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COMPREHENSIVE GEOECOLOGICAL ASSESSMENT OF THE FEATURES OF URBANIZED TERRITORIES

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Objective. *The aim of the study is to identify important features of the geoecological study of cities, as well as to consider the main approaches and methods that are used in the geoecological analysis of morphologically heterogeneous indicators.*

Materials and methods. *The object of research is geosystems in geography and ecosystems in ecological science. It is this systematic approach that brings ecology and geography closer together.*

Results. *As a result of the interaction of society with the natural environment, one can see a new branch of knowledge - geoecology. So, it is necessary to take into account spatial or territorial patterns. The science of geoecology is the link between geography and ecology for solving various problems of the natural environment. Exactly, we can talk about the spatio-temporal features that have the interaction of organisms with the environment and territorially differentiated systems of relationships.*

Conclusion. *At the present time, the modern interest of society in environmental science is quite explainable. Its main problem is survival in those conditions of the natural environment, which are greatly changed as a result of human economic activity. All over the world, a large role is assigned to the health of the population due to the problem of anthropogenic pollution of the environment. It causes significant damage in the geographical, biological, economic spheres, as well as its individual enterprises. There is a serious threat of violations not only of the biosphere, geosphere, atmosphere, but, in general, the entire geographic envelope. The first area is the subject of environmental research, and the second area is geography. As a result of these events, one can undoubtedly speak of a huge similarity and overlap between these sciences.*

Keywords: *geoecological research; geosystem analysis; city; geographical approach; geographic environment; landscape approach; ecological approach; ecological-geographical analysis*

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Научная статья | Геоэкология

КОМПЛЕКСНАЯ ГЕОЭКОЛОГИЧЕСКАЯ ОЦЕНКА ОСОБЕННОСТЕЙ УРБАНИЗИРОВАННЫХ ТЕРРИТОРИЙ

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Цель работы. Целью исследования является выявление важных особенностей геоэкологического изучения городов, а также рассмотрение основных подходов и методов, которые используются при геоэкологическом анализе морфологически неоднородных показателей.

Материалы и методы. Объектом исследования являются геосистемы в географии и экосистемы в экологии. Именно такой системный подход сближает экологию и географию.

Результаты. В результате взаимодействия общества с природной средой можно увидеть новую отрасль знаний – геоэкологию. Итак, необходимо учитывать пространственные или территориальные закономерности. Наука геоэкология является связующим звеном между географией и экологией для решения различных проблем природной среды. Именно, можно говорить о пространственно-временных особенностях взаимодействия организмов со средой и территориально дифференцированных системах взаимоотношений.

Заключение. В настоящее время современный интерес общества к науке об окружающей среде вполне объясним. Его главная проблема – выживание в тех условиях природной среды, которые сильно изменились в результате хозяйственной деятельности человека. Во всем мире большая роль отводится здоровью населения в связи с проблемой антропогенного загрязнения окружающей среды. Она наносит значительный ущерб в географической, биологической, экономической сферах, а также отдельным ее предприятиям. Возникает серьезная угроза нарушений не только биосферы, геосферы, атмосферы, но и вообще всей географической оболочки. Первое направление – предмет экологических исследований, второе – география. В результате этих

событий, несомненно, можно говорить об огромном сходстве и пересечении этих наук.

Ключевые слова: *геоэкологическое исследование; геосистемный анализ; город; географический подход; географическая среда; ландшафтный подход; экологический подход; эколого-географический анализ*

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Introduction

Currently, geoeological research is at the stage of its active development. They are aimed primarily at solving the problems of many issues that can be studied within the framework of such geographical systems as “nature - economy - society”. All this can take place on the basis of comprehensive research: ecological, physical-geographical, economic-geographical and socio-ecological.

Research in the field of geography and ecology is aimed at developing not only theoretical foundations, principles and standards for rational environmental management, but also sustainable development of society, as well as optimizing its interaction with the natural environment [5; 31].

