ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 6| June 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2023: 8.224 || ISI Value: 1.188

PREDICTION-INFORMATIONAL PROPERTIES OF NATURAL COMPONENTS AND COMPLEXES OF THE ARID ZONE OF UZBEKISTAN

V.A. Rafikov[1], K.J. Allanazarov[2], B. Sharipov[3], N.D. Sarsenbaev[4]

[1]*Doctor of Geographical Sciences, Director of the Institute of Seismology of the Academy of Sciences of the Republic of Uzbekistan*

[2]*Candidate of Geographical Sciences, Associate Professor of Karakalpak State University,*

[3]*Master Student of "Geodesy and Cartography" of the Faculty of Geography and Natural Resources of the National University of Uzbekistan*

[4]*Student of Karakalpak State University.*

Article DOI: https://doi.org/10.36713/epra13661
DOI No: 10.36713/epra13661

ABSTRACT

The large-scale increase in ecological and socio-economic consequences of the interaction between society and nature requires the development of a forecast of changes, identifying the main characteristics and nature of geosystems. It is a very difficult task to reliably forecast the structural and dynamic state of landscapes located in the zone of intensive management, because the role of the anthropogenic factor in the change of the natural environment is increasing now that scientific and technical progress has made great progress.

KEY WORDS: ***ecology, geosystem, ecosystem, monitoring, arid zones, irrigated lands, geographic forecast.***

INTRODUCTION

The increase on a large scale of ecological and socio-economic consequences of the interaction between society and nature dictates the development of a forecast of changes in geosystems with the identification of their main properties and nature. A reliable forecast of the structural and dynamic state of landscapes located in the zone of intensive management is a very difficult task, because at the present time, when scientific and technological progress has made great progress, the anthropogenic factor becomes an incentive for the transformation of the natural environment. Therefore, landscapes are changing in time and space more quickly than expected. The same is due to the development on a large scale of various negative natural phenomena that have not been observed before. All this leads to a more cautious approach to the issue of forecasting changes in landscapes, especially in ecologically stressed or disaster-prone regions.

Considering this circumstance, we decided that before moving on to predicting the natural environment, it is first necessary to conduct a deep and comprehensive analysis of the forecasting factors, without which it is impossible to develop at least short-term general forecasts, especially long-term ones.

In 2017, employees of the Laboratory of Geoecology of the Institute of Seismology of the Academy of Sciences of the Republic of Uzbekistan conducted research on the development of basic concepts for predicting arid geosystems in Uzbekistan. Continuing work on the development of scientific principles and methods for predicting arid geosystems in 2021, research was carried out in the field of prediction-informational properties of natural components and complexes, assessing the degree of their disturbance under the influence of economic activity and determining the trend of landscape change in the desert zone of Uzbekistan, and also raised issues stability of geosystems and their predictive properties.

In solving the above problems, in addition to theoretical developments in the works of the country's leading geographers-forecasters, we also relied on the method of logical thinking based on the materials of many years (since 1963) of observations of the dynamics of the natural environment of the arid zone of Uzbekistan.

MAIN PART

It is important to take into account the prediction-informational properties of natural components and geosystems, along with other factors, when predicting changes in landscapes under the influence of human economic activity. The experience of predicting a possible change in the natural environment of a number of regions of Uzbekistan under the influence of external factors shows that landscapes contain huge information of a predictive nature, reliable and correct consideration of which in forecasting has a great effect on the conditionality of the predictive development. Yu.G.Simonov [5], T.V.Zvonkov [1], V.S.Preobrajenskii [4] and others repeatedly drew attention to this. Developing the idea of these authors about the use of the prediction-informational properties of geosystems in substantiating the forecasting of changes in the natural environment, we, on the basis of a deep landscape analysis of the arid zone of Uzbekistan, tried to identify a number of prediction-informational properties of natural complexes, which we consider appropriate to use in physical and geographical forecasting.

Before proceeding to the substantiation of the predictive and informative properties of arid landscapes, it is necessary to analyze the natural components that make up the structure of geosystems. On the other hand, a systematic analysis of the informative properties of natural components makes it easier to identify the general properties of geosystems.

