ANNOTATION

for the academic degree of Doctor of Philosophy (PhD)

The specialty 6D060800 – «Ecology»

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on the topic of dissertation work

«Geoecological studies of the marine area and the coastal zone of the Caspian Sea within the territory of the city of Aktau using remote sensing»

The relevance of research.

In the modern world the problems of the environment and sustainable development are of particular importance and are becoming more and more urgent and require comprehensive research for effective solutions. The Caspian Sea is one of the largest inland bodies of water in the world, attracting the attention of scientists and specialists in the field of geoecology. In this context, the city of Aktau, located on the shores of the Caspian Sea, becomes an object of special interest for research in the field of marine and coastal ecology. At the summit of the five Caspian littoral States, significant progress was made in the preparation of a Convention on the legal status of the Caspian Sea. The Heads of the states discussed issues of cooperation in transport, security, economy and environmental protection. An intergovernmental Commission on the management of water resources of the Caspian Sea was also established. Monitoring of the coastal zone for environmental protection is a very important task, especially in areas subject to rapid changes, such as the coast of the Caspian Sea.

Special attention is paid to the sustainable use of the Caspian Sea, which plays a key role in the fields of transport, tourism, fishing and industry. The need for environmental impact assessment is emphasized in connection with the active development of promising sites, which outlines the importance of remote sensing for monitoring the state of the ecosystem. The use of remote sensing is becoming an integral method for effective monitoring and visualization of coastline maps to update the latest data on the environmental situation at the research site.

The study is devoted to monitoring the state of ecosystems of coastal zones and the Caspian Sea using the NDVI index and geographic information systems (GIS). GIS provides effective visualization of spatial pollution data and provides information about data sources. The study aims to improve understanding and management of the ecological state of the Caspian Sea, emphasizing the need to use modern technologies for effective monitoring and sustainable development of the region.

This work is devoted to the study of the environment status in the specified area using modern methods and technologies, including remote sensing. The stress is laid on geoecological aspects affecting marine and coastal ecosystems, as well as the interaction of human activities with the marine environment.

Purpose of research. The purpose is to identify main factors affecting the ecological state of the Caspian Sea near the city of Aktau on the basis of remote sensing and geoinformation systems (GIS) data, followed by the development of

recommendations to eliminate or mitigate negative impacts on the marine ecosystem.

The main objectives of research:

1. Carry out a comprehensive analysis of water and soil using geochemical parameters, physico-chemical characteristics in the coastal zone and the marine part of the Caspian Sea near the city of Aktau;

2. Search and receive information about the Earth's surface of the studied area, with spectral channels from the Sentinel-2 and Landsat-8 space satellites with high resolution;

3. Calculate the difference between infrared and visible radiation to obtain the NDVI index in the range from -1 to 1, and analyze the temporal dynamics of changes in vegetation and soil cover to identify trends in the coastal zone of Aktau city;

4. Development of cartographies based on remote sensing data with an assessment of their applicability for geoecological research;

5. Determination of ecotoxicity of water and soil using biotests to obtain a reliable and objective assessment of the environment status;

6. Building a mathematical model based on empirical data for the coastal zone and the marine part of the Caspian Sea and developing recommendations for resource management: the results of the study will provide information necessary for the formation of strategies for the sustainable use and protection of natural resources in the region under consideration;

Object of research: the coastal zone and the marine part of the Caspian Sea near the city of Aktau.

Subject of research: the ecosystems' state of the coastal zones and the water area of the Caspian Sea focused on their ecological condition and sustainable use. The study focuses on the application of the NDVI index to assess vegetation health, identify changes in ecosystems, and monitor the site under research. The use of geographic information systems (GIS) for visualization of spatial pollution data and integration of various information sources is also considered.

Research methods:

Seawater sampling was carried out in accordance with GOST 17.1.5.05-85 «General requirements for sampling surface and marine waters». Immediately after sampling, each water sample was poured into special storage tanks according to GOST 17.1.5.04-81. The water sampling procedure was performed using a plastic «Hydro Bios» type bathometer with a volume of 1.7 liters. To determine the content of heavy metals in the soil, the method of atomic absorption spectrometry with plasma atomization was applied using a high-precision AAS MGA-915M apparatus (manufactured by Lumex, Russia). To determine the toxicity of the samples, the main microbiological methods of cultivating microorganisms in aero- and anaerobic conditions were used in the work

The data obtained were processed using the Statistica 10 analytical software interface. The choice of the analysis method was carried out using the Kruskal-Wallis ANOVA criterion statistics due to the limited volume of samples and different data distribution laws.

