Urbanization as an ecological phenomenon

Mikhail A. Lomskov[1*], *Nikolay* V. Pimenov[1], *Regina* F. Ivannikova[1], *Alexander* M. Konovalov[1], and *Alexander* S. Tishchenko[2]

[1]Federal State Budgetary Educational Institution of Higher Education «Moscow State Academy of Veterinary Medicine and Biotechnology - MVA named after K.I. Skryabin», 23 Academic Skryabin St., Moscow, 109472, Russia
[2]Federal State Budgetary Educational Institution of Higher Education «Kuban State Agrarian University named after I.T. Trubilin», 13, Kalinina str., Krasnodar, 350044, Russia

Abstract. In this article authors discuss the main ecological aspects of the urbanization process. In particular, such phenomena as anthropogenic transformation of the environment, which is the basis of all further transformations forming urban areas, are analyzed. In addition, the processes of anthropogenic change of organisms, for example, cultivation and domestication, are considered. Unfortunately, in modern science, the process of urbanization is usually considered from economic, social, and cultural positions, often without affecting the environmental component. This fact is a significant omission, especially in the context of an increase in the number of natural landscapes transformed by human.

1 Introduction

The legitimization of civic participation in the promotion of the ideas of rational nature management implies certain transformations of the spiritual life of society in the direction of a more distinct value position, expressed in meaningful collective action. Although the concern of the country's population with environmental problems is currently growing, this does not lead to a significant increase in the scale and influence of the environmental movement in the fields of education, politics, economics and culture.

The transformation of the human environment has now reached a huge scale [10]. Anthropogenic pressure has an unprecedented impact on the biosphere of our planet [8, 9]. Never before, during the entire existence of life on Earth, has any biological species had such opportunities to influence (both direct and indirect) on living things, which modern man has. In modern realities, it is quite appropriate to talk about the fact that, with very rare exceptions, there are no places and organisms left on the planet that are not affected to varying degrees by anthropogenic impact [5, 6, 7].

Of particular interest for the study of the processes of anthropogenic impact on the environment are the landscapes created by man, transformed to the highest degree in comparison with natural sites.

As an example of such anthropogenic formations, first of all, it is necessary to mention the territories of cities and urban agglomerations (from Latin «aglomero» – «to join», «to

* Corresponding author: lomskovma@mail.ru

accumulate»), similar to modern cities such as Tokyo, Jakarta, Delhi, Manila, Beijing, Moscow, Sao Paulo, Seoul, Mexico City and many others other.

2 Research objective

Taking into account all the above, the purpose of this work was to analyze the process of urbanization from the point of view of ecological transformations carried out by man in the environment.

3 Research methodology

The following main components were used in the methodology of the research: system review, definitions development, environmental monitoring, critical analysis and synthesis.

4 Research results and their discussion

Initially, in the course of research, it is advisable to consider the definitions of terms often used in this work.

Landscape (from German «landschaft» – «type of terrain», «landscape») – a natural-territorial complex that includes a homogeneous (from the point of view of geology) territory, as well as a natural component interconnected with it, through the exchange of energy and substances (animal and plant life, microorganisms, etc.).

Any natural landscape is characterized by a certain system, a history of development, during which there is a joint transformation of abiotic and biotic components, accompanied by the emergence of adaptations.

Transformation of landscapes (from Lat. «transformation» – «convert», «metamorphosis») – changing the state of the planet's landscapes and associated natural communities. Depending on the reasons that led to the transformation, there are 2 main types of landscape transformation:

- natural (caused by various natural disasters, catastrophes, for example, floods, volcanic eruptions, etc., caused by natural causes without human intervention);
- anthropogenic (associated with various variants of human impact on the environment (deforestation, plowing of land, construction of cities, etc.)).

In the modern realities of the development of human civilization, the transformation of the environment is carried out by people constantly. Man cuts down forests, plows meadows and steppes, drains swamps, changes the hydrological regimes of rivers, builds technological structures and dwellings, lays various roads and other types of communications. All this is by no means a complete list of various options for anthropogenic impact on natural communities.