Geological structure (geostructure, neotectonics, modern movements of the earth's crust, lithological composition of sediments) - determines the general direction and nature of landscape changes, the speed or intensity of natural, natural-anthropogenic processes and phenomena. A certain regularity is observed in the geological structure of the territory of Uzbekistan: the orogenic area, which occupies the foothill-mountainous part of the republic, is characterized by natural drainage with active glacial, gravitational (slope), karst, erosion processes and salt leaching, and for the platform area, which occupies the plain-altered desert, insufficient drainage with dispersion and wedging out of groundwater, the predominance continental salt accumulations in the aeration zone and eolian processes on a large scale.

In the geological structure of a particular territory, the composition and nature of the rocks are of primary importance; in the mountains of the Western Tien Shan, Hissar, Turkistan and Zarafshan ranges, metamorphic, intrusive, effusive, sedimentary rocks of varying degrees of strength and hardness are widespread, they are mostly rocky and semi-rocky rocks, scree-landslide processes are developed, as products of mechanical (physical) weathering, while erosional processes occur relatively slowly. On the slopes of the mountains, especially in the low and middle mountains, loess, loess-like loams, affected by erosion and landslide processes, are widespread as a result of the irrational use of vegetation cover and water resources. The foothill proluvial plains of the Mirzacho'l, Fergana, Chirchik-Ahangaran, Kashkadarya, Surkhandarya, and Zarafshan valleys consist of loess-like soil of various thicknesses and coarse broken deposits covered with loess, prone to erosion processes and subsidence. In general, the lithological composition of Quaternary deposits varies from mountains to the peripheral part of deltas, inclusive, which accordingly changes both the speed of groundwater movement and the amount of salts in soils. This also determines the need for the construction of a certain type of drainage.

In the desert zone, the nature of the lithic composition determines the development of one or another type of natural process. On the dried bottom of the Aral Sea, formations of eolian landforms are associated with bottom sandy soils, and mainly salt accumulations dominate in loamy-clayey deposits.

Relief (genetic type, shape, dynamics and dissection of the relief, relief-forming processes) - in the prognostic aspect, together with the geological structure, determines the categories of landscape stability, the boundaries of geosystems, the dynamism of natural processes and phenomena, the nature of the structure of natural complexes and the possibility of using landscape resources in one or another branches of the national economy.

The shape of the relief, along with other natural conditions (drainage, soil composition), determines the difference in the groundwater regime and soil process (salt regime) during the development of irrigation, in particular, convex, are the area of water erosion and deflation; concave - the area of accumulation of halo geochemical runoff of substances; flat, sloping or slightly sloping - the area of formation of eolian accumulative forms - transit and migration of halo geochemical flows, elevated areas of irrigated lands are salt accumulators.

The dynamics of relief formation is one of the main factors that must be taken into account when predicting changes in geosystems. Each relief form is prone to certain types or groups of relief-forming processes, therefore, a reliable determination of this relief feature is very necessary to predict the development of certain processes or phenomena.

In the sandy desert, inter-ridge or inter-dune basins with steep slopes are in an active stage of development, while the absence of cliffs indicates the attenuation of deflation. Hence it is clear that it is necessary to take into account the peculiarities of the state of the dynamics of relief-forming processes.

The dissection of the relief often determines the direction of salinization-desalinization processes. Large slopes - up to 0.01 (in the regional plan) - usually create salt removal zones, medium ones - up to 0.001 - form salt transit zones. Small slopes - 0.0001 and less - characteristic of low land areas (low river terraces, deltas, peripheral sections of alluvial fans, etc.), create vertical forms of moisture-salt exchange and contribute to the accumulation of salts in soils, soils and groundwater. Local slopes create heterogeneity in salinity in a given zone. So, in the zone of salt transit, areas of salinization or removal of salts can be observed, the same can be said about other zones. These are the so-called forms of mesorelief. The microrelief can create salinity spotting and wick salinization, fresh soils along depressions, etc. [2].

One of the morphometric indicators of the relief is the depth of the dissection of the territory, which determines the heterogeneity of agricultural production of the venous properties of the earth and land reclamation measures (construction of hydraulic structures, etc.), however, on the other hand, this feature of the relief is necessary for the early determination of the risk of waterlogging, salinization and erosion soils as a result of irrigation.

