

## ABSTRACT

of thesis for the degree of doctor of philosophy (Ph.D.) speciality 6D060800 - Ecology

**KHUSNITDINOVA MARINA ALEKSANDROVNA**

### **Geoenvironmental problems of the border territory of the Republic of Kazakhstan and their solutions (based on the example of Kazakhstan – Kyrgyzstan sector)**

The thesis is aimed at researching the landscape-ecological state, of the main geoenvironmental problems and the development of a complex of environmental protection measures for the sustainable nature management in the border Kazakh-Kyrgyz sector.

**The object of the research** is the border area of the Kazakh-Kyrgyz sector.

**The subject of the research** is geocological problems of the border areas of the Republics of Kazakhstan and Kyrgyzstan.

**The aim of the study** is to establish the geocological problems and develop a set of environmental protection measures aimed at preserving the landscape-resource potential and preventing negative environmental situations in the border area of the Kazakh-Kyrgyz sector.

To achieve the goal, the following **tasks** were assigned:

-to carry out an information search and analyze the modern theoretical and methodological foundations of research on the nature management in border areas;

- to assess the natural-economic systems and anthropogenic disturbance of border areas;

- to assess the landscape-ecological state of border areas.

- to develop the main directions for the development of sustainable nature management and environmental protection measures to stabilize the landscape and ecological state of the border Kazakh-Kyrgyz sector.

**Research methodology.** This study refers to a comprehensive interdisciplinary study, where the theoretical and methodological platform was the synthesis of systemic, natural-historical, landscape-ecological and GIS-technological approaches, including a set of leading principles and methods of landscape science, geocology, etc.

The study of the border Kazakh-Kyrgyz sector was based on landscape-ecological approach. The cartographic method was the leading method for displaying the landscape-ecological and socio-economic state of the border area. When creating thematic maps of the border area, the classification constructions were based on conjugate approaches to studying the landscape structure as the basis for sustainable nature management - historical, genetic and structural.

The use of methods for decrypting remote sensing data and modern GIS technologies made it possible to solve a number of research tasks. One of the main forms of studying the landscape-ecological and socio-economic state of the border Kazakh-Kyrgyz sector was conducted field research, including - research methods at key sites using standardized forms of description, field mapping methods, which made it possible to determine the degree of anthropogenic disturbance and landscape-ecological state, identify the main geocological problems.

**Sources of research materials** - were scientific literature and articles; statistical materials - the Committee for Land Management of the Ministry of Agriculture of the Republic of Kazakhstan, the Agency for Statistics of the Republic of Kazakhstan, etc .; cartographic material (geological map of Kazakhstan, scale 1: 500 000; geomorphological map of Kazakhstan, scale 1: 1 500 000; soil map for the territory of Almaty and Zhambyl regions of the Republic of Kazakhstan, scale 1: 300 000, vegetation map of Kazakhstan and Central Asia, scale 1: 2 500 000; topographic base, scale 1: 500 000); fund materials of the Institute of Geography and Water Security; factual material obtained by the author in field research (2017-2020). Remote sensing data including multispectral satellite images from Landsat, Sentinel, Alos, etc.

**Relevance of the research topic.** This scientific research is within the framework of solving the problems of rational nature management and research on the development of natural-economic

systems (NES) of border areas. The results obtained show that the sustainable development of NES of neighboring states (Kazakhstan and Kyrgyzstan) in the border territories is based on the principles of coordinated interstate policy in the field of ecology.

The problem of rational nature management of the border territories is considered as one of the relevant areas of research in domestic science, is consistent with the adopted Programs for Sustainable Development of the Republic of Kazakhstan and is related to the implementation of long-term priority state documents. In the “Kazakhstan-2050” Strategy, one of the main priorities is the development of cross-border cooperation as the most effective form of integration. An effective step in the field of cross-border nature management in the context of transborder cooperation is the accession of Kazakhstan and Kyrgyzstan to international conventions and agreements. The heads of CIS governments, which include Kazakhstan and Kyrgyzstan, signed an agreement on cooperation in the field of environmental safety and economic development, in which one of the tasks is to develop a strategy for transboundary nature management.

**Natural and economic conditions of the border area of the Kazakh-Kyrgyz sector.** It has been established that the borderline Kazakh-Kyrgyz sector is characterized by a complex spatial structural organization of landscapes, which is determined by the geographic location, geological and geomorphological features and the direction of the physical and geographical processes.

