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ECOLOGICAL CONDITION OF POST-INDUSTRIAL TOWNS OF UKRAINE BASED ON THE CASE STUDY OF DROHOBYCH TOWN

Terletska Oksana e - mail: Oksanater1989@gmail.com

https://orcid.org/0000-0003-3795-8653

Lvov National University by Ivan Franko

Key words: ecological condition in cities, post-industrial period, problematic ecological situations.

Summary. The current state of most of former powerful industrial cities and towns of Ukraine is characterized by industrial decline; therefore, their ecological condition was expected to improve. Drohobych is a striking example of such a town. The notion “post-industrial” used in the research work, on the one hand, designates the phase after the industrial phase (the one that lasted before the industrial crisis), and on the other hand, it is used to denote the phenomenon of industrial reduction, i.e. significant decrease of industrial potential.

The aim and objectives of the research article were dedicated to the study of current ecological state of Drohobych urban environment based on certain research material, as well as detection of the most ecologically threatening season conditions.

Based on the elaborated large-scale map of urban landscapes of Drohobych and with the help of the original author’s experimental material, there has been represented the current ecological state of natural components (surface and municipal, soils, atmosphere) within the

territory of the town of Drohobych. It has been determined that each of the aforementioned components of the urban environment is associated with chemical compounds exceeding maximum allowable concentrations. Moreover, the most threatening values in terms of bacteriological quality are related to the quality of surface and municipal waters. The most hazardous situation occurs during spring period since due to worn-out condition of the pipelines, snowmelt waters leak in municipal water supply network. The same situation can be observed in water from open wells, which is used by the population for drinking. During the research process, there have been analysed disturbing ecological situations, some of which could be characterized as critical. The research works prove the popular idea that ecological condition of Ukrainian post-industrial cities and towns significantly improved after the cessation of many large enterprises to be wrong.

Introduction. The existing crisis of industrial cities and towns within the territory of Ukraine at the close of the 20^{th} and at the beginning of the 21^{st} centuries fundamentally changed both their industrial structure and their ecological condition. Notwithstanding the fact that drastic decrease of industrial emissions should have improved environmental conditions, simultaneous drastic cancellation of funding of environmentally-friendly measures, combined with ageing of equipment at still functioning enterprises and city supply lines could result in significant deterioration of ecological situation in the cities and towns.

The notion “post-industrial” used in the research work, on the one hand, designates the phase after the industrial phase (the one that lasted before the industrial crisis), and on the other hand, it is used to denote the phenomenon of industrial reduction, i.e. significant decrease of industrial potential.

Each ecological condition of urban system is maintained by certain mechanisms of regulation, correction, and control. By such mechanisms, we mean a certain complex of logical connections and procedures determining the occurrence of changes in certain developing (evolving) systems (Khoroshavyna, 2005). In terms of urban ecosystems, these logical connections are usually regulated by society, while at the same time, they are as well corrected by the remains of their natural basis, which can in a certain way influence public

decisions (i.e. the ability of their implementation) due to the specificities of lithogenous basis, water regime, along with the geophysical regime of the city atmospheric constituent.

The objective of the research. Bases on specific research materials, to represent the current ecological condition of the town of Drohobych with the clearly represented industrial structure. Based on this case study, to distinguish common ecological issues immanent to alike cities and towns of Ukraine.

Materials and methods applied. The article is based on the author's own research findings related to ecological characteristics of the main system-shaping components, library materials of municipal enterprise "Drohobychvodokanal" ("Drohobych water channel"), and reference sources. Among the main research methods, there have been applied cartographic, systemic, field, and laboratory analysis.

Presentation of basic material of the research. Until quite recently, the town of Drohobych has been a unique natural and economic complex ranked second in industry potential among the towns of Lviv region. However, in terms of population and area, it could be characterized as moderately populated, like most of urban settlements of Ukraine.