Thus, the fact of anthropogenic changes on the face, however, such transformations still remain not fully studied and analyzed, especially from the point of view of biological changes occurring in these territories. What terminology should be used to characterize such phenomena? What kind of processes are taking place with the environment in the transformed territories? What changes occur with the organisms that originally inhabited the landscapes that were transformed in the future? What kind of ecological communities do such anthropogenic changes lead to the formation? These and a number of other issues require careful study.

In the scientific environment, the term «urbanization» has been used for many years to describe the processes associated with the urban environment, formed from the Latin word «urbs» – «city» (urbanus – «urban», through the English «urbanization»). The interpretation

of the term «urbanization» in the conceptual cycle of various social and scientific aspects is mainly reduced to the historical and social processes of increasing the role of cities in society, the growth of urban population and the development of urban agglomerations.

Thus, O.A. Panesh (2008) gave the following definition of urbanization: «The historical process of increasing the role of cities in the life of society, associated with the concentration and intensification of non-agricultural functions, the spread of urban lifestyle, the formation of specific socio-spatial forms of settlement» [3]. K.K. Ibragimova with co-authors (2012) supplemented the concept: «The growth and development of cities, the increase in the proportion of urban population in the country, region, world. Acquisition by rural areas of external and social features characteristic of the city» [1].

After analyzing the presented definitions, it becomes obvious that the authors consider this concept exclusively as social, political, economic, but, unfortunately, not ecological in any way. Only the definition given by Z.G. Sayfullina and A.M. Mingazheva (2017) indicates an ecological orientation, but remains very abstract: «The process of increasing the share of the urban population and strengthening the influence of cities on the biosphere» [4].

It becomes obvious that in its original meaning, the term «urbanization» is unacceptable to denote a certain ecological phenomenon, because it does not characterize the processes occurring with the environment at all.

Thus, in modern biological science, including ecology, the following definition should obviously be used:

Urbanization is the process of anthropogenic transformation of biogeocenoses from a natural (little-modified) state to a completely transformed one, with varying degrees of isolation of created objects and buildings from the environment.

In other words, the phenomenon of urbanization is the whole complex of transformations of the planet's environment by man, starting from the first paths trodden by people in the forest or steppe, campfires, etc. to modern megacities, and, potentially, to autonomous cities of the future, including Space exploration.

Being a process of anthropogenic transformation of the environment, urbanization constantly requires a significant amount of energy needed, for example, for the following:

- Construction and repair of buildings, structures;
- Laying and maintenance of communications;
- Providing the population with food and household goods;
- Creation of an appropriate level of infrastructure (medical care, cultural and sports events, education, etc.).

As the population grows, the number of energy subsidies from humans to maintain the stability of the anthropogenic environment increases. As an obvious example, we can mention the increase in the volume of food supplies to large cities. Another question is that not all food products are eventually sold through retail chains and some of them are simply thrown into landfills. This is how the processes of formation of new biocenoses develop, including vegetation changes, synanthropization of fauna, etc.

In order to function in a stable state, the urban system must constantly be under the control of a person who regulates and directs all energy flows, thereby maintaining the stability of the anthropogenic environment. In this aspect, it is possible to trace a certain analogy between cities and pedigreed animals. After all, both modern animal breeds, as technological formations, and cities can exist and fully function only on the condition that the person who created them will ensure the uninterrupted supply of the necessary amount of energy and matter to these systems. It should be recalled that a breed is a group of domestic animals created by a person within a species with homogeneous genotypes that ensure stable transmission of characteristic properties to offspring in a series of generations and existence in certain conditions of the anthropogenic environment (I.G. Lebedev, 2018) [2].

If the supply of energy and substances is stopped for one reason or another, then the destruction of the man-made system will occur. In the case of animal breeds – degeneration, in the case of cities – dilapidation and desolation.