Climatic conditions (air and soil temperature, wind, precipitation, etc.) - determine at a certain level and intensity, and the scale of eolian, halogeochemical, erosion processes. In the flat part of Uzbekistan, where an arid climate prevails, predictively, under conditions of close occurrence of the groundwater level, salt accumulation in the aeration zone (formation and development of halophyte natural complexes), intensification of deflationary-accumulative processes (formation and development of aeolian natural complexes), intensification erosion and mudflow processes (contributing to the development of erosion-landslide and mudflow landscapes), etc.

Wind is the leading factor in the dissection of the relief surface, especially in planned massifs with sandy-loamy soils, siltation of irrigation canals and reclamation systems laid among sandy deserts, sanding of irrigated lands and cultivated pastures. Wind increases transpiration and physical evaporation and thereby dries out the topsoil and increases the frequency of crop watering.

Hydrogeological conditions - determine the direction of the soil-reclamation state of lands and the pasturereclamation feature of ecosystems. These include: the depth of groundwater, their mineralization, chemical composition and speed of movement. Since in the predominant part of the desert and semi-desert zones of Uzbekistan, due to insufficient drainage of the territory during irrigation, groundwater lies close to the surface, they participate in the soil-forming process, giving hydro morphism to geosystems.

The depth of groundwater determines the reclamation irrigation regime: in intensively drained areas of deltas, terraces and hilly plains, where there is a steady downward flow of moisture, groundwater does not affect the water-salt regime of soils, the latter develop according to an automorphic type, and the crop is grown due to suspended moisture, lands due to increased underground outflow of groundwater usually do not saline, on weakly and untrained parts of deltas, alluvial fans, terraces, etc., where vertical water exchange dominates, groundwater is a direct source of salt accumulation in the root layer. Soils develop in a hydromorphic manner, and accumulated salts are regularly removed by drainage and flushing. At the same time, if the outflow of salts by drainage water is greater than the inflow, then a negative salt balance is observed, otherwise a positive one will develop. The whole essence of saline soil reclamation is aimed specifically at achieving a permanent negative water-salt balance of the irrigation array.

The mineralization of groundwater often determines the degree of soil salinity: the more mineralized groundwater, the more salinized soils. Observations have established that the slower the horizontal outflow of moisture, the more intense the salt accumulation in the soils, the proportion of chloride and sodium ions predominates in the composition of salts. This phenomenon is especially strong in drainless delta plains, large depressions of alluvial terraces, flat plains, large depressions of alluvial terraces, flat plains of the dried bottom of the Aral Sea.

Surface water. In the arid conditions of Uzbekistan, taking into account the hydrological features of landscapes is of paramount importance, because the formation of intrazonal and hydromorphic (subaqueous and super aqueous) natural complexes is associated with the impact of water bodies, where the influence of surface waters on the mode of functioning and development of landscapes is observed, as a result of which their productivity is relatively high (hydromorphic, fresh, several times richer than automorphic ones).

In the flat part of the republic, as a result of the discharge of drainage and waste waters from oases into drainless desert basins, artificial lakes of various sizes and volumes are currently being formed (the number of lakes, according to 1999 data, exceeds 100). Around these water bodies (Arnasay, Aydarsay, Dengizkul, Sarykamysh, Karateren, etc.) at a certain distance from the shore, hydromorphic and semi-hydromorphic natural complexes are formed. At the same time, typical (hydrohalophytic) geosystems are formed in the place of dried-up similar lakes. It is necessary to pay attention to this when predicting changes in hydromorphic and subaqueous complexes in the drying trend.

Surface water is a source of salts accumulated in the soil during irrigation, and the degree of mineralization of water determines the salinity of irrigated lands. This phenomenon has been particularly pronounced in recent years in connection with the discharge of drainage and other categories of water into the Amudarya and Syrdarya basins, in which the water salinity is steadily increasing from year to year. In this regard, at present, the irrigated lands of the lower reaches of the Amudarya and Syrdarya, Mirzacho'l, Bukhara and Karshi oases are washed longer with large leaching rates due to the progressive salinization of irrigated lands.

Surface watercourses (Amu Darya, Kashkadarya, Sherabaddarya, etc.) transport a huge amount of sediment to irrigated lands (up to 20 ... 50 m^3/ha), and intensive silting is observed in canal beds and at the bottom of reservoirs as a result of their accumulation.

