ЕКОЛОГІЯ

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Landscape-ecological carcass model of urban landscape and methods of optimize urban landscapes (on the patterns of Ganja and Mingachevir cities)

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ABSTRACT

State of the problem. The article outlines the natural and anthropogenic foundations of urban landscapes and the organization and modeling of ecological carcasses. Currently, the impact of human activity in the area, on the landscapes, especially on urban landscapes, sometimes leads to the fundamental change and reconstruction of several landscape units or components, the degradation of the sensitive ecosystems of the area, and the creation of completely anthropogenic complexes.

Object learning. The main object learning is as follows; study of the differentiation characteristics of the factors influencing the formation of modern geosystems (relief, climate, hydrological and hydrogeological conditions, etc.), researching eco-geographical problems caused by anthropogenic changes, drawing up a map with appropriate content on a large scale, structural and functional characteristics of modern natural geosystems spreading in the research area, exposure to severe anthropogenic influences, study of ecological problems, studying the structural-functional aspects, levels of anthropogenic loading and assimilation, as well as the ecological condition of the modern natural geosystems spreading in the research area, complex study of optimization and large-scale ecological stability, drawing up of ecological potential assessment maps of landscapes.

The purpose of this study is the landscape ecological formation of urban landscapes in the Republic of Azerbaijan, the optimization of urban landscapes, the analysis and generalization of urban development processes at the level of urban creation and living environment, and the determination of the main regularities of the formation of this environment, taking into account innovation and traditional processes.

Methodology. Ecological analyses were carried out on relevant urban landscapes, and four environmental hazard zones were identified in Ganja, and three in Mingachevir (1: 20000) scale ecological risk maps were drawn up. In the end, the principles of the organization of "ecosystems" based on the optimization of both urban landscapes were analyzed.

Research results. The degree of anthropogenic disturbance of the territory was determined, and a map-scheme of the ecogeographic assessment of landscape complexes was drawn up. The study of anthropogenic changes in natural landscapes and the evaluation of the anthropogenic impact in percentage according to digital electronic map fragments was carried out. In the ArcGIS program, the inclination and exposure of slopes in the area, the hypsometry of the relief in the area, the density of roads, the ecogeographical condition of modern urban landscapes, risk zones, and optimization of urban landscapes, etc. maps have been drawn up.

The scientific novelty of the research. The importance and functional role of the city as a complex living environment for the country's population is defined. In the process of city planning in the Republic of Azerbaijan, the face of the city, the composition system of urban architecture, innovations, and traditional features are determined. The main city-forming function and role of the river were determined in the studied cities. And the linear features of the development of the cities, and the differences in formation were determined and analyzed. Accordingly, each of the cities has its own unique development models. Environmental problems of cities were investigated and environmental risk and optimization maps were drawn up.

Keywords*: urban landscapes, ecological state, ecological norm limit, optimization of landscapes, landscape-ecological carcass.*

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Introduction As a result of hundreds of years of spontaneous use of natural resources, natural landscapes have undergone global changes and different levels of anthropogenicization. Increase of the world population, expansion of its need, continuous increase in the use of mineral resources, an application of new technologies and expansion of production in the fields of energetics, industry, agriculture and transport, anthropogenic change of the world landscapes, in the background of expansion and complication of the international economic relations increase of urban landscapes are happening.

These or other factors have led to the strengthening of society's interaction with nature and an increase in the anthropogenic burden on natural landscapes. It is impossible to make efficient use of natural resources, to predict the preservation of natural landscapes in a condition suitable for human life without knowing its complex and interconnected mechanisms of ecological balance and deep knowledge of ecology. From this point of view, the demand and interest in solving landscape and ecological problems and shortages in environmental protection is growing day by day.

Method and study level. During the research, the field research materials, mathematic-statistic methods and ArcGIS 10.3 program in mapping have been used. The research was performed by Y.A. Garibov [2, 3, 4], M.J. Ismayilov [6], and others in this area in Azerbaijan, also M.M. Nazaruk, O.H. Topchiev in Ukraine [20, 24]. However, optimization of landscapes must become rich with the new research according to the requirements of the time. Landscape optimization is a social-economic requirement. Properly, scientifically optimized geosystems must fully compensate for the livelihoods of present and future generations and ensure ecological balance and biodiversity. It is important to take into account the risk and dangers of natural anthropogenic origin which form a danger for the population's life activity.

