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LANDSCAPE-AMELIORATIVE APPROACH AND ASSESSMENT IN THE STUDY OF LANDSCAPE COMPLEXES

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Abstract. In this scientific paper, the landscape-meliorative approach and the evaluation of landscapes based on various principles are examined in the context of studying landscape complexes, with the Middle Zarafshan as a study.

Keywords: landscape, melioration, principles of melioration, meliorative assessment, assessment levels.

Landshaft komplekslarini tadqiq etishda landshaft-meliorativ yondashish va baholash

Annotatsiya. Ushbu maqolada landshaft komplekslarini tadqiq etishda landshaft-meliorativ yondashish hamda turli prinsiplar asosida landshaftlarni meliorativ baholash ishlari O‘rta Zarafshon havzasi misolida tahlil qilinadi.

Kalit so‘zlar: landshaft, meliorasiya, meliorasiyalash prinsiplari, meliorativ baholash, baholash darajalari.

Ландшафтно-мелиоративный подход и оценка при изучении ландшафтных комплексов

Аннотация. В данной статье на примере Средне-Зерафшанского бассейна анализируются исследования ландшафтных комплексов с применением ландшафтно-мелиоративного подхода, а также мелиоративная оценка ландшафтов на основе различных принципов.

Ключевые слова: ландшафт, мелиорация, принципы мелиорации, мелиоративная оценка, уровни оценки.

Introduction. The term *melioration* is derived from the Latin word *melioratio*, meaning "improvement." The primary objective of melioration is to fundamentally enhance lands—specifically, landscape complexes—through organizational, economic, and technical measures, thereby altering their natural conditions and economic productivity in a way beneficial for human economic activity.

In recent years, the concept of *“nature and society”* has emerged as one of the widely applied scientific notions within geographic sources, understood as a systemic relationship. Human society, as an inseparable component of nature, maintains a constant interaction with it, continuously influencing, transforming, and developing all of its components, including landscape complexes and their structural organization.

The interrelationship and mutual influence between nature and society have existed since the emergence of humans. All positive and negative changes occurring in nature are intrinsically linked to human economic activity, or, in other words, to anthropogenic factors. The impact of humans on nature—and specifically on landscape complexes as integral parts thereof—has been significant enough to leave lasting traces since the advent of irrigated agriculture [1].

Literature Review. The inception of irrigated agriculture marked the beginning of human engagement with the most basic forms of land reclamation. During the Bronze Age, a period dominated by arid-climate geosystems, early societies began modifying the natural environment by digging irrigation ditches, constructing short-distance canals, and building earthen dams to divert water to arable

lands. These interventions transformed natural landscape complexes into anthropogenically modified agro-landscapes.

From that point forward, meliorative practices steadily evolved and expanded, particularly within the Sokh alluvial fan region. The environmental consequences of melioration and its transformative effects on landscape complexes have been extensively examined in scholarly works by V.S. Anoshko (1974), D.L. Armand (1975), A. Rafiqov (1976), F.N. Milkov (1978), A.M. Shulgin (1980), A. Abdulqosimov (1984), V.B. Mikhno (1984), A.A. Chibilev (1979, 1982), K.M. Boymirzaev (1995), A. Rakhmatullaev (2018), Q. Yarashov (2022), and others. These studies underscore the complex interplay between anthropogenic activity and environmental dynamics, particularly in the context of landscape transformation through melioration.

Research Methodology. The scientific basis for the assimilation [5], analysis [7], rational use, and management system organization [6] of natural complexes, as well as for the meliorative assessment [2], landscape-meliorative mapping [1], zoning [8], and landscape-meliorative approach [4] serves as the foundation of this study. Such an approach defines the core essence, objectives, and tasks of the landscape-meliorative direction, a branch of landscape science.

The gradual transformation of the landscape complexes in the Middle Zarafshan region is directly linked to the widespread development of irrigation melioration. Considering the diversity and characteristic features of the landscape complexes in the Middle Zarafshan, melioration efforts have been applied over many years across several directions. These include lowering the groundwater table to optimize agricultural use, constructing collector-drainage systems, implementing crop rotation properly, establishing shelterbelt forests to combat wind erosion, and stabilizing aeolian sands around oases through phytomelioration.