Soil cover - determines the possibility of using land in irrigated and rainfed agriculture, their salt regime, natural fertility, irrigation rates, susceptibility to deflation and water erosion, etc.; along with other factors determine the nature of the ameliorative state of the land. The type of soils often corresponds to territories drained to varying degrees: in particular, gray soil (typical), due to development under eluvial conditions, are predominantly located within the naturally drained parts of foothill slopes; takyr soils and takyrs, solonchaks (active and residual) usually develop on undrained plains of subaqueous deltas and alluvial terraces, etc. Thus, based on the type of soil, it is possible to give a preliminary assessment of the future state of the lands of a particular landscape as a result of their development.

The mechanical composition is the main factor in the hydrophysical characteristics of soils. The “lighter” the soil (the larger the soil particles), the lower its water-holding capacity, but the greater the conductivity value at full saturation, i.e. filtration coefficient [6]. The mechanical composition of soils determines the height of the rise in the groundwater level, the depth of wetting of the root layer, the rate and height of moisture evaporation. It has been established that the heavy mechanical composition of soils contributes to the rapid rise of ground moisture in the aeration zone (in clays up to 600 mm in height), deep drying of the soil profile, but slow water filtration. In this regard, in the loamy-clay soils of deltas in the first years of development, the rate of rise in the groundwater level ranges from 1 to 2, sometimes 3 m per year. In the zone of the Karakum Canal on the deltaic plains, the average rate of groundwater level rise was 1.1–1.2 m/year [6].

The water-salt regime of soils is the main factor determining the reclamation state of lands. Based on the presence of a certain amount of salts in the aeration zone and finding out the trends in the development of salinization or desalinization, it is possible to predict the ameliorative state of the lands of a particular geosystem. At the same time, the type, physical and chemical properties of soils serve as basic materials in substantiating the genesis and further development of the reclamation state of the irrigated massif. It has been established that the soils of the arid zone of Central Asia at various depths contain readily soluble salts, which were formed as a result of the hyper genesis of Quaternary cover deposits in other natural geochemical conditions. Salts, being the main source of secondary salinization, are redistributed in the root layer when groundwater rises. Under the conditions of practically drainless deltaic plains, the participation of residual salts in the formation of the salt regime of irrigated soils is especially intense. In this regard, the ameliorative state of the delta lands is deteriorating, because of the positive salt balance,

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they are difficult to meliorate. In addition, due to their location at the end of the river flow, salts contained in irrigation waters aggravate salt accumulation in soils.

In the head part of the deltas of the foothill plains, where the underground outflow is normally provided, there is a stable horizontal water exchange. Here, the reclamation state of the lands is due to water-erosion and suffusion-karst processes. The eluvial regime of soil development contributes to the automorphic reclamation regime of irrigation.

Vegetation - based on the analysis of the state of phytocenoses, it is possible to identify a significant amount of information about the possibility of changing them in the future. Long-term observations of the state of vegetation in deserts and oases indicate that the vegetation cover exposed to human influence is in a different life stage. The sandy desert pastures, which are under intensive grazing, are being transformed at a rapid pace. This phenomenon occurs with particular force near the wells, where from 1,000 to 5,000 sheep are fed per day. Coming to the watering place, the sheep trample the surface of the sand. It is in a loose position and is buffeted by the wind to form bare shifting dunes and dune chains, changing the typical topography of immobile sands.

Under the influence of grazing, not only the nature and forms of relief change, but also the vegetation cover. In place of grassy-ephemeral pastures, shrub-ephemeral pastures are formed, i.e. as a result of the disappearance of a number of plant species (wormwood, some ephemera, etc.), juzgun, singren, as well as weeds such as adraspan, selenium, astragalus, Richter's saltwort, etc., appear. Thus, judging by the dynamics of the transformation of the vegetation of the sandy desert, it is possible to predict the emerging vegetation cover.

It has been established that each type of vegetation contains a certain state of the groundwater regime, the water-salt regime of soils, as well as the stage of development or evolution of one or another type of soil cover. Based on the analysis of the informative properties of vegetation, it is possible to make a certain forecast about the future composition of biocenoses.

The Yulgun (salt cedar, tamarix) association, as a typical tugai vegetation, develops in conditions of close groundwater level with mineralization from 3 to 10-15, partly up to 20 g-l and more. However, it can also grow at a depth of groundwater below 5 m. The wide distribution of salt cedar indicates the evolution of bog, bog-meadow and floodplain-alluvial soils into meadow-takyr soils, and typical solonchaks into residual or takyr soils. In the Amudarya delta, as a result of desertification, the former hydromorphic soils passed into the semi-hydromorphic and automorphic stages of development. An indicator of this regional change in the soil cover is the scale of development of the salt cedar, which occupied a dominant place as far back as the late 1970s. On the dry part of the seabed, after the transition of typical solonchaks on the periphery of the bedrock coast to residual, these plants became widespread.

