ABSTRACT

to dissertation work of Dyuisenkhan Ayana Askarbekkyzy on the topic «Scientific substantiation of the application of the system of integrated use of surface, ground and collector-drainage waters in the irrigated areas of the South of Kazakhstan (on the example of the Maktaaral region)» submitted for the degree of Doctor of Philosophy (PhD) in the educational program: 8D08603 - Water resources management using IT-technologies

Relevance of the research topic.

In Kazakhstan, the problem of water availability for irrigated agriculture is limited by the availability of water resources, since most irrigated areas are located in the basins of transboundary rivers. Thus, there are 8 water management basins in the Republic of Kazakhstan, 7 of which are transboundary, i.e. they are dependent on water resources from neighboring countries. The Aral-Syrdarya WMB, which includes two regions of Kazakhstan - Turkestan and Kyzylorda. In these regions a very large amount of water consumption is related to agriculture and it is here that irrigated agriculture is widely developed. In general, the area of irrigated land only in these two regions is about half of the total irrigated area of Kazakhstan.

The Aral-Syrdarya WMB experiences irrigation water deficit. Therefore, water availability of operating irrigation and drainage systems fluctuates within 75-95%, and in dry years it drops to 50-60%. At the same time, huge volumes of collector-drainage water formed in irrigated areas (up to 30-50% of water supply) pollute water sources and worsen the ecological-reclamation state. This situation is the main prerequisite aimed at improving water availability for irrigated agriculture by developing and applying the system of integrated use of surface, ground and collector-drainage water. This will ultimately reduce the vulnerability of the economy to extreme climatic events and changes, such as drought, water scarcity and climate change, and will contribute to ensuring water and food security of the country.

Aim of the dissertation research:

To develop scientific substantiation of application of the system of complex use of surface, ground and collector-drainage water for effective water supply of irrigated areas of South Kazakhstan on the example of Maktaaral district.

Research Objectives:

– study of current state and forecast of water availability in irrigated areas of Kazakhstan;

– scientific and technological substantiation of integrated water resources use to increase water availability in irrigated areas of South Kazakhstan;

– study of possibility to use ground and collector-drainage water for increasing water availability in irrigated lands;

– establishment of limits of change of chemical composition of mineralized water resources at use of chemical meliorant;

– scientific substantiation of application of the system of integrated use of surface, ground and collector-drainage water in irrigated agriculture.

Research Methods.

Studies on development of the system of measures on integrated use of irrigation, ground and collector-drainage water for increasing water availability in irrigated lands were carried out according to the Methodology of field experiment with the use of methods of analysis of agrochemical soil properties (State Standard 26205-91, State Standard 26213-91, State Standard 26423-85). To collect reliable information on drainage efficiency of applied irrigation systems, experimental data obtained at the experimental plot of "Ketebay" LLP (Mactaaral district, Turkestan region), where researches were conducted, were used. At chemical analysis of water (irrigation, ground, collector-drainage water) were determined: total salt content, anions and cations, nitrates, phosphorus, humus and pH.

All field studies were conducted in accordance with the requirements of standards, norms and rules of technological and environmental safety, reflected in the legislative acts of the Republic of Kazakhstan and carried out according to generally accepted methods, in compliance with GOSTs and industry standards (State standard 31885-2012, 1ST RK State standard R 51592-2003).

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

The main points to be defended include:

– assessment of current state and forecast of water availability in irrigated areas of Kazakhstan;

– establishment of influence of sorbents and meliorants on ion-salt composition of surface, ground and collector-drainage waters.

– increasing the share of groundwater and collector-drainage water in the irrigation norm;

– development of irrigation regime and technology under integrated use of surface, ground and collector-drainage waters taking into account their share in irrigation norm, soil properties and quality of water resources.

For this purpose, regularities of ecological and meliorative processes in root-inhabited layer of soils under joint use of surface, ground and collector-drainage waters were investigated taking into account water-physical and chemical properties of soils, level of occurrence and mineralization of ground waters.

– improvement of groundwater use technology for subirrigation, collector-drainage water for irrigation.

– scientific substantiation and adaptation of the system of integrated use of surface, ground and collector-drainage water, providing reduction of water withdrawal for irrigation and drainage from irrigated lands.