Therefore, these types of melioration have played a crucial role in the anthropogenic transformation of landscape complexes, the formation of current geosystems, changes in their morphological structure, and the replacement of natural geocomplexes by anthropogenic geocomplexes.

Analysis Results. Considering that the formation, development, and gradual evolution of the current landscape complexes in the Middle Zarafshan basin are intrinsically linked to melioration measures—an integral part of human economic activity—we believe that their study should be conducted within the framework of the landscape-meliorative approach.

All types and scales of landscape complexes existing in nature, including those in the Middle Zarafshan basin, represent an integral and complexly structured natural-anthropogenic formation. The meliorative state of landscape complexes is extraordinarily complex and varied, depending on factors such as the surface structure, slope, lithological composition, depth of the groundwater table, degree of soil salinization and waterlogging, among other characteristics.

It is important to emphasize that a component-based approach alone cannot serve as the leading criterion for optimizing the relationship between meliorative systems and landscape complexes, forecasting the gradual development of meliorative landscape complexes, managing landscape-meliorative systems, or designing new landscapes. Therefore, alongside the component-based approach, a comprehensive landscape-meliorative approach holds significant scientific, theoretical, and practical importance in the study of landscape complexes.

Assessment of the Meliorative Condition of Landscape Complexes and Development of Optimization Measures Assessing the meliorative condition of landscape complexes and developing measures and recommendations aimed at their optimization provides practical support to meliorators, irrigators, and agricultural specialists. It helps determine which types of melioration and agrotechnical practices can be applied to landscape complexes characterized by diverse local conditions.