On the territory of the border sector, a landscape map was created on a scale of 1: 1 000 000, which acts as the basis for landscape-ecological researches. The classification compositions of the map were systematized on the basis of a typological classification developed by Isachenko A.G. (1991, 1996), Nikolaev V.A. (1976, 1979), Geldyeva G.V., Veselova L.K. (1979, 2004, 2011) and others. As a mapped taxonomic unit were selected the kinds of landscapes. A total of 58 kinds were selected on the landscape map. The greatest species diversity (43% of the selected landscape kinds) is characterized the foothill landscapes. The landscapes of high mountains, mid mountains and low mountains account for 34% of the species diversity.

The basis of the socio-economic development of the Kazakh-Kyrgyz border sector is agriculture, extractive and processing industries, as well as modern demographic processes (population size, density, natural population growth, migration, etc.) that have an impact on socio-economic development. More than 80% of the population of the border Kazakh-Kyrgyz sector lives in rural areas. The population is unevenly settled in the border sector. In recent years, there has been a general trend of population growth in both border sectors due to the natural movement of the population. In 2005-2018, the natural population growth in the border area of the Kazakhstani sector increased 1.8 times, and the Kyrgyz sector - 1.7 times. Based on the analysis of the development of agricultural and industrial production of the border sector, border areas were identified by the level of their economic development (from low to high). A high level of economic development is observed in two border regions (Karasai and Talgar) of the kazakh sector and in one Chui border region of the kyrgyz sector.

**Assessment of anthropogenic disturbance and landscape-ecological state, geocological problems of the border area of the Kazakh-Kyrgyz sector.** A comprehensive indicator of anthropogenic disturbance of the landscape of the border sector was estimated by a set of indicators grouped by a system of parameters. An assessment of the degree of anthropogenic disturbance showed that agricultural type of anthropogenic impact (pasture, agrogenic and meliorative) covers on 80% of the border sector. The pasture type of impact dominates (48.5% of the sector) and is present in almost all types of landscapes. Landscapes of moderate and weak degree of disturbance prevail. A relatively strong and strong transformation of landscapes is observed in areas of mining, concentration of settlements, in the territories of large-scale reclamation and agrogenic development. Mainly within the landscapes of foothill plains, covering 22% of the territory of the border Kazakh sector and 12% of the territory of the Kyrgyz sector.

The assessment of the landscape-ecological state of the border sector was based on the principle of multi-purpose use of the territory and environmentally significant assessment indicators (criteria). The development of assessment scales was preceded by a comparative analysis of the criteria for the environmental status of landscapes adopted in Kazakhstan and Kyrgyzstan. It has been established

that in the border area of the Kazakh sector, dominate the landscapes of relatively favorable and satisfactory ecological conditions and cover 84.3% of the total area. A stressful ecological state (7.1%) is noted in the landscapes of the foothills of Almaty, Taraz and Assy residential and industrial complexes, in the area of lake Biylikol, located in the northwest of the border territory of the Zhambyl region (this ecological state is due to the impact of historical pollution). Also, within the Kara-Balta-Shu interfluvium (due to transboundary pollution of water bodies and intensive reclamation of the territory) and fragmentary - on the irrigated arable land of the Zhambyl district of the Almaty region; in the north-west of the Moyynkum sand massif (the formation of anthropogenic-conditioned loose and fluid sands).

On the border territory of the Kyrgyz sector, landscapes of a relatively favorable ecological state are dominating (43.8%) and located in mountain systems. The stressful ecological state (4.9%) is noted within the Kara-Balta and Tokmak industrial and residential complexes, in the foothill and valley landscapes of the Toktash-Shu interfluvium, especially within the Alamudunsky, Sokuluksky districts and the cities of Tokmak and Kara-Balta, the Kichi-Kemin river valley (historical pollution of the radioactive mudflow). Point focuses of a critical ecological state are observed to the areas of the Kara-Balta, Burda, Ak-Tuz tailings of radioactive and toxic wastes representing an environmental hazard of transboundary nature.

The main geocological problems in the border area of the Kazakh-Kyrgyz sector have been identified, which are: degradation of agricultural lands; degradation of floodplain and forest ecosystems; problems associated with disturbance of the hydrological regime, water distribution and pollution of surface waters; problems associated with industrial and household waste, including radioactive waste.

