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METHODOLOGICAL PROBLEMS OF MONITORING IN RESEARCH OF NATURAL ECOLOGICAL SYSTEMS IN THE CONDITIONS OF FORMATION OF AGROCENOSIS

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Abstract
This article examines ways to address methodological issues in studying natural ecological and natural-technical systems with the goal of identifying the most effective methods for obtaining information that supports measures for the rational use of natural resources and environmental protection.

Keywords: Ecological and natural-technical systems, ecological functions, natural resources

Introduction

The rapid growth and globalization of environmental research in recent years, drawing on the latest scientific advances, has generated and exacerbated numerous methodological challenges associated with the development and refinement of methods for studying the functional interactions between humans and the natural environment. To address these challenges, new theories, concepts, and doctrines are being developed regarding the scientific understanding of natural territorial complexes represented by ecological systems formed by such

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fundamental components as the lithosphere, hydrosphere, atmosphere, and biosphere. Against this backdrop, a number of new scientific disciplines with an environmental focus have emerged-geoecology, environmental geology, engineering ecology, geomedicine, and others.

In recent years, ecosystem analysis has become a key area of research in this area, recognizing the ecological functions of the geological environment as the primary nature-forming factor and an important source of information for the rational use of natural resources [Popov E.V., Dolzhenko R.A., Simonov V.L., 2021]. New methods and technologies for studying natural objects and phenomena have been developed, leading to new approaches to interpreting the data obtained, and new emphases in the methodology of studying the interactions between human society and the natural environment.

First and foremost, the methodology of modern environmental research is focused on providing a scientifically sound information base for rational environmental management, which refers to the most economical, efficient, and environmentally friendly methods of development. Systems analysis enables targeted study of the consequences of human industrial and economic activity and the acquisition of reliable data necessary for developing measures for the rational exploitation of natural resources, assessing the ecological capacity of natural territorial objects, their resilience to anthropogenic impacts, and determining practical use in accordance with environmental protection requirements. This entails creating the most favorable conditions for the restoration of lost resources in order to ensure the long-term interests of further industrial and economic development, comfortable living conditions, and the preservation of human health [Van A.V., 2012]. In the current situation, the most important area of research is to establish the ecological state, resource capacity, and economic capacity limits of a territory, which are revealed by analyzing and identifying natural ecological systems and natural-technical systems for areas transformed by human activity.

The fundamental principle of rational use of natural resources lies in understanding the interrelationships of natural ecosystems, each of which is characterized by well-defined natural indicators that serve as the information basis for human economic activity, long-term planning, and forecasting of future development. Therefore, ecosystem analysis is the primary method for obtaining

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the necessary information for a comprehensive study of natural and natural-technical objects of exploitation [Koplan-Dix V.A., 2017].

The primary criteria for identifying and assessing natural ecosystems are the ecological functions of the lithosphere and the state of the ecological and geological conditions of the surface part of the earth's crust, which is part of the life-support zone and interacts with the biota.

A natural-technical ecological-geological system includes existing industrial and residential buildings, engineering structures, and their complexes that disrupt the established natural environment, transform the topography, watershed, vegetation, and wildlife, and pollute the environment with industrial and household waste. This system is studied to establish its current state and monitor changes under the influence of human activity.

The methodology for studying natural-technical systems includes, in addition to general methods applicable to all natural ecological systems, specific approaches focused on studying their transformation under the influence of anthropogeny. Monitoring changes in natural ecological systems under the influence of human activity plays an important role in the environmental assessment of a territory, the results of which form the basis for scientific forecasting of its future development, addressing issues of nature conservation and restoration.

The territory of southeastern Western Siberia is a zone of developed industry and intensive agricultural production. The distribution of industrial and economic facilities is uneven, and in areas where they are concentrated, significant transformation of the natural environment occurs under the influence of anthropogenic factors. At the same time, there are still significant expanses of undeveloped land. Comparative analysis of the ecological state of natural ecological and natural-technical systems is one method for assessing the transformation of the natural environment under anthropogenic conditions.

