

**"Introduction of digital technologies in water resources management in the Almaty region and improvement of the water use accounting system" is the topic of the dissertation for the degree of Doctor of Philosophy (PhD) in the specialization 6D080500-Water resources and water contribution,
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ABSTRACT

The relevance of the research's subject. Head of State Kassym-Jomart Tokayev stated in his Address to the People of Kazakhstan on September 1, 2020, that "it is impossible to build a competitive economy without the development of agriculture." "A significant barrier is the irrigation system's outmoded technology. Saying that 40% of the water in the nation is wasted would not be an exaggeration. This cannot happen in a nation that already has water shortages. Regulatory and legal oversight of this sector must be ensured, and economic incentives must be created to encourage the adoption of cutting-edge inventions and technology.

Increasing the number of water consumption meters and applying digital technologies to govern their management are obviously necessary to address this issue. Water protection and efficient, orderly, and essential usage are critical issues that are now on the table, taking into account how water is used in managing water resources. It is presently possible to classify the nation's reclamation systems and the level of its metrological security as being in crisis. In reality, the majority of reclamation networks, particularly open channels, and efforts to document water consumption at hydraulic structures, do not adhere to regulatory and metrological standards.

This is caused by the moral and physical wear of outdated water meters and measurement devices, failure for a variety of operational causes, and real malfunction owing to poor maintenance, repair, and metrological testing. Because of this, the issues with managing water resources in reclamation systems are handled utilizing hydrometric instruments that are readily accessible and straightforward techniques of detecting water level and velocity.

Modernization, repair of irrigation systems to extend irrigated areas, effective water usage, the introduction of digital technology to account for water consumption in the water sector, and time are all necessary solutions to these problems.

In most cases, the use of outdated measuring technologies determines the relevance of developing new technological foundations for information support of efficient water use in terms of water system accounting and the organization of water meters due to the practical loss of means of accounting for water use in water resources management.

Between 2020 and 2023, several types of research were conducted at NAO KazNAU. Third event of the budget program 267: "Irrigation technologies and technical means for the introduction of new irrigated lands, reconstruction and modernization of existing irrigation systems". "Increasing the availability of knowledge and scientific research" on the application of scientific research in the agro-industrial complex, taking into account the formation of water resources in

basins and rivers, and the development of principles and methods of balanced management of water distribution in irrigation systems based on hydrological data.

The purpose for the research for the dissertation. The goal of the project is to enhance water accounting tools for the efficient management of water resources as well as the effectiveness of hydro-reclamation systems. constructing a water measuring structure of the most basic form and design and offering applications for it in the water industry.

The following tasks were established to help accomplish this goal:

- gathering and analyzing data on water levels in the Almaty region's reclamation systems;
- evaluating the technical state of open irrigation systems in order to introduce water metering equipment powered by flow energy;
- studying the characteristics of the irrigation canals in the Almaty region as a subject for water accounting;
- theorizing the use of water metering devices driven by hydraulic flow energy in open channels of on-farm irrigation systems;
- creation of a water level meter device model and improvement of design characteristics;
- doing laboratory research to examine the water level meter's hydraulic properties;
- creation of engineering calculation techniques and advice for design and operational organizations; determining the water metering system's economic viability.

Research methods. In order to complete the complex of investigations, theoretical, laboratory, and material studies were conducted. Laboratory research was done in an experimental facility in the "Water Hub" lab of KazNAUI. Error theory, factor planning for experiments, computer math tools, industrial procedures, and statistical criteria based on variance and regression analysis were all used in the research's execution.

Numerous laboratory, quantitative, and material investigations that obtained test findings with real-world applications are employed in the educational and economic hub of KAZNAUI "Saimasai" in the Enbekshikazakh district of the Almaty area, demonstrating the validity of scientific conclusions.

The key points (new knowledge and other findings based on tested scientific ideas).

1. Analyses of the information flow about the water resources of the Almaty region are conducted;
2. A digital technology solution is suggested that offers data on the elevated water level utilized in the region of Almaty's efficient water resource management;
3. For the remote management and monitoring of water resources in irrigation system channels, a tool has been developed.
4. A sketch was put out for different electronic computers with remote control for water resources that runs on the Arduino software.

5. The Almaty region's reclamation systems now include the findings of research that improve the management and accounting of water distribution;

Description of the main results of the study. An experiment carried out at the educational and economic center "Saimasai" KazNAU in the Enbekshikazakh district of the Almaty area verified the validity of scientific findings.

The management of water resources in the Almaty region underwent meticulously accurate, highly technical, and experimental examinations of the key procedures of water metering technology utilizing a new installation.

The innovative gadget design and the study findings are essential for contemporary applied science and practice. The research's findings turned out to be extremely beneficial from both a scientific and practical standpoint.