Ecological analysis of the urban landscapes. Recently, the horizontal and vertical structures and functional elements of urbanization and urban landscapes are rapidly increasing in Azerbaijan, as well as all over the world [1, 7, 8]. The introduction of new man-made, seliteb, and road communication elements in the urban landscapes requires a consistent analysis of the ecological situation of the landscape here. For this purpose, the landscape-ecological situation was studied by the monitoring information of the Ministry of Environment and Natural Resources and our field research in Ganja and Mingachevir (table 1, 2).

Although an average and maximal density of dust, Nitrogen 4 oxide, Nitrogen 2 oxide, hydrogen sulfide, and hydrogen fluoride are normal in the atmosphere of Ganja city, but the average and maximal density of sulfur dioxide is higher than the others. The amount of dust, carbon monoxide, and phenol is more than the norm in Mingachevir City (table 1 and 2).

Table 1

Dynamics of maximal density (mg/m^3) of noxious substances in the atmosphere of Ganja city

Ingredients	DPL mg/m^3	Years (mg/m^3)				
		2012	2013	2014	2015	2016
Dust	0,15	0,4				
Sulphur dioxide gas	0,05	0,054	0.059	0.054	0.061	0.052
Nitrogen 4-oxide	0,04	0,23	0.06	0.05	0.06	0.05
Nitrogen 2- oxide	0,06	0,04	0.04	0.05	0.04	0.05
Hydrogen sulfide	-	0,008	0.004	0.004	0.004	0.003
Hydrogen fluoride	0,005	0,009	0.009	0.009	0.009	0.009

Table 2

Maximal density (mg/m^3) of noxious substances in the atmosphere of Mingachevir city

Ingredients	DPL mg/m^3	Years (mg/m^3)				
		2012	2013	2014	2015	2016
Dust	0,15	0.7	0,5	0,7	0,8	0.7
Sulphur dioxide gas	0,05	0.030	0,028	0,020	0,087	0.021
Carbon monoxide	3	4	5	5	5	6
Nitrogen 4-oxide	0,04	0.07	0,16	0,06	0,06	0.06
Nitrogen 2- oxide	0,06	0.12	0,05	0,05	0,05	0.04
PH	0,003	0.009	0,009	0,009	0,009	0.009

Landscape - ecological carcass to use the landscapes as an ecological passage. The river-valley landscapes are the most optimal variant to play an ecological passage role. Such landscapes form buffer zones among the techno-genic landscapes as the main elements of the ecological carcass in the city. There

are less built structural units and these are structural units of urban landscapes loaded with more greenery [14, 15, 16].

A zone of the landscape-ecological carcass mustn't be less than 25% of the total area of the urban landscape according to the available ecological norms. The basic and second-degree elements of the landscape-ecological carcass are separated in the system structure. The basic elements provide natural-ecological completeness of the landscape. They execute the regulatory function of the ecological balance in the urban landscape and protect biological diversity. The second-degree elements execute functions of the basic elements at a local level [5, 17, 21, 25]. The basic elements are separated into some groups: 1. Basic; 2. Key elements; 3. Transit elements. The second-degree elements are separated into groups: 1. Local elements; 2. Buffer elements; 3. Rehabilitation elements (Fig. 1.)

A means of formation of the landscape-ecological carcass is to realize measures system in planning and development of the urban zone. This means that it is impossible to optimize the urban landscapes without the composition of the ecological carcass model. The greenery norm is 10 m^2 per capita. The greenery work is the most important ingredient of the ecological carcass formation. While forming the "green passage" of the ecological carcass, proper selection of preferred plants is also a very important factor [9, 10, 13, 19]. So, the plants suitable for the climate at the regional level and the microclimate at the local level should be selected and planted (Fig. 2).

