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Regional Climate System Modelling for the European Sea Regions

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A MedCORDEX-Baltic Earth-COST Workshop

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Universitat de les Illes Balears, Palma de Mallorca, Spain, 14- 16 March 2018

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Regional model of forming catastrophic spring runoff in condition climate change on the plain rivers Black sea basin in Ukraine

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1. Introduction

The study is devoted to solving an important scientific problem - concerning the development, implementation and verification of a unified calculation method for determining the characteristics of the spring flood runoff of ungauged rivers in the territory of plain Ukraine, taking into account current and future climate change. Spring floods is the most voluminous and potentially dangerous phase of the water regime of the plain rivers of Ukraine. In some years, spring floods can be catastrophic, the probability of occurrence of such phenomena is estimated at the level of 1-2 times per 100 years. In the development of techniques for determining the maximum water discharges of ungauged rivers the base probability, as a rule, is taken at 1%, and the estimated values are the maximum modules or the discharges of spring flood with the probability of exceeding P = 1%.

2. Methodology and data

An analytical review of the normative framework in the field of calculations of maximum runoff showed that despite the vast experience gained by scientists in this issue, the problem is still far from its solution due to the multifactority of the investigated phenomenon and regional features of the forming of maximum runoff on the rivers.

The author proposed a new modified version of the operator model [1] for determining the maximum runoff of spring flood, which allows to take into account the possible impact of climate change on the estimated values of the maximum modules 1% probability of exceeding (Fig.1).

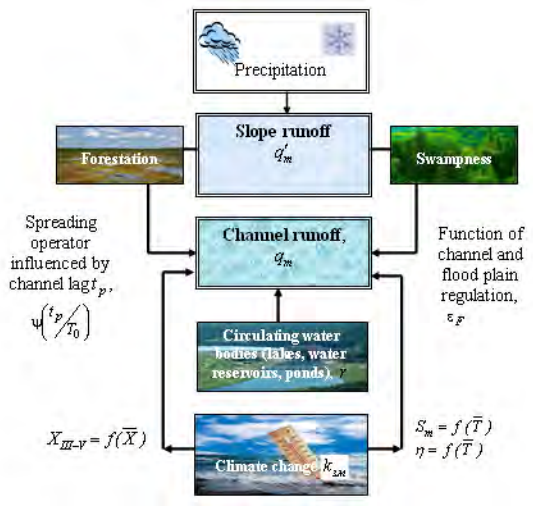

Figure 1. Block diagram of maximum runoff formation.

Climate change is taken into account by introducing a separate coefficient, based on a comparison of the main parameters of the method obtained on the basis of current data (maximum snow supply at the beginning of the spring flood, precipitation during the spring flood and runoff coefficients), and similar values obtained from climatic modeling data.

To substantiate the main parameters of the proposed method, data from 340 hydrological stations and 229 meteorological stations on plain rivers Black sea basin in Ukraine were used.

3. Results

During the spatial-temporal generalizations of the maximum runoff characteristics, was analyzed the cyclicity of the fluctuations of the maximum runoff of spring flood and done the synchronization zoning of the plain territory of Ukraine on the of spring runoff using factor, cluster and hydro-genetic analysis; was carried out estimate homogeneity of the initial information, statistical processing of the initial time-series of maximum snow supplies, maximum discharges and layers of the spring runoff. For the determination of precipitation in the spring period, proposed the regional calculation formula, the maximum snow supplies and the coefficients of their variation are generalized in the form of a map. The