At the moment, studying the modern urban system is an interesting and challenging research process. This is a special territorial system, which is both a complex national economic complex and a form of human settlement. In this case, the approach to the study of the urban environment must necessarily be comprehensive, even when the study of the sides of his life takes place separately [13; 29].

One of the main tasks of the geoeological study of the urban system is to show it as a complex of interacting geographic and socio-economic phenomena [4; 10]. That is, it is need to know not only the peculiarities of its position, identify patterns of population and territory growth, assess natural conditions as an environment for development, but also identify the features of the economic component and relationships in the settlement system, relationships with the natural environment [9; 27].

When conducting such a study, the main thing is to pay attention to the study of geoeological studies, as well as environmental problems and the development of the city [41; 42; 44].

A feature of the geoeological studies of cities is the different quality and different scale of the elements of its geosystems, as well as the extreme diversity [28; 35]. Thus, geoeology focuses on comprehensive studies that are associated

with the quality of the living environment of the population and the development of recommendations for rational nature management, with a geoecological assessment of the consequences of economic activities.

Methods

In this article, to study the features of the geoecological study of cities, a group of theoretical methods was used using analysis, synthesis, abstraction, the rules of abstract logic, the theory of similarity and analogy, as well as various specific scientific and general scientific principles and methods.

The methodological setting of geoecological research can be formulated as a set of the following approaches: ecological, landscape, geographic. A number of scientists distinguish the methods of geoecological analysis: the method of ecological-geographical analysis, the method of geosystem analysis, methods of cluster and factor analysis. The most important are ecological-geographic and geosystem analysis [13]. In the geoecological analysis of a large number of morphologically heterogeneous indicators, cluster and factual analysis methods are used.

Discussion

It is important to say that the science of geoecology as a geographical discipline becomes the science of the geographical environment as a whole, as well as its natural territorial complexes, geosystems. All this is studied as a habitat for organisms on the one hand, but on the other hand, as an environment for socio-economic activity. The aim of the study is to optimize the solution of problems that are associated with the state of the surrounding landscapes, natural and anthropogenic processes affecting it, with the receipt of natural benefits. Namely, the totality of natural resources and conditions that can be used by humanity.

Results

From the point of view of studying geoecological research, it is worth paying special attention to the problems of the development of the environment and the urban system.

As early as the 4th century, there were the beginnings of urban settlements. The word “city” originally meant “fenced in”, after a while - a settlement, protected, fenced.

From history, the concept of “city” included [20]: a fairly clear demarcation of the location using a different type of fence; the need for a number of functional systems that are associated with defense and administration (secular and ecclesiastical), craft, trade and education; certain civil rights of the urban

area, as well as forms of self-government, which in most cases are enshrined in customs, traditions or laws.

As a result, it can be noted that in the past the city fulfilled the social needs of people and satisfied their psychological, biological, labor, material, ethnic, social and spiritual needs. He also kept them safe and healthy, while providing resources. An urban area is the place that the population has deliberately chosen and implemented their habitat here or occupied an ecological niche [30; 38]. The basic rules for building an urban system are: safety, accessibility, resources, health and attractiveness.

After some time, the urban area has undergone changes in the time of social, demographic, natural, economic, technological, political phenomena and processes [2].

According to the size of cities, at present, the following classification has been adopted in geography: small cities – up to 50 thousand inhabitants, medium – 50-100, large – 100-250, large – 150-500, the largest – 500-1000 thousand inhabitants and over 1 million are millionaire cities.

The concept of “city” lies in the ecosystem, which includes three complex subsystems:

1. Natural environment. It consists in the totality of the following systems: man-made, natural, economic and social.

2. Urban population. It unites the totality of people who are connected by the urban environment and social relations. They are engaged in the definition of a number of functions: the development and management of the city, its functioning, the development of the urban area [36; 38]. But the urban population is the main city-forming factor [32; 34].

3. Urban environment. This subsystem includes the habitat of human production activities. It consists in the totality of man-made, social, natural and economic conditions of human life.