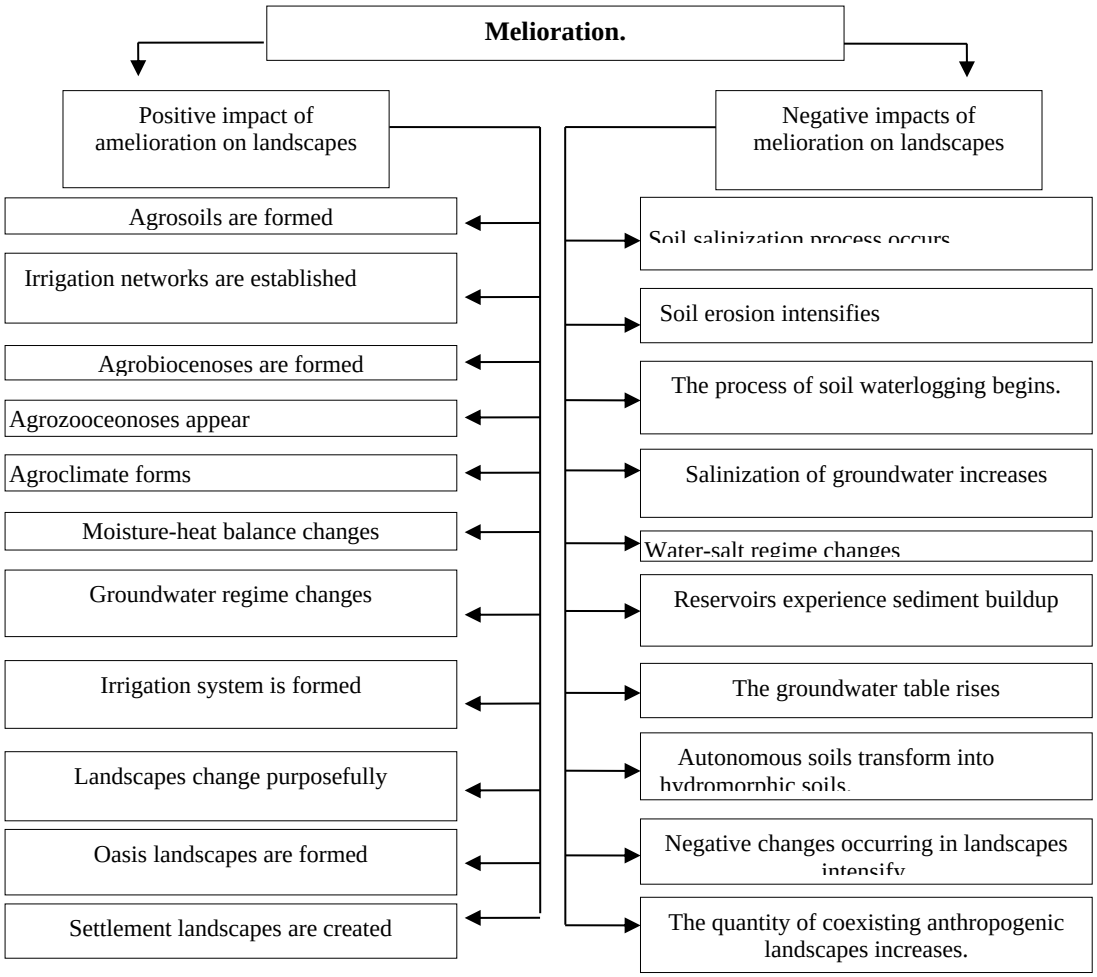

Figure 1. Changes in landscapes under the influence of melioration

According to V.B. Mikhno (1984), the landscape-meliorative approach addresses complex tasks associated with the transformation, qualitative assessment, optimization, and compilation of landscape-meliorative cadastres of landscape complexes [4]. These tasks include:

1. Developing principles and methods for the melioration of landscape complexes;
2. Advancing landscape-meliorative research;
3. Analyzing the interaction between meliorative systems and landscape complexes;
4. Predicting the functional state of landscape-meliorative systems;
5. Designing new landscapes;
6. Studying the regional characteristics of landscape complex melioration.

V.B. Mikhno (1984) emphasizes that the melioration of landscape complexes of various types and at any taxonomic scale requires adherence to principles that consider their regional characteristics, typological features, paragenetic, and paradynamic relationships [4].

Regional Principle of Melioration of Landscape Complexes. Environmental scientists emphasize that in altering nature, it is essential first to consider the natural conditions of each specific region. Meliorative measures proposed to specialists should be developed taking into account the natural geographic conditions of the particular region and, furthermore, of each local site.

The consideration of regional characteristics of landscape complexes in melioration practice has long been evident in activities such as the correct introduction of crop rotation, adherence to advanced agrotechnical rules during soil cultivation, and fertilization of crop fields, all carried out in close connection with zonal and local conditions [2].

Regional complexes are distinguished by their genetic homogeneity, territorial integrity, and unique individual structure. Therefore, when justifying meliorative measures applied to optimize landscape complexes, besides the examples mentioned above, it is also necessary to analyze and

consider their origin, territorial integrity features, and distinctive individual structure. The revelation of regional characteristics of landscape complexes is achieved through natural geographic zoning.

Thus, the necessity and appropriateness of applying the regional principle in the melioration of landscape complexes is supported by empirical evidence. Adherence to the regional principle serves as a fundamental basis for the creation of long-term and efficient meliorative systems.

Typological Principle of Melioration of Landscape Complexes. Typological landscape complexes differ from regional landscape complexes by characteristics such as the scattered distribution of their range, genetic heterogeneity, and morphological similarity. The identification and delimitation of typological complexes at local sites are carried out based on landscape mapping. Typological landscape complexes (landscape types, site types, tract types, and facies types) consist of natural formations of the same type that are morphologically similar to each other.

Applying the typological principle in the study and project design of landscape complexes for melioration purposes requires considering the zonal, altitudinal-geomorphological, and lithological characteristics of site types, tract types, and facies types, as well as the landscape structure. Otherwise, if such features of typological landscape complexes are not taken into account in the development of melioration projects and the melioration of landscapes, unexpected negative consequences will gradually emerge in the reclaimed natural complexes, leading to desertification of agro-landscapes [7].