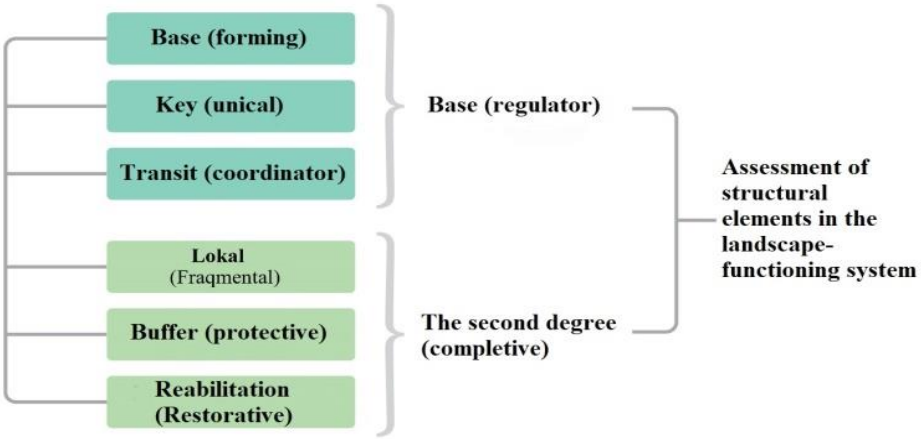

Fig. 1. Structural elements of the landscape-ecological carcass

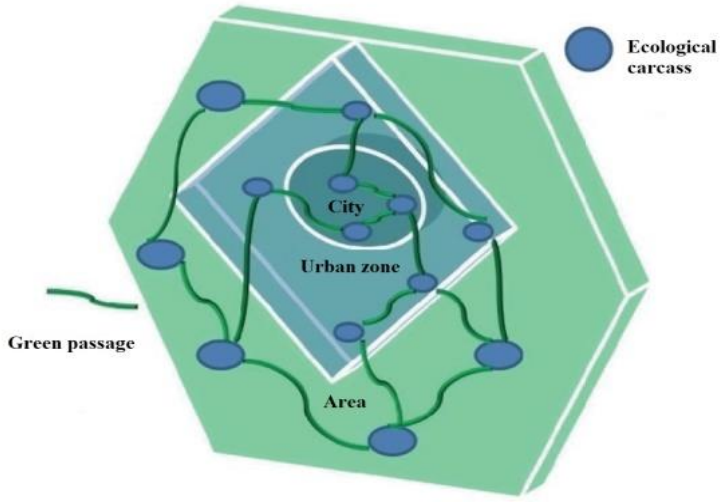

Fig. 2. Landscape-ecological carcass model in Ganja and Mingachevir cities

Examples of the main ecological carcass elements are Ganjachay as a base element and local green areas as secondary elements. In Mingachevir, it is more convenient to take the main base element of the landscape-ecological carcass, the river-valley landscapes of the Kur, and the aquatic landscapes of swamps as a key element. From the second level elements of the ecological carcass, it is expedient to organize and include special sanitary protection zones around small-scale natural-anthropogenic greenery, suburban agro-landscapes, and reaction areas, and rehabilitation elements. Each of the above-mentioned ecological carcass elements of the urban landscape in Ganja and Mingachevir cities must be

coordinated with the other by corresponding "green passages" of different levels.

From this point of view, we propose to give the main advantage to local plants when conducting landscaping in Ganja and Mingachevir which are the research zones. This will not only protect urban landscapes but also help maintain the ecological balance between their structural elements of natural and anthropogenic origin. According to the available ecological norms, an area of the ecological carcass shouldn't be less than 25%. If we take into account that at present the area of the landscape ecological carcass is 27,5 km^2 in Ganja, but in Mingachevir it mustn't be less than 32,5 km^2. This index falls behind in both urban landscapes. So, its area is 1,4 km^2 (1,3%, 23,7% less than the ecological norm) in Ganja, but in Mingachevir it is 6 km^2 (4,6%-20,4% less than the ecological norm).

"Ecocity concept". The future city is considered an eco-city, eco-polis. The American ecologist Richard Register used this term for the first time in 1978 [6]. This is an ecologically clean city. Some researchers think that the eco-city must provide itself with energy freely. The settlement zone should be at a minimal level. The role of "ecological passages" is especially important in the formation of the cities. One of the reasons for the eco-city's formation is the preservation of the natural environment of the city [11, 12, 23].