The technical outcome made possible by the newly introduced water level measurement tool is the development of a device for receiving, converting, and remotely transmitting data about the water level of reservoirs for monitoring. This device allows for the simultaneous and efficient collection of data on water bodies, measuring, receiving, processing, and automating the process of transmitting data to the greatest extent possible.

Calculations that showed that the use of a new device for receiving, converting, and transmitting information about the water level of rivers, channels, and open channels reduced transport costs by only 48287040 tenge, and the error of the data obtained is about 2%, confirmed the economic effectiveness of the dissertation work.

Positive technical and economic statistics for the new installation support its potential and the requirement for implementation in Republic of Kazakhstan water management institutions for system water accounting.

Substantiation of the novelty and significance of the results obtained. Modern digital technologies include a device designed for receiving, converting and transmitting information about water levels in water resources management and allowing for effective remote collection of information, maximum automation of the information transmission process. In the digitization of water management and water resources management, it fully corresponds to what is considered as a developed achievement of science and technology.

Practical significance. The proposed technological tool was proposed for implementation in reclamation systems of water resources management in Almaty region. During the implementation of the results of the work, the automated means of remote control of the water level demonstrated its advantages in reclamation systems. In the economic center "Saimasai" KazNAUI in the Enbekshikazakh district of Almaty region, an Act of implementation of the results of scientific research, scientific and technical works and (or) the results of scientific and scientific and technical activities and the rules for its coordination was drawn up using an automated tool.

"Irrigation tray in reclamation systems" to prevent water losses while increasing the reclamation efficiency of water intake lands. The patent for the utility model was received in 12.08.2022, No. 7345.

The patent for the invention for the "Test Receiver" tool for determining pollution and the amount of water sediment in water utilities was received in 2021. No. 35412.

A patent was obtained for the design of a device designed for receiving, converting and transmitting information about water levels and allowing for effective remote collection of information, maximum automation of the information transmission process (utility model patent No. 7346 dated 12.08.2022).

Compliance with the directions of scientific development or state programs. Dissertation "Irrigation technologies and technical means for the introduction of new irrigated lands", reconstruction and modernization of existing irrigation systems 3rd event of the budget program 267 "Increasing the availability of knowledge and scientific research" on the implementation of applied scientific research in the field of agro-industrial complex, taking into account the formation of water resources in basins and rivers, development of principles and methods of balanced management water distribution in irrigation systems based on hydrological information" confirms the output of effective solutions indicating the relevance of the research performed on the topic of the doctoral dissertation.

Description of the doctoral student's contribution to the preparation of each publication.

The research results and the main results of the dissertation were tested and presented in indexed publications, journals included in the list of the KKSON of the Ministry of Education and Science of the Republic of Kazakhstan, as well as at two international scientific and practical conferences:

- Analysis of methods for determining the useful volume of water intake. XXIII International Scientific and Practical Conference of young scientists and students "Youth of agrarian science: achievements and prospects" April 26-27, 2019.

- The impact of anthropogenic loads on the water resources of the Almaty region. Materials of the international scientific and practical conference dedicated to the 60th anniversary of Candidate of Agricultural Sciences, Associate Professor Makhambetova Rosa Karymsakkyzy on the topic "Water safety: problems and solutions" on April 29, 2022.

- Devices that increase the efficiency of monitoring the distribution and calculation of water in reclamation systems. Research, result No. 4(88) Almaty, Kaznaru, 2020. ISSN 2304-3334

- Increasing water productivity in irrigation with regard to geology and hydrogeological conditions. NEWS of the National Academy of Sciences of the Republic of Kazakhstan series of geology and technical sciences ISSN 2224-5278 Volume 3, Number 453 (2022)

- Software structure of a remotely controlled device used in water resources management. No. 1 (97) Research, result. Almaty, Kaznaru, 2023.

- Sampler, patent for invention No. 35412, 2021.

- Device for receiving, converting and transmitting information about water level of reservoirs for monitoring. Utility model patent No. 7346 dated 12. 08.2022.

- Irrigation channel of reclamation system. Utility model Patent No. 7345 dated 12.08.2022

- Based on the materials of dissertation research, 3 patents and 5 publications: in the Scopus database and the Web of Science "News of the National Academy of Sciences of the Republic of Kazakhstan. The journal "Series of geology and technical sciences" published 1 article, as well as 2 articles in scientific journals "Searches, results" included in the list of the Committee for Quality Assurance in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan, 2 articles at scientific conferences.

The structure and scope of the dissertation. The dissertation work consists of 134 pages of computer text and 14 tables, 25 figures, 149 titles of used literature and 3 appendices.