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**THE ASSESSMENT OF THE ENVIRONMENTAL SITUATION AT THE TERRITORY
OF THE DARNYTSYA INDUSTRIAL AREA OF THE KYIV CITY**

Introduction

Under the modern conditions the formation of environmental situation at local and regional levels is mostly defined by industrial facilities. The major sources of environmental impacts are of course enterprises of heavy branches of industry. They shape the environmental problems of a territory and impose challenges for authorities to manage these issues and for population to protect their health and life. There are uncountable examples of industrial spur, which brought financial benefits, but destroy the ecosystems. And this deterioration process may take a very short period of time. For example, Sudan was a developing country with industry limited to utilities and small-scale food processing, and over the next 20 years after the oil extraction boom in 1999 it has turned into the area with one of the worst environmental situation in the region [1, p. 140]. The absence of the nature protecting legislation at that time and its slow development over the last decade — both have outcome in the chronic serious environmental problems at the location majority of industrial facilities [1, p. 146]. The same story has turned to be possible in more developed areas, as a widely known case of Sicily, where fifty years of industrialization have led to natural resources depleted and immense health effects, including congenital malformations, poisonings and increased children morbidity [2, p.247].

Problem statement

The concerns about the industry impacts will increase in the future as the growing demand for goods and services leads to expansion of production processes, raising the need to study and understand the complex interactions between urban natural and technogenic environment [3, p. 39]. The particular importance of this task is for urban areas, which have been the centers of industries concentration since the early stages of industrialization, where the density of population is constantly growing.

The modern trends of urban development state the need to relocate the industrial facilities to the areas outside the areas of compact human residence. The idea of creating industrial estates, which are vast section land allocated for a variety of industries joined by common infrastructure and management. Although this approach will not abolish environmental problems, but plainly relocate them, it gives possibility to make existence of population in cities more comfortable and safe.

Roberts and Sykes present the urban renewal as a complex of actions aimed at solution of urban problems, including improvement of economic, physical, social and environmental face of a city [6]. Most of the cities at post-Soviet territory have large industrial zones with aged infrastructure, which have lost businesses and economic activity. Notwithstanding the valuable land on which such areas stand, they

contribute little to city finances and maintaining them in their present state becomes a liability for unstable economy [7].

The territories revealed after the removal of industrial facilities must undergo certain type of renovation. The processes involved into the renovation are of different essence and discussed by the scholars and practitioners under the concepts of urban renewal (also called urban regeneration in the United Kingdom and urban redevelopment in the United States [5, p. 7]. In Ukraine the trend is taking growing popularity and we are now the witnesses of a range of successful projects of transforming industrial areas into shopping and entertainment centers – Art-plant “Platform” and shopping mall “Darynok” in Kyiv, business and innovation center — “Prompylad.Renovation” in Ivano-Frankivsk, residential districts — residential complex “Semytshiv” in Lviv, etc.

The target of city revival is making it a sustainable city, which has a range of dimensions — social, economic, environmental, cultural and physical. However, the success of cities renovation is decided by one of these components — environment condition, which defines the safety of human activity at the given areas [8]. As a result, the plans of city renewal cannot be developed without a prior comprehensive assessment of the environment condition at the study area.

Thus, **the aim of the given research** is to analyze the environmental impacts of one of the biggest and oldest industrial zones of Kyiv – Darnytsya industrial zone – with the purpose of making predictions about the threats for human health and priority areas for application of correction and mitigation actions.

Analysis of the previous research

The growing population density and expansion infrastructure, increase in the number of vehicles, accumulation of wastes, uncontrolled economic activity are the factors, which cause the deterioration of both the environmental and socio-economic living conditions of urban population. The mentioned processes and their consequences are covered in a wide range of works by V. Shevchuk, L. Melnyk, M. Klymenko, V. Kucheryavy, A. Shapar, F. Stolberg, O. Tetior and other scientists.