Principle of Considering Paradynamic and Paragenetic Relationships in the Melioration of Landscape Complexes. Meliorated landscape complexes are constantly in dynamic interaction with the adjacent natural environment. These interactions occur through the flows of matter and energy. Taking into account the processes of matter and energy exchange is of vital importance when meliorating both natural and anthropogenic landscape complexes. It should be recognized that understanding the paradynamic interactions between landscape complexes can only be achieved through a comprehensive analysis of matter and energy exchange processes [8].

The paragenetic relationship and paradynamic mutual influence between transformed landscape complexes and adjacent natural complexes are reflected in constructed reservoirs, main canals, and irrigated agro-landscapes. The commissioning of a reservoir impacts the environment and creates a paragenetic system. From that point on, anthropogenic landscapes formed under human economic activity simultaneously create zones of direct and inverse influence. For example, under geomorphological influence, shores erode, their morphology changes, steep cliffs and beaches form; hydrogeological influence raises groundwater levels in adjacent natural complexes; evolutionary changes occur in the soil-vegetation cover; and climatic influence causes detectable microclimatic changes up to 2–3 km away [5].

Melioration of all types of landscape complexes is carried out by affecting their natural geographical components. Depending on the natural characteristics and stability level of the landscape complexes, melioration can be performed by impacting a single natural geographical component or several components simultaneously. Therefore, V.B. Mikhno (1984) classified methods for meliorating landscape complexes into two groups: 1) the component method and 2) the complex or aggregate method [4].

Component Method of Landscape Melioration. This method is aimed at altering landscape complexes by influencing a single component. For example, irrigating the gray-brown soils of a desert landscape complex can, to some extent, change its natural geographical conditions, ecosystem, and increase its productivity. However, it is not always possible to achieve the desired goal by impacting only one component during the melioration of landscape complexes. This is because in all geosystems, processes of matter and energy exchange, inter-component relationships, and mutual interactions occur in a highly complex manner across space and time. Therefore, it is more appropriate to meliorate complex landscapes using an integrated, complex method.

The Complex Method of Landscape Melioration. Achieving planned objectives by meliorating only a single component of a landscape complex’s natural conditions is difficult for increasing productivity and ensuring sustainable development. For this purpose, it is necessary to apply a complex, integrated impact by altering the characteristics of several interconnected components and creating optimal conditions. For example, optimizing the complex meliorative condition of landscape complexes, enhancing productivity, and ensuring their efficient use require simultaneous influence on all natural geographic components.

This approach to melioration allows achieving desired results in transformed landscape complexes within a short period. Successful implementation of such projects necessitates identifying the leading factor in the melioration of landscape complexes [6].

Assessment of Landscape Complexes in Landscape-Meliorative Research. The issue of assessing geocomplexes formed in various natural environments during the study of landscape complexes in the landscape-meliorative field holds great scientific and practical significance. Landscape-meliorative assessment involves comparing diverse natural complexes, determining their suitability for a specific type of melioration, and identifying the likelihood and nature of influence of natural processes, phenomena, geographic components, and geosystems on the proposed or established melioration system.

Thus, the main goal of landscape-meliorative assessment is to determine the degree of suitability of each landscape complex for a particular type of melioration [2].

Landscape complexes are typically melioratively assessed by qualitatively and quantitatively analyzing all geographic elements and components. Qualitative meliorative assessment of an area is based on comparative analysis of descriptions of natural geographic components and landscape complexes, with the main objective aimed at a specific type of melioration. Quantitative meliorative assessment, differing from qualitative assessment, relies on considering quantitative indicators of landscape complexes expressed in a point (scoring) system.

Landscape-Meliorative Assessment for Meliorative Use of Natural Complexes Landscape-meliorative assessment research conducted for the purposes of meliorative utilization of natural complexes aims to reveal the main essence of the interaction mechanism within the "natural complex melioration" system, particularly determining the feasibility of implementing meliorative measures in specific regions or locations. In meliorative assessment of landscape complexes, it is advisable to use qualitative and quantitative indicators that define the meliorative condition of a particular area, tract, or site type.