Six eco-cities are available in the countries of the European Union: Malmo (Sweden), Dublin (Ireland), Tallinn (Estonia), Hillerot (Denmark), Hamburg (Germany), Augustemburg (Denmark). Besides, the eco-cities exist in North America and Australia. Its formation is planned in the south of moscow. According to the russian scientists' idea satellite cities with a population of up to 300 000 can be created as eco-cities [18, 21]. It should include a park and park-garden recreation area. We offer Mingachevir as an eco "city" taking into account the population. Because the city of Mingachevir fully justifies itself and meets the requirements among the cities studied, both in terms of energy self-sufficiency and the characteristics of the population.

Optimization. It is necessary to fulfill the most accurate measures system which will be realized for the elimination of the ecological problems, that is a process of landscape optimization in a planned form in the zone [2]. Optimization of the landscapes is a purposeful process that is realized to improve the environmental stress and risk zones by assessing the current ecological state [7]. The best optimization method is considered greenery. In both cities, which are the research area, conifers are the phytoncide they secrete. Correct placement of sanitary-protection zones is an important factor.

The ecologically risky zones of the urban landscapes are grouped according to the riskiness degree [19]. There are five risky categories: 1. with a radius of 1000-2000 m; 2. with a radius of 1000-500 m; 3. with a radius of 500-300 m; 4. with a radius of 300-100 m and 5. with a radius less than 100 m. There are four of this group of risk zones belonging to groups 1, 3, 4, and 5 (Fig. 3).

