

ANNOTATION

for the academic degree of Doctor of Philosophy (PhD)

The specialty 6D060800 (8D05201) – «Ecology»

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on the topic of dissertation work

«Conservation of biodiversity of flora and fauna in the area of the Caspian plant cement at the Mela Shetpe deposit Yuzhnoye in the mountainous Mangystau»

The relevance of research.

This paper examines the ecological condition of the Caspian Cement Plant territory, located within the Mangistau mountain-arid zone, with a particular focus on the Shetpe-Southern Chalk quarry. The study is relevant due to the increased anthropogenic pressure on the region's natural ecosystems, resulting in part from the development of cement production, which is accompanied by emissions of dust, solid particles, and gaseous pollutants that negatively impact components of the biosphere.

The purpose of this study is to conduct a comprehensive assessment of the impact of industrial activities, including boron mining, on the state of flora and fauna, using modern methods of remote sensing and geographic information system (GIS) technologies. Special attention is given to the analysis of vegetation cover, as it serves as a sensitive indicator of environmental changes under anthropogenic influence.

During the study, physico-chemical analyses of environmental components were carried out, the degree of ecosystem transformation was assessed, and the main factors affecting the stability of geosystems under mining conditions were identified. It was established that intensive industrial activity contributes to the degradation of vegetation cover and a reduction in biological diversity.

Based on the results obtained, scientifically grounded recommendations have been developed to reduce anthropogenic pressure, restore natural ecosystems, and preserve the region's biodiversity. The findings of this study can be applied in implementing environmental protection measures, including within the framework of national environmental programs.

Purpose of research.

To assess the ecological condition of the environment in the area surrounding the Caspi Cement plant, located at the Southern Chalk Deposit of Shetpe in Mountain Mangystau, to determine the impact of industrial activities on biodiversity, and to develop measures for reducing anthropogenic pressure.

The main objectives of research:

1) To investigate the main components of the ecosystem within the study area (atmospheric air, soils, water resources, flora, and fauna) and assess their current ecological condition.

2) To determine the degree of impact of industrial emissions from the Caspi Cement plant on the environment, as well as on the biodiversity of flora and fauna.

3) To analyze the state of biodiversity in the study area using Geographic Information Systems (GIS), assess its spatial distribution, and develop thematic maps.

4) To provide a scientific justification for the ecological and technological efficiency of using basin-type solar distillers with a triangular corrugated surface to reduce technogenic impacts caused by the industrial activities of the Caspi Cement plant.

Object of research: the objects of the study are the ecosystems of the territories adjacent to the Caspi Cement plant, located within the Southern Chalk Deposit of Shetpe, including atmospheric air, soil cover, plant communities (flora), animal communities (fauna), and biodiversity indicators within the area affected by industrial emissions.

Subject of research: the subject of the study is a comprehensive assessment of the environmental condition within the zone affected by the industrial activities of the Caspi Cement plant, as well as the scientific determination of the impact of anthropogenic pressure on species composition, the distribution patterns of flora and fauna, and the level of biodiversity.

Research methods:

The expedition studies were conducted in the summer and autumn using the route exploration method, based on passing a certain section of the route and preliminary study and observation of the area to collect information. In the course of field research, herbarium specimens and photographic materials were collected, as well as species lists of the flora of the studied region were compiled.