Thus, as a result of the evolution of soils against the background of a change in the groundwater regime, the transformation of biocenoses will occur. Reliable and timely indication of these phenomena provides comprehensive information for predicting the future state of phytocenoses.

Prediction-informational properties of natural complexes are determined based on the analysis of the properties of natural components that make up their structure. In this paper, the identification of these properties of desert landscapes is substantiated by the example of the subaerial deltaic geosystems of Uzbekistan, as the dominant physical and geographical complexes, studied to a sufficient extent in terms of landscape genesis and structural and dynamic state.

Conjugate (interconnected) analysis of the landscape-forming components of dry deltas allows us to consider them as a single integral geosystem in which lithogenic, biogenic, hydro genic and other components are closely interconnected and interdependent. Deltas, as integral physical and geographical complexes, are typical objects of landscape research, in which the general structure, internal composition (texture), the trend of change and the nature of the exploitation of natural resources and other features are clarified. A comprehensive analysis of geosystems of deltas is necessary to solve other scientific and applied issues related to the use of natural resources.

Deltas are differentiated by internal differences into a number of naturally isolated complexes that differ from each other in the properties of landscape-forming components. The main criterion for identifying geosystems here is the delimitation of the territory with the same lithological-geomorphological structure, which is the leading indicator of the division of the geosystem into smaller physical and geographical units. Under delta conditions, changes in other components in space depend on lithogenic ones. Therefore, the more accurately the natural boundary of geological-geomorphological structures is determined, the greater the conditionality of the detected contours.

Based on the analysis of the lithological-geomorphological structure of the piedmont deltas, three parts or three geosystems can be distinguished in them, which differ sharply from each other. This is the apical part - a sloping plain, composed of coarse clastic deposits overlain by thin fine earth, then there is a middle strip - a gentle plain, composed of a sandy-loamy-clayey stratum with separate tongues, thin layers of pebbles wedged into it, the latter is a flat plain, consisting of clayey-loamy-sandy deposits with interlayers and lenses of sand. These three parts of the foothill deltas correspond to three areas or zones of the hydrogeological process: the absorption zone (groundwater recharge area), the discharge zone (wedging out area), the dispersion zone (immersion area).

The soil cover also gradually changes from the top part of the delta to the periphery inclusive: eluvial soils are common in the head part (zone of development of water erosion), in the middle - hydromorphic (zone of development of saz, meadow, and other soils), in the peripheral - semi-hydromorphic or hydromorphic (zone development of saline soils).

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Thus, all three parts of the deltas, differing sharply from each other, form independent geosystems in space with all individual landscape features. However, these geosystems are so interconnected that they cannot be separated from each other. The top part of the delta, as an area of erosion, absorption of water masses, accumulation of the coarsest or largest substances transported from the entire basin, serves as their accumulator and guides the migration of liquid and solid substances throughout the delta geosystem.

The middle part of the delta, as an area of storage of liquid substances, serves as their evaporator and accumulator of easily and sparingly soluble salts in the aeration zone, part of the underground sub-pressure water flow wedges out to the surface in the form of springs (saz zone).

The peripheral part of the delta is the area of dissipation of the groundwater flow and its consumption for total evaporation, filtration and accumulation of salts in the root-inhabited soil layer, sedimentation along the stream channels is also observed here.

On the basis of the regularities in the distribution of geosystems in the foothill deltas, it is possible to identify their specific zoning, confined to naturally isolated parts. The upper part is characterized by sloping loamy-pebble intensively drained plains with spreading irrigated light and typical gray soils; middle - gently sloping pebble-loamy-clay very weakly (intensely artificially) drained plains with saline meadow, meadow-saz soils in combination with differently saline irrigated meadow soils; peripheral - flat loamy-sandy-clayey non-drained (intensive artificially drained) plains with variously saline irrigated meadow soils.

