

## Forecasting changes of arid geosystems under ecological destabilizing conditions in the Aral Sea region

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**Abstract:** We discuss the main natural and anthropogenic factors of forecasting and establish the basic tendencies to change natural complexes. We conclude that the Aral Sea and the Aral Sea region are genetically uniform and paragenetically dynamical macro geosystems. By considering properties and features of structural and dynamic conditions of superaqual, subequal, and eluvial geosystems of the Aral Sea region and the Aral Sea, a forecast of its transformation by 2020 year is developed. We develop a practical plan of action for cardinal improvement of the environment in the Amu Darya Delta and the dried bottom of the Aral Sea.

**Key words:** geosystem; landscapes; geographical forecast; desertification

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### 1 Introduction

Predicting the intense desertification of the deltaic plains of the Aral Sea coastal zone has application to further development of the Aral Sea region. Determination of the sustainable progressive change in the natural environment of the Aral Sea region with the decline of the Aral Sea level requires prediction of the transformation of the regional geosystems until a certain time<sup>[1]</sup>. An application of special importance is the forecast of geosystem drying during sea-level changes. Those natural phenomena and processes resulting from drying of the sea will have a direct impact on the deltaic plains in the surrounding Aral area. Therefore, in addition to considering the drying sea and surrounding Aral area as the genetic geosystem in forecasting, one should be aware of synchronicity in space and time of many of the expected natural processes<sup>[2]</sup>.

There is great scientific value in forecasting changes in the natural environment of the Aral Sea region because in the future the region must have sustainable ge-

osystems and negative phenomena must be controlled to qualitatively transform nature in a suitable direction. Environmental destabilization of the region is related to the deterioration of the natural environment; the rapid pace of the decrease in productivity, soil, and other natural resources; and the poor medical and hygienic living conditions. The accelerated desertification of the region and the aforementioned negative natural and anthropogenic processes on a large scale require development of varying approaches to scientific prediction<sup>[3]</sup>.

The practical goal of forecasting changes to the region's geosystems is to develop appropriate measures for timely prevention of negative natural and anthropogenic phenomena and processes.

Anthropogenic desertification and desiccation of the sea owing to catastrophic decline in the sea level of the Aral Sea accelerate the dynamics of physical and geographical processes and phenomena and intensify the development of natural complexes. Here the dynamics of geosystems and natural processes occur with greater intensity and rapidity than in other regions of Central Asia. In this regard, the Aral Sea and its surrounding region is the only region where the geosystems are developing with great activity<sup>[4]</sup>.

The active changes of the geosystems here includes

dynamics of the natural processes (salt accumulation, desalinization, deflation, accumulation of substances, the rise and fall of groundwater levels, etc.), transformation of the groundwater regime, land cover change, and formation of Aeolian landforms. It was found that the higher the degree of activation of natural processes, the more intense is the drying sea in the morphological differentiation of parts of the landscape.

Because of uneven watering the structural-dynamic status of the Amu Darya River Plains Delta geosystem is undergoing various stages of change. On those sites (arrays) where flooding of ecosystems is almost never observed, transformation of natural systems is well known, as evident by the formation of eluvial properties specific to desert landscape areas. Between river-end valleys, where regular flooding occurs to varying degrees, large hydro morph and, on the periphery, half hydromorph conditions remain. These conditions are due to the development of subaqueous and primarily supaqueous geosystems there.

In the inland valleys of the western and central parts of the Amu Darya Delta, the watering should result in gradual changes of geosystems as the water table drops below 5–7 m. There will be almost all kinds of transformation of geosystems, from lake to eluvial, inclusive, for a certain period of time<sup>[3]</sup>.

Between boiler hills in the Amu Darya Delta, because of the dominance of top-down currents, the moisture geosystem exhibits eluvial properties; hence the predominance of natural desalinization in the soil affects the accelerated development (evolution) over a large area of mainly automorphic soils (desert-sandy, takir, and residually saline), which contribute to the dissemination of xerophyte, halophyte, and psamphyte groups. Naturally, in this context automorphic Aeolian processes become dominant. From here, one can draw the important conclusion that further intensification of eluvial dynamic processes with predominance of muddy-clay soils should be expected with formation of takir, sandy, and sandy-loamy Aeolian geosystems.

## 2 Purpose of the research

Based on scientific data and explanations, our goal is to develop a forecast of geosystem degradation of the

Amu Darya Delta, by including the progressive reduction of the reservoir and the results of anthropogenic desertification.

To achieve this goal in this work we need to pursue the following interrelated objectives:

- 1) Determine the scientific and applied value of forecasting changes to Aral Sea geosystems;
- 2) explain the scientific basis and identify the main factors affecting prediction, and
- 3) develop a forecast of the changes in desertification of the Amu Darya Delta geosystems.

## 3 Materials and methods

The main principle for predicting geosystem changes is based on a historical and dynamic evolutionary study. Once a clear idea of the history of the region of geosystems is established one can make decisions based on knowledge of the natural evolution. Based on an analysis of the evolution of the paleolandscapes of the deltaic plain of the Aral Sea region we have identified three stages of development since their establishment. In the third stage of development currently are the landscapes of the Akcha Darya Delta, the Zana Darya Delta, and the eastern part of the Amu Darya Delta.

The natural systems of the Aral Sea and surrounding area are highly dynamic and exhibit different trends of mainly anthropogenic desertification. Therefore, the impact of anthropogenic influences plays a dominant role in the total transformation of geosystems and should be considered first and foremost when predicting changes at certain dates.

Sochava<sup>[5]</sup> stressed that projections should be based on the use of all the capabilities of modern science; that is, one should use the most reliable methods of research. The wider, fuller, and more integrated a forecast is, the better it will be. According to Zvonkov<sup>[6]</sup>, forecast of the past, present, and future is based on three groups of methods: identification of historically stable and continuity tendencies of the development of the natural environment for the past, diagnostic methods for the present (causal analysis), and predictive methods for the future (extrapolation of stable predictive signs of past and present). For regional forecasts, it is important to identify sustainable trends in the de-

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