

ANNOTATION

Of dissertations for the degree of doctor of philosophy (PhD) in
the speciality 6D060800 – «Ecology»

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**«Processes of relief formation of the coastal zone of the Alakol lake and
their impact on the natural and economic systems of the coast»**

The relevance of the research topic. Natural and economic systems of the Alakol lake shore are localized within various types and forms of terrain and develop under the negative impact of dangerous geomorphological processes, including abrasion, deflation, erosion, suffusion, etc. Since ancient times, economic activity here has been represented by traditional irrigation agriculture, cattle breeding and haymaking, and commercial fishing. Currently, the use of land in coastal areas is undergoing rapid changes, which are associated with active tourist and recreational development, including the growth of settlements, the expansion of the engineering and transport network (roads, railways, oil pipelines), the construction of health resorts and tourist facilities. At the same time, a significant dynamic in the development of tourism on Lake Alakol in a relatively short time was given by the adoption of state programs, including the "Concept for the development of the tourism industry of the Republic of Kazakhstan until 2023", from the President's Address, the sixth basic principle of the "new economic course of development of our country "is" Greening "of the economy and environmental protection and "Regional development programs until 2025". According to the research of Valeyev et al. (2019), the sustainable development of the territory and the development of tourism are hindered by environmental problems associated with dangerous manifestations of relief-forming processes: abrasions, flooding, maggot formation, deflation, run-up phenomena, etc. One of the limiting factors for the development of recreational infrastructure in the territory is the poorly studied terrain-forming processes. The development of active types of tourism requires the study of the possible consequences of anthropogenic pressure on the lake shore and the surrounding area. The administrative measures taken do not take into account the need for a comprehensive approach to the infrastructural development of the tourist, agricultural, and residential potential of the coastal territories.

At the same time, the territory over the past decades has experienced a high degree of manifestation of modern relief-forming processes, especially at the border of the interaction of the aquatic environment with land. The intensity of relief formation is caused by regional climatic changes affecting the level of the reservoir, wind-wave conditions, geology, morphometry of the coastal relief, as well as increasing technogenic activity. Exogenous processes pose a direct threat to recreational and infrastructure facilities, the transport system, and environmental safety, especially in the area of interaction between water and land.

For the purpose of sustainable territorial development and development, it is necessary to conduct comprehensive scientific and applied studies of the

interaction of natural and anthropogenic processes within the coastal zone of Lake Alakol, to identify problems associated with the development of dangerous exogenous processes. On the south-western, eastern and northern coasts of the lake, problems are associated with active abrasive processes, under the influence of which the lands of settlements, recreational facilities, transport and infrastructure are destroyed. In the north-eastern and north-western parts of the lake, extensive flooding of low-lying banks is problematic, causing salinization of soils, flooding and degradation of hay and pasture lands.

The solution to this problem requires detailed comprehensive studies that will allow us to develop proposals for a system of measures for sustainable development and the disclosure of the recreational potential of Lake Alakol. In turn, the application of the developed recommendations will serve the environmentally sustainable development of natural and economic objects of the coastal territory. The favorable geographical location, significant natural and economic potential will allow the research area to become a driver of socio-economic development of the cross-border region in the future, provided that the scientifically-based principles of nature management and sustainable management of the territory are observed.

The object of the study. Natural and economic territorial complexes of the coastal zone of Lake Alakol.

The subject of the study. Ecological and geomorphological conditions of the territory, taking into account the adverse impact of modern processes of relief formation on natural and economic systems.

The purpose and objectives of the study.

The purpose of the study: To study the influence of the processes of modern relief formation on the ecological and geomorphological conditions of sustainable use of natural resources by natural and economic systems of the coastal zone of the Alakol lake

To achieve this goal, the following tasks have been developed:

- to study and systematize the theoretical and methodological foundations of studying the ecological and geomorphological conditions of the modern relief formation of the coastal zone of the Alakol lake;
- to perform an analysis of the ecological and geomorphological conditions of the modern relief formation of the coastal zone of the Alakol lake and identify the spatial structure of the distribution of relief-forming processes;
- perform a spatial and temporal analysis of the impact of ecological and geomorphological conditions on the natural and economic systems of the coast using GIS and remote sensing;
- develop priority ways to stabilize the ecological and geomorphological conditions of the coastal zone of Lake Alakol.

