

ANNOTATION

dissertation work on the topic: «Water resources management in the Esil water basin under conditions of non-stationary climate and runoff», Kanatuly Adilet for the degree of Doctor of Philosophy (PhD) in the specialty «8D08603 – Water resources management using IT-technologies».

Relevance of the topic and research. At the current stage of development, the management of water resources in Kazakhstan needs to be elevated to a new, higher level by applying the principles of integrated water resources management, recognized as a global practice. In reality, this principle is not practically implemented and is only declared in theory. As a new approach, global science suggests a methodology for integrated water resources management, within which criteria for assessing the water supply of regions have been developed. In the light of the Concept of Sustainable Development, this methodology allows for a more effective solution to the problems of rational water use. The advantage of integrated water resources management lies in the possibility of integrated decision-making, addressing issues of water deficit or shortage, drinking water quality, and other water management problems on equal terms with the issues of conservation and restoration of water resources, as well as the ecological rehabilitation of water bodies.

Moreover, further development of research on this topic requires an improvement in the accuracy of assessments conducted at the regional level. To achieve this, we propose to continue efforts in consolidating accumulated hydrological-climatic and water management data, utilizing information technologies, and developing recommendations for water resources management in the Esil River basin.

The purpose of the dissertation research. The goal of the dissertation research is to develop recommendations for the management of water resources in the Esil River basin under conditions of non-stationary climate and streamflow. To achieve this goal, the following tasks were set:

1. Analysis and assessment of natural conditions affecting river flow and the hydrological regime of the rivers in the Esil River basin: Examination of the topographical features of the watershed. Evaluation of climatic factors influencing streamflow. Investigation into the conditions and factors affecting snow cover formation. Analysis of the hydrographic network. Characterization of the hydrological regime of the rivers. Assessment of the hydrological knowledge of the territory.

2. Evaluation of spatial-temporal patterns of streamflow changes: Assessment of multi-year variations in streamflow. Statistical analysis of the temporal structure of data series. Identification of low-flow periods.

3. Analysis and assessment of key hydrological characteristics of the rivers in the Esil River basin: Examination of annual streamflow. Evaluation of intra-

annual distribution of streamflow. Analysis of maximum and minimum streamflow. Assessment of secured streamflow values.

4. Analysis and assessment of the water resource load in the region: Evaluation of the impact of reservoirs on river flow. Examination of changes in water resource load due to climate and anthropogenic factors.

5. Assessment of flood hazards in the Esil River basin: Quantitative evaluation of hydrological extremes characterizing flood hazards in the Esil River basin.

6. Analysis and synthesis of conceptual approaches and principles for assessing water availability in the Esil River basin.

7. Development of recommendations for the concept of managing surface water resources in the conditions of non-stationary climate and streamflow in the Esil River basin for the purpose of rational use and management of water resources.

Research methods: Among the approaches and methods proposed for solving the stated tasks, the main ones utilized include the systems method, comparative method, quantitative (mathematical) method, statistical method, cartographic method, computer information processing and logical modeling method, sustainable development concept, integrated water resources management methodology, modern techniques for assessing water supply for the population and economy in water-deficient areas (actual water supply), methods and techniques for determining anthropogenic loads on water bodies and their watersheds (direct and indirect impacts).

Hydrological changes over time are determined based on the analysis of hydrometeorological datasets. Spatial changes in hydrological characteristics and the processing of cartographic materials are conducted using geoinformation technologies.

Basic provisions (proven scientific hypotheses and other conclusions that are new information).

- Methodology and results of assessing the impact of a complex set of factors related to economic activities on the annual flow of the Esil River within the water management basin;

- Assessment of the norm and variability of annual, maximum, and minimum flow under non-stationary conditions in the basins of the Esil water management basin at various levels of economic activity;

- Results of evaluating changes in the intra-annual distribution of river flow at different levels of economic activity;

- Quantitative assessment results of the impact of reservoirs on river flow in years with varying water levels;

- Quantitative assessment results of changes in the load on water resources in the considered region under the influence of climate and anthropogenic factors;

- Quantitative assessment results of hydrological extremes characterizing the flood hazard for the Esil water management basin;

- Recommendations for the concept of managing surface water resources under conditions of climate and flow non-stationarity in the Esil water

management basin for the purpose of rational utilization and management of water resources.

Description of the main results of the study.