Kyiv as a capital city is often considered by researchers in terms of its environmental condition — the related works have been conducted by O. Afanasieva, T. Bagatska, L. Olyanytska, I. Panasyuk, S. Shevchuk, V. Scherbak and N. Semenyuk (condition of waters), T. Shupova, V. Nazarenko (wellbeing of fauna), P. Yavorovsky, I. Yatsuk, G. Matushevych (soils condition), M. Kirova, O. Pryimachenko, N. Klebanova, T. Shevchenko (air pollu-

tion composition and levels), M. Kovalenko, R. Derkul'sky, O. Zibtseva, V. Philipovych, O. Polischuk (condition of green infrastructure). However, these works represent the study of separate environmental components without integration of the information.

More complex information about the environment of Kyiv is given in the reports by the state authorities in the form of the Annual Report on Environment Condition in Kyiv, Report on Regional Environment in Kyiv Oblast, Ecological Passport of Kyiv, Complex City Program of Environmental Welfare of the City of Kyiv in 2019–2021, etc. These reports provide a multidimensional view of the Kyiv urban ecosystem state, but usually say nothing about the sources of pollution and direct interactions between these sources and changes in the environment components condition. So, the study of the process of transforming urban environment by the impacts of industrial zone is necessary for understanding functional connections in the system “natural environment — technosphere”.

Methods and materials

The detailed guides to the study of environmental impacts of individual types of industries are now available for all major polluters, like chemical, mining, cement, oil, power generation enterprises and animal farming. However, the widely accepted methodologies lack the recommendation on the assessment of complex impacts of industrial facilities at urban territories. This problem is a perspective field of research, where the works by I. Kustysheva and U. Svedin should be mentioned [9; 10].

In order to assess the impact of the Darnytsya industrial zone on the environment the ecosystem approach have been employed. According to basic definition of this method of analysis it is necessary to split the studied object into its structural elements, to set their characteristics and to define interactions between.

The systems approach is a problem solving paradigm [4, p. 41]. In other words, it is a way to see all environmental problems as a complex phenomenon with specific structure, behaviour and development regularities. Such perception opens the new plans of the environment functional balance and energy and matter flows.

The condition of the area under the influence of the Darnytsya industrial area is studied in terms of air pollution levels, soils pollution, condition of water bodies and plant associations. The tests of environment components state were based on the application of analytical chemical and instrumental methods, as well as bioindication methods, which provide the integral picture of ecosystem well-being.

Thus, the analysis of hydrosphere at the study area includes the evaluation of their overall condition by visual assessment and determination of water quality, based on samples taken according to standard technique from the studied objects. The visual observation of surface water bodies' condition has been evaluated by the technique developed by Matsyura M. V. and Matsyura O. V., accounting condition of the water bed and coast, water vegetation and level of their pollution and anthropogenic transformation [11].

In order to assess the quality of ambient air and the soil pollution levels it is also possible to evaluate the condition of green plantations at the study area. The condition of trees has been determined visually by the sum of basic biomorphological signs: density of crown, foliage level, foliage, size and colour of leaves (needles), presence or absence of deviations and deformations in the structure of trunk, crown and sprout, presence and share of dry sprouts in the crown or dry top, integrity and state of bark. The aggregated evaluation of trees condition is based on attribution to one of three quality groups: 1 — good, 2 — satisfactory and 3 — unsatisfactory conditions.

Results and discussions

The structure of the Darnytsya industrial area includes Darnytsky car-repair plant, tank repair plant, pharmaceutical factory, railway depot, depot of subway, depot of trams and silk factory. As a result, the area includes a wide range of stationary and mobile sources of air pollution, which produce pollution of all possible forms: mechanical, chemical, physical, biological and aesthetic. The Darnytsya industrial zone is located mostly within the Dniprovsky district of Kyiv, which is one of the largest in the city (the area of the region is 67 km²). However, it should be noted that the current structure of industrial complex at the studied area doesn't create such a strong pressure on the environment as it did 30 years ago in times of plan economy. Moreover, the residual pollution of that time is a decisive factor, affecting the formation of modern environmental situation and potential human health threats. Among these issues pollution of soils with heavy metals and persistent organic pollutants is of major concern.

The analysis of the Dniprovsky district of the city of Kyiv from the point of exposure to the negative environmental impacts of the Darnytsya industrial area shows that the potentially affected area is approximately 10 km² and the potentially affected population accounts almost 54 thousand people. The impact area includes surface water bodies – lakes and ponds, municipal parks of recreational value and a range of minor industrial facilities and green plantations.