Until recently, there was situated the largest oil refining complex in Ukraine would process oil supplied from Dolyna oil deposit producing separate oil products. Nowadays, the complex lost its leading status and serves exclusively as a transfer tank farm. Numerous modern industrial cities and towns are in the similar condition.

Currently, the potential of the town's industrial complex is mainly shaped by the following industry branches: mechanical engineering (4-5%), oil refining industry (37%), food industry (7.5%), construction materials (1.2%), light industry (1%), chemical industry (0.7%), printing industry (0.1%).

The multi-sector industry complex consists of 31 industrial state-owned enterprises (without small enterprises), which produce a wide range of industrial products.

Within the town's territory, there is settled an extended network of artificial reservoirs, which increasingly complicated natural water network functioning. The residential constituent represented by multi-level and individual (low-level) housing development is situated unevenly, depending on both natural factors, as well as industrial objects. Moreover, all the complex is interconnected by numerous transport routes.

Consequently, natural landscapes underwent significant transformations and anthropogenic modifications. There was created a certain landscape urban system (Fig. 1).

Currently, Drohobych urban system could be characterized by the following main specificities:

– extension, and, consequently, the seizure of a range of rural residential structures. This is the reason why the areas of individual housing development are increasing within the urban system;

– transition of numerous enterprises from active functioning to decline and even liquidation, and therefore, changes of intensity of anthropogenic pressure on modified landscapes;

– as the result of insufficient funding, significant deterioration of road surfaces, which consequently affects the surrounding urban complex components;

– there can be observed certain loosening of control based on the urban system components (including water constituents), which leads on the one hand to uncontrolled interaction of natural and anthropogenic factors of urban system development, and on the other hand, to increasing influence of natural landscape-regulating factors.

