FUNDAMENTALS OF DEVELOPING A GREEN INFRASTRUCTURE STRATEGY FOR LOCAL PLANNING OF THE TERRITORY OF THE WESTERN-NORTH CITY OF KARAKALPAKSTAN

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Abstract: This article will develop a local territorial planning strategy based on green infrastructure for the western-northern regions of Karakalpakstan. The study analyzes the impact of urbanization processes on the ecological balance, and also studies ways of rational use of existing landscapes and natural resources. Issues of integrating elements of green infrastructure into urban planning practice are highlighted as an important factor in sustainable development, climate change, and improving the living standards of the population.

Key words: Karakalpakstan, urbanization, urban planning, ecological balance, green infrastructure, park, recreational area, project

In recent years, the rapid urbanization of cities has negatively affected the ecological balance. The reduction of green spaces, air pollution, and the acceleration of climate change are examples of this. The cities of Nukus, Takhtakupyr, and Kungrad, located in the northwestern part of the Republic of Karakalpakstan, are also developing under urbanist pressure. From this point of view, there is a need to introduce the concept of green infrastructure in territorial planning. Green infrastructure is an important tool not only for ensuring environmental sustainability, but also for improving social well-being and forming an aesthetic environment. This article develops strategic approaches that contribute to the sustainable development of Karakalpakstan's cities in terms of ecology and function.

The research methodology is based on a comprehensive urban planning analysis, environmental monitoring, data processing using GIS (geoinformation systems) technologies, as well as a comparative analysis of international experience. In the western-northern regions of Karakalpakstan, natural-geographical conditions, water resources, soil fertility, wind regime, and climatic parameters were studied as the main indicators. At the same time, the level of use of green areas by the population, recreational needs, and traffic flows were analyzed using statistical methods. The survey results showed that

68% of respondents indicated the absence of a park or park within a 500-meter radius of their place of residence, and 75% noted the lack of recreational areas during the summer months. 82% of the population noted that they believe that the expansion of green infrastructure will improve health and quality of life. Analysis of environmental monitoring confirmed the prevalence of wind erosion and dust storms as the main problem: 62 days per year are recorded in the city of Nukus, and 71 days per year in Kungrad. It has been scientifically proven that green areas and forests improve the ecological situation by reducing wind speed and capturing dust particles.

Table 1. Indicators of green infrastructure development in the western-northern region of Karakalpakstan. 2024 data

№	City/District	Green area share (%)	Population (thousand)	Green space per 1 person (m2)	Number of parks	New projects	Nearness of water body	Transport Integration	Stability estimate
1	Nukus	21	340	6,2	12	5	Yes	Good	Average
2	Takhtakupir	18	76	5,1	4	2	No	Middle	Low
3	Kungrad	20	110	5,7	6	3	Yes	Goo	Average
4	Muynak	15	30	4,8	2	1	Yes	Low	Low
5	Domestic	22	160	7,3	7	4	No	Good	Good
6	Chimbay	19	95	5,	5	2	Yes	Middle	Average
7	Bloody lake	17	45		3	1	No	Low	Low
8	Beruni	20	120	6,1	6	3	Yes	Good	Average
9	Ellikkala	19	80	5,4	4	2	No	Middle	Average
10	Amu Darya	18	70	5,0	3	2	Yes	Low	Low

The results showed that if elements of green infrastructure are systematically implemented in the western-northern cities of Karakalpakstan, the following results can be achieved:

1. Ecological efficiency - wind erosion decreases by 15-20%, the number of dusty days is reduced, and the air quality index improves.

2. Social effectiveness - the population's access to recreational areas will expand, healthcare costs will decrease, and the quality of life will improve.

3. Economic efficiency - tourism potential will increase, new jobs will be created through green projects, and opportunities for attracting investments will expand.

The research results showed that the implementation of green infrastructure ensures environmental, social, and economic efficiency. Ecologically, wind erosion is projected to decrease by 15-20%, the number of dusty days will be reduced, and the air quality index will improve. Social effectiveness is manifested in the expansion of the population's access to recreational areas, a reduction in healthcare costs, and an improvement in the quality of life. From an economic point of view, an increase in tourism potential, the creation of new jobs, and the expansion of investment flows are expected. One of the important issues identified during the discussion is the lack of financial resources. For the large-scale implementation of green infrastructure elements, it is necessary to harmonize the funds of the state budget, international organizations, and the private sector. International experience shows that 45% of projects in Europe are financed through public-private partnerships, and in Asian countries - through international grants.

The level of ecological culture of the population is also an important issue. As a result of the survey, 40% of respondents stated that they do not have sufficient knowledge about planting trees and maintaining green spaces. Therefore, along with the implementation of green infrastructure projects, it is necessary to strengthen environmental education and awareness-raising activities.

According to official statistics, the area of green spaces in the city of Nukus was expanded by 3% in 2023, but this indicator is still low in accordance with international recommendations. According to the standards of the World Health Organization (WHO), there should be at least 9 square meters of green space for each urban resident. In the city of Nukus, this figure is only 5.2 square meters

[12]. Therefore, a new strategy based on green infrastructure can eliminate these shortcomings.

The following proposals were put forward in the development of the urban planning strategy:

• Creation of a new recreation area of 150 hectares along the Amu Darya River in the city of Nukus;

• Formation of ecological landscape zones around 70 hectares of artificial reservoirs in Kungrad;

• Creation of 40 hectares of green corridors along river tributaries in Takhtakupyr;

• Double the existing parks in Shumanay and create new forest plantations.

If these proposals are implemented, by 2030 the environmental indicators of the western-northern cities of Karakalpakstan will significantly improve. It is predicted that the amount of dust in the air will decrease by 18 percent, and the total share of green areas will reach 15 percent.

In addition, the green infrastructure strategy will have a positive impact on the regional economy. For example, the creation of a new recreation area in the city of Nukus will attract more than 50 thousand tourists a year. In Kungrad, ecological zones created around water bodies contribute to the development of fishing, tourism, and the service sector.

The green infrastructure strategy developed for the western-northern urban areas of Karakalpakstan is an important tool for ensuring environmental sustainability, strengthening social equality, and stimulating economic development. The research results showed that the existing green areas are insufficient in terms of volume and quality, are unevenly distributed across the territory, and do not function as a single system. Therefore, an integrated approach to territorial planning is necessary. The concept of developing green corridors, ecological parks, recreational areas by the water, and green spaces associated with cultural heritage plays an important role in ensuring the ecological and urbanistic sustainability of cities [6]. Thanks to the implementation of this strategy, environmental indicators will improve, public health will be strengthened, tourism and small business will develop, and the investment attractiveness of the cities of Karakalpakstan will increase.

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