The locations of the plants were determined using GPS devices. Micrographs of plant anatomical structures were obtained using a MEIJI microscope equipped with a CAM V500B 6M video camera (1.5 megapixels, 1440×1080 pixels resolution). Statistical processing of morphometric parameters was performed according to the methodology of G.F. Lakin, while A.I. Tolmachev's methods were applied for biological and ecological analysis. The accepted species names are based on data from the Plants of the World Online (POWO) database. To determine the taxonomic affiliation of the species, fundamental scientific works were consulted, including Flora of the USSR edited by V.L. Komarov, Flora of Kazakhstan under the guidance of N.V. Pavlov, and J.E. Nurmakhambetov's study Results of a Comprehensive Expedition to South Ustyurt (Assessment of Biodiversity). Species verification was carried out using iNaturalist platforms, birds.kz, mammals.kz, Plantarium and POWO. Satellite images from Landsat 5, Landsat 8 and Landsat 9 were used to assess the condition of the vegetation cover. The spatial resolution of these images was 15-30 meters, depending on the spectral channels used. All remote sensing data was obtained from official NASA open sources. The components of the environment, particularly the content of heavy metals in soil and vegetation, were analyzed using atomic absorption spectrometry (AAS) with plasma atomization (MGA 915). Additionally, the methodology for calculating the concentration of harmful substances in atmospheric air from industrial emissions (OND-86) was applied. For comprehensive spatial analysis, the unified software package Prism-District version 3.0 and the atmospheric calculation program SANZONE, which

includes modules for determining sanitary protection zones (program for calculating atmospheric pollution – PCAP), were used. Statistical data processing was conducted using the analytical software interface Statistica 10. Cartographic schemes of the study area were developed using satellite imagery and GIS programs (Google Maps, ArcGIS, MapInfo Professional v.12), while the processing of maps and diagrams was carried out with CorelDRAW 11 graphics software. Cartographic materials were produced using GIS software products, including MapInfo Professional v.10.2 and SAS.Planet 160707.

Scientific novelty of the research:

1) For the first time, the relationship between anthropogenic pressure factors (atmospheric dust pollution, gaseous pollutants, and degradation of the surface soil layer) and biodiversity indicators (species composition, population density, and community structure) within the impact zone of the Southern Chalk Deposit of Shetpe and the Caspi Cement plant has been scientifically established using an integrated approach based on ecological bioindication and spatial analysis methods.

2) A comprehensive environmental and technological assessment of conservation measures aimed at preserving biodiversity and maintaining ecosystem stability within the impact zone of the Southern Chalk Quarry of Shetpe and the Caspi Cement plant was carried out. The effectiveness of these measures in reducing anthropogenic pressure, limiting the spread of pollutants, and enhancing the natural self-recovery capacity of ecosystems was scientifically evaluated.

3) Under arid climatic conditions, the role of plant and animal biodiversity in maintaining ecosystem stability was qualitatively assessed using bioindication methods. A spatial database of biodiversity indicators for the study area and surrounding natural habitats was developed, and digital thematic maps were produced using Geographic Information Systems (GIS). The obtained results provide a scientific basis for improving sustainable natural resource management and ecosystem-based management.

4) A technology for desalinating saline groundwater using a mobile solar-powered desalination unit adapted to arid climatic conditions was proposed to reduce dust emissions, prevent secondary soil salinization, and mitigate the corrosion degradation of metal structures within the impact zone of the Southern Chalk Quarry of Shetpe and the Caspi Cement plant. The improved efficiency of the desalination system through the incorporation of an auxiliary (secondary) evaporation basin was scientifically substantiated, demonstrating its potential for conserving water resources and reducing environmental pressure on ecosystems.

Provisions issued for the defense of dissertation work:

The results obtained in the course of research are confirmed by retrospective, gravimetric, atomic absorption, analytical methods and statistical processing of experimental data. Special certified methods, standard GOST RK, were used to perform planned research works and chemical laboratory experiments. The equipment and materials used in the research meet the requirements of the regulatory and technical documentation.

The main principle recommended for protection:

- The results of environmental monitoring of the qualitative and quantitative characteristics of atmospheric air within the impact zone of the Caspi Cement plant are presented. The monitoring identified the spatio-temporal distribution patterns of particulate matter (PM10 and PM2.5), gaseous pollutants, and other industrial emissions, and assessed their compliance with sanitary, hygienic, and environmental standards.

