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INTEGRATION OF NATURAL ELEMENTS IN URBAN PLANNING AND IMPROVEMENT OF RESIDENTS' QUALITY OF LIFE

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Abstract. The article discusses the issue of integrating natural elements into urban environments based on eco-revitalization of industrial monomers. The state of the ecological environment of modern industrial monomers is outlined, structured by types of pollution for industrial cities as a whole, and monomers in particular. Types of natural elements and their characteristics are investigated and classified. Based on the presented factors, options for integrating natural elements at the urban planning level are proposed. The research and analyzed sources indicate the impact of integrated natural elements on the livelihoods of residents in industrial cities as a whole, and monomers in particular. Thus, it is found that the integration of natural elements into the environment at various levels can affect the psycho-social factors of city perception. As a result of the identified statements, concepts are proposed for improving the quality of life of residents through the integration of natural elements into the environment.

Keywords: Industrial monocities, urbanization, ecological factors, eco-revitalization, natural elements, green city framework.

The state of the environmental conditions in modern industrial monocities

Industrial monocities are cities with a narrow profile of specialization, which are factory-centric. The urban environment and compositional-spatial structure of the city are formed based on the principle of orientation towards industrial zones and depend on their location.



Fig. 1. Model of Possible Negative Environmental and Social Consequences of Urbanization (according to V. Kucheryaviy) [1]

Industrial monomists have a finite life cycle, the final stage of which should be the revitalization of the urban environment and the industrial object in particular, according to the dissertation referenced. Accordingly, there is a range of principles and techniques for the revitalization of industrial monomists. Revitalization must be based on ecological principles, using methods of recultivation, reintegration, and rehabilitation of existing and abandoned industrial zones. The most effective approach is to analyze the ecological preconditions and conditions for the ecological development of industrial monomists at three levels of perception – macro-level (regional component), meso-level (agglomeration component), and micro-level (city component) – using regional, urban planning, and urbanistic approaches, respectively.

Industrial monomists from different periods of development have different levels of impact on the environment as a whole or on individual aspects (soil, air, water) due to the application of nature protection mechanisms established during the construction of industrial objects. Historical industrial monomists have a higher level of pollution due to the duration and intensity of their impact on the environment.

In addition, one of the main preconditions for the emergence of industrial cities is the presence and demand for natural resources, to which industry and residential development of worker settlements tend to gravitate. Raw and human resources are the main condition for the successful functioning of an industrial city. However, they require service and provision for use – water supply and energy supply. The reduction and limitation of resources are key issues in such a consumption chain, the solution of which is to ensure the rational use and preservation of natural resources.

The next stage of the monomist's existence process is, in fact, the work of the industrial enterprise. The level of environmental friendliness of production depends on a number of factors: historical factors (the period of construction determines the

level of development of energy-saving and environmentally friendly technologies), the type and category of production (production can be more or less harmful depending on the type of product being produced), the amount of production and the scale of production, the availability of programs and measures to increase environmental friendliness, energy efficiency, etc.

The assessment of the level of environmental pollution in a particular region is determined by the Pollution Index. The calculation is carried out in the following stages [12.13.14]:

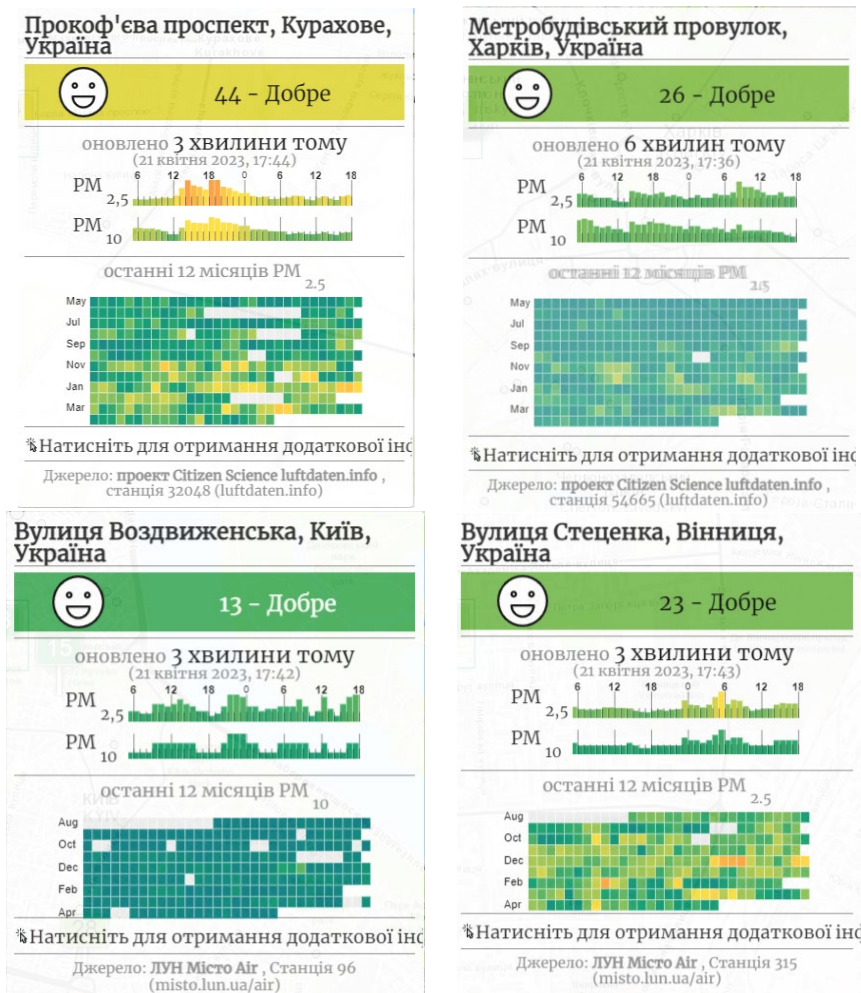
- determination of a list of pollutants that are typical for the given region (pollutants from industrial enterprises, transportation, agricultural land, and other sources)
- collection of data on the level of emissions of each pollutant
- determination of regulatory values for each pollutant (declared by the corresponding authorities for air, water, soil, etc.)
- calculation of the Pollution Index for each pollutant using the formula: Pollution Index (PI) = (Actual Value / Standard Value) x 100, where Actual Value is the actual level of emissions of the pollutant, and Standard Value is the regulatory value for that pollutant
- calculation of the overall Pollution Index for the region, which is determined as the average value of the Pollution Indices for all pollutants, using the formula: Pollution Index (PI) = (PI1 + PI2 + ... + PIn) / n, where PI1, PI2, ..., PIn are the Pollution Indices for each pollutant, and n is the number of pollutants.

The Pollution Index can be used to compare the level of pollution in different regions and to identify trends in the development of the environmental situation in a particular region. This can help to implement measures to reduce pollution levels and improve the environmental situation in regions or individual cities [309, 310, 311].

Therefore, according to the data from the "waqi.info" resource, which shows, among other things, the real-time air quality index for cities in Ukraine, the following indicators are available (see Tab 1):

Table 1. Air quality index for cities in Ukraine.





The available data allows comparing the indicators of industrial mono-cities and industrial poly-cities, and indicates a higher level of air quality in large industrial poly-cities in Ukraine. In addition, there are other factors present for industrial cities in general, and mono-cities in particular, based on the types of pollution. (see Tab 2).

Table 2. Factors by type of pollution

Type	Sources	Composition-Spatial Methods of Revitalization
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 Air	• Industrial enterprises • Transport • Household sources • Agriculture • Fires	• Eco-reconstruction of equipment • Revitalization of industrial zones • Arrangement of bicycle zones and bike path systems • Expansion of recreational areas • Development of technology parks and industrial parks
 Soil	• Industrial enterprises • Landfills • Construction and repair work • Agriculture • Entertainment venues and parks	• Reclamation of land of closed enterprises • Rehabilitation of industrial zone areas • Reconstruction of waste management systems • Application of eco-materials • Development of agro-technoparks • Greening of degraded areas
 Water	• Industrial wastewater • Atmospheric discharge • Municipal waste • Sewage • Soil contamination	• Reconstruction of water drainage systems and sewage control • Artificial flooding of areas in need • Creation of closed-loop irrigation systems for agricultural land • Changing the paradigm of waste management • Reconstruction of recreational areas and urban water bodies.
 Waste	• Accumulation of large amounts of waste	• Rehabilitation of existing landfills • Compliance with waste management systems and norms • Use of biodegradable materials • Reconstruction of waste collection and management systems • Reconstruction of communal areas.
 Noise	• Noise from industrial sources • Traffic noise • Construction noise • Elevated noise levels from recreational areas	• Eco-revitalization of industrial areas • Use of noise and vibration absorbing screens and greenery to create a comfortable environment • Reconstruction of urban road networks, moving highways outside of residential areas.

Industrial cities have a number of negative factors that harm the environment. This issue is particularly acute in historic cities where industrial enterprises require equipment replacement and modernization. In cities that are in economic decline, environmental problems are not considered a top priority. Another problem is the reclamation

of abandoned industrial areas in post-industrial and industrial cities. There are also regional problems at the macro level, which depend on both geographical factors and typological features of the monomyth itself.

Types of natural elements and their characteristics

Modern cities have a complex structure made up of various elements, among which so-called "green areas" play a special role. These areas include recreational zones, parks, health centers, medical facilities, schools, etc. At present, interest in such territories is growing every year, as they allow solving one of the main problems of urban development, namely the harmonization of natural, man-made, and social environments.