According to Y.F. Kobchenko (1975), it is necessary to select quantitative indicators characterizing the climatic, geological, geomorphological, hydrogeological, engineering-geological, soil, and landscape conditions of territories designated for melioration or meliorated areas. Based on the analysis of collected quantitative indicators related to natural geographic components, he classified studied territories from the melioration viewpoint into three categories — most favorable, favorable, and less favorable areas — using a 5-point evaluation system for meliorative assessment. For example, lands most suitable for melioration received a score of 5 points, favorable lands received 3–4 points, and less favorable lands received 1–2 points [3].

Currently, there are several types of melioration, including climatic, land, water, soil, phytomelioration, and others. Climatic melioration helps create an optimal microclimate in a particular area; hydromelioration enables efficient use of water resources and prevents water shortages; soil melioration improves soil properties, increases fertility, and slows salinization processes; phytomelioration changes the vegetation cover, stabilizes drifting sands, and creates a natural geographic environment that prevents wind and water erosion, increases biomass productivity, and so forth.

Therefore, the role of various types of melioration carried out and applied in different directions is extremely significant in improving the characteristics of the natural geographic environment and the meliorative condition of landscape complexes, in their rational and efficient use of their natural potential, as well as in preventing natural geographic processes.

The morphological structure, natural conditions, and meliorative state of the Middle Zarafshan landscape complexes have a complex character. Their landscape-meliorative characteristics sharply change from the upper part of the slope to the lower part. Such changes are expressed in the structure and slope of the land surface that determines the meliorative condition of the landscape complexes, in the geological-geomorphological conditions and lithological composition, in the varying depths of the groundwater table and the diversity of mineralization levels, in the degrees of erosion, salinization, and waterlogging of the soil cover, and in the fragmentation density of the slope surface. Therefore, meliorative assessment of each landscape complex of the slope requires various quantitative indicators related to its components and local natural conditions.

For the meliorative development of landscape complexes, it is primarily important to have morphometric indicators related to relief characteristics. When determining the characteristic

morphometric features of the relief, factors such as its erosion fragmentation, surface slope, distance from the irrigation source, and availability of water resources must be taken into account.

- **Unfavorable (1 point)** – degraded lands and unproductive landscape complexes unsuitable for agricultural use: quarries, ravines, technogenic waste areas, stony lands on slopes, fragmented steep slopes of terraces. These require costly cultural, technical, and biological reclamation works.
- **Less favorable (2 points)** – landscape complexes requiring meliorative works such as increasing productivity of heavily eroded and fragmented lands by water erosion, stopping soil erosion and aeolian sand encroachment into oases through phytomelioration, enriching degraded desert plant species, and increasing biomass.
- **Relatively favorable (3 points)** – landscape complexes that require additional complex meliorations for appropriate use, especially irrigation: washing salts from agro-landscape soils, increasing the density of tussock networks in meadow-marsh and marsh hydromorphic landscapes, fixing desert landscape complexes, cleaning crop fields from stones brought by floods, and drying marshy lands.
- **Favorable (4 points)** – landscape complexes that require some additional light agro-meliorative and hydraulic engineering measures during irrigation. Such meliorative measures include preventive soil washing, preliminary application of organic and mineral fertilizers to crop fields, deep plowing, introducing special crop rotation, digging canals, etc. Landscape complexes in this category do not require the above meliorative measures until irrigation systems are established.
- **Very favorable (5 points)** – landscape complexes that do not require additional light meliorative measures beyond usual tillage and irrigation.

Conclusion and Recommendations. Each component of the Middle Zarafshan landscape complexes possesses unique characteristics and rarely recurring features. Consequently, each component also exhibits its own distinct identifying traits. These characteristic features are reflected in aspects such as the slope and fragmentation degree of the relief, lithological composition, changes in groundwater level and its mineralization along the slope, erosion, salinization, and waterlogging processes in the soil cover, as well as other properties of the components.Such features in the natural conditions and distinctive characteristics of the components can be expressed and described not only by qualitative indicators but also quantitatively to a certain extent.

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