A description of the main results of the research.

As a result of the study, scientific substantiation of the system of integrated use of surface, ground and collector-drainage water for increasing water availability in irrigated areas of southern Kazakhstan has been developed. The current state of water resources has been analyzed and key problems have been identified: high dependence on transboundary water sources, uneven distribution of water resources, and significant water losses in existing irrigation systems. Based on the assessment of chemical composition and water quality characteristics, the optimal limits of

using mineralized water when combined with river water and ameliorants have been established. Recommendations on increasing the share of groundwater and collector-drainage water in the irrigation norm have been developed, which allows reducing the load on surface resources.

Practical application of the research results confirmed their efficiency: implementation of the proposed system at the pilot plots allowed to reduce water withdrawal and water disposal volumes by 10-15%, as well as to improve ecological condition of lands. The developed irrigation regimes and subirrigation technologies provided optimal conditions for crop growth and reduced the risk of secondary soil salinization. Thus, the results of the work not only increase the resilience of irrigated agriculture to water and climatic challenges, but also create prerequisites for long-term food and environmental security of the region.

Justification of the relevance and importance of the obtained results.

The novelty of the research consists in development and scientific substantiation of the system of integrated use of surface, ground and collector-drainage waters for increasing water availability in irrigated areas of southern Kazakhstan, which was not conducted earlier in such an integrated approach. Limits of use of mineralized water and ameliorants providing ecologically safe and effective use of water resources are established. In addition, the regularities of ecological and meliorative processes in the root-inhabited layer of soils under the joint use of different types of water were determined for the first time, which allowed developing optimal irrigation regimes and subirrigation technologies. These results significantly expand the possibilities of local water resources utilization and reduce the region's dependence on transboundary water sources.

The obtained results have an important practical significance for solving urgent problems of water availability under conditions of water deficit and climate change. Implementation of the developed system allows reducing the volume of water withdrawal and water disposal by 10-15%, improving the ecological condition of lands, minimizing the risk of secondary salinization and creating conditions for sustainable agricultural development. These achievements contribute to improving food security in the region and adaptation of the water sector to extreme climatic conditions, making them an important contribution to sustainable development in southern Kazakhstan.

Relevance to science development directions or government programs.

The research corresponds to the priority directions of science development and the state water resources management program of the Republic of Kazakhstan for 2024-2030 aimed at improving sustainability of the water sector and adaptation to climate change. The work supports the objectives of the Water Security Concept, focusing on the use of innovative technologies and integrated approaches to optimize water supply, reduce water losses and improve the ecological and reclamation condition of lands. The developed system of integrated water resources use also contributes to the implementation of the National Project for the development of agro-industrial complex focused on improving the efficiency of irrigated agriculture, food security and environmental sustainability.

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

The doctoral student has made significant contributions to each publication based on the results of the dissertation research. In the article published in the publication recommended by the Science and Higher Education Quality Assurance Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan, the doctoral student conducted a comprehensive analysis of the state of water resources, developed scientific bases of integrated use of surface, ground and collector-drainage waters, and substantiated recommendations on their application to improve water availability in irrigated lands.

In international presentations, doctoral students have performed modeling of ecological and reclamation processes, conducted field and laboratory studies of the chemical composition of water resources, and developed innovative approaches to their use.

The conference proceedings reflect the results of experimental implementation of the proposed system at the experimental plots, which the doctoral student independently organized and supervised. All stages of the research, including data collection, analysis of results and preparation of scientific texts, were carried out under the direct participation of the doctoral student, which confirms his key role in achieving the obtained scientific results.

The scope and structure of the dissertation.

The dissertation consists of an introduction, four sections, conclusion, list of references and appendices, occupying a total of 116 pages. The work includes 41 tables and 22 figures that illustrate the results of the research. The first section presents analysis of the current state of water resources and forecast of their changes; the second section is devoted to natural-climatic conditions and research methodology; the third section studies the possibilities of groundwater and collector-drainage water use; the fourth section contains scientific substantiation of the system of their integrated use. The list of literature includes 110 sources, and the appendices contain additional materials confirming the research results.