The results of the study made it possible to develop the **main directions of sustainable transboundary nature management and to develop targeted environmental protection measures** for the sustainable nature management of the border Kazakh-Kyrgyz sector.

**Based on the obtained results obtained, the following conclusions were made:**

1. The landscape-ecological research method is the basis for identifying and assessing geocological problems in the context of transboundary nature management. In particular, the application of the landscape-indicator method, assessment of landscape diversity and anthropogenic disturbance, targeted landscape mapping, natural zoning, using the method of remote sensing and modern GIS technologies, allowing the development of basic environmental protection measures aimed at the balanced nature management in the adjacent territories of Kazakhstan and Kyrgyzstan.

2. An assessment of the natural conditions and the characteristics of the economic use of the territory of the kazakh-kyrgyz border sector showed that the natural conditions of the border sector are characterized by similar geological and geomorphological, climatic conditions, the prevalence of mountainous terrain, that are predetermined the similarity of the landscape organization of the border areas. The historical community of nature management in the Soviet period and modern natural and landscape conditions predetermined similar conditions for nature management and the development of natural and anthropogenic processes over almost the entire transboundary sector. Within the border sector, landscape diversity is represented by a wide range of natural complexes - from deserts on foothill plains to alpine meadows.

An evaluation of anthropogenic disturbance of the border area of the kazakh-kyrgyz sector showed that dominate the landscapes of moderate and minor degree of disturbance.

3. As a result of the assessment of the landscape-ecological state of the border territory of the kazakh-kyrgyz sector, it was determined dominated the landscapes of relatively favorable and satisfactory ecological conditions - cover 84.3% of the total area (Kazakh sector) and 70,3% (Kyrgyz sector).

Geocological problems of the border Kazakh-Kyrgyz sector are - degradation of agricultural lands; degradation of floodplain and forest ecosystems; problems associated with disturbance of the hydrological regime, water distribution and pollution of surface waters; problems associated with industrial and household waste, including radioactive waste.

4. The main direction of sustainable nature management of the border kazakh-kyrgyz

sector is development of agreed mechanisms for integrated management of transboundary water resources and development of measures to reduce their pollution.

**The scientific novelty** of the research lies in the complex solution of geoecological problems of the border Kazakh-Kyrgyz sector on the basis of a landscape-ecological approach, in the development of the main directions for the development of sustainable cross-border nature management.

Among the provisions with **scientific novelty of the research** carried out, the following can be attributed:

- for the first time, an assessment of the structural organization of the landscapes of the zonal range of the border Kazakh-Kyrgyz sector for sustainable transboundary nature management was carried out;

- for the first time, an assessment of the landscape-ecological state of border areas was given on the basis of the degree of anthropogenic disturbance of landscapes and the main indicators of agricultural and technogenic impact;

- for the first time for the border areas, a series of thematic medium-scale assessment maps has been created, aimed at balanced transboundary nature management;

- for the first time, the main directions for the development of sustainable cross-border nature management were developed and a map of targeted environmental protection measures was created to stabilize the landscape-ecological state of the border Kazakh-Kyrgyz sector.

#### **The main conditions for the defense:**

1. Implementation of the tasks of preserving the landscape-resource potential and balanced nature management is possible on the basis of the application of the landscape-ecological approach in the development of a nature management system aimed at sustainable development of border areas.

2. The system of nature management in border areas must be implemented on the basis of the regularities of the structural organization of landscapes, a comprehensive account of anthropogenic disturbance of the natural system, the availability of water resources, a modern system of land use and land management.

3. The use of the landscape-ecological approach, remote sensing data and the results of field monitoring observations in the study of border areas makes it possible to establish the types, nature and degree of anthropogenic disturbance of natural-territorial complexes, assess their landscape-ecological state and determine the existing geoecological problems.

4. The application of the developed scientifically grounded directions of sustainable nature management and targeted environmental protection measures contributes to the elimination of geoecological problems and is aimed at stabilizing the landscape and ecological state of border areas.

#### **The theoretical and practical significance of the research.**

*The theoretical significance* of the research results is to obtain the new scientific knowledge in the field of transboundary nature management, characterized by the presence of interstate environmental problems. The obtain results can be a scientific and practical platform for the development of modern economically sound technologies. Which are aimed at accelerated industrial and innovative development of border regions and increase the efficiency of the use of natural resources to maintain a high-quality environment and increase the well-being of the population.

