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Tatyana Vasilevna Nazarenko
Basic Ph.D. student of the department: "Architecture",
Tashkent University of Architecture and Civil Engineering,
Uzbekistan, Tashkent

ECOLOGY AND ARCHITECTURE: INNOVATIVE SOLUTIONS FOR THE REDEVELOPMENT OF INDUSTRIAL AREAS

ABSTRACT: This article examines the process of redeveloping industrial areas through the lens of sustainable development and ecology. It analyzes key principles of architectural design aimed at minimizing negative environmental impacts, including the use of recycled materials and the adaptation of buildings to climatic conditions. Successful examples of transforming abandoned industrial sites are also presented, illustrating the synergy between architecture and ecology. The article emphasizes the importance of a comprehensive approach to redevelopment for improving quality of life and restoring ecosystems.
KEYWORDS:redevelopment, ecology, architecture, sustainable development, industry, building adaptation, recycled materials, quality of life, ecosystem restoration.

INTRODUCTION. In recent decades, it has become evident that the industrial revolution has left a profound impact on the environmental situation in the world. Fresh air, clean rivers, and healthy ecosystems have become scarce due to urbanization and industrialization. However, there will come a time when we must view this legacy from a new perspective, utilizing the principles of sustainable development for the redevelopment of industrial areas. In this article, we will explore how ecology and architecture can come together to create innovative solutions in this important field.

Redevelopment is the process of transforming abandoned or underutilized industrial sites into new, functional spaces. These spaces can be used for both commercial and residential purposes. The primary goal of redevelopment is not only to restore these areas but also to improve the quality of life for people and minimize harmful impacts on the environment.

Architectural solutions aimed at improving the environmental situation include the use of sustainable materials, optimization of energy consumption, and the implementation of modern technologies. The use of recycled materials, such as glass, concrete, and metal, lays the foundation for creating environmentally friendly buildings. Furthermore, designing with consideration for climate conditions can significantly reduce heating and air conditioning costs.

RESEARCH MATERIALS AND METHODOLOGY. Today, the main focus in urban development is shifting towards protecting the environment: improving public health, sustainable use of natural resources, preserving ecological systems, and applying innovative technologies for wastewater treatment and other processes.

Urban populations represent the main center where the process of production and its ecological component takes place. The process of urbanization has greatly affected the population, leading to a certain duality. On one hand, there is the growth and development of cities, an increase in job opportunities, and improved comfort for residents. On the other hand, urbanization has a strong impact on nature, disrupting its balance. Urban populations also suffer from increased population density, complex social adaptation, and higher morbidity rates compared to rural residents.

According to Maslov N.V., several main negative factors can be identified that impact human health, including:

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- Climatic factors – the state of the microclimate in urban environments. For instance, phenomena such as dust, fog, and smog can obstruct sunlight. The air temperature in the city is slightly higher than outside, whereas ultraviolet solar radiation is much lower indoors than outdoors. The combination of these phenomena directly affects people's well-being.
- Energy factors – indicators of resource efficiency. Demand for living standards rises, resulting in increased production of various goods and subsequently increasing energy consumption for their production.
- Chemical factors – results from human and technological influences that lead to pollution of urban environments. Urban transport is one of the main polluters of the atmosphere, while housing and communal services utilize natural resources, primarily water. In large cities, the primary source of pollution is industry: electric power generation, chemical, petrochemical, coal, and gas industries, machine engineering, pulp and paper production, as well as manufacturing of building materials, food, and light industries.
- Physical factors – including the impact of noise, electromagnetic, and ionizing environmental pollution.
- Biological factors – microorganisms contained in the atmosphere and hydrosphere that can be carriers of various infections due to air, water, and soil pollution [1, p. 33].

"Cities are systems that function over centuries, and urban ecological planning differs in that it assesses not only the consequences of building objects and their complexes. It is important to continuously adjust the methods of functional and technical content of these complexes and the development of planning structures." [1, p. 9].

During the period of intensified industrialization, the city represented a productive and economic hub with established interactions between residential areas and industrial facilities. At that time, the popular design approach was to build industrial facilities in separate zones with residential areas nearby, thus protecting the city with a sanitary zone. In major industrial cities, factories and plants were designed in a dispersed manner, blending into the fabric of the city and occupying available spaces. After implementing a tiered system for constructing cities based on cultural and domestic services, industry began to be isolated from housing by protective sanitary strips. The road network and transport started to be considered the planning framework of the city, which opened up new areas for industrial project design and residential areas positioned at significant distances from them. Subsequently, all urban planning concepts changed due to the relevance of such issues as ecology and social factors. All primary functions were consolidated into a single planning element within the city, representing a harmonious combination of residential, industrial, cultural, and service functions in a unified area. This period saw the informatization of society, where the population began to harness its potential in science and the scientific support of production. Scientific and production complexes emerged that posed no ecological hazard and could be located adjacent to residential areas [2, p. 12].