This zoning of geosystems is typical for those deltas that have a perfect structure. Those deltas, in which the peripheral part is cut by the river valley (deltas of Sangardak, Tupalang, Kasansay, Namangan, etc.), have a slightly different geosystem, groundwater is deeply submerged in them and there are no soil salinization processes.

Deltas located in the flat part of Central Asia have similar properties, but, as mentioned above, due to the wide distribution of fine earth deposits of great thickness, often underlain by clayey, sandstone and conglomerate up to Quaternary deposits, as well as a slight slope of the relief surface, the areas of the zones identified above vary considerably. The most widespread geosystems occupy the middle and peripheral parts of deltas, while the top part of most deltas is typical only for a small area, which is due to the nature of the accumulation of coarse clastic deposits during their hyper genesis and remoteness from mountain ranges for a considerable distance.

In lowland deltas, due to the presence of thick fine-earth deposits and the lack of groundwater, wedging out of groundwater is not observed, they only approach the surface up to 5-10 m, sometimes even less. Therefore, soils in most cases under natural conditions have an eluvial character. These include the subaerial deltas of the Obruchev steppe, the Northern Afghan rivers, the ancient Zarafshan, Kashkadarya deltas, etc. Under irrigation conditions, all dry flatland deltas acquired the properties of hydro morphism with mineralized groundwater.

In coastal deltas, the zoning of geosystems, in contrast to foothill deltas, is directed mainly from the channel to the periphery. This is due to the location of the main channels of rivers or channels with thick riverbanks in topographically commanding areas of the territory, which are formed as a result of regular accumulation of sediments in the channel. The bed of the Amudarya from Nukus to the seashore is located in the fault zone, where the earth's crust is uplifted. In coastal deltas, as well as foothill and flat ones, the branching of the channel into numerous branches or channels begins from their top part, therefore, the migration of liquid substances by underground flows also occurs from the head part towards the discharge area.

Inter-channel depressions - accumulators and evaporators of underground and surface runoff, are accumulators of solid runoff and salts. A strip of powerful riverbanks and inter-channel depressions usually includes either scattered sands or lakes in a complex of quarrels. In the Aral delta, the extreme peripheral strips are occupied by lakes and quarrels (Sudoche Lake, Karaumbet Sor, etc.), which serve as areas or centers of unloading the underground flow of the delta, moreover, their level is much lower (by about 10-12 m) compared to with the surrounding plain.

CONCLUSION

Based on the identified main physical-geographical features, it is possible to determine the zonality of the geosystems of coastal deltas. The main artery of the coastal delta is confined to their middle zone, bordered by powerful riverbeds, in which, due to the dominance of channel sediments and the dissection of the relief (0-8 m and more), groundwater is slightly saline, predominantly hydro carbonate-calcium and hydro carbonate-sulfate composition. In this regard, due to the presence of a secured underground outflow, the soils do not contain a large amount of salts. The riverbanks are characterized by: dissected sandy loamy-sandy elevated areas of alluvial-deltaic plains along the main branches of the rivers with tugai forests on meadow-takyr tugai and alluvial meadow soils.

Inter-channel depressions, which differ due to the lack of flow of the territory, the presence of lake and marsh complexes overgrown with reeds and brooms, are typical of the following: inter-channel loamy-clay depressions with reed and reed beds on alluvial bog, meadow-bog soils; inter-channel depressions with typical swamps and lakes, sometimes overgrown with reeds.

Lake basins, often confined to the periphery of coastal deltas, are characterized by the following complexes: drainless basins with lakes, bordered by a swampy strip overgrown with tee and cattail; drainless loamy-clay depressions with quarrels, devoid of vegetation.

Thus, the coastal deltas are characterized by the following geosystems, starting from the main channel: near-channel swells, inter-channel depressions, and lacustrine (sor) drainless basins. These geosystems mainly correspond to the facies zones identified by V.I. Popov et al. [3] in the Amudarya delta.

Revealing the zonality of geosystems in deltas is facilitated by the differential use of melioration on irrigated lands, increasing the efficiency of agro technical, agro-ameliorative, hydro technical, organizational and economic measures.

A comprehensive analysis of the structural-dynamic state of subaerial deltaic landscapes has shown that they contain a significant amount of predictive information that should be used in predicting their changes in connection with an increase in the scale of the use of natural potentials. At the same time, it is necessary to pay attention to the differentiated natural complexes of subaerial deltas of various species, which often have regional features.

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