*The practical value and significance* of the work is reduced to solving environmental problems by providing management structures with special geographic information - cartographic support and science-based recommendations. The results of this research study can make a significant contribution to the development of international programs and projects. Which are aimed at creating a joint strategy for coordinated and mutually beneficial development of transboundary territories of Kazakhstan and Kyrgyzstan.

#### **The results of the dissertation research are implemented in:**

1. KazNII of animal husbandry and fodder production - "Map of the current ecological state of the landscapes of the border area of the Kazakh-Kyrgyz sector", scale 1: 1,000,000 (**Implementation act dated November 30, 2020 No. 01-601**), when carrying out research under the program No. 0.0884 " Development of intensive technologies for livestock industries. "

2. Fund "Farmer of Kazakhstan" - "Map of environmental protection measures to stabilize the ecological state of the border area of the Kazakh-Kyrgyz sector", scale 1: 1,000,000 (**Implementation Act dated November 27, 2020 No. 01-3-19**), when implementing the project on reducing the degradation of pasture land in Zhambyl region in 2018 and a project to develop pasture management plans in Almaty region in 2019-2020.

The results of a comprehensive evaluation of the landscape-ecological and socio-economic states of the border kazakh-kyrgyz sector are possible to use in the preparation of land use and land management plans for the border territory. As well as can be used in development and preparation of strategies and programs of socio-economic development of the border regions of the Republic of Kazakhstan. Also, the developed approaches to solving geoenvironmental problems and perspective directions of cross-border cooperation are recommended to be used in the implementation and adjustment of state strategies and development programs; to strengthen cooperation between the Republic of Kazakhstan and the Kyrgyz Republic in the prevention and liquidation of natural and man-made emergencies and their consequences. Cartographic models will be in demand in the preparation and improvement of curriculum programs in higher educational institutions of geographical, environmental, land management and other areas.

The dissertation work was carried out as part of the research work of the Ministry of Education and Science of the Republic of Kazakhstan on grant financing (2015-2017) on the topic: "To develop a scheme for organizing sustainable nature management of the border area of Kazakhstan in the context of transboundary cooperation", the scientific results obtained for 2015-2017 are presented.

**The personal contribution of the author** to the solution of the problems put forward in the work is:

- in assessing the structural organization of landscapes of the zonal series of the border Kazakh-Kyrgyz sector;

- in conducting scientific research on the study of anthropogenic disturbance and landscape-ecological state of the border Kazakh-Kyrgyz sector in conjunction with the "Institute of Geography and Water Security" of the Ministry of Education and Science of the Republic of Kazakhstan;

- in the development and creation of a series of assessment maps of the border Kazakh-Kyrgyz sector;

- in the development of targeted environmental protection measures, contributing to the elimination of geocological problems and aimed at stabilizing the landscape-ecological state of the border Kazakh-Kyrgyz sector;

- in the preparation and publication of the scientific results obtained on the topic of the research carried out in rating journals (Agricultural Systems - Q1, Human Ecology - Q1). The main provisions of scientific articles are reflected in the sections of the thesis for the PhD degree.

**Research approbation.** The main results of the dissertation were reported:

- at the International Scientific and Practical Conference: "Nature, Ecology and National Economy" (2015, Voronezh, Russian Federation);

- at the International Scientific and Practical Conference: "Anthropogenic Transformation of Geospace: History and Present" (2015, Volgograd, Russian Federation);

- at the XV Meeting of Geographers of Siberia and the Far East. (2015, Ulan-Ude, Russian Federation);

- at the XXXIV International Scientific and Practical (correspondence) conference: "Integration of world scientific processes as the basis of social progress" (2016, Kazan, Russian Federation);

- at the International (Republic) scientific-practical conference: "Youth and Science-2016" (2016, Petropavlovsk, Kazakhstan);

- at the 16th International Multidisciplinary Scientific GeoConference: "SGEM 2016" (2016, Sofia, Bulgaria).

**According to the materials of the research published** 11 publications, including 2 articles in journals included in the Scopus database, 3 articles in republican scientific journals from the Committee list, 6 abstracts in materials of international conferences and summits.

**Thesis structure.** The dissertation work is presented on 189 pages and consists of normative references, definitions, designations and abbreviations, an introduction, 4 sections, a conclusion and a list of sources used from 245 titles, of which 36 are in foreign languages; contains 14 tables, 30 figures and 19 appendices.