

ANNOTATION

of the dissertation for the degree of doctor of philosophy (PhD)
specialty 6D061000 – Hydrology

Arystambekova Dinara Dandybaevna

«Calculation of the runoff of the spring flood of plain rivers in Kazakhstan»

General description of the thesis. This dissertation is based on materials that were obtained by analysis and restoration, as well as determination of statistical parameters of the spring flood for the main rivers of water basins in the flat territories of Kazakhstan: Zhayik-Caspian, Tobyl-Torgaysky and Nura –Sarysu. The possibility of forecasting the spring runoff for plain rivers in Kazakhstan is considered.

The analysis of research on the rivers by basins and the choice of hydrological stations for calculating the characteristics of spring runoff were carried out. A databank was compiled on the annual runoff, the maximum spring runoff and the runoff layer of the spring flood. The conclusions of the work are following:

According the Zhayik-Caspian, Tobyl-Torgai and Nura - Sarysu basins:

- data on annual runoff, spring flood runoff layer and maximum runoff at hydrological posts were collected;

- choice of the calculation period was carried out according to long-term observations (1940-2019);

- hydrological series of observations at posts were restored using regression analysis;

- statistical parameters of spring runoff were determined, their calculation accuracy and efficiency of bringing the norm to a long-term period were estimated;

- the natural runoff was restored, taking into account the large reservoirs on the river Zhayik, Elek, Kargaly and Tobyl.

On the topic of the research, the following planned works were carried out: norms of the runoff layer and the maximum runoff of the spring flood were determined for 26 hydrological stations in the Zhayik - Caspian basin, for Tobyl-Torgai - 27 hydrological stations, for the Nura - Sarysu basin - 21 hydrological stations. The coefficients of variation and asymmetry were determined taking into account the bias of the parameter values.

According to the method of harmonic analysis of the precipitation time series, the forecast results of the runoff layer of the winter flood show that in most of the considered plain rivers, an increase in spring runoff is expected by 2025 and 2030.

Relevance of the research topic. Knowledge of the characteristics of the spring flood is necessary in the design and operation of various hydraulic structures, water conservatories and ponds. There is a close relationship between the flood runoff and the maximum flow rate. The study, calculation and forecast of the maximum water flow is impossible without knowledge of the flood flow.

A detailed study of the characteristics of the spring flood of the rivers of Kazakhstan was carried out in 1960-1970 and published in materials on the water resources of the USSR for individual basins. These materials are outdated, and need

to be updated taking into account the data of the last 40-50 years and the influence of anthropogenic and climatic factors.

All of the above determines the relevance of the thesis topic.

Purpose and objectives of the study.

The aim of the study is to calculate and forecast the characteristics of the spring flood flow of the main flat rivers of Kazakhstan. The achievement of this goal was carried out by solving the following tasks:

- collection and processing of observations over a long-term period;
- selection of the calculation period and bringing series of observations to the calculation period;
- selection of the distribution law for spring flood runoff and the definition of different security runoff;
- analysis of long-term fluctuations in spring runoff;
- calculation of flood runoff characteristics in the presence and insufficiency of observational data;
- determination of the possibility of predicting spring flood elements taking into account the influence of drainage factors.

The object of the study is the runoff of the spring flood of plain rivers in Kazakhstan.

The subject of the study includes the issues of restoration of spring flood runoff, determination and assessment of statistical parameters of spring runoff of the main rivers of the Zhayyk-Caspian, Tobyl-Torgai and Nura - Sarysu water basins in the lowland territories of Kazakhstan, as well as consideration of methods for forecasting spring runoff of the lowland rivers of Kazakhstan.

Method of research. Regression analysis, hydrological analogy, correlation analysis, and a homogeneity test were used to reconstruct a number of hydrological observations and to calculate runoff.

In general, in hydrological studies, one of the main methods is the method of statistical analysis. Since this method is widely used in hydrological calculations to restore runoff, determine and evaluate statistical parameters.

The method of harmonic analysis of the indices of the General circulation of the atmosphere was developed for the forecast of spring flow of flat rivers of Kazakhstan.

The full content of these methods is described in each Chapter and sections as they are applied. This will allow the reader to get acquainted with the methods of research and verify the objectivity of the results.

Scientific novelty. In the process of research new scientific results were obtained:

- for the first time, data for a long-term period were collected and processed, and given to the calculation period for four considered water basins;
- norm and coefficients of variation of spring runoff characteristics were calculated for observed, calculation, conditional natural periods and for the last 40 years;
- for the first time, the accuracy of runoff layer norm calculation and maximum discharges of spring floods for the observed and calculation periods was evaluated;

- the effectiveness of bringing the norm and the coefficients of variation of the layer of a spring drain to the long-term period was evaluated;
- for the first time, a long-term forecast of the spring flood runoff layer on the main flat rivers of Kazakhstan was made using a new forecast method taking into account flow-forming factors and climate changes.