The green plantations at the territories adjacent to the Darnytsky industrial include part of Bykovnyansky forest massif and parks of the district: Peremoha and Kioto.

The quality condition of the assessed plant associations is different depending on their type. Thus, quality condition of trees in the forest is good: trees are mostly healthy, normally developed, thickly foliated, leaves color and size are normal, diseases and damages are absent, without mechanical damages.

Quality condition of trees in the roadside territory is satisfactory: trees are relatively healthy with the unevenly developed crown, not enough foliated, disease and damage wreckers can be present, but they are on the initial stage, which can be removed, with the presence of insignificant mechanical damages, not threatening life of trees. But generally most of the trees are in good condition: trees without signs of weakening make up 65%, weak — 25 %, extremely weak — 7 %, drying and dead — 3 %.

The impact area includes two lakes — Veselka and Milen'ke. The results of testing show that the water of these lakes meets the standards of the water for recreational needs and belongs to the III-IV quality class: salinity, acidity, hardness, organic pollution by COD and concentration of petrochemicals are within the sanitary standards, but are at the top of acceptable range.

The visual assessment of the Veselka Lake shows that the state of the reservoir is “still good”, but the degradation processes is actively developing. The status of the reservoir should cause concern to residents and it is necessary to implement a set of measures for its conservation and protection.

The status of the Milen'ke Lake can be estimated as “satisfactory”, but in the reservoir the active negative changes take place. It is necessary to apply urgent measures to stop the destructive processes in the lake and its ecosystem, to improve the environment condition.

In general the condition of the Veselka Lake is much better than “Milen'ke” by all parameters, including level of anthropogenic pressure and littering. By the characteristic of the water plantation they are both poor, except of the fact that Veselka Lake is located in forest territory, so there is higher number of plants, but not much higher diversity. Still the lake is home to several species of rare and endangered animals, including moor frog (*Rana tarrestris*). The level of degradation of the landscape and biocenosis is very high for the Milen'ke Lake and are not really visible for the Veselka Lake. If to rely on responses of the residents Veselka has no changes, except of the amount of visitors and waste from them.

But there is another threat to these objects: in the Land Registry we can see that this territory is intended for new buildings. It means that by 2025 year there will be no natural (virgin) forest here. There is also an idea to relocate habitats of this lake, as it would be cheaper than create a new protected area and support it.

As for the air quality it can be continuously evaluated based on the data from three stationary observation posts of air monitoring, which output the information about the level of atmospheric pollution in the form of the air pollution index on digital map available through the Internet. One of these points is located within the impact area. The analysis of data over the period of 2017 shows moderate level of pollution (pollution index equals 6.3). However, the stationary monitoring accounts non-specific pollutants, which under current conditions mostly come from traffic, as the intensity of industrial operations is quite low now, except the Pharmaceutical factory.

Soil pollution in the Dniprovsky district is one of the highest in Kyiv city. The most noticeable pollutants are Chromium, Copper, Zinc and Nickel, but the humus content in soils is still considerable. The content of heavy metals has been studied based on the samples of soil taken at 5 points at green islands at the close proximity to the industrial facilities and 3 samples were taken in relatively unaffected point - Bykovnyansky forest and two parks. Thus, the analysis has showed relatively increased concentration of Zn (1.52 – 1.78 MPC). The content of Cu in soils of the area shows very clear difference of the values obtained for the samples from green areas and industrial area: from 0.43 in Bykovnyansky forest to 2.68-3.2 MPC in the industrial area. The concentration of Cr does not demonstrate increased levels in gross form, but the mobile forms of Cr exceed the sanitary threshold – the values are within the range 7.8-8.1, while the standard is 6 mg/kg. Ni is present in trace amounts. So, the territory under investigation should undergo soil remediation to reduce the potential negative impact on human health and plant association condition.

Another important component of environment quality at this territory is an increased level of ionizing radiation, which is typical for all territory of Kyiv city, except Golosiivsky and Svyatoshynsky districts, probably due to specific distribution of radioactive particles in 1986. The authors' observations and the state radiological monitoring show that the level of ionizing radiation is within the acceptable limits, but at the top threshold of the standard. This implies a risk for human health as low levels of ionizing radiation still possess the pathogenic potential.