As you know, the geoecological state of urban areas, as well as the quality of the living environment of the urban population are determined, first of all, by the relationship of natural and anthropogenic factors. The urban environment in small and large cities is largely different. At present, one can see a deterioration in the quality of the environment in large cities, where human economic activity is most manifested, and in small and medium-sized ones [26].

Researchers of urban areas distinguish three main groups of processes that affect the successful development of the city: natural (endogenous and exogenous); natural-man-made (natural, but qualitatively and quantitatively changed by human economic activity); technogenic (arose as a result of human engineering and economic activities).

The main purpose of studying the natural conditions in a given place is to determine what is the greatest impact of individual fragments of the natural environment on certain elements of the economy of the urban system [15].

Regardless of social and natural adverse events, the development of small and medium-sized cities is determined [8]. The permanent existence of small towns is determined, first of all, by their direct relationship with the natural and anthropogenic environment. The ecological resources of a small town depend, to a greater extent, on natural factors, the state of the environment, lands, historical and architectural landscapes, and forests. The material and energy resources of the environment include the main condition for the sustainable existence of a small town. Thanks to them, a small town retains significant independence from external social and economic changes.

Small towns located in the forest-steppe zone are more sustainable. The high ecological potential of these cities is explained by the presence of the following factors: supplies of drinking water, building materials, energy resources; optimization of the use of household plots to provide the entire population with food; the use of fertile soils. However, small towns have the main elements of urban infrastructure: schools, warehouses, communications, hospitals, libraries, local industrial enterprises [21; 43].

The ecological potential of a small town is the property of a given territory to maintain its system under the influence of external factors (man-made and natural), to make it possible to perform other or additional socio-economic functions of a small town [1]. All this can be done provided that there is no deterioration in the living conditions of the urban and rural population, as well as be able to continue to perform socio-economic functions within the specified limits. It should be noted that the ecological potential of the urban environment is formed from the sum of the potential of the location and the potential of the territory.

Three groups of factors [33] are determined using the location potential: transport accessibility is the need to go to the minimum transport costs; work orientation (labor resources) – minimum labor costs are required; striving to benefit from the territorial concentration of production [40].

The potential for the location of the territory is ascertained by regional conditions: physical and geographical, as well as economic and geographical.

Geographical resources (construction, industrial, aesthetic, recreational) and those properties of natural conditions that determine the characteristics of these territories, as well as its suitability and significance, affect not only for living, but also for the comfortable existence of people, i.e., to create a habitat [34].

Most often, outside the city, natural factors are used to determine the microclimate, and in the urban area, urban planning factors are the main ones.

The climate of the area is seriously affected by the technological processes of the development of industry and energy, the development of transport in the urban environment, as well as emissions of negative substances into the atmosphere [16; 17]. It should be noted that the influx of direct solar radiation to the active surface of the earth decreases by 10-25%, however, in the surface layer of the city, the temperature rises by 8-160C.

The climate of the urban area, together with other meteorological factors, is determined not only by the wind regime, but also by the nature of the underlying surface. An important aspect of the surface of urban development is the existence of semi-enclosed spaces in it, snatched out by the development plan. The nature of the circulation of air flows is significantly affected by the increased surface roughness of urban locations with high-rise and low-rise buildings. Heat transfer to the environment can be very difficult due to the mutual irradiation of vertical and horizontal surfaces and weakened ventilation inside semi-enclosed rooms. Special microclimate conditions are also formed by various artificial surfaces [17].

In the event that more than 50% is the building density, then this characterizes, mainly, the ancient territory. Here you can designate the highest degree of surface coverage by all kinds of road surfaces; areal distribution of technogenic soils, the greatest thermal impact on soils, often in industrial areas, as well as soil pollution (chemical and biological). In urban areas with low-rise planning, natural landscapes dominate. These include: open water bodies, natural relief, forest parks, parks and other green spaces. It can be noted that nature itself is included in the landscape of such urban complexes. In humans, environmental needs are met through the unity of buildings in space, as well as the same surfaces and green spaces. These urban areas can be called complex natural-anthropogenic systems. In these cities, it is necessary to preserve green spaces, which are equal in area to territories occupied not only by asphalt pavements, but also by industrial zones, various buildings and many other urban structures.