Unlike undeveloped territories, areas within natural-technical systems are characterized by the presence of artificial man-made objects that are functionally interconnected with nature-forming components of the environment, which undergo destructive transformation under the influence of human activity. Thus, natural and artificial elements interact with each other to form new systems with different functional indicators. Such systems emerge and exist within the context

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of natural ecological systems, and their interconnections are determined by the scale and form of human production and economic activity in this area [Volchkova N.N., 2022].

The Priobskoye Plateau (the eastern part of the Novosibirsk Region on both sides of the Ob River) is considered the most distinctive local agricultural system. It is represented by a forest-steppe landscape of an elevated plateau with riverine slopes and mixed-grass meadows, where the most productive lands are concentrated. The agricultural value of the soils is classified as high- and very high-quality. Agricultural land accounts for 80% of the territory.

The Astrakhan Region is located in the southeast of the East European Plain, within the Caspian Lowland, where the Volga River flows into the Caspian Sea. It is composed of a forest-steppe landscape of an elevated plateau with riverine slopes and forb-grass meadows, where the most productive lands are concentrated, consisting of thick (up to 0.5 m) layers of ordinary chernozem, sometimes leached (editor's insert: The nomenclature of soils by layer thickness includes terms describing the thickness of humus, arable, and other horizons, for example, shallow (up to 20 cm), medium-thick (20-30 cm), thick (30-40 cm), and deeply humus-rich (more than 40 cm) soils.). The agricultural value of the soils belongs to the high- and very high-quality category. According to soil surveys conducted by the Astrakhan Regional Design and Survey Station for Agricultural Chemicalization, the average humus content in soils in the Astrakhan Region is 1.34%. However, it should be noted that globally, soils with a humus content of 3-4% are considered productive. In the region, only floodplain (alluvial) soils are considered productive.

A 3.66-hectare plot in the Volga River Delta in the Volodarsky District is used for agricultural land. It is suitable for agriculture due to its fertile soils and favorable climate. A 4.55-hectare plot in the village of Sergievka in the Ikryaninsky District, 3 km east of the Astrakhan-Makhachkala highway and 120 meters west of the Bakhtemir River, is also used. An 8.1-hectare plot in the village of Biryukovka in the Privolzhsky District, near a river, is surrounded by a berm. Electricity is available nearby, and the area includes irrigation checks.

River erosion is common on erosional slopes from the border with the Volgograd Region to the Volga Delta.

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Gullies form due to soil moisture, with the highest rate of moisture accumulation observed in the spring.

The slopes of the Baerovsky knolls in the Volga Delta and in the Western Substeppe Ilmens are often subject to water erosion.

Gull formation is caused by careless human activity. Overgrazing on elevated areas or plowing along the slopes of the knolls destroys vegetation and leads to the erosion of the topsoil, even with little rainfall. As of January 1, 2024, the total area of agricultural land in the Astrakhan Region was 3,630.2 thousand hectares, of which 2,977.8 thousand hectares were agricultural land.

Land distribution by category:

Arable land — 276.9 thousand hectares;

hayfields — 372.5 thousand hectares;

pastures — 2,316.1 thousand hectares;

fallow land — 7.1 thousand hectares;

perennial crops — 5.2 thousand hectares.

In February 2025, it was reported that the area of agricultural land in the Astrakhan Region would increase to 98.4 thousand hectares in the new agricultural season.

It was also noted that the area and number of reservoirs, swamps, and wetlands are variable and depend on natural (water regime, climate phenomena, etc.) and anthropogenic (drainage or flooding of territories, etc.) factors.