- A comprehensive geoecological assessment of the soil cover within the Southern Chalk Deposit of Shetpe and the Caspi Cement plant area was carried out. The study determined the physicochemical properties of soils, including the degree of salinity, heavy metal concentrations, and structural–dispersive changes, as well as the intensity of degradation processes caused by anthropogenic impacts, such as soil erosion, secondary salinization, and industrial contamination. Based on the obtained results, the stability of soil ecosystems and the level of ecological risk were scientifically characterized.

- The impact of the industrial activities of the Caspi Cement plant on the biodiversity of flora and fauna was investigated using ecological bioindication and geospatial analysis. The study systematized quantitative and qualitative indicators of species composition, population density, and the spatial distribution of plant and animal communities, resulting in the development of a biodiversity database. Furthermore, thematic maps characterizing the ecological condition of the study area were produced, and the spatial patterns of anthropogenic pressure were identified.

- The results of scientific and experimental studies on the desalination of saline groundwater using a mobile solar-powered desalination unit adapted to arid climatic conditions are presented. The proposed technology is intended to reduce dust emissions, prevent secondary soil salinization, and mitigate the corrosion degradation of metal structures within the impact zone of the Southern Chalk Quarry of Shetpe and the Caspi Cement plant. The ecological and technological performance of the system was evaluated by assessing desalination efficiency, the evaporation–solar radiation regime, and the increase in productivity achieved through the incorporation of an auxiliary (secondary) evaporation basin.

Theoretical and practical significance of research results.

The scientifically substantiated results of environmental monitoring conducted within the Southern Chalk Quarry of Shetpe and the impact zone of the Caspi Cement plant, together with the developed biodiversity database and digital thematic maps, can be used by specialists of the Mangystau Region Department of Natural Resources and Environmental Management, as well as by environmental scientists, geobotanists, biologists, geographers, researchers at higher education institutions, industrial enterprise specialists, and environmental experts for environmental monitoring, environmental assessment, and the development of environmental protection measures. The developed mobile solar-powered desalination unit can be applied within the Southern Chalk Quarry of Shetpe and the Caspi Cement plant area for desalinating saline groundwater used for dust suppression and the plant's technical water supply. Its application also contributes to preventing the premature corrosion degradation of metal structures and industrial equipment. The economic efficiency of the proposed technology has been confirmed

by the results of calculations performed within the framework of the project «Development of a Desalination System Based on Conventional and Alternative Energy Resources».

Author's contribution. In the orientation studies, as well as production experiments, the author directly participated in the process, regulatory parameters and ensured the exact observance of the methodology. His active participation contributed to increasing the reliability of the data obtained and the quality of the conducted research.

Communication of work with other research works. Dissertation work within the framework of the state grant "Young Scientist" of the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan in 2023-2025. No. AP19175489 was implemented as part of the project «Scientific substantiation of ecological aspects of biodiversity conservation on the territory of Shetpe-Southern Chalk quarry using GIS technologies»

Approbation of work. The results of the study were reported at the IV International Scientific and Practical Conference "Industrial Technologies and Engineering" (M. Auezov South Kazakhstan University on October 26-27, 2018), the III International Conference Book Edition of the countries of the Commonwealth of Independent States "Best young scientist" -2021, (19-23), as well as in 2018 during a scientific internship at Yildiz Technical University, Turkey. In addition, the main provisions of the dissertation were widely discussed at the Academic Council of the Faculty of Engineering in 2024-2025, at meetings of the Department of Ecology and Geology.

Publications of research work: based on the materials of the dissertation, 8 works were published, including: 3 publication in journals included in the Scopus database, 3 articles in scientific publications recommended by the Committee for Quality Assurance in Science and Higher Education, the rest of the articles have been published in International scientific and practical conferences and the patent of the Republic of Kazakhstan for utility model No. 9128 dated 05/17/2024 «Basin type water desalination plant» was obtained.

Scope and structure of the dissertation: The dissertation consists of an introduction, 4 chapters, conclusions, appendices, and a bibliography comprising 169 titles. The work is presented on 166 pages with 41 drawings and 36 tables