Scientific and practical significance of the work:

Currently, the Hydrometeorological Service regularly produces forecasts of seasonal, quarterly and monthly water inflow into the HPP reservoir, forecasts of rivers in irrigated areas for the growing season and shorter periods. Forecasts of spring flood characteristics of flat rivers and ice phenomena are also issued. The lead time of these forecasts ranges from several days to several months. Such lead time is insufficient for solving and planning many water management tasks. As it is known, the main factor influencing the process of flow formation are meteorological. Therefore, if meteorological factors are known, it is possible to develop a methodology for forecasting runoff based on correlation dependencies.

Weather data were collected to forecast spring runoff of plain rivers of Kazakhstan. The idea of the method of constructing scenarios of changes in weather data for the future is simple and physically well-founded: climate change at any point is possible only when the General circulation of the atmosphere changes. Therefore, it is necessary to jointly analyze the time series of large-scale circulation of temperature and precipitation in order to establish, firstly, the presence of climatic fluctuations in temperature and precipitation in the past during the 20th century and, secondly, to establish a relationship between these climatic fluctuations and fluctuations in the indices of the general atmospheric circulation . Based on such relationships, it is possible to build scenarios of changes in the studied parameters for the future.

As a result of a harmonic analysis of the indices of general circulation, secular and half-century harmonics responsible for climatic fluctuations were identified. Assuming that these harmonics will remain in the general circulation indices, the author of the method constructed a scenario of changes in precipitation and temperature in the basins of Zhaik, Elek and Central Kazakhstan rivers.

Many sectors of the economy, whose activities are closely related to the use of water resources, need hydrological forecasts of various kinds. A reliable forecast allows them to optimize business activities taking into account the needs of production. During the operation of hydropower plants, forecasts are needed in order to optimize river flow control regimes, to plan electricity generation and to take measures to pass the flood through hydroelectric facilities. Of great importance are the long-term forecasts of the influx of water into the reservoirs of large hydropower plants.

New characteristics of the spring runoff of plain rivers of Kazakhstan: the runoff layer and the maximum runoff of the spring flood and their various provided values are very important information for the construction of reservoirs and ponds, as well as for making a forecast.

The results of the study can be used in compiling cadastral materials and assessing the water resources of plain rivers of Kazakhstan. In addition, it serves to deepen the theoretical and practical skills of students of educational institutions.

The economic effect is to ensure the safety of the population from extreme natural phenomena caused by high flood and saturation of large areas. The results of the study and the decisions made thereon will ensure the sustainable development of the lowlands.

The main provisions to be defended:

1. A full-fledged study of the flow of spring floods of the plain rivers of Kazakhstan. Based on a database of annual runoff, runoff layer, and maximum spring flood runoff over three basins, calculation periods were selected to determine the characteristics of spring runoff.

2. The statistical parameters of the spring runoff were evaluated. Analysis and assessment of spring runoff parameters in the presence and insufficiency of observational data.

3. Based on the developed method for the long-term forecast of the spring flood of flat rivers of Kazakhstan, a forecast is made for 2025 and 2030 by the method of harmonic analysis of the general circulation indices.

Author's share in scientific work. The author analyzed the literature on this topic, identified the goals and objectives of scientific work, collected and statistically processed data, carried out hydrological calculations and analyzed the results of the study. In addition to that, the author personally participated in the writing and design of the thesis.

Relationship with research plans. The dissertation was carried out on the basis of a scientific project: "Determining the characteristics of the spring runoff of the plain rivers of Kazakhstan" (№2008/GF4) in 2014-2017.

Work approbation. The main provisions and results of the thesis are presented in reports of republican and international scientific conferences:

- XI international scientific - practical conference "Scientific prospects of the XXI century. Achievements and prospects of the new century" (Part 5. 4 (11) Russia, Novosibirsk, 2015).

- Collection of scientific papers on the materials of the IV international scientific-practical conference "Prospects for the development of science and education" (Moscow, 04.29.2016).

- IV International Farabi readings. Materials of the international scientific conference of students and young scientists "Farabi Alemi" (Almaty, April 10-13, 2017).

Publication of the results of the study. The manuscript of the dissertation was thoroughly prepared at the Department of Meteorology and Hydrology at the Faculty of Geography and Environmental Sciences, Al-Farabi Kazakh National University. The dissertation was recommended for defence at an extended meeting of the department. According to the main results of the research work, 13 scientific articles were published in domestic and foreign scientific journals, of which 2 articles and 2 theses in scientific conference collections held in Kazakhstan and abroad; 6 articles in publications recommended by the Monitoring Committee for Education and Science of the Ministry of Education and Science Kazakhstan; in a journal "Vestnik KazNU" a series of geography and "Hydrometeorology and ecology" RSE "Kazhydromet"; 3 articles - published in journals included in the international

Scopus database: 1. "Journal of Environmental Management and Tourism"; 2. "Jordan Journal of Civil Engineering" and 3. Journal of Ecological Engineering.

The structure and scope of the thesis. The thesis consists of introduction, review of domestic and foreign scientific and technical literature, seven chapters, conclusion, list of references and applications. The total volume of the thesis is 106 pages of computerized typesetting, 15 figures, 34 tables, 148 references and 18 applications.