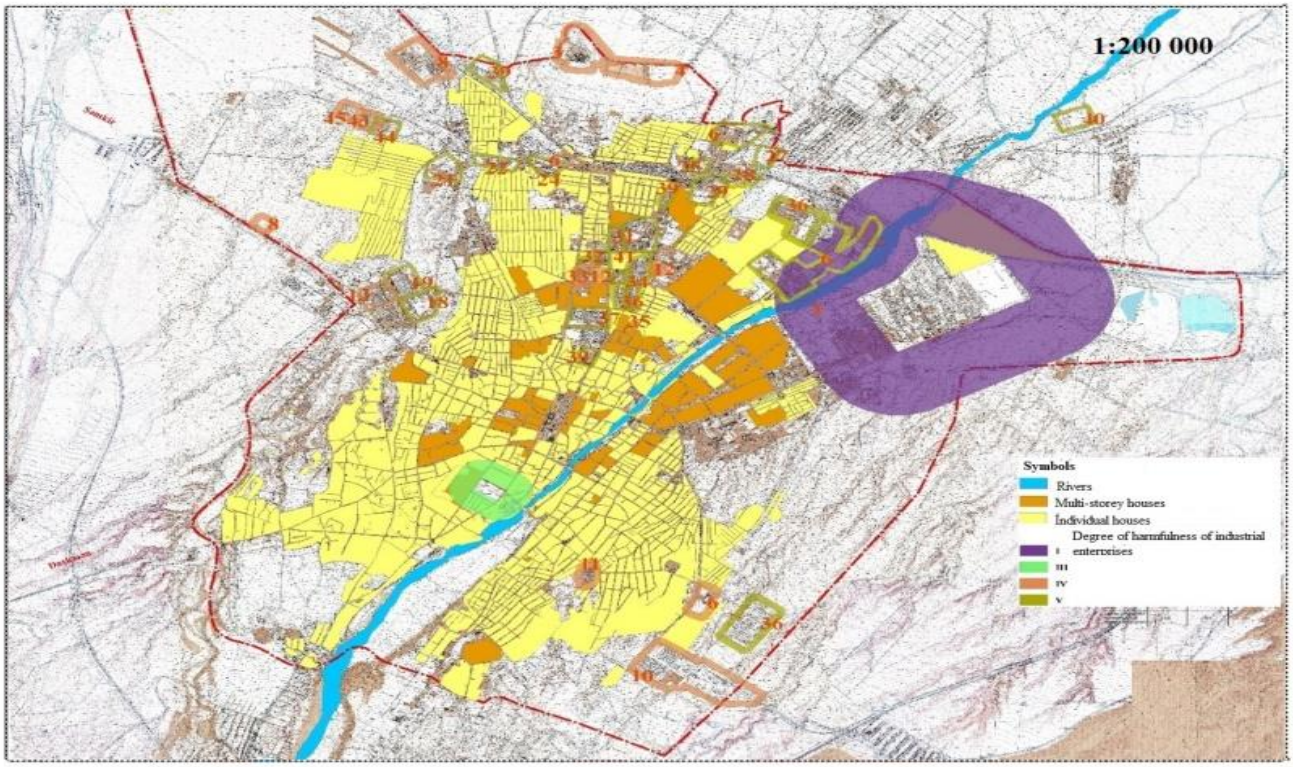

Fig. 3. Ecologically risk and optimization map of Ganja city

The optimization measures are fulfilled by building sanitary protection and greenery zones in the same radius [17]. This is possible at the expense of the "green passages" that connect ecological carcass elements (Fig. 4).

There are 4 zones in the chain of ecological risk category in Ganja and 3 zones in Mingachevir. The reason for its predominance in Ganja is that it is the largest industrial city in the country which makes the urban landscape in Ganja larger than in Mingachevir. Three of the ecologically risk zones, the zones that belong to the 1, 2, and 4th groups exist in Mingachevir (Fig. 4). So, the realization of the measures optimized by the scientific methods of geosystems is the main way of achieving resistant social-economic and ecological conditions taking into account the available

