

# ECOLOGICAL ASSESSMENT OF THE URBAN LANDSCAPES OF MOGILEV CITY. PARTICULARITIES OF THEIR FORMING AND ANTHROPOGENIC TRANSFORMATION

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## **Abstract**

This paper focuses on the investigation undertaken in Mogilev – the biggest industrial and transport centre of Belarus. Critical anthropogenic transformation and contamination of given urban territory makes actual its research for working out a set of effective measures to optimize its using and remediation. Landscape subdivision of Mogilev, further mapping of its urban landscapes in rank of Land Type as well as the analysis of their current and former using and peculiarities of historical transformation has been made to solve the problem. The results were associated with ecological assessment of the urban landscapes of Mogilev, which had been carried out on the next stage of current investigation. 48 landscapes in rank of Land Type have been distinguished and thoroughly described as a result of undertaken research. The level of its anthropogenic transformation and environmental contamination is determined by their location in different historical-urban-planning zones as well as by modern anthropogenic load. Alterations in relief, natural vegetation and contents of heavy metals in the soils (geomorphologic, geobotanical and geochemical signs) have been investigated to work out the criterion of ecological assessment of intensity of anthropogenic transformation and pollution of Mogilev. According to above signs 4 gradations of transformation of the urban landscapes have been proposed (slightly transformed areas; transformed; with dangerous transformation; with critical transformation). At the end of the research the grouping of the urban landscapes of Mogilev in accordance with the results of ecological assessment and the map of their modern ecological conditions has been done.

## **Introduction**

City as the object of investigation has always been interesting issue for the representatives of many specialties: town builders, planners, architects, historians, environmentalists and so on. It has a particular interest from the point of view of its researching as a complex phenomenon because this makes possible to create the integrated assessment of the state of the urban environment, to analyze its spatial and historical transformation, to find specific features of interaction between inhabitants of the city and urban environment. This investigation is devoted to the questions of researching of the urban environment; it focuses on the problems of distinguishing and exploring of the urban landscapes. The territory of Mogilev – the biggest industrial and transport centre of Belarus is taken as the example of the city where particularities of forming and further historical transformation of the urban landscapes are regarded as well as where the complex geoeological assessment of their modern state is given.

## **Methods**

48 natural landscapes in rank of Land Type have been distinguished on the territory of Mogilev (table 1). Particularities of the forms of mesorelief with taking into account its genesis, morphological type and location in the system of the local drainage have been taken as the main classification signs of distinguishing of the Land Types i.e. relief of the territory

has been taken into account in close connection to the natural drainage and sum of precipitations. Another important sign – soil forming structures has been used on the next stage of current investigation. Thus, combination of all above factors of forming of the Land Types (forms of relief, soil forming structures, precipitations) determines distribution of the soils and vegetation associations on this territory. Therefore soils and vegetation layer have served as vitally important indication signs for distinguishing of the Land Types not being determinative criteria for its classification, at the same time.

index	natural landscape (in rank of Land Type)	%, from the total squire of the city
1-1	low crest-like flood lands	2,7
1-2	flat-wavy low flood lands	2,9
1-3	high flood lands	0,8
1-4	flat-hilly terrace	1,5
1-5	flat-wavy terrace	13,8
1-6	relict terrace	4,6
1-7	slopes of the river Dniper	1,1
2-1	small rivers valleys	7,6
2-2	gullies and hollows	0,8
2-3	melting glacier waters former channels	3,8
3-1	secondary fluvial-glacial plain	10,7
3-2	loess plato-like plain	3,6
3-3	hilly slightly and flat wavy secondary moraine plain	16,2
3-4	wavy secondary moraine plain	23,4
3-5	hilly-wavy secondary moraine plain	6,5

Table 1. Land Types of the territory of Mogilev

Objective ecological assessment of the urban landscapes is possible when the following stages of the research are successively committed:

- Working out of criteria and assessment of intensity of anthropogenic transformation of the territory;
- Comparing of the data received to the contours of distinguished urban landscapes;
- Assessment of stability of the landscapes to anthropogenic impacts;
- Definition of the level of transformation of the urban landscapes;
- Analysis of the data of transformation and stability of the urban landscapes.

