are the most favorable for agriculture.

Overlapping one another of two mentioned elements let us present areas that are the most favorable for development of settlement regarding discussed environmental conditions (Fig. 2). The greatest area of overlapping elements is in the territory of the buffer zone of the Landscape Park, in its northern and western parts. It is worth mentioning that these are areas that are under the greatest investment pressure. The smallest area with favorable natural conditions for development of settlement is the one in the eastern part of the buffer zone.

However, they are equally situated in the whole territory, that is the basis for equal, rational development of settlement with respect to natural conditions.

What is especially valuable is the fact that areas with optimum conditions for development of settlement are at the same time external areas of the Landscape Park. Therefore, their development follows rules of environmental protection in protected areas. According to these rules development of settlement should take place mainly beyond protected areas, to a lesser degree – in the area of the buffer zone, and should be limited to minimum within the borders of the Park. On the other hand, it is of crucial importance to maintain using soils in the Park for farming, with respect to rules of protection of environment and landscape.

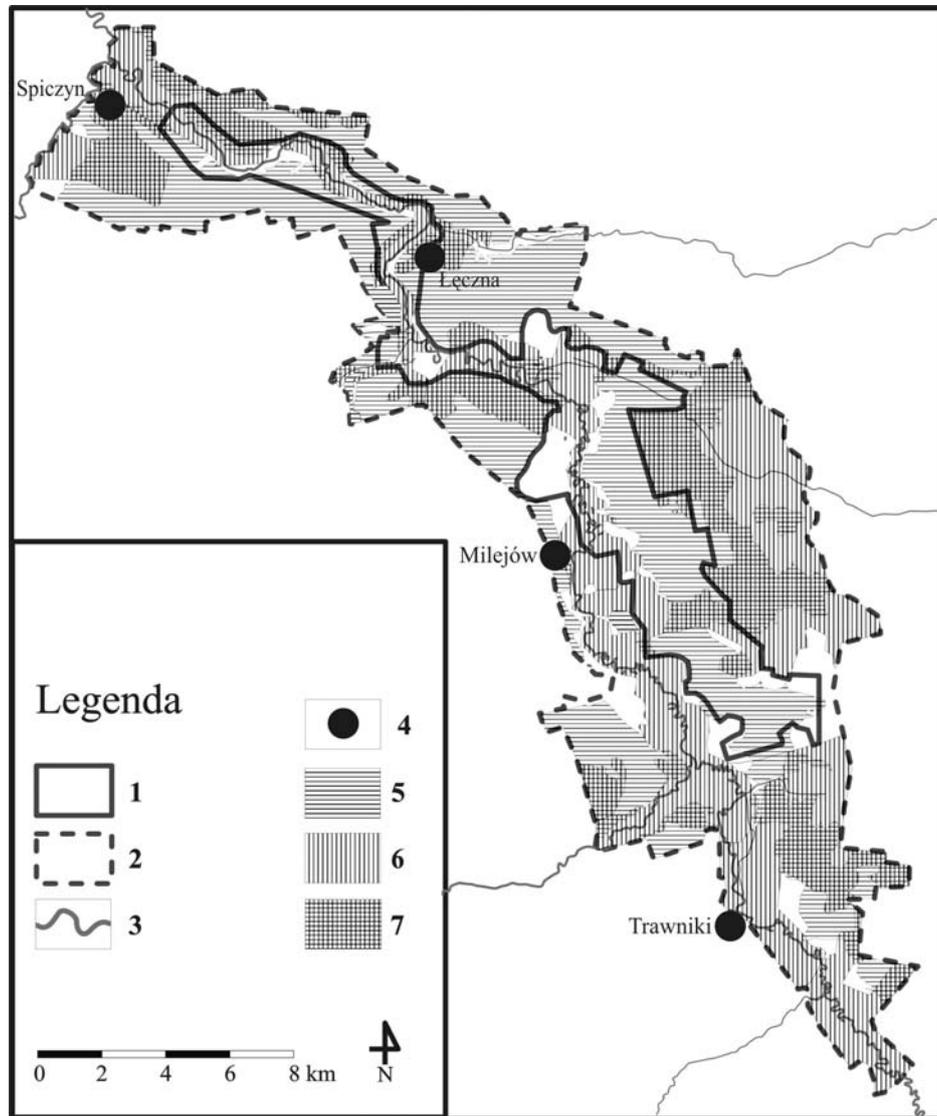


Fig. 2. Map of areas of the most favorable natural conditions regarding settlement build up: 1 – the boundary of NLP, 2 – the boundary of NLP buffer zone, 3 – the network of rivers, 4 – the names of main villages, 5 – the most favorable areas for development of settlement regarding relief and water conditions, 6 – the most favorable areas for development of settlement regarding soil conditions, 7 – the most favorable areas for development of settlement regarding environmental conditions

