

ABSTRACT

on the thesis of Dinara Birzhanovna Barmakova, "Hydrogeological and ameliorative processes management on irrigated lands of Almaty region on the basis on a geoinformation-analytical system," submitted for the degree of Doctor of Philosophy (PhD) in the specialty 6D075500 – "Hydrogeology and Engineering Geology."

Relevance of the Study: Irrigated agriculture in our country has been considered essential as a source of prosperity and economic development. Kazakhstan, for the most part, is located in an arid zone, so irrigation is a crucial factor in maintaining and developing the agricultural sector and, overall, can and should ensure the country's food security. Currently, global challenges related to climate change, unresolved issues with water allocation in transboundary rivers, and the unsatisfactory technical condition of irrigation systems exacerbate the problems of irrigated agriculture. In response to these challenges, the government has been actively pursuing policies in recent years to reconstruct irrigation systems, rehabilitate these lands, diversify agricultural crops, reduce the area under moisture-loving crops, and expand the use of water-saving technologies. Against this backdrop, significant changes are occurring in the hydrogeological-reclamation and soil-reclamation processes on irrigated lands, particularly during periods of low water levels. In the reclaimed lands of southeastern Kazakhstan, due to a lack of irrigation water and deterioration of irrigation systems, groundwater levels are declining, and changes are observed in the established long-term leaching regime and the water-salt balance of these areas. Therefore, studying hydrogeological-reclamation conditions, quantitatively assessing the changing hydrogeological and hydrochemical parameters of groundwater, as well as the components of the water-salt balance of irrigated lands, using modern software tools and research methods to develop measures to mitigate and manage the development of negative consequences, is highly relevant. The subject of this study is the irrigated lands of the Almaty region.

The subject of this study is the hydrogeological and meliorative processes occurring on irrigated lands.

The goal of this work is to study and analyze hydrogeological conditions and water balance studies, as well as to substantiate and apply modern software tools in a geoinformation and analytical system to automate the processing, construction, and spatial analysis of hydrogeological maps for the management of hydrogeological and meliorative processes on irrigated lands.

To achieve this goal, the following **objectives** were addressed:

- study of the hydrogeological conditions of irrigated areas under changing irrigation and economic conditions and the establishment of the main patterns of formation of the groundwater level and chemical regime;
- analysis of water balance studies on irrigated areas to determine the general direction of hydrogeological and meliorative processes for the development of preventive measures;

- the use of modern software tools in a geoinformation and analytical system for creating databases, automating processing processes, and constructing and visualizing hydrogeological maps;
- the use of geostatistical methods for spatial analysis and evaluation of hydrogeochemical study results to manage hydrogeological and meliorative processes on irrigated lands.

Research Methods. The study utilized research methods including field hydrogeological, laboratory, and water balance methods, modern GIS technologies for working with cartographic data, and geostatistical methods for spatial analysis of hydrogeochemical study results.

The scientific novelty of the work consists of the following:

1. Based on the research results, the main patterns of disturbed groundwater regimes and water balance components on irrigated lands were established under changing irrigation and economic factors.
2. The use of ArcGIS tools within a geoinformation and analytical system allowed us to substantiate the feasibility of creating geodatabases and spatial models of hydrogeological conditions, and visualizing the hydrodynamic and hydrochemical processes occurring in groundwater in irrigated lands.
3. A methodology for constructing maps of the hydrogeological and meliorative conditions of irrigated lands using ArcGIS tools, calculating areas, and automatically processing data for assessing the meliorative status of irrigated lands was substantiated.
4. Based on a spatial analysis of the results of hydrochemical studies using geostatistical methods, a relationship was established between soil salinity, the chemistry of groundwater, irrigation water, and drainage availability for further management and minimizing their negative impact.

Key points to be defended:

1. Using the results of hydrogeological and water balance studies on irrigated lands under changing irrigation and economic factors allowed us to identify the key patterns in the formation of groundwater regimes and water-salt balance components, in order to develop measures to minimize their negative impacts on these areas.
2. The potential of using modern ArcGIS tools to create geodatabases, construct thematic maps, automate the construction of hydrogeological maps, and calculate areas for monitoring and assessing the reclamation status of irrigated lands was substantiated.
3. Spatial analysis of hydrochemical groundwater studies using statistical methods allowed us to substantiate changes in the ion-salt composition of groundwater, for further forecasting and management of hydrochemical processes on irrigated lands. The practical significance of the research includes establishing fundamental patterns in groundwater level and hydrochemical regimes, identifying changes in the water-salt balance under current management conditions, and substantiating the feasibility of using additional ArcGIS tools for processing, automating construction processes, performing calculations, and visualizing the results of hydrogeological studies. This

research also supports spatial analysis of hydrochemical studies based on geostatistical methods for managing hydrogeological and reclamation processes.

The author's personal contribution includes direct field hydrogeological and water balance studies, substantiating the feasibility and developing a methodology for using additional ArcGIS tools for office data processing, constructing thematic maps, and analyzing the results.

Publications

The main results of the thesis have been published in nine articles, including two in international peer-reviewed scientific journals included in the Scopus and Web of Science databases (Water; Paddy and Water Environment). Five articles have been published in various international and national scientific journals and publications. Two articles have been published in international conference proceedings, including one included in the Scopus database (InterCarto.InterGIS).

Brief Description of the Main Contents of the thesis.

The thesis consists of an introduction, four main sections, a conclusion, and a list of references. Each chapter concludes with well-reasoned conclusions and results. The dissertation is a complete, independent research project containing new, concrete solutions aimed at improving the monitoring and management of hydrogeological and meliorative processes on irrigated lands.

The introduction substantiates the relevance of the dissertation research; formulates the purpose and main objectives of the work; and describes the degree of novelty of the results obtained and their validation.

In the first chapter, the author describes the natural and irrigation conditions of the study site.


The second chapter provides an overview of hydrogeological studies on irrigated lands and the use of geographic information systems.

The third chapter is devoted to the study of hydrogeological and meliorative processes on irrigated lands.

The fourth chapter describes the application of a geographic information and analytical system in hydrogeological studies.

The work is presented on 121 typewritten pages and contains 12 tables and 31 figures, as well as a list of 91 references.

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