Alterations in relief, natural vegetation and contents of heavy metals in the soils (geomorphologic, geobotanical and geochemical criteria) have been explored to work out the criteria for assessment of intensity of anthropogenic transformation of the territory. Data of the level of urban-planning assimilation of the landscapes (urban-planning criterion) have been used as an additional criterion. It took into account the main character and time of urban-planning transformation of the urban territory.

Data of intensity of removed soils have been used to investigate the level of transformation of relief. They were based on the materials of description of the soil holes made by the engineering-geological service of the project institute "Mogilevgrazhdanproject". Its network is sufficient to cover almost the whole territory of the city that made possible to conduct further interpolation of the results.

Coefficients of concentration ( $K_c$ ) of heavy metals in the soils have been taken as the main signs of transformation of geochemical environment. Coefficients of dispersion ( $K_c$  and  $Z_c$ ) of heavy metals in the snow layer and bottom sediments of the local hydrographical network have been regarded as additional. These data were kindly provided by the laboratory of lake studies of the Belarusian State University, Mogilev center of hygiene and epidemiology, and

laboratory of ecological monitoring of Mogilev inspection of the natural resources and environmental protection.

Geobotanical map of the natural vegetation of the landscapes of Mogilev made in accordance with classification (1) has been used to compose a scheme of prevailed urban phytocoenosis. Further analyzing of the degree of their anthropogenisation made possible to define the level of transformation of the natural vegetation.

The concept proposed by M. Conzen has been used to find the level of transformation of the urban environment (2). According to this concept a new urban-planning form is created as a result of a definite historical period of urban-planning assimilation of the urban environment. This form possesses not only a typical architectural features and functional load but also and specific natural complex: new microforms of relief are appearing, new geochemical situation and new phytocoenosis are forming). In the process of further evolution of the territory (that is occupied by another urban-planning form) it obtains new architectural and natural features. Simultaneously, as a matter of time certain components and elements of the environment are altered insignificantly (litogenic basis, relief, wooden vegetation) and others are completely and repeatedly changed (grass phytocoenosis) under the influence of the natural and anthropogenic processes direct and indirect.

Analysis of the quantitative and qualitative characteristics of separate components of each ecosystem made possible to carry out the system of assessment of the urban landscapes which includes the definitions "slightly transformed", "average transformation", and "considerably transformed" (table 2). In addition, analysis of contemporary conditions of the Land Types of the city from the point of view of their historical age and built-up character has been made to assess the level and historical peculiarities of urban-planning transformation of the environment of Mogilev. Conclusions about the level of urban-planning transformation of the Land Types including definitions "slightly transformed", "average transformation", and "considerably transformed" have been made in accordance with the character of building-up of the landscapes, percentage of the territory under certain kind of built-up and time scopes of different kinds of anthropogenic transformation (table 3).

## Results

48 natural landscapes in rank of Land Type have been distinguished on the territory of Mogilev. They were analyzed and described in order to define the level of their anthropogenic transformation. Thorough analysis of all indicators in accordance with the results received on the previous stage of current investigation made possible to obtain integral assessment of anthropogenic transformation of the territory of Mogilev and compose

Criteria	Considerably transformed	Average transformation	Slightly transformed
1. Geomorphologic (intensity of the removed soils, m)	>5	0,5-5	0-0,5
2. Geochemical ( $K_c$ of heavy metals)	>8	4-8	<4
3. Geobotanical (urbophytocoenosis)	Artificial and spontaneously appeared vegetation	Spontaneously appeared and considerably transformed natural vegetation	Natural and semi natural spontaneously appeared vegetation

Table 2. Criteria of assessment of anthropogenic transformation of the urban landscapes (geomorphologic, geobotanical and geochemical criteria).