Rules of proper location of settlements should be followed in further development of analyzed area because of protection demands that until now have not been followed to expected level. The first of them is limitation of settlement spreading, that is very often on farming areas of plateaus. That refers to areas with high farming suitability of soils. What is very important because of natural

conditions is prohibition of further development of settlements in flooded areas. From the perspective of natural and landscape features it is recommended to limit development of new settlements within river valleys, including edging spheres of the valleys. The exception might be only thickening of country settlements.

## CONCLUSIONS

Analyzed area of the Landscape Park with its buffer zone is the area with a big diversity of natural conditions. Settlements have been developed in here in connection to this diversity since the most distant times. The main indicated factors that have decided about location of settlements through the last century are structure of the network of rivers and soils' quality. The importance of rivers has decreased with time while importance of outside natural factors, mainly network of roads, has increased.

While analyzing structure of residential settlements in details, it is difficult to indicate the most important factors that decide about location. Certainly, relief and water conditions are of greater importance (boggy and flooded areas) but only in the areas where conditions are extremely unfavorable for settlements. In principle, location of settlements in the country depends on several factors that determine diversity of farming usage of soils. Influence of natural conditions on settlement is often indirect through dependence of specific types of cultivations (meadows, pastures, arable soils) on soils' quality and ground slope.

The importance of analyzed natural factors for the structure of settlements has decreased in the period that has been analyzed. However, they still have got a significant influence on the structure of settlements. What has changed are the reasons for preferring some features and discriminating other ones. Areas marked in the article that favorable for settlements because of natural conditions may still be an important source of information, that together with social-economic conditions should be the basis for rational spatial in the area of the Park and its buffer zone.

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#### PRZYRODNICZE UWARUNKOWANIA ROZWOJU OSADNICTWA W REJONIE NADWIEPRZAŃSKIEGO PARKU KRAJOBRAZOWEGO (POLSKA PŁD.-WSCH.)

**Streszczenie.** W publikacji przedstawiono zależności pomiędzy przestrzenną strukturą osadnictwa a przyrodniczymi uwarunkowaniami jego powstania w rejonie Nadwieprzańskiego Parku Krajobrazowego. W części pierwszej scharakteryzowano zależności pomiędzy tymi dwoma elementami w skali ogólnej – wpływ różnych komponentów środowiska naturalnego na lokalizację poszczególnych miejscowości. Przeprowadzone na tym etapie analizy wykazały przede wszystkim znaczącą rolę układu sieci rzecznej, a także rozmieszczenia żyznych gleb dla kształtowania osadnictwa.

W części drugiej przeanalizowano podobne zależności w skali szczegółowej, a więc dla poszczególnych budynków mieszkalnych. Wyniki przedstawiono oddzielnie dla trzech okresów (lata: 1936, 1985, 2004), ukazując w ten sposób tendencje w rozwoju zabudowy i zmiany znaczenia poszczególnych elementów środowiska naturalnego dla jej rozmieszczenia. W tym wypadku zależności były mniej wyraźne i związane z łącznym oddziaływaniem kilku czynników. We wszystkich przypadkach stwierdzono jednak w badanym okresie spadek znaczenia czynników naturalnych.

Wykazanie roli badanych komponentów środowiska pozwoliło na określenie optymalnych dla rozwoju osadnictwa cech każdego z tych komponentów. Na tej podstawie wydzielono obszary o warunkach naturalnych korzystnych dla racjonalnego rozwoju zabudowy mieszkaniowej.

**Słowa kluczowe:** przyrodnicze uwarunkowania osadnictwa, Nadwieprzański Park Krajobrazowy, krajobraz wiejski, planowanie przestrzenne