Due to the introduction of a significant amount of energy into the transformed environment, a person, today, is able to carry out cardinal transformations of natural communities. For example, the following conditional stages of transformation of forest communities can be traced:

- Impassable wilds;
- Exploited forests;
- Recreational forests;
- Park-type forests;
- Forest parks;
- Parklands;
- Public gardens;
- Industrial zones (completely paved areas, devoid of any vegetation);
- Completely isolated territories of agro-industrial complexes (for example, poultry farms) or space stations.

All the arguments listed above demonstrate that urbanization is, first of all, an ecological process. This can easily be explained by the fact that, first of all, when creating any settlements, a person transforms the environment (uproots, digs up, changes the hydrological regime of water bodies, etc.). Only after the landscape transformations have been carried out, the construction of various structures begins (both residential buildings and household buildings, infrastructure facilities, for example, shops, hospitals, etc.). It is the anthropogenic transformation of natural objects that is the foundation for further social, economic, socio-political, cultural changes in a particular territory.

Anthropogenic transformation of the natural environment is the basis for the eventual formation of such an urbanized type of landscape as a city. When discussing issues related to the term «city», it is advisable to start with the following. Discussing urban formations from the point of view of environmental science, it is more correct to operate not with the term «city», but to use the concept of «urban landscape», since the concept of «city» is too replicated, blurred, perceived already as a kind of abstraction and, as mentioned above, does not have clear parameters for differentiation from other types of settlements.

Before defining the term «urban landscape», it should be noted immediately that urban structures always negatively affect natural landscapes. This circumstance is explained by the fact that urban planning and sanitary and hygienic standards were of paramount importance in the planning of urban areas. As a rule, sufficient attention was paid to environmental issues.

It should also be mentioned that, as a rule, the planning and design of urban areas were carried out according to standards that determine the requirements not for the city (as an integral territorial entity), but for its individual districts that differ in their functions (for example, industrial zones, engineering and transport corridors, etc.). As a result of the application of such a project approach to the city as to disparate territories, at present the structure of many cities is not a single whole and undergoes periodic restructuring in the conditions of an already changed (anthropogenic) environment.

At the initial stages of the transformation of territories, a person carries out structural and functional changes in the natural landscape, transforming the vertical and horizontal structure of natural-territorial complexes, creating a new category of territorial formations – urban landscapes.

An urban landscape is an area with an anthropogenically created structure formed on the basis of the original natural and constantly (to one degree or another) transformed in the course of its existence.

The transformation of territories already transformed by man is carried out during the construction of urban facilities, communications, roads, and the functioning of those already built. Thus, the main components determining the structure of urban landscapes are engineering communications and the road network. They determine the direction and intensity of the main flows of energy and substances in cities.

The process of formation and development of cities leads, among other things, to significant transformations in the following structures and phenomena:

- the relief of the Earth 's surface;
- physical and mechanical properties of rocks;
- hydrogeological conditions;
- directions of individual physic-geological processes.

So, in particular, there are usually two processes in urban areas: lowering and raising the surface marks. The first of them is connected with the cutting of the soil, terracing of slopes, the device of recesses, lowering and subsidence of the earth's surface. The second is caused by the movement of soils, storage of dumps, solid industrial and household waste, filling of ravines, swamps, etc.

It should also be noted that within urban landscapes, as in the formation of cities, and to maintain their functioning, a person transforms the environment not only on the surface, but also in the soil environment and in the lithosphere. This circumstance, from the point of view of ecology, fundamentally distinguishes the city from other settlements (villages, rural area, etc.). In particular, there are large underground utilities in cities, represented by various pipelines, electric cables, etc. In many cities, there is a subway, the construction and operation of which radically transforms the structure of the soil to depths of about 100 m (depending on the depth of the stations).

Do not forget about the pressure exerted on the earth's surface by multi-storey buildings, skyscrapers. The impact of all these man-made factors is absent in rural areas.

Thus, as one of the defining ecological criteria for distinguishing a city from all other forms of anthropogenic settlements, it would be advisable to operate with the degree of environmental transformations carried out by man not only on the surface, but also in soil horizons.