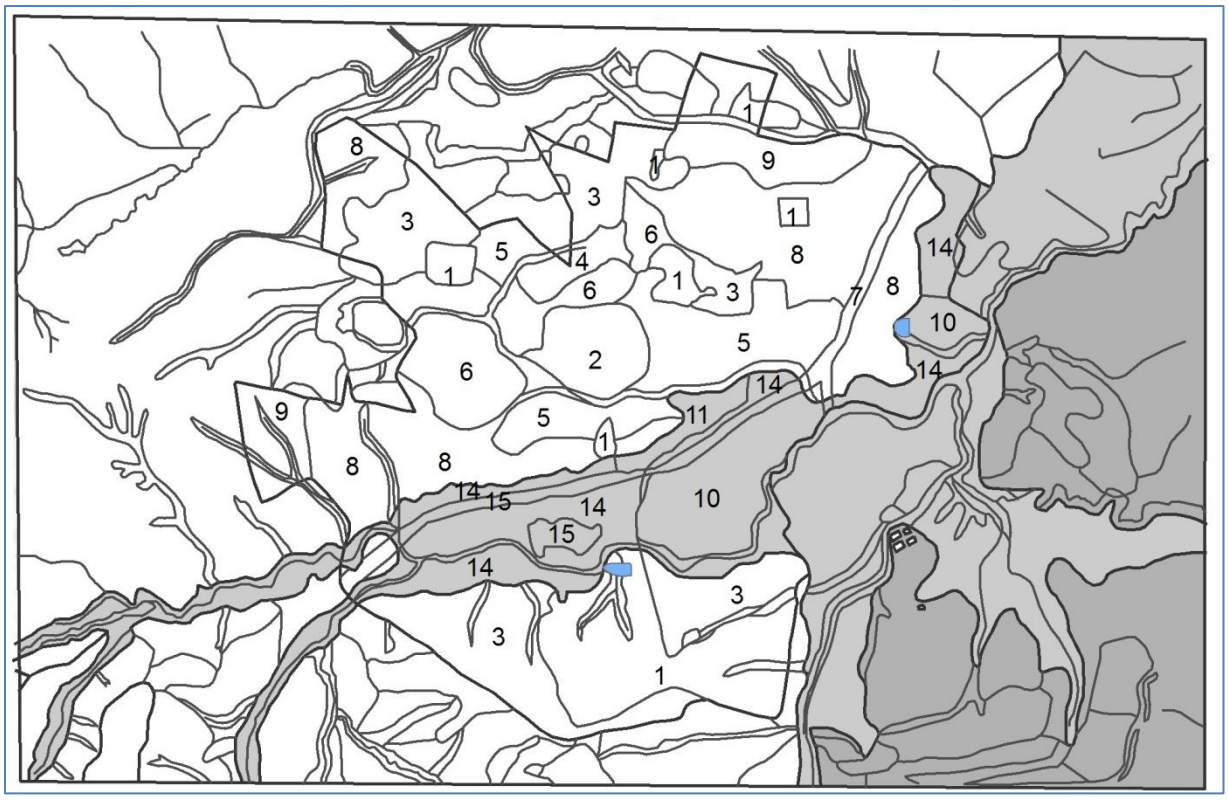

Fig. 1. Landscape structure of Drohobych urban system.

Drohobych landscape.

The area of piedmont ancient terraced (III-V) dissected gently-dipping interfluves.

Natural landmarks: 1. Landscaped areas and recreation spaces located at convex and dipping hills with different exposure; 2. The centre of business, public, educational, cultural, and commercial activities with multi-level development at terraced hills; 3. Housing development at lower terraces above flood-plain with the complex of adjacent allotments; 4. Low-level development at lower areas of dipping hills; 5. Multi-level (up to 9 levels) development at convex hills and even terrace sections; 6. Combined development at higher and median sections of dipping hills, along with the complex of landscaped territories; 7. Transportation network; 8. Industrial objects at lower areas of the dipping hills with erosional forms; 9. The lands for agricultural use at lower watershed area of dipping hills

2. The area of terraced river valleys.

Natural landmarks: 10. Housing development at lower terraces above flood-plain a with the complex of adjacent allotments; 11. Multi-level (up to 9 levels) development at convex hills and even terrace sections; 12. Combined development at higher and median sections of dipping hills, along with the complex of landscaped territories; 13. Transportation network; 14. Industrial objects at lower areas of the dipping hills with erosional forms; 15. Landscaped areas and recreation spaces located at convex and dipping hills with different exposure.

Undoubtedly, urban ecosystems, as well as natural ones, are characterized by certain adaptability to the instability of the environment, along with their inherent structural constituents. Such adaptation mechanism implements the functions associated with instability, continuity, interconnection, and is aimed at preservation of the characteristic features of the existing system, i.e. within the framework of the same territorial entity, ecosystem, enterprise, city. Meanwhile, among the most efficient adaptation mechanisms, there is blocking and restrictive mechanism – it allows separate structures of the urban system territorial organization to differ significantly by organizational quality. Provided one of them acquires higher organizational quality, other strive to acquire the same or similar quality or act towards reduction of the prevailing organizational quality. That is why urban system are highly heterogeneous and have developed internal regulation mechanisms. Meanwhile, the leading function often belongs to the most organized constituent. Basically, such mechanism functions with the help of damping mechanism (compensation mechanism leading to forced system operation for the purposes of reducing of its parameters due to respective increase of environment characteristics (Melnyk, 2006). Usually, the natural constituent of urban systems reduces its own parameters. Whereas, during the period of economic crisis, when many large

enterprises stopped or significantly reduced their production, the reduction of parameters pressing the ecological environment occurs at the expense of industrial sector.

The ecological condition of the city or town is defined by numerous factors, however, the principal indicators include the state of surface and municipal waters, as well as soils and atmosphere.

Following the research findings, river waters within the area of Drohobych have the increased level (exceeding maximum allowable concentration level (MAC) of Natrium+Chlorum, Calcium and Ammonium, however, the moderate exceedance of MAC was observed (up to 9.9 mg/dm^3 – Natrium+Chlorum and 7.35 mg/dm^3 – Ammonium). This indicates that based on chemical composition open waters of Drohobych could be characterized as relatively appropriate.