However, since this factor is of regional and even national level, its consideration and mitigation are beyond the scope of the given study. Nevertheless, the recommended soil remediation for the given territory will also contribute to removal of certain radioactive elements, accumulated in soils.

The overall environmental situation in the vicinity of the Darnytsya industrial zone is integrally satisfactory. However, the condition of separate environment components is different: air and soil pollution are considerable, while the phytocenosis and water bodies, both natural and artificial, are relatively better preserved. Since this territory will undergo a major reconstruction according to the project of the Master Plan for Kyiv by 2025, it will become a residential area, where the health threats for people from the polluted and disbalanced environment are minimal.

Conclusions

1. The plans of the urban industrial zones revival must take into account the environmental condition of the project area and include actions aimed at enhancement of environment quality.

2. The studied area is under the technogenic pressure the Darnytsky industrial zone, which includes Darnytsky car-repair plant, tank repair plant, pharmaceutical factory, railway depot, depot of subway, depot of trams and silk factory. The total area of impact is.

3. Overpopulation in Kyiv city causes the biggest problems. The possible way of solution is popularization of the Kiev region.

4. Overbuilding is another aspect of the previous problem. The way of solution is use the abandoned facility, former industrial/military territory or old buildings.

5. The approximately 10 km² and the potentially affected population is almost 54 thousand people.

6. The condition of green plantations on the territory is from good (forest area) to satisfactory (roadside and protective tree stripes).

7. The condition of the water objects is satisfactory, but with clear signs of degradation processes running within. The quality of water varies from the III to IV quality class. Almost all water bodies in this area are not suitable for recreational use. However, the Veselka Lake could be included into the system of protected areas or covered with some conservation projects. Milen'ke Lake cannot have the status of the Natural Reserve Fund, but it is possible to get local population informed about the state of this lake and encouraged to its protection with through the information campaign.

8. Level of air pollution is very high, but mostly due to transport emissions.

9. Pollution of soils is also considerable and caused by intensive industrial exploitation in the past.

10. The further transformation of industrial area must be preceded by soil remediation and cleaning of coastal areas of water bodies.

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Радомська М. М., Рябчевський О. В., Чаплигіна О. В.

ОЦІНКА ЕКОЛОГІЧНОЇ СИТУАЦІЇ НА ТЕРИТОРІЇ ВПЛИВУ ДАРНИЦЬКОЇ ПРОМЗОНИ МІСТА КИЄВА

Стан міських екосистем сильно залежить від багатьох факторів, включаючи щільність населення, ефективність надання комунальних послуг та рівень техногенного тиску. Основними джерелами негативного впливу на навколишнє середовище міських територій є промислові зони. Внаслідок зниження ефективності експлуатації промислових зон та зниження ділової активності вони вважаються пасивом, що вимагає управлінських рішень.

В роботі обговорюються сучасні тенденції до ревіталізації міст, особливо міських промислових зон. Найбільш типовими напрямками перетворення промислових зон є житлові райони, зони відпочинку, розважальні та торгові центри. Необхідність аналізу стану довкілля на території до його реконструкції обґрунтовується необхідністю запобігання ризикам для здоров'я населення.

Вплив Дарницької промислової зони на прилеглу територію вивчено окремо для основних компонентів навколишнього середовища. Джерелами забруднення навколишнього середовища тут виступають Дарницький авторемонтний завод, танкоремонтний завод, фармацевтична фабрика, залізничне депо, депо метро, депо трамваїв і шовкової фабрики. Аналіз показав значний рівень забруднення атмосферного повітря, але в основному обумовлений транспортом, в той час як ґрунти забруднені важкими металами внаслідок тривалої промислової діяльності на території.

Стан зелених насаджень району впливу промзони оцінений як нормальний, особливо в частині залишків природного лісового фітоценозу. Стан водних об'єктів задовільний, але має чітку тенденцію до деградації. Пропонується включити одне з озер у мережу природоохоронних об'єктів для запобігання подальшому зниженню якості, та провести інформаційну кампанію щодо заохочення місцевого населення до ощадливого використання рекреаційних ресурсів на території.

Встановлено, що проєкт реконструкції та перетворення Дарницької промислової зони у житловий район або сервісний центр повинен включати рекультивуацію ґрунтів та благоустрій прибережної зони водних об'єктів.