The following scientific results have been obtained:

- Evaluation of spatial-temporal patterns of flow variations, including assessment of multi-year flow fluctuations, statistical structure of time series, and categorization of low-flow and high-flow years.
- Detailed quantitative assessment of changes in annual, maximum, and minimum river flows in the studied region, considering the impact of climate and anthropogenic influences during the contemporary period.
- Identification of periods of river flow with different levels of economic activity: conditionally natural flow and disturbed flow, with the restoration of natural flow in the basins of the Esil water management basin.
- Quantitative identification of changes in the intra-annual distribution of river flow in the Esil water management basin as a result of anthropogenic impacts on flow regimes.
- Quantitative identification of changes in the influence of reservoirs on the flow of rivers in the Esil water management basin due to anthropogenic impacts on flow regimes.
- Quantitative identification of changes in hydrological extremes, characterizing flood hazards for the Esil water management basin.
- Quantitative identification of changes in the load on water resources in the studied region under the influence of climate and anthropogenic factors.
- Quantitative identification of changes in the use of water resources in the Esil water management basin in various sectors of the economy.
- Development of recommendations for the concept of managing surface water resources under conditions of climate and flow non-stationarity in the Esil water management basin, aiming at the rational utilization and management of water resources.

Justification of the novelty and significance of the results obtained.

In the modern world, there is growing concern about the excessive consumption and pollution of water resources. According to experts' estimates, the annual demand for freshwater resources worldwide increases on average by 1%, influenced by factors such as population growth, economic and social development, and changes in consumption patterns. According to forecasts by UN experts, the global demand for freshwater resources is expected to continue increasing at the same rates until 2050. This will have a negative impact on the level of water consumption, which is projected to increase by 20-30%, primarily due to the growth of industry and agriculture.

The Republic of Kazakhstan is geographically situated in the zone of so-called "risky agriculture" and falls under the category of arid climates. In recent years, the country has been facing a situation of water consumption shortage. The crisis in water resources is attributed to ineffective management. Consequently, one of the pressing issues related to the problem of water resource utilization in Kazakhstan today is the challenge of efficient transboundary management of

watercourses, as almost half of the country's water flow is generated in the territories of neighboring states, and seven out of eight basins are transboundary. Therefore, the high dependence of Kazakhstan's water potential on other countries, along with the extensive and uncontrolled pollution of rivers originating in the territories of neighboring states, underscores the relevance of studying the issues of international water resource management for the Republic.

In this dissertation, the following novelty is substantiated, and the following significant results have been obtained: Proceed to provide details about the novel aspects and key results obtained in the dissertation work.

- Methodology and results of assessing the impact of a complex set of economic activity factors on the annual flow of the rivers in the Esil water management basin.

- Methodology for assessing the norm and variability of annual, maximum, and minimum flow under non-stationary conditions in the basins of the rivers in the Esil water management basin at various levels of economic activity.

- Methodology and results of quantitative assessment of changes in the load on water resources in the studied region under the influence of climate and anthropogenic factors.

- Methodology and results of quantitative assessment of hydrological extremes characterizing the flood hazard for the Esil water management basin.

- Recommendations for the concept of managing surface water resources under conditions of climate and flow non-stationarity in the Esil water management basin for the purpose of rational utilization and management of water resources.

The obtained scientific results can be used to assess the river flow in the Esil water management basin, develop environmental conservation measures, and apply the recommendations to rationally utilize the natural resources of the region. This will aid in justifying models for adapting economic activities to the changing climate and water resources of the considered territory.

Compliance with the directions of scientific development and government programs.

The scientific research conducted on the dissertation topic has been integrated as a fundamental component of the ongoing project with the identification number AP19679134, titled "Development and Improvement of Methodological Foundations for Calculating Minimum River Flow in the Plains of Kazakhstan under Non-stationary Climate and Flow Conditions." The project is under the auspices of the State Institution "Committee on Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan," with the implementation period spanning from 2023 to 2025.

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

The applicant's personal contribution involves the collection and analysis of original information, the reconstruction of observation series, and the execution of hydrological calculations. These include assessing multi-year flow fluctuations, analyzing the statistical structure of time series, grouping low-flow years,

evaluating annual flow, examining intra-annual flow distribution, assessing the impact of reservoirs on river flow, estimating changes in the load on water resources under the influence of climate and anthropogenic factors, and quantitatively assessing hydrological extremes characterizing flood hazards. Additionally, the applicant contributed to developing recommendations for managing surface water resources in the non-stationary climate and flow conditions of the Esil water management basin for rational utilization and management of water resources.

The main provisions, conclusions, and results of the dissertation work have been presented at the following international scientific conferences:

International Scientific and Practical Conference "Water Resources Management in the Conditions of Globalization," Almaty, Republic of Kazakhstan, 2021.

International Conference dedicated to the 70th anniversary of B.M. Koybakov "Climate and Water Resources: Land Reclamation and Ecology," Taraz, Republic of Kazakhstan, 2022.

The dissertation topic has resulted in the publication of 8 scientific articles, including 3 articles in publications recommended by the Committee for Control in Education and Science of the Republic of Kazakhstan (KCSO) and 1 article in a Q1 Scopus (Elsevier) journal with a percentile ranking of 76.

Structure and scope of the dissertation. The dissertation comprises an introduction, six sections, a conclusion, and a list of references containing 151 entries. The total volume of the work is 150 pages of computer-generated text, and it is complemented by 41 tables and 19 figures to enhance the presentation of the research findings.