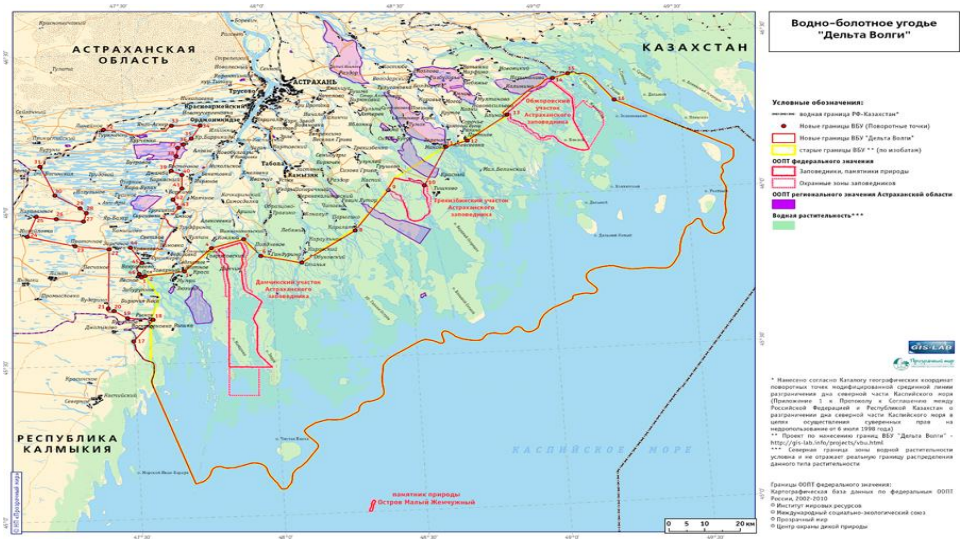

Figure 1. Volga Delta wetland

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Agrocenoses-artificial ecosystems created by humans to produce agricultural products-are being formed in the Astrakhan Region. The region straddles two natural zones-semi-desert and desert-and agrocenoses are being created in an arid climate.

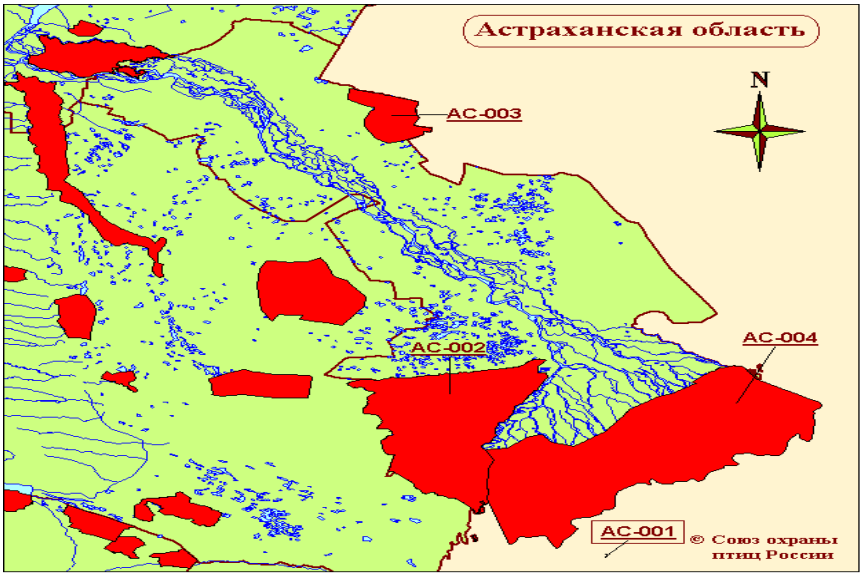

Figure 2. Astrakhan region

Characteristics of agrocenoses:

They utilize solar energy, as well as the energy humans expend on soil cultivation, fertilizing and weeding plants, and protecting against diseases.

Species diversity is reduced due to artificial selection: humans propagate high-yielding varieties of certain species and control undesirable species (weeds, pests).

The cycle of substances is incomplete and open, as humans extract the majority of the products for their own needs ["Environmental Protection of the Astrakhan Region" 2023].

The urban system is represented by a natural-anthropogenic complex consisting of architectural and construction objects with established infrastructure against a background of varying degrees of disturbance of the natural environment. The growth and development of urban economy, accompanied by an increase in the proportion of the urban population, leads to the complete loss of primary natural

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features. When a critical degree of urbanization is reached, the territory loses its natural systemic connections and acquires new anthropogenic functions.

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