Ключові слова: забруднення навколишнього середовища; компоненти навколишнього середовища; якість навколишнього середовища; ревіталізація міських територій.

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THE ASSESSMENT OF THE ENVIRONMENTAL SITUATION AT THE TERRITORY OF THE DARNYTSYA INDUSTRIAL AREA OF THE KYIV CITY

The condition of urban ecosystems is strongly dependant on many factors, including population density, efficiency of municipal services provision and level of technogenic pressure. The major sources of negative impacts at urban territories on the environment are industrial zones. Due to decreasing efficiency of industrial zones exploitation and reduced business activity they are considered a liability demanding managerial solutions. The current trends for revitalization of cities, especially urban industrial zones, have been discussed. The most typical directions of industrial zones transformation is residential districts, recreational areas, entertaining and shopping centers. The need for the analysis of environment condition at the territory prior to its refurbishing is substantiated by the necessity to prevent population health risks.

The impacts of the Darnytsya industrial zone on the adjoined territory have been studied separately for major environment components. The sources of environment pollution here are Darnytsky car-repair plant, tank repair plant, pharmaceutical factory, railway depot, depot of subway, depot of trams and silk factory. The analysis has showed the considerable level of air pollution, but it is mostly conditioned by traffic, while soils are polluted with heavy metals, due to long term industrial activity at the territory. The green infrastructure of the affected area is in normal condition, especially residuals of natural forest phytocenosis. The state of water bodies is satisfactory, but with clear tendency to degradation. It is offered to include one of the lakes into the network of protected areas to prevent further quality reduction and conduct the information campaign on encourage local population to careful use of recreational resources at the territory. The project of the Darnytsky industrial area renovation and transformation to residential district or service center must include the soil remediation and maintenance of water objects.

Keywords: environment pollution; environment components; environment quality; urban areas revival.

Радомская М. М., Рябчевский О. В., Чаплыгина А. В.

ОЦЕНКА ЭКОЛОГИЧЕСКОЙ СИТУАЦИИ НА ТЕРРИТОРИИ ВЛИЯНИЯ ДАРНИЦКОЙ ПРОМЗОНЫ ГОРОДА КИЕВА

Состояние городских экосистем сильно зависит от многих факторов, включая плотность населения, качество коммунальных услуг и уровень техногенной нагрузки. Основными источниками негативного воздействия на окружающую среду городских территорий являются промышленные зоны. В результате снижения эффективности эксплуатации промышленных зон и снижение деловой активности они считаются пассивом, что требует управленческих решений. В работе обсуждаются современные тенденции в ревитализации городов, особенно городских промышленных зон. Наиболее типичными направлениями преобразования промышленных зон являются жилые районы, зоны отдыха, развлекательные и торговые центры. Необходимость анализа состояния окружающей среды на территории до его реконструкции обосновывается стремлением предотвратить риски для здоровья населения.

Влияние Дарницкой промышленной зоны на прилегающую территорию изучено отдельно для основных компонентов окружающей среды. Источниками загрязнения окружающей среды здесь выступают Дарницкий авторемонтный завод, танкоремонтный завод, фармацевтическая фабрика, железнодорожное депо, депо метро, депо трамваев и шелковая фабрика. Анализ показал значительный уровень загрязнения атмосферного воздуха, но в основном обусловлен транспортом, в то время как почвы загрязнены тяжелыми металлами вследствие продолжительной промышленной деятельности на территории. Состояние зеленых насаждений района в зоне воздействия промзоны оценено как нормальное, особенно в части остатков природного лесного фитоценоза. Состояние водных объектов удовлетворительное, но имеет четкую тенденцию к деградации. Предлагается включить одно из озер в сеть природоохранных объектов для предотвращения дальнейшего снижения качества, и провести информационную кампанию по агитации местного населения к экономному использованию рекреационных ресурсов на территории. Установлено, что проект реконструкции и преобразования Дарницкого промышленной зоны в жилой район или сервисный центр должен включать рекультивацию почв и благоустройство прибрежной зоны водных объектов.

Ключевые слова: загрязнение окружающей среды; компоненты окружающей среды; качество окружающей среды; ревитализация городских территорий.

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