Ground waters were researched based on the analysis of water samples taken from open wells from different town districts. The analysis of the obtained data represents that along with the overall satisfactory ecological background, in terms of chemical properties, there are certain exceedings of Calcium in ground waters (mainly on the territories with multi-level housing development) and Natrium+Chlorium (at industrial areas).

Exceeding of maximum allowable concentration level of Ammonium in river systems of Drohobych reflects the respective negative pressure on the state of river flora and fauna. Usually, Ammonium leaks in river system from sewage treatment plants and agricultural runoff. Exceeding of MAC of Ammonium causes disruption in connections between plants, animals and microorganisms, therefore, breaking the self-regulation mechanism of river ecosystems.

The residents of Drohobych usually use water from open wells for their domestic purposes. The analysis of such water was conducted in various parts of the town. Practically everywhere there was observed that the presence of Escherichia coli exceeds maximum allowable concentration 80 times.

The analysis of water from open urban water basins (Seret River and municipal ponds) confirms that there are observed deviations from organoleptic parameters (yellowish colour and sediment). The amount of bicarbonates, Ammonium and nitrites critically exceeds the normal values. Moreover, the amount of Escherichia coli exceeds the average value by 80000 times. Meanwhile, in many areas water objects are used for recreational purposes.

The results of the bacteriological study of water conducted at the beginning of summer 2017 were practically catastrophic. The study findings showed that Drohobych waters contained Escherichia coli in the amount exceeding maximum allowable concentration

350000 times, which poses a serious threat for public health. Comparison of the results of bacteriological studies in different seasons showed that the most threatening situation occurs during spring period and at the beginning of summer. In autumn, the situation changes mostly due to the reduction of Escherichia coli in water pumping wells.

In most cases, urban soils usually face constant disturbances, stirring, cutting of the soil profile and introduction of foreign materials. A typical phenomenon is the absence or inversion of genetic horizons at the considerable depth. Profile of urban soils and soil-like substrates combine artificial layers of different capacity and colour.

It should be noted that based on the results of semi-quantitative spectral analysis, urban soil of Drohobych town either do not exceed maximum allowable concentration values or are on the verge of maximum allowable concentration values due to the presence of certain elements. Nevertheless, such soils could be regarded as potentially hazardous from the ecological perspective. The town territory can be traced by Pb, P, Sr.

Concentration of Plumbum (one of the most hazardous heavy metals) within the town area is shown in Fig. 2. Based on the obtained values, it is advisable to divide the town territory into five classes: relatively hazardous concentration (8-10 mg/kg); relatively neutral (5-7 mg/kg); relatively satisfactory (2-4 mg/kg); satisfactory (1-1,5 mg/kg); not detected.