To download satellite images, the Sentinel Hub platform was used, via the main EO Browser server. The platform used two main space satellites Sentinel-2 and Landsat-8.

Scientific novelty of the research: It encloses the use of an integrated approach combining the NDVI index and geographic information systems (GIS) for monitoring, building a mathematical model based on empirical data and analyzing ecosystems of coastal zones and the Caspian Sea.

Principles for defending a dissertation work:

- geochemical parameters and physico-chemical characteristics of seawater, soil of the coastal zone of the Caspian Sea near the city of Aktau;
- the results of calculating the NDVI index in the range from -1 to 1 of the difference between infrared and visible radiation on the state of density and health of vegetation;
- schematic maps based on remote sensing data on the state of the soil, vegetation of the marine part and the coastal zone of the Caspian Sea near the city of Aktau;
- results of biotests of ecotoxicity of seawater and soil and analysis of the temporal dynamics of changes in vegetation and soil cover in the coastal zone of Aktau city;
- a mathematical model for predicting soil pollution in the coastal zone of the Caspian Sea with heavy metals and metalloid;
- recommendations for preparation of strategies for sustainable development and protection of natural resources of the marine part and the coastal zone of the Caspian Sea in the Aktau city area.

Thus, the results of the study provide practical tools for improving environmental management and developing sustainable strategies for the development of coastal regions.

Practical significance of the obtained results: The results of the study provide information necessary for the development and implementation of strategies for sustainable management of the Caspian Sea resources, taking into account the impact of anthropogenic factors. Research can contribute to improving the management of natural resources and contribute to the sustainable development of the Caspian Sea region. Application of a hybrid approach to research and development of new scientific recommendations.

Personal contribution of the author to the dissertation work: conducting physico-chemical analyses, determining toxicity by biotesting, developing cartograms based on remote sensing data, as well as building a mathematical model based on empirical data.

Relation of work to other research works.

The dissertation work is completed:

1. within the framework of the Commercial Agreement No. 42/19 dated 09/27/2019 between «Kazakhstan Agency of Applied Ecology» KAPE LLP and KUTI named after Sh. Yesenova, for the performance of research work: «The current state of the coastal strip of the northeastern Caspian Sea within the boundaries of the Mangystau region» (the mentor: Doctor of Technical Sciences,

prof. Kenzhetaev G.Zh), on the basis of contract No. UII63264 dated 09/10/2018 between North Caspian Operating Company and KAPE;

2. within the framework of the scientific and technical project on grant financing, Agreement No. 198 dated 11/12/2020 IRN AR08956547 «Pilot study of the mode of sea currents on the Mangystau shelf of the Caspian Sea»;

3. Within the framework of the state grant «Zhas galim» of the Committee of Science of the Ministry of Education and Science of the Republic of Kazakhstan for 2023-2025, IRN AP19175679 «Comprehensive study and assessment of the ecological state of the Eastern coast of the Caspian Sea near the city of Aktau» on the basis of agreement No. 146 ZHG-4 dated May 17, 2023;

4. Program-targeted financing for 2023-2025 IRN BR21882122 «Sustainable development of natural, economic and socio-economic systems of the West Kazakhstan region in the context of green growth: a comprehensive analysis, concept, forecast estimates and scenarios».

Approbation of work.

The research results were reported and discussed at international scientific and practical conferences: the International Scientific and Practical Conference «I International Yesenov Readings» held within the framework of the Program for the modernization of public consciousness «Orientation to the future: Rukhani Zhangyru», (Aktau, 2018), the International Scientific and Practical Conference «Geoecological and technological aspects of the development of deposits of hard-to-recover hydrocarbons» (Aktau, 2019), at the VIII International scientific and practical Internet conference, (Mogilev, Belarus-2019), the International scientific and practical online conference «The Caspian Sea in the XXI century: regional and global problems, cooperation and security» dedicated to the 70th anniversary of Professor, Doctor of Technical Sciences Kenzhetaev G. Zh., (Aktau, 2020).

Research publications: Based on the materials of the dissertation, 22 scientific papers have been published, of which: 6 articles have been published in magazines recommended by the KKSON of the Ministry of Education and Science of the Republic of Kazakhstan; 1 article in the magazine included in the Scopus database, the rest of the articles in collections of international scientific and scientific conferences.

Scope and structure of the dissertation: The dissertation consists of an introduction, 4 chapters, a conclusion, and a list of 127 references. The work is presented on 134 pages of computer text, illustrated with 51 figures, 29 tables and appendices.