Name	Character of built-up	% from the square of the complex	Time of beginning of assimilation	Transformation level
1	2	3	4	5
Low flood lands (1-1)	Individual one-floor stone and wooden, with kitchen gardens and orchards	about 10%	40-60s years of the 20th century	Slightly transformed
Slopes of the valley of the river Dniper (1-7)	Individual one-floor stone and wooden, with kitchen gardens and orchards; modern cottage built-up	more than 10%	since 60s years of the 20th century	Average transformation
Relict terrace (1-6)	Individual one-floor stone and wooden, with kitchen gardens and orchards	more than 40%	20-70s years of the 20th century	Considerably transformed
	Multi-stored block of flats	less than 5%	50-80s years of the 20th century	

Table 3. Criteria of assessment of the urban-planning transformation of the urban landscapes (urban-planning criterion) (example).

a map of assessment of anthropogenic transformation of the urban landscapes of Mogilev. Its analysis provided us with the following results. In accordance with the received values of the coefficient  $K_t$  the following gradations of transformation of the urban landscapes have been found:

- $K_t \leq 1,0$  – slightly transformed;
- $K_t = 1,0 - 2,5$  – transformed;
- $K_t = 2,5 - 4,0$  – with dangerous transformation;
- $K_t \geq 4,0$  – with critical transformation.

Classification of the Land Types of Mogilev has been done with application of given criteria. Comparing of the main characteristics of transformation of the basic elements of ecosystems to the landscape situation and their factual state (according to the materials of the field trips) makes possible to classify the territory of the city in accordance with the level of its transformation.

1. **Slightly transformed urban landscapes:** low crest-like flood lands ( $K_t=0,1$ ), flat-wavy low flood lands ( $K_t=0,2-0,3$ ), high flood lands ( $K_t=0,3-0,5$ ).
2. **Transformed urban landscapes:** flat-hilly terrace ( $K_t=0,9-1,3$ ), relict terrace ( $K_t=0,8-1,2$ ), slopes of the river Dniper ( $K_t=1,0-1,4$ ), small rivers valleys ( $K_t=1,0-2,0$ ), gullies and hollows ( $K_t=1,1$ ).
3. **Urban landscapes with dangerous level of transformation:** melting glacier waters former channels ( $K_t=2,5-3,0$ ), secondary fluvial-glacial plain ( $K_t=2,6-3,6$ ), flat-wavy terrace ( $K_t=2,8-4,0$ ), wavy secondary moraine plain ( $K_t=3,0-3,8$ ), loess plato-like plain ( $K_t=3,2-3,6$ ), hilly-wavy secondary moraine plain ( $K_t=1,8-2,8$ ).
4. **Urban landscapes with critical transformation:** hilly slightly and flat wavy secondary moraine plain ( $K_t=4,2 - 4,3$ ).

### Discussion and conclusions

Assessment of anthropogenic transformation of the urban landscapes of Mogilev gave us a

chance to make the following conclusions:

- Urban landscapes of hilly slightly and flat wavy secondary moraine plain have undergone the most considerable transformation. They occupy about 15% of the territory of the city and are characterized by a critical level of transformation and significant alteration all without any exception components of the natural complex;
- Urban landscapes of high and low flood lands of the river Dniپر are the less transformed in Mogilev. It could be explained its relatively far location from the historical center of the city. They occupy about 7% of the territory of Mogilev and are characterized by comparatively insignificant transformation;
- Transformed urban landscapes (flat-hilly terrace, relict terrace, slopes of the river Dniپر, small rivers valleys, gullies and hollows) occupy more than 15% of the territory of the city. Specific forms of relief unfavorable for rapid anthropogenic transformation and location on periphery of the urban territory are typical for them. Due to these reasons assimilation of given urban landscapes is being done in the last queue;
- Urban landscapes with dangerous transformation is the biggest group among all the rest urban landscapes. They occupy more than 50% of the whole square of Mogilev. These urban landscapes are undergoing rapid and intensive anthropogenic transformation of all the natural components that may lead to their transition to the state of the urban landscapes with critical transformation in the future.
- Urban landscapes of the northern part of the city are the most transformed. It is connected with the particularities of historical evolution of the territory of Mogilev.

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### **References**

1. А.А. Ниценко. Сады и парки как объект геоботанического исследования. Вестник Ленинградского университета. - сер. Биологич. . - №15. С. 54-62. (1969).
- 2 M.P. Conzen. The study of urban form in the United States. Urban Morphology. **Vol. 5**. PP. 3-14. (2001).