Natural elements can be divided into two general categories:

- Natural-landscape;
- Artificial.

Natural-landscape objects can include various individual elements such as:

- Water bodies and rivers;
- Various natural landscapes (gullies, hills, ravines, etc.);
- Beaches;
- Forest and non-forest vegetation.

Among the advantages of such territories are their large size, rich variety of health resources, and the possibility of diverse functional filling. However, even such places have their problems, including historical ties to the local area, which often prevent them from fully realizing adaptive development strategies, making them convenient and endowed with all necessary criteria. The adaptation of such territories to the pace of development of rapidly developing urban areas is often a problem, leading to other issues such as accessibility.

An example of this can be the city of Dnipro, Ukraine (see Fig 2). The problem is that the waterfront area is facing an industrial city that is growing rapidly, and it is becoming increasingly difficult to provide all the criteria for recreational areas for the growing population. For some areas of the city, they are located at a very far distance and do not provide the necessary space.



Fig. 2. — Example of a natural landscape area in the city of Dnipro, left bank (author's development).

Man-made natural elements can include various botanical gardens, school grounds, recreational centers, small parks, vertical gardens, facade plant systems, and so on. The uniqueness of such elements lies in their flexibility and ability to integrate in various ways. These elements have gained a lot of popularity recently, thanks to technological developments that make their implementation and maintenance quite simple. In addition, such elements allow for a significant increase in the green space of the city, as their "compactness" and transformability make them suitable for integration in any urban planning zone.

Integration options of natural elements at the urban planning level.

The main tasks of integrated natural elements are combating ecological pollution, creating recreational areas, and improving the quality of life of the population. Therefore, it is necessary to establish certain criteria for each natural element that they will meet to achieve the desired result. Among these criteria, it is possible to distinguish the necessary area for greening, functional filling, accessibility, ergonomics, artistic diversity [16].

The most influential parameter on the criteria is the integration site of the natural element. The option of its placement and location should be chosen based on the specific needs of a particular city area. Secondly, the location may dictate the option of integration and functional filling.

Analyzing urban situations in different cities, the following integration areas for natural elements can be identified:

- Creation of parks, squares, botanical gardens, etc., based on unused urban areas. Very often, cities have areas that can be classified as recreational, but they are not used functionally or technologically. These areas may include small ravines, gullies, hills, water bodies, etc.
- Use of "abandoned" architectural objects. In many cities, there is a problem of so-called "abandoned" architectural objects that are left for various reasons. Often, such objects have fairly large areas, such as workshops of some enterprises, which can be reconstructed and used for the benefit of society.
- Renovation of polluted areas. Polluted areas are a significant problem for different cities, but there are already technologies that allow neutralizing soil pollution and creating recreational areas there.
- Reconstruction of the urban space. Many urban planning projects have proven that from the competent reconstruction of public spaces, whether it is squares, parks, streets, etc., it is possible to create a natural environment [17].
- New construction. In this case, integrating natural elements is easier and has more implementation options. These can be vertical open gardens, which are buildings filled with various greenery and are publicly accessible. Creating landscape parks, squares, and various areas filled with greenery, including the construction of new residential quarters, based on the idea of "green architecture", as exemplified by Bjarke Ingels' "8 House" [15].

The impact of integrated natural elements on the livelihoods of residents

The urban environment of industrial monocities has a hierarchical structure of construction and is formed according to principles oriented towards the industrial object. "Workers' settlements, and later, social cities, and similar micro-districts, were built to emphasize the significance of production through planning and spatial composition methods. Thus, residential streets usually had "production points" that enclosed street panoramas. Pedestrian and transport routes were located with consideration of a certain scenario of movement, where the mandatory element was the production zone or a panoramic view of the industrial object. The dominant features in construction were industrial objects that could stand out in terms of height or volumetric planning decisions. Therefore, at any moment of existence, a person was forced to contemplate production objects, which led to a certain hyperbolized perception of the significance of the plant in relation to the individual as a cog in this mechanism" [6.7]. As a result, due to the displacement or reconstruction of central objects, both the architectural environment and the sense of life for the residents of this environment are lost, as the dominant feature of the composition disappears. Eco-revitalization is a mechanism for integrating such natural elements.

Spatial solutions for industrial objects usually have monstrous compositional decisions caused by the utilitarian, purely functional construction of the environment. Such objects are separated from public and residential buildings by sanitary protection zones, landscaping elements, and fencing structures, and only have an impact on the

panoramas of construction. They are background elements in the compositional-spatial structure. Residential and public buildings are located with regard to the entrances of enterprises. Thus, the formation of industrial zones has a primary influence on the life of residents of industrial monocities.