At the present stage of the development of environmental science, it is obvious that by influencing the environment and creating an anthropogenic environment, a person also affects organisms that previously inhabited the territories he changed.

Such an impact is due to the fact that a person forms fundamentally new living conditions, transforming the environment itself, changing the intensity of the impact of environmental factors (up to the complete exclusion of the action of individual factors), introducing new organisms, etc. Often such anthropogenic changes are carried out without any consideration of the fundamental ecological laws of the interaction of organisms with the environment. As an example, when a person did not take into account (not completely or absolutely did not take into account) these environmental aspects, we can mention various experiments on the relocation of organisms from their natural range to other regions of the World, in particular, to Australia. Some of these experiments failed, or led to significant (mostly negative) consequences for the natural environment, negatively affecting the biodiversity of representatives of the flora and fauna of specific territories.

By changing the environment, a person in most cases violates the stable state of natural systems, because when carrying out any economic activity, he does not take into account the basic ecological laws of the functioning of the biosphere. So, in particular, due to huge energy subsidies going to maintain the existence of artificially created little adaptive organisms, man practically leveled the effect of natural selection, allowing degenerate forms of living beings to survive in an urbanized environment.

In these conditions, the conservation of biological diversity of species is put under great pressure, by narrowing the natural space. Urbanization, as part of the anthropogenic impact and transformation of organisms, has a significant impact on the adaptability of organisms and their population stability. All these factors determine the environmental risks of biodiversity conservation and require new forms and approaches to the stabilization of the ecological situation.

5 Conclusion

Urbanization is a process of anthropogenic transformation of biogeocenoses, and should be considered as an ecological phenomenon. The ongoing changes in natural landscapes and the environment entail changes in ecosystems and homeostasis of populations of organisms, a reduction in the number of natural inhabitants and the spread of cultivated forms. The process is transformational in nature with the consequences of adaptive changes and the development of isolation of the created environmental objects. Isolation has affected to varying degrees all the inhabitants of the changed landscapes and the formed new ecosystem. As a rule, crisis ecological situations are noted in the formed urbanized ecosystems and new approaches to the conservation of species' biodiversity are required, in particular the development of park territories.

References

1. K. K. Ibragimova, I. I. Rahimov, A. I. Ziyatdinova, *Dictionary-reference of Terms on Ecology and Nature Protection* (Otechestvo, Kazan, 2012).
2. I. G. Lebedev, *Wild and domestic animals in an anthropogenic environment* (Zoovetkniga, Moscow, 2018).
3. O. A. Panesh, S. I. Chitao, D. A. Kuasheva, *Concise Dictionary of Environmental Terms* (Editorial and Publishing Department of Adygea State University, Maykop, 2008).
4. Z. G. Sayfullina, A. M. Mingazheva, *Dictionary of Environmental Terms* (Ufa, 2017)
5. I. G. Lebedev, N. V. Pimenov, M. A. Lomskov, R. F. Ivannikova, IOP Conf. Series: Earth and Environmental Science **677**, 042005 (2021)
6. M. A. Lomskov, N. V. Pimenov, R. F. Ivannikova, M. V. Selina, IOP Conf. Series: Earth and Environmental Science **981**, 042058 (2022)
7. A. S. Tishchenko, V. M. Terekhov, N. V. Pimenov, R. F. Ivannikova, IOP Conf. Series: Earth and Environmental Science **981**, 042067 (2022)
8. I. Y. Pavlinov, G. Y. Lyubarsky, *Biological Systematic: Evolution of Ideas* (Association of Scientific Publications KMK, Moscow, 2011)
9. E. I. Kolchinskiy, *Ernst Mayr and Contemporary Evolution Synthesis* (KMK, Moscow, 2006)
10. Yu. P. Altukhov, E. A. Salmenkova, O. L. Kurbatova, *Dynamics of Population Gene Pool Under the Anthropogenic Influence* (Science, Moscow, 2004)