The concept of a city includes a system that functions and develops very quickly [18]. It includes such sections as housing and communal services, the system of social services, transport infrastructure, as well as medicine and education, leisure and recreation facilities.

An accumulation system can also be called a city. Harmful substances within the city, as a rule, have a positive balance. All this leads to the accumulation of waste that was received earlier in the previous transformations; to the violation of the natural relief of the area: in some places there are hills, and somewhere landslides and sinkholes. Natural surface water resources can become silted up and, as a result, change their direction. For convenience, water streams are hidden un-

derground in the sewers of the drainage system. The consequence of this is the termination of the natural self-purification of water and the content of harmful impurities increases. As a result, the composition and properties of water change [25].

Phenomena not characteristic of living nature have a certain pattern of accumulation in the city. So, the atmosphere is clogged with gas emissions, soils accumulate harmful substances. Since nature loses its ability to heal itself and is unable to recycle all the negative consequences of urbanization, the effect of their accumulation occurs.

An ecosystem can also be called a city, which has a huge interdependence with the environment. Typically, all ecosystems are open, and cities are ultra-open ecosystems. They not only depend on the environment as much as possible, but also influence it. On the one hand, the city consumes natural resources and energy, on the other, it produces a large amount of all kinds of waste [6].

The city is an unbalanced ecosystem. The ecological balance within the urban area has been disrupted. The structures of cities develop and function not according to the laws of nature, but, as a rule, in accordance with the needs of people. These structures arise under the influence of the destructive and creative activities of many generations of people. The reaction of nature to such transformations is not always unambiguous [16]. As a result, the amount of matter and energy that the city needs for normal functioning is much more than it produces. Ecological balance, in this case, is achieved by attracting from outside a large number of flows of substances and energy. As a result, the ecological balance of ecological systems is not sustainable.

The urban area is a set of artificial ecological microsystems. Here it is necessary to note the buildings and structures of residential, as well as industrial, communal and warehouse development [22; 39]. Buildings and structures are not an autonomous ecological system due to the fact that they are closed [45]. It is important to note that everything is interconnected with the natural environment. After all, dust, gases and living microorganisms from polluted outdoor air enter the premises. This mode of aeration and insolation does not always ensure the deterioration of the ecological situation in buildings. It is the noise pollution of the territories adjacent to the development that has the greatest impact on the ecological comfort of the internal environment. For example, rail transport also affects vibration phenomena.

There are three main directions for the impact of a modern city on the human environment [14].

First, the creation of a new, high-quality environment. The urban area itself has become a kind of habitat.

Secondly, the urban system has turned into hotbeds of active influence on the surrounding space. At the same time, an active metabolism with the immediate environment is maintained in each city. Examples of city metabolism include the organization of suburban agriculture, as well as the need for water supply and collection of sewage.

Thirdly, the urban system began to noticeably influence the course of natural processes. As a result, the power supply of cities is increasing; there is an increase in industrial production and traffic flows; the length of the zone of contacts between the rural environment and the technogenic environment of the city, where natural processes prevail, is increasing [23; 37].

There are three groups of problems, taking into account the analysis of the problems of interaction between man and the natural environment in a modern city.

Firstly, these are the problems associated with the impact of the man-made changed environment on the urban population [3; 4].

Secondly, these are problems that arise when the (polluted) environment influences urban areas, the landscapes not only of these cities, but also of adjacent territories.

Thirdly, these are problems that are the result of the influence of urban areas (polluted environment) on their material and technical facilities.

It is necessary to dwell on each problem. It is known that environmental pollution negatively affects the health of the population. As a result, due to the poor health of workers, the quality and productivity of labor decreases. Unfortunately, the incidence of children is especially noteworthy [5; 11].

At present, the impact of urban environmental pollution on natural objects is significant. Emissions from urban areas intensively pollute not only water and air basins, but also soil. As a result, this is the destruction of natural systems. Urban planning changes the soil water regime and destroys the lithosphere. The quality of not only water, but also land resources can be preserved only if the anthropogenic load on the soil cover is reduced.