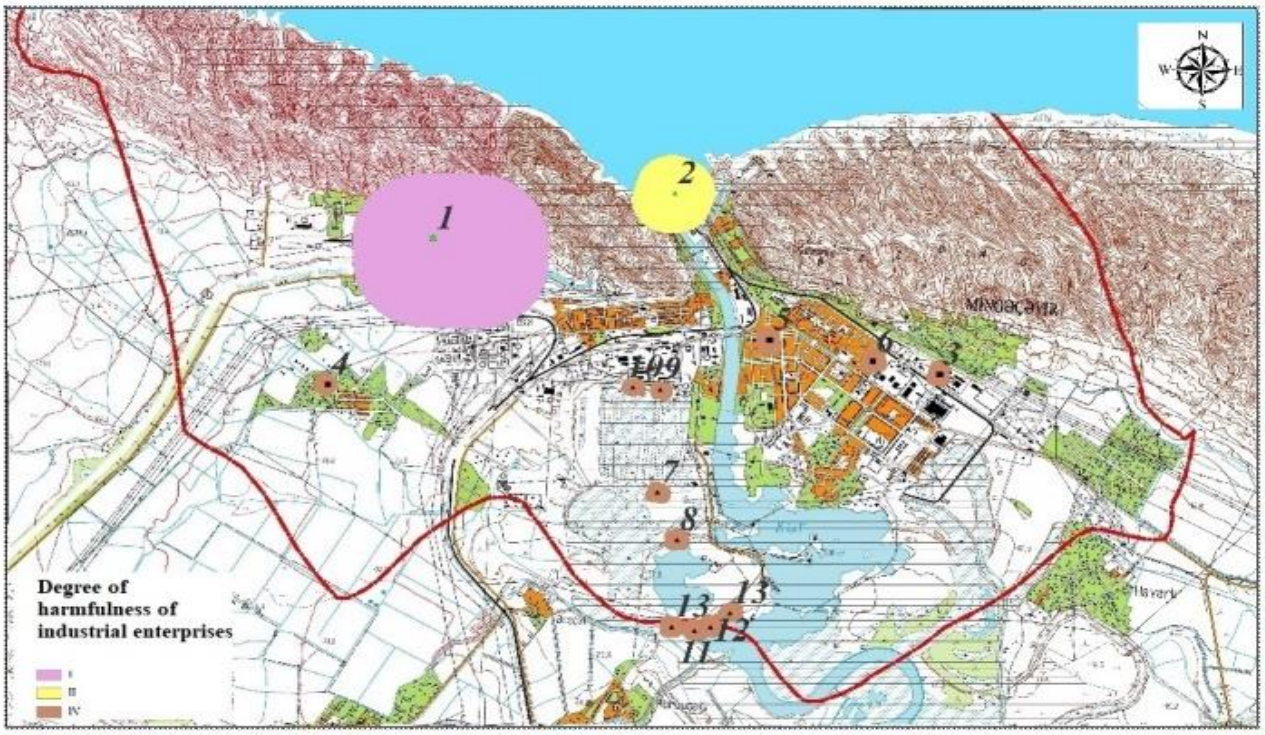

Fig. 4. Ecologically risk zones and optimization map of Mingachevir city

environment in Azerbaijan [3].

Conclusions. It was determined that the permissible ecological norm level of some ingredients in soil, water, air, and plant cover of the urban landscape was repeatedly violated. The average and maximal density of sulfur gas is higher in comparison with others in the atmosphere of Ganja. However, the amount of dust, carbon monoxide, and phenol is more than the ecological norm in Mingachevir. The ecological problems in the basins of the cities have been investigated, and the chemical elements that repeatedly violate the norm of water pollution have been identified. The riskiness rates of the industrial enterprises in Ganja and Mingachevir have been identified, and 4 ecological risk zones in Ganja, and 3 ecological risk zones in Mingachevir have been determined, the large-scale maps (s=1:20 000) which reflect corresponding sanitary-protective zones have complied to optimize the same zones.

The ecological carcass models were suggested for the urban landscapes in Ganja and Mingachevir for the first time, and the main and second-degree ecological carcass elements that are met in their zone over corresponding urban landscapes were identified. The present positions of the ecological carcass elements in the city zones and their importance were analyzed. The formation of the ecological "green passages" which connect the same elements was proposed.

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Ландшафтно-екологічна каркасна модель міського ландшафту та методи оптимізації міських ландшафтів (на прикладах міст Гянджа і Мінгечевир)

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У статті окреслено природні та антропогенні основи міських ландшафтів та організацію і моделювання екологічних каркасів. В даний час вплив людської діяльності на території, на ландшафти, особливо на міські ландшафти, інколи призводить до кардинальної зміни та реконструкції кількох одиниць або компонентів ландшафту, деградації чутливих екосистем території, створення повністю антропогенні комплекси. Метою даного досліджен-

ня є ландшафтно-екологічне формування міських ландшафтів Азербайджанської Республіки, оптимізація міських ландшафтів, аналіз і узагальнення процесів містобудування на рівні міського створення і середовища проживання, а також визначення основних закономірностей формування цього середовища з урахуванням інноваційних і традиційних процесів. Було проведено екологічний аналіз відповідних міських ландшафтів, і було визначено чотири зони екологічної небезпеки в Гянджі та три в Мінгечавірі (1:20000). Були проаналізовані принципи організації «екосистем» на основі оптимізації обох міських ландшафтів. Визначено ступінь антропогенної порушеності території та складено карту-схему еколого-географічної оцінки ландшафтних комплексів. Проведено дослідження антропогенних змін природних ландшафтів та зроблено оцінку антропогенного впливу у відсотках за фрагментами цифрових електронних карт. У програмі ArcGIS було складено карти нахилу та експозиції схилів місцевості, гіпсометрії рельєфу місцевості, щільності доріг, екогеографічного стану сучасних міських ландшафтів, зон ризику та оптимізації міських ландшафтів тощо. Визначено значення та функціональну роль міста як комплексного середовища життєдіяльності населення країни. У процесі містобудування в Азербайджанській Республіці визначається обличчя міста, композиційна система міської архітектури, нововведення, традиційні риси. У досліджуваних містах визначено основну містоутворюючу функцію та роль річки. Визначено та проаналізовано і лінійні особливості розвитку міст, і відмінності у формуванні. Відповідно, кожне з міст має свої унікальні моделі розвитку. Досліджено екологічні проблеми міст, складено карти екологічних ризиків та оптимізації.

***Ключові слова**: урбанізовані ландшафти, екологічний стан, екологічна нормативна межа, оптимізація ландшафтів, ландшафтно-екологічний каркас.*

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