ABSTRACT

To dissertation work of Alimbayev Yerzhan on the topic «Improving water availability of water management systems in the lower reaches of the Syrdarya river basin under conditions of full water flow regulation» submitted for the degree of Doctor of Philosophy (PhD) in the specialization 6D080500 - Water resources and water concumption

Relevance of the research topic. The catchment basin of the Syr Darya River originates in the mountainous regions of Kyrgyzstan and is the largest water body in Central Asia after the Amu Darya River, which flows into the Aral Sea in the Kyzylorda region of Kazakhstan through the territories of Tajikistan and Uzbekistan. Therefore, its water resources are widely used for the development of economic sectors in these countries and for ensuring the population's food supply. Since the flows of the main riverbed of the Syr Darya Basin and its tributaries are currently fully regulated by hydraulic engineering structures, its area of coverage can be considered a natural-technogenic water management complex.

As a result, the natural hydrological regime of the river has been completely altered and is now a natural-technogenic water object subject to regulation and management. The current hydrological regime of the Syr Darya River, due to its considerable impact on the economic sectors of the Kyzylorda region located in its lower reaches—including agriculture, which is the main water consumer—and on the level of water availability and water quality, will, in the future, require a comprehensive assessment of the ecological-climatic, hydrological, and hydrogeochemical state of the region. This, in turn, will necessitate the development of integrated programs of interest to all economic and production sectors, aimed at ensuring the sustainability of the natural system and improving environmental living conditions. This constitutes one of the most pressing issues in the scientific and practical field of agriculture today.

The catchment basin of the Syr Darya River originates in the mountainous regions of Kyrgyzstan and is the largest water body in Central Asia after the Amu Darya River, which flows into the Aral Sea in the Kyzylorda region of Kazakhstan through the

Aim of the dissertation research: The objective of the dissertation research is to assess the effective use of water resources and the water supply of economic sectors, taking into account geoecological constraints in the water management field, through a comprehensive study of the hydrological and hydrochemical regime that has developed under natural-technogenic conditions within the Kyzylorda region, located in the lower reaches, in connection with the complete regulation of runoff in the catchment basin of the Syr Darya River.

Research Objectives:

- Determining the characteristics of hydrological regime regulation of the Syr Darya River under natural and natural-technogenic conditions in temporal

and spatial scales;

- Determining the features of hydrological regime formation by assessing, on a spatial scale, the degree of availability of mean annual runoff in the lower reaches of the Syr Darya River;
- Assessing changes in river flow and the availability of water flow in temporal and spatial scales through the construction of a mathematical model of integral measurement test indicators for evaluating natural-technogenic activity in the lower reaches of the Syr Darya River;
- Assessing the effective use of water resources in production by constructing a mathematical model of integral measurement test indicators for evaluating the use of Syr Darya River water resources in the economic sectors of the Kyzylorda region;

Providing scientific justification for the principles and measures ensuring the sustainable development of the agricultural sector of the Kyzylorda region, based on integral indicators of geoecological constraints in the water management sector, to ensure the effective and rational use of water resources formed under natural-technogenic conditions in the lower reaches of the Syr Darya River.

Research Methods.

The study of the hydrological regime formed under natural and natural-technogenic conditions in the lower reaches of the Syr Darya River was carried out using methodological guidelines applied in the field of environmental management. The research employed dialectical approaches based on the geosystem method as the primary qualitative tool for describing natural runoff, along with methods of analysis, analogy, comparison, classification, systematization, empirical and mathematical modeling.

Main points to be defended (proven scientific hypotheses and other conclusions that constitute new knowledge).

Through a comprehensive assessment of the formation of the hydrological regime under natural and technogenic conditions in the lower reaches of the Syr Darya River in temporal and spatial scales, the following conclusions have been drawn:

- By constructing a mathematical model of the water flow re-regulation indicator and assessing the degree of formation and regulation of the water flow in the lower valley of the Syr Darya catchment basin, it has been established that it constitutes a natural-technogenic water management complex with a fully regulated hydrological regime;
- A mathematical model of river flow indicators was developed, reflecting the dynamics of riverbed desiccation due to natural-technogenic impact. Using this model, the direction and rate of riverbed desiccation caused by technogenic impact in the lower valley of the Shardara Reservoir of the Syr Darya River basin were determined;
- Based on the average annual water flow at hydrological posts Naryn,

Shardara, Tomenaryk, Kyzylorda, and Kazaly, and its statistical descriptions in spatial scale, the water flow directed to the Toktogul and Shardara reservoirs and released downstream was assessed in temporal-spatial scale, and the hydrological regime for the off-season period (January–March and October–December) and for the agricultural growing season (April–September) was defined;

- To evaluate the efficiency of water resource use in agricultural production in the lower reaches of the Syr Darya Basin, through the analysis and development of test indicators reflecting primarily ecological and economic conditions, the efficiency of water use in the agricultural sector of the administrative districts of the Kyzylorda region was comprehensively assessed.