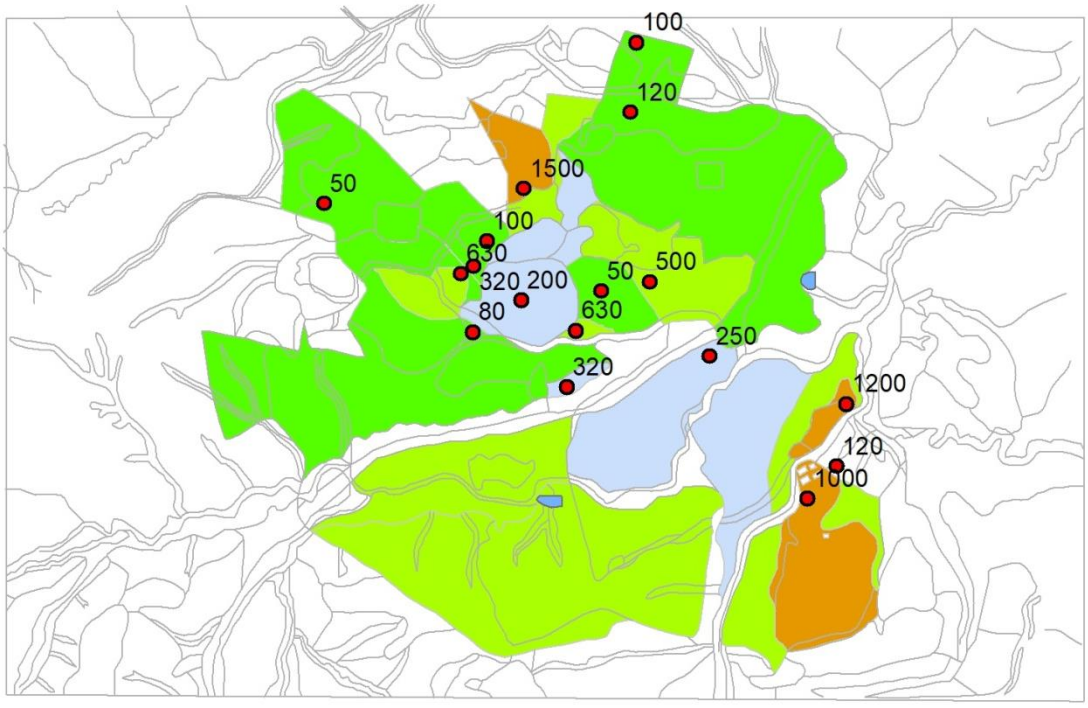

Fig. 2. Distribution of Plumbum within the territory of Drohobych town.

The areas with relatively hazardous and relatively neutral Plumbum concentration in soil are located at the north of Drohobych and constitute a rather localized territory. The adjacent territories from the east, south and southeast have a relatively satisfactory concentration of Plumbum in soil. Most of the town territory is located in the area of satisfactory Plumbum concentration, while at the town outskirts, there were practically no Plumbum in soil detected.

Differentiation of the town territory by Phosphorus concentration level in urban soils shows its spotty distribution (Fig. 3).

There have been distinguished four classes of pollution: relatively hazardous (1000-1500 mg/kg); relatively neutral (500-630 mg/kg); relatively satisfactory (200-320 mg/kg); satisfactory (50-100 mg/kg).

The territories with relatively hazardous Phosphorus concentration occupy a small land area at the north (almost overlaps the area of the highest Plumbum concentration) and at the southeast of the town, within the area of dense industrial development. The territories with relatively neutral Phosphorus concentration in soil are found in spots throughout the entire town area. The territory with relatively satisfactory concentration of Phosphorus is represented as a wide stripe stretching from the northwest to the southeast and covering the entire central area of the town. The area with satisfactory Phosphorus concentration level are mostly located at the town outskirts.