Unfortunately, environmental pollution often leads to irreversible consequences. Gas emissions into the atmosphere in the urban environment, which contain toxic substances, pollute the territory of the city, along with this, the productivity of agricultural crops decreases. In the future, this yield returns to the city along with agricultural products. In addition, polluted and water resources, reservoirs that supply the entire population with fisheries, which contain all those chemicals that come from industrial facilities. Of course, all this has a negative impact on human health [7; 9; 24].

One of the most harmful and dangerous types of soil degradation is their contamination with heavy metals. This creates enormous problems in the active use of

land and water resources. The highest concentration of heavy metals can be seen in dust deposition that settles on artificial surfaces. More dangerous for the surrounding areas is the open soil surface, mainly around parking lots and factories.

According to the degree of pollution in the city, it is possible to determine the areas that are more favorable, from an ecological point of view, for human life, as well as, on the contrary, subject to strong anthropogenic loads [12; 19; 21].

At present, for the study of geoecological conditions, as well as the degree of pollution of the territory, it is of great importance not so much to acquire new knowledge as to systematize it. As a result, a systematic approach is used to study this problem.

Geoecology, mainly, reflects to a greater extent the complex views of the world, as well as complex and ambiguous processes of integration of the synthesis of social and natural phenomena. Ecological, landscape and geographical approaches played the greatest role in its appearance and formation [10; 40].

The direction of the geographical approach is determined by the study of various processes and phenomena that are classified territorially, develop and are organized in space and time.

The use of the landscape approach is carried out to identify patterns of formation, functioning, dynamics and evolution, as well as territorial integration and differentiation of natural complexes - landscapes.

Considering the ecological approach envisages the relationship between the environment and human activities.

The study of a complex complex geoecological process in its structure presupposes the use of a combination of ecological, geographical and many other research methods. The main importance, among them, is the ecological-geographical and geosystem analysis.

Conclusion

Geosystem analysis is a set of methods for studying natural-anthropogenic and natural landscapes. The process is carried out using ways to identify the relationship between components and elements of landscapes and their close relationship with other landscapes.

The concept of “ecological-geographical analysis” includes a set of methods for studying the interaction of natural-anthropogenic and natural landscapes with society. This analysis includes landscape, comparative geographical, distance, cartographic and other methods.

These two analyzes: ecological-geographical and geosystems are aimed at the geoecological assessment of the territory, which consists in determining the

degree of productivity of natural-landscape conditions for human habitation and economic activity.

Of great importance in the geoecological analysis of the maximum number of morphologically heterogeneous indicators is the use of cluster and factor analysis methods. A significant point among a large set of various factors affecting the quality of the natural environment and human health is the selection of the most and least important. Principal component analysis is of particular interest in factor analysis. The most measurable features (observables) are functions of a set of more important existing factors. The main task of factor analysis is their identification. The first factor provides the most valuable information. In comparison with the rest, while the second most important factor again becomes the main one. The number of all these main components cannot exceed the number of primary factors. Components that are of little importance are usually not considered. All this allows you to narrow the circle and make it much fewer factors that need to be considered and not lose sight of the most significant ones. Using this method, it is possible to study the impact of natural and anthropogenic factors on the nature and degree of pollution of the study area, as well as due to a comprehensive assessment of the quality of the natural environment, the most significant pollutants are identified and further tasks and measures are proposed to improve this situation.

Cluster analysis methods, or classification methods, can be applied in the study of anthropogenic pressure on cities. Because of this method, it is possible to classify a number of objects in space into clusters or groups. As a result, in the first class you can see objects that are close in meaning, but these classes are distant from each other. Initially, the objects under consideration are studied as a number of independent classes, after which a pair of the most approximate classes is determined; thus, several classes are combined into one. As a result, this number of classes is reduced by one. In the course of the next split, two classes are formed. To study the anthropogenic load on the natural environment, it is best to use in combination the method of cluster analysis and the method of factor analysis.

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