Adescriptionofthemainresultsofthe research. In connection with the crop transplanting network within a specialized crop rotation system designed to regulate and manage the development of soil cover in the hydro-agrolandscapes of irrigated lands in the Kyzylorda region, a structural layout of the irrigation system is proposed, incorporating an integrated irrigation technique. This includes, firstly, the management and regulation of solar radiation intensity, which damages soil development along the crop transplanting line within the crop rotation, increasing its rate; secondly, an increase in the rate of biological turnover of water and matter through soil moisture leveling along the crop transplanting line; thirdly, through the crop transplanting line in the crop rotation system, biological stability of yield can be ensured, along with the method of using groundwater in fields cultivated with melons and gourds. This system can be used as part of a sub-irrigation method similar to the camelthorn irrigation system, allowing for efficient use of the hydrological regime of water resources formed as a result of technogenic activity. Based on the performed programmatic and computational work, it has been proven that through its phased implementation into production, the area of irrigated lands can be increased to 300,000 hectares by the year 2030.

Justificationoftherelevanceandimportanceoftheobtainedresults.

Through a comprehensive assessment of the formation of the hydrological regime under natural and technogenic conditions in the lower reaches of the Syr Darya River in temporal and spatial scales, the following scientific novelty has been achieved:

- The threshold coefficient of water flow pollution formed under natural-technogenic conditions was substantiated and improved, along with a system of measures to ensure the development of irrigated zones in time and space;
- In order to expand the area of irrigated land in the Kyzylorda region to 300,000 hectares in the future, a crop rotation irrigation system design was proposed. This system enables the management and regulation of soil development processes within the crop rotation framework, its hydro-agrolandscape system, ensures the unity of technology or method of crop rotation and irrigation, and introduces a sub-irrigation method suitable for irrigated lands.

Theoretical and practical implications of the study. The results of the dissertation offer a new perspective on the prospects for the efficient use of water resources in the Kazakh section of the Syr Darya River and water supply for production and agriculture, specifically:

- Mathematical models of indicators reflecting the dynamics of regulation and desiccation of river flows due to natural-technogenic impact make it possible to clarify the hydrological and hydrochemical regimes of runoff generated by the activity of the natural-technogenic complex formed in the lower part of the Syr Darya River;
- The main conceptual features of the "water crisis" coefficient and its mathematical model, which allow for a comparison between the water resources used by the economic sectors of the Kyzylorda region and the actual available river water resources, provide a basis for assessing, regulating, and managing their functional capabilities and the degree of water availability under natural-technogenic conditions in spatio-temporal terms;
- Mathematical models of indicators for the ecological and economic evaluation of the efficient use of Syr Darya River water resources in agricultural production ensure a comprehensive assessment of water use efficiency in agriculture within the Kyzylorda region and allow it to be limited from a geoecological standpoint.

Relevancetosciencedevelopmentdirectionsorgovernmentprograms. This study was carried out in NAO KazNAIU in 2016-2017 under the project "Development of technology for the restoration of degraded land on rice irrigation systems" of the scientific and technical program of the Ministry of Agriculture of the Republic of Kazakhstan "Management of water and land resources on rice irrigation systems of Kazakhstan" (2015-2017) and confirms the release of effective solutions indicating the relevance of the research performed on the topic of a doctoral dissertation.

A description of the doctoral student's contribution to each publication.

The doctoral candidate made a significant contribution to the preparation of each publication resulting from the dissertation research. In the article published in journals recommended by the Committee for Quality Assurance in the Field of Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan, an analysis of the state of water resources was conducted, and recommendations were presented regarding their application to improve water supply in irrigated lands.

In international publications, the doctoral candidate assessed the efficiency of water resource use in agriculture, evaluated needs, and proposed an irrigation method for melon crops.

The conference materials reflect the results of research work carried out and supervised independently by the doctoral candidate. The research activities, including information gathering, result analysis, and scientific text preparation, were conducted with the direct involvement of the doctoral candidate, confirming their leading role in achieving the results of the scientific work obtained.

The scope and structure of the dissertation. The dissertation consists of an introduction, four sections, a conclusion, 113 used literature and appendices; contains 160 pages of computer text, illustrated with 37 drawings and 25 tables.