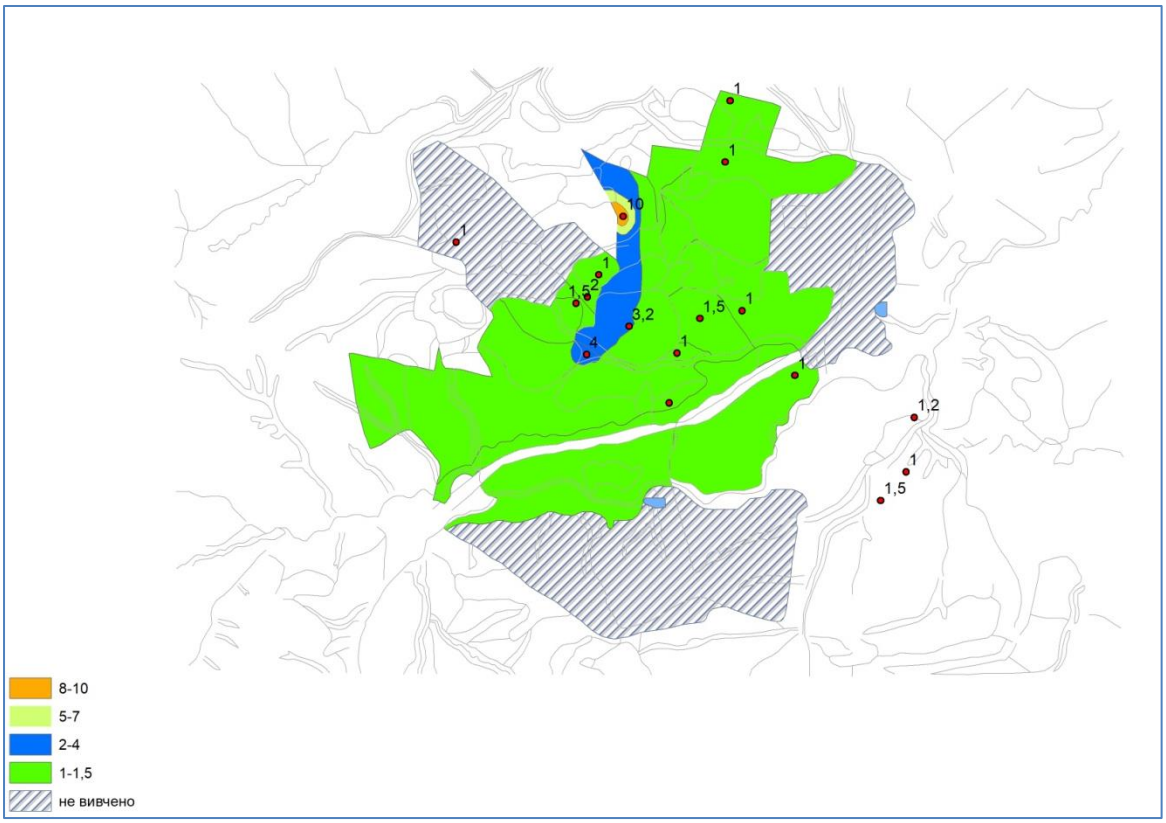

Fig. 3. Distribution of Phosphorus within the territory of Drohobych town.

The differentiation of urban soils of Drohobych by content of Sr (Fig. 4) signifies that we can clearly define three classes: relatively hazardous (2000 mg/kg); relatively neutral (150-200 mg/kg) and relatively satisfactory (100-120 mg/kg).

The area with relatively hazardous Strontium concentration in municipal soils is located at the north-west of the town and is strictly localized. The territories nearby have relatively neutral Sr concentration and are located closer to the eastern and western directions. The same Sr concentration was observed at the territory on the southeast of the town, within the area of dense industrial development. All the other town territories contain relatively satisfactory level of Sr in soils.

