

INVESTIGATION OF THE NATURAL RIVER FLOW FOR SELECTED WATERSHED IN BULGARIA

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The aim of the research is to make evaluation of the water resources in large-scale water systems and to recover natural river flow of Tundja River. The empirical distribution of the annual flow, maximum flow and minimum monthly flows is investigated. The multi-criteria optimization of the empirical distribution function is performed and discussed (Gerassimov, 1988 and 1999).

For the purposes of the study the drainage basin of Tundja River is selected. Tundja is one of transboundary Rivers of Bulgaria located in the Southern part of the country. Data concerning 21 river stations and 11 rainfall stations along the Tundja River and some of the river tributaries are executed for the 1960-2002 period. The main characteristics of multi-annual and minimum discharges are obtained (Bojilova, 2003a).

The generation of the monthly data series for selected cross sections is made. As a rule the generation is made in direction from the upper tributaries to the main river body. The main hydro-technical works are taken into consideration during the analysis: reservoir Koprinka built in 1955 and reservoir Jrebchevo built in 1964. The main irrigation works in the drainage basin are considered too. In fact along the main body of Tundja River are situated most important disturbances. The disturbances on river tributaries are smaller. The river discharges are generated using balance equations for upper reaches and taking into consideration the spatial regional correlations between the discharge, areas and elevations. For reconstruction of natural river flow the double-mass curve analysis is performed. Some extra part of drainage area is also taken into consideration. The recovered annual and monthly time series for the 1961-2002 period are generated for selected twenty-one cross-sections (Bojkova, 2004).

The method proposed from Gerasimov (1988) for approximation and multi-criteria optimisation of the empirical distribution functions of hydrological time series is applied. The main ideas of the method are:

- Approximation of the empirical distribution functions by regression analysis of appropriately transformed coordinates; empirical cumulative frequencies are transformed to normal distribution quantiles and logarithms are taken of the random variables;
- Choosing of the most appropriate approximation.

The method is executed to approximate the empirical distribution function of recovered natural annual and minimum monthly flows. The maximum registered discharges for the selected cross-sections are object of approximation too. The multi-criteria optimization of the empirical distribution function is performed.

The main conclusion from the application of the method is that the exponential approximation functions in most of the cases are not deviate significantly from the

lognormal models. In the same time the exponential functions are more flexible and give confidence.

Some remarks for the applied method of Gerassimov for approximation and multi-criteria optimisation can be made:

The method gives reliable analytical approximation of the empirical distribution functions;

The method gives stable estimation of the quantiles for the maximum river discharge;

It is possible to perform without bias extrapolation of the empirical distributions;

The large number of approximation curves is generated. As a result it is possible to select the most appropriate approximation of the empirical distribution function.

Using multi-criteria optimisation it was possible to obtain the discharges with requested probabilities for design purposes of the water works. The results are demanded for water management master plans in the created new water boards in Bulgaria.

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