The prolonged growth of industrial enterprises in many countries has led to adverse environmental impacts in urban areas. The scaling of cities and industrialization (increased traffic, engineering systems, production capacities) negatively affected the ecological situation. Despite technological changes, enterprises have still created pollution control systems. The industrial environment became more aggressive (air, soil, and water pollution, radioactive contamination, damaged territories, and excessive noise levels) and impacted the city as a whole. The increase in personal vehicular traffic and intense urban development also detrimentally affected the city's ecological condition.

To ensure the ecological sustainability of the city and combat environmental pollution, it is necessary to create planning infrastructures where each function is aimed at preserving natural resources. Shepelev N.P. and Shumilov M.S. propose two approaches to reduce pressure on the environment. The first approach involves technological and technical measures aimed at improving production and

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vehicle fleets. The second approach is urban planning, which focuses on limiting the harmful impact of production facilities through planning solutions and extensive greening. By closely examining the second approach, a trend can be observed that combines and cooperates industries, creating unified wastewater treatment facilities while improving ecology and economic efficiency. However, this method has a downside: it leads to increased emissions from facilities in one location and pollution of the environment. Decentralization of production will also result in a uniform rise in overall pollution in the city, making it very costly and problematic to create protective zones around industrial areas due to their extensive territories [2, p. 15].

Maslov N.V. proposes two groups of methods for environmental protection. The first group includes zonal-territorial methods that cover large land areas, while the second includes local methods limited to specific areas associated with construction, enterprises, or engineering structures. The second group can also comprise production-technological systems and units. Of course, local environmental protection methods are used in problematic enterprises related to eco-hazardous industries, transport systems, liquid waste treatment facilities, warehouses, and adjacent territories [1].

In Uzbekistan, a serious environmental problem has arisen, as Tashkent has recently been ranked among the 10 most polluted cities in the world in terms of air quality. For instance, in January 2024, approximately 19 days were classified as “harmful to health,” indicating a rise in harmful substances in the city's atmosphere, directly affecting human health and the overall ecological sustainability of the city. Experts believe that this environmental situation is prompted by the accelerated development of urbanization, coupled with emissions from industrial plants and power stations, increased vehicular traffic, and reduced greenery due to new constructions. “Fifteen years ago, the city was covered by greenery at 20-30%, but this figure has now decreased to 10-18%. Active urban development has led to concrete and asphalt replacing trees and greenery,” said climate expert Erkin Abdulahatov [3].

The State Statistics Committee of the Republic of Uzbekistan reported on the ecological situation in the Republic in 2020, revealing that the most polluted regions are Tashkent and Kashkadarya regions. Annual emissions amounted to approximately 430 and 128 tons, respectively. This situation is linked to the density of industrial zones [4].

Many countries, like Uzbekistan, face acute environmental threats in large cities. Numerous examples showcase improved conditions in cities under crisis. Evidence includes many projects, renovations, and other initiatives aimed at transforming former industrial zones. One such example is the High Line project in New York City, where an abandoned railway line was converted into a park with greenery, recreation areas, and cultural spaces. This solution not only enhanced the quality of life for local residents but also restored biodiversity in the urban environment.

Figure – 1. Plan and perspective of King`s Cross area, London.

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Another successful example is the "London Canals" project, where abandoned industrial zones were transformed into new neighborhoods with residential buildings, shops, and public spaces. Ecodesign principles were actively employed, including more efficient water management systems and the integration of green technologies. On the site of former warehouses and manufacturing buildings, new residential units, offices, shops, restaurants, and educational institutions have been reconstructed or built, and public spaces have been beautified. Old gas tanks were repurposed into housing. The area's design also focused on its ecological footprint, which is evident in the constructed homes that possess high energy efficiency ratings. Additionally, there was adherence to the principle of maximizing preservation and reconstruction of existing historical buildings (see Fig. 1) [5].

TECHNOLOGICAL INNOVATIONS AND THE ROLE OF HUMANS. Modern technologies play an important role in the redevelopment of industrial sites. The use of Intelligent Building Management Systems (BMS) allows for the optimization of energy flows and reduction of operational costs, as do smart lighting and climate control systems, making buildings more efficient and environmentally friendly. Moreover, engaging the local community in the redevelopment process is becoming an essential aspect. Involving residents in the design and implementation of new spaces helps to create an environmentally sustainable environment that meets their needs and expectations. Thus, the goal is not just to create functional spaces but also to foster a sense of local belonging, enhancing social ties.

CONCLUSION. The redevelopment of industrial sites offers a unique opportunity to connect the past and the future, marking a step towards sustainable development. Innovative architectural solutions based on ecological principles have the ability not only to restore abandoned areas but also to make them centers of attraction for new ideas and technologies. By offering efficient and environmentally friendly ways to reuse old industrial properties, we can create landscapes that promote sustainability and harmony with nature. With each new redevelopment project, humanity takes another step towards a cleaner, greener, and more sustainable city. In the end, ecology and architecture can—and should—coexist in symbiosis, providing a quality and safe future for all.

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