A series of studies were conducted to identify the influence of integrated natural elements on the livelihood of residents.

The study "The influence of green spaces on the health of urban residents" [8] showed that greenery in cities can improve residents' health, reduce the risk of certain chronic diseases, and enhance their quality of life. "Modern urban lifestyles are associated with chronic stress, lack of physical activity, and the impact of anthropogenic environmental factors. Urban green spaces such as parks, playgrounds, and residential greenery can contribute to mental and physical health, reduce morbidity and mortality among urban residents by providing psychological relaxation and stress relief, stimulating social cohesion, maintaining physical activity, and reducing the impact of air pollutants, noise, and excessive heat" [8]. In addition, the results of the study on the effect of green cover on reducing emissions and improving air quality in urban environments indicate that greenery can significantly reduce the amount of emissions from transportation and industry, helping to improve air quality in cities [9]. An interesting study is the one on "Using natural elements to reduce the urban heat island effect," which confirmed that the use of greenery, water bodies, and other natural elements can help reduce the temperature effect of the urban heat island in urban environments, improving the comfort and health of residents [10]. Also, the study on "Position of Water Elements as an Urban Furniture" showed that characteristic and creative water elements in the design of urban furniture improve both the quality of use and the visual quality of the space where they are located, and can positively influence urban identity and the psychological state of users [11].

Therefore, based on the identified studies and the conditions and factors shaping industrial monomyths, it can be concluded that the integration of natural elements into the environment at different levels can affect the psycho-social factors of perceiving the city.

Table 3. Factors influencing recreational areas in cities

Factor	Consequence
Improving air quality	Greenery reduces the amount of heat radiated from asphalt and buildings, thereby reducing air pollution levels due to the thermal effect.
Improving Physical and Mental Health	Nature can have a positive impact on people's physical and mental health. Walking in a green environment can reduce stress and improve mood.
Reducing the Risk of Natural Disasters	Natural elements can reduce the risk of floods and fires by absorbing and holding water. This helps to minimize the negative consequences for local residents.
Reducing Noise Pollution	Plants and other natural elements can reduce the level of noise in the city, which contributes to reducing stress levels and improving

	the quality of life for residents.
Increasing Economic Development	Natural elements can be attractive to tourists, which contributes to the development of tourism and an increase in the city's revenue. In addition, green spaces can increase property values and attract new residents and businesses.
Green Plantings and Parks	Green spaces can have a positive impact on people's psychological health and reduce stress levels. Residents of "green" cities are less prone to depression and other mental illnesses. Recreational areas can also stimulate the city's economy by attracting tourists and providing jobs in the tourism and landscape design industries.
Water Bodies, Rivers, and Lakes	Water bodies can provide various types of recreation and entertainment, as well as be an important source of freshwater for local residents.
Placement of Elements	The placement of natural elements can affect their use and accessibility for residents. For example, if a park is located far from residential areas, its use may be difficult for many residents.
Accessibility of Infrastructure	The accessibility of infrastructure that helps to use natural elements, such as bicycle paths, walking trails, etc., can also affect their use.
Type of Natural Element	The type of natural element can affect how it is used and its impact on residents' livelihoods. For example, parks with sports facilities may be more attractive to active residents than parks with landscape design.
Cultural Factors	Cultural factors can also influence the use of natural elements. For example, parks with traditional or cultural significance may be more popular among residents who value these aspects of their community.
Level of pollution	The level of pollution can affect the quality of natural elements and their impact on the livelihoods of residents.

Conclusions

The conducted research allows us to state the importance of integrating natural elements into urban planning and their impact on improving the quality of life for residents. The environment of industrial cities, and mono-cities in particular, has a predominantly depressive character in terms of composition and space orientation, which focuses on industrial objects as compositional and spatial dominants. Eco-revitalization, as a method of rehabilitating urban spaces, makes it possible to analyze the urban environment at three levels of perception: meso-level, macro-level, and micro-level, thereby identifying and structuring the research problems. By analyzing the state of the ecological environment, types of pollution that affect urban systems were identified. The relevance of the issue of revitalizing and restoring recreational areas is increasing every year, which makes it possible to solve the issue of harmonizing natural, technological, and social environments. Accordingly, the research identified types of natural elements and their characteristics and created their classification.

The research identified potential areas for integrating natural elements, providing a basis for further study of eco-revitalization methods and the implementation of theoretical and practical experiments based on it. Based on the identified prerequisites and problems, options for integrating natural elements at the urban planning level were proposed. Based on the conducted research and analyzed sources, the influence of integrated natural elements on the life of residents of industrial cities in general, and mono-cities in particular, was established. Thus, the integration of natural elements into the environment can affect the psycho-social factors of perception of the city by including green elements both in the structure of urban design and in the compositional-spatial structure of construction.

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