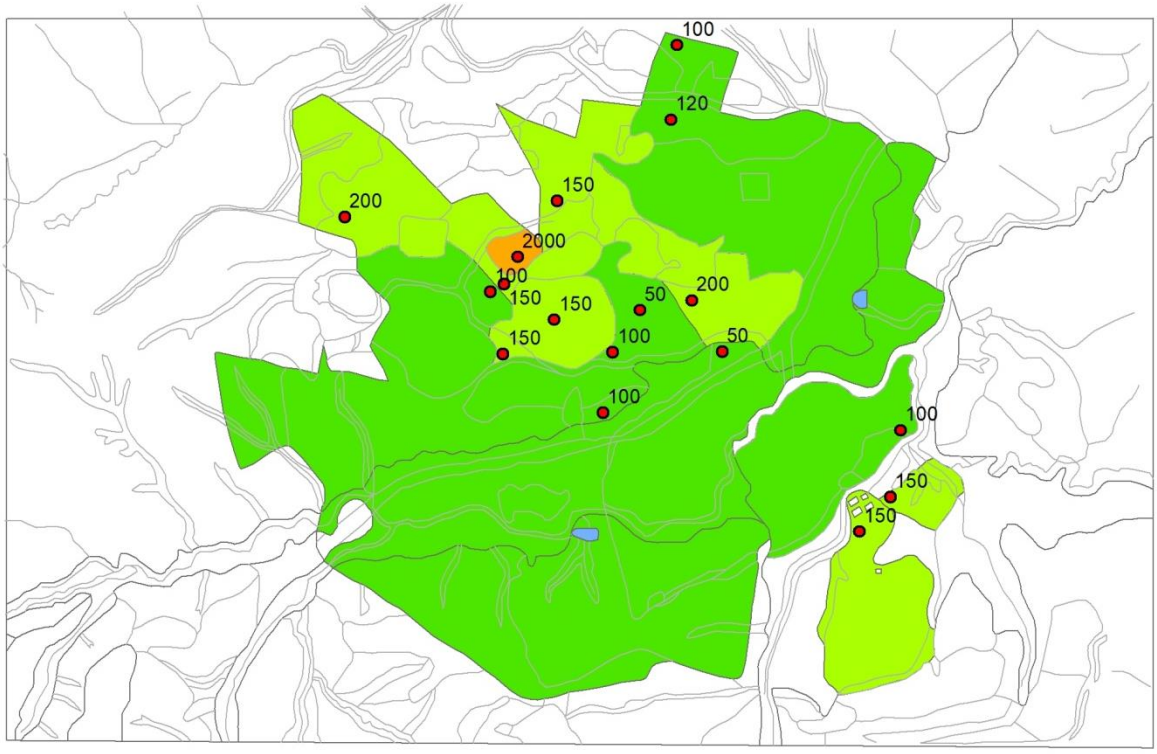

Fig. 4. Distribution of Strontium within the territory of Drohobych town.

As for other chemical elements, their distribution in soils of Drohobych is of background character and does not exceed maximum allowable concentration values.

The research of the ecological condition of air in areas of motor transport load, in particular, research of the impact of motor transport emissions on public health is of vital importance these days, especially in terms of large urban systems due to the fact that growing motor transport load (which is inevitable in modern urban ecosystems) is among the most pressing issues on the agenda. The ecological state of Drohobych is predetermined by its specific, closely interrelated complex of natural, urban planning, engineering, socio-economical and other conditions. Notwithstanding the decline of industrial production, ecological situation in Drohobych, as well as in Ukraine in general, is tense, therefore, posing a range of issues for urban residents, and for the whole region.

The carried out research prove that in accordance with the average values of CO pollution per vehicle in areas of motorways, the lowest level of air pollution could be observed in motorways with asphalt coverage and straight road section (2.15 ppm). Within the area of crossroads, where vehicles reduce their speed under the same pollution conditions, the level of pollution per vehicle increases up to 2.26 ppm. Under the same pollution conditions,

at ring road areas, pollution level grows up to 2.28 ppm. In case of uphill road section, air pollution level by CO increases up to 2.94 ppm.

The highest CO pollution value is observed on motorways covered with paving. The average value is 3,29 ppm per vehicle.

Conclusions. The conducted research based on the ecological state of natural components of Drohobych town proved that there is a significant spatial quality differentiation, especially, in terms of drinking water. Combined with the overall excess of potassium and hydrogencarbonates, there are observed nitrites in the southern part of the town within the private residential area with numerous adjacent allotments and land plots at lower hill sections and terraces above flood-plain. Within the area of water pumping wells, which supply waters from municipal water intakes, there is also observed significant spatial differentiation of water quality. It is especially threatening that the concentration of Escherichia coli in municipal waters is 80 times higher than maximum allowable value. The overall analysis confirms that the waters used for domestic use are not appropriate and are associated with serious issues. As for open waters, their condition is critical and requires immediate prohibition, primarily for recreational purposes.

In terms of urban soils, the situation within the town area could be regarded as ecologically problematic. In this regard, the north-west town district is the most hazardous. Besides, roads remain ecologically hazardous area. Depending on the road coverage, profile, its crossing, the amount of CO emissions is being differentiated, and therefore, it significantly affects the surrounding areas.

Overall, the studies prove that the popular idea that ecological condition of Ukrainian post-industrial cities and towns significantly improved after the cessation of many large enterprises is wrong.

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