The material base of the research. Maps and materials that characterize the morphometry of the terrain. Maps of the underwater coastal slope bathymetry scheme with a transverse profile of the underwater coastal slope for key sections of the South-Western, Eastern, and Northern coast. Geomorphological map of the

coast of Lake Alakol with scale 1: 200 000. The legend highlights the position, type of terrain, subtype of terrain and age. Map of modern relief-forming processes of the coast of Alakol lake, scale 1: 200 000. The legend explains the types of the coast, the areal distribution of the complex of modern relief-forming exogenous processes within the geomorphological types of relief, and the point distribution of leading and secondary exogenous processes. The maps scheme changes the shoreline of the Lake Alakol from 1990 to 2018, with an interval of 5 years for key sections. Schemes and table of dynamics of processing of coasts in the context of years according to field research data. High-precision digital models of the relief of coastal bluffs on the monitoring sites (Akshi and Koktuma villages). Land use map of the coastal zone of Alakol lake, scale 1: 200,000. Map of ecological and geomorphological conditions of the lake coastal, scale 1: 200,000. Forecast map of spatial changes in the reservoir when the water level rises.

Sources of research materials. Scientific literature and articles, materials of the Republican Geological Fund (explanatory notes, research reports), cartographic material (geological map with a scale of 1: 200 000, map of Quaternary deposits with a scale of 1:500 000, map of geomorphology with a scale of 1:1 500 000), topo bases with a scale of 1: 200 000 and 1: 100 000, actual material obtained by the author in field research as part of an expedition group. Remote sensing data including digital terrain model SRTM (30m), multispectral satellite images Landsat, Sentinel, Alos, etc.

Methodological base of the research. In this study, the following classes of different methods were identified and used:

- **cameral method** (geoinformation, cartographic, comparative, descriptive, historical, etc.);
- **remote sensing method** (decryption, MNDWI indexes, comparative);
- **field monitoring studies** (empirical, setting reference points on the profile, instrumental measurements, field observations, ground-based laser scanning and bathymetric measurements).

Obtaining the main results of the study was based on the application of a complex of proposed methods and approaches. Using the described methods, various input data were obtained, territory mapping was performed, and thematic maps were created in GIS programs. The received actual field and stock materials, cartographic and statistical data were processed. The structures of incoming geodata, analysis of spatial geodata using various tools and modules, and interpretation of the received data is formed. A comparative and descriptive analysis was performed, expert evaluation and monitoring of data were given.

The scientific and practical significance of the research work. The scientific significance is to obtain data for understanding the mechanism and identifying features of the formation of coastal zones of lakes in arid territories, in the context of regional climate change, increased recreational loads, and other anthropogenic factors. Threats and negative impact of exogeodynamic processes on valuable recreational territories, agricultural lands, and residential lands and their spatial distribution are determined. The theoretical foundations of the most effective methods of shore protection have been developed and scientifically

substantiated in order to preserve the coastal abrasion-denudation ledge and develop the recreational potential of Lake Alakol. The practical significance of the research is expressed in the reduction of ecological and geomorphological risks, in mitigating the negative impact of modern exogenous processes on the natural and economic systems of the coast. The cartographic results of the research are an applied basis for creating complex schemes for the development of the territories of the research area, including for urban design and planning works, for the development of recreational and transport infrastructure of the Alakol lake coast.

The scientific novelty of the research. The scientific novelty of the research consists in conducting a comprehensive study of the modern relief formation of the lakeshore Alakol lake and its influence on natural and economic systems. Past research, including analysis of the relief of the coastal area Alakol lake, held 60 years ago. During this period, the surface relief has changed, which needs to be updated, while the distinctive feature of the study is the use of modern geoinformation methods, including the use of remote sensing, digital mapping, ground-based laser scanning, etc. The scientific novelty consists of the following works:

- applied and adapted methods for research of exogeodynamic processes in the framework of their impact on natural and economic systems.

- instrumental monitoring of coastal ledge erosion was organized for the first time and accurate quantitative data on dynamics were obtained.

- for the first time in the study of ecological and geomorphological conditions of the coast of Lake Alakol applied GIS methods and technologies, including laser scanner for three-dimensional modeling of banks, multi-temporal satellite images, updated bathymetry of the water of the coastal zone key sites, sounder.

- scientific-based proposals were developed to create a system of measures to reduce the ecological and geomorphological risks of the coastal zone of the Alakol lake for sustainable use and development of coastal land use.

Provisions for defense

- Based on a detailed analysis and mapping of natural and anthropogenic factors of modern relief formation on the abrasion and accumulative shores of Lake Alakol, the prevailing types of impact determining the main features of relief formation of the coastal zone have been identified. On the northern coast, the influence of wind-wave currents, surging phenomena, and residential use of territories prevail; on the south-western coast – wind-wave currents, recreational, agricultural, and industrial use of the territory; on the east coast – wind-wave currents and recreational use of the territory; on the north-west and north-east coasts - the processes of flooding and salinization of coastal areas and the impact of agricultural land use.

- The quantitative parameters of the dynamics of changes in the coastal zone with an annual average rate of processing of abrasion and accumulative shores are determined based on monitoring high-precision observations of key sites for calculating forecast constructions, which vary from 3.5 to 5.0 m/year.

– Based on the assessment and mapping of the processes of modern relief formation of the coastal zone of Lake Alakol, the main types and quantitative parameters of the impact of modern relief-forming processes on the natural and economic systems of the coastal zone are determined, including that the processing of the shores and flooding of residential areas occurs within 1% of the area of the coast, the impact of abrasion processes and the long-shore transfer of sedimentary material within recreational zones – by 4.8%, the destruction of sections of the transport network under the influence of run-up phenomena, flooding and waterlogging – by 5.3%, the impact of run-up phenomena, flooding and waterlogging of agricultural land - by 25.8% of the area of the coast.

– Scientifically-based environmental measures have been developed and mapped to stabilize the ecological and geomorphological conditions of the lakeshore. Alakol, including the substantiation of effective methods of shore reinforcement of abrasive shores; the optimal organization of the territory of the coastal zone is proposed based on the consideration of the average long-term rates of development of negative processes of relief formation; the need for monitoring studies in areas of development of dangerous processes of relief formation is justified; further development of recreational and ecotourist use of the coastal zone, including amateur fishing, taking into account ecological and recreational capacity is recommended.

The personal contribution of the author to the research. Search, collection and systematization of input data, field research, including participation in a route expedition around the lake. Alakol. Data processing and analysis, interpretation of results, preparation of scientific publications (review, discussion, editorial Board). The results obtained during the research allowed the applicant to publish 12 scientific publications in co-authorship. The main provisions of scientific articles are reflected in the chapters of the dissertation for the PhD degree.

Testing of the study. Preparation of oral and poster presentations by the author at international conferences and scientific seminars in Almaty in 2016-2017; Dushanbe, November 2018 (Tajikistan); Tashkent, April 2019 (Uzbekistan); Vienna, April 2019 (Austria), remote participation in Krasnoyarsk and Volgograd (Russia). A total of 8 articles were published, of which 3 articles were published at conferences, 2 articles in publications included in the Scopus database, and 3 articles in CCFES publications.

Structure of the dissertation. The thesis consists of an introduction, 4 chapters, conclusion, list of sources used, 40 tables, 111 figures and appendices. The list of sources used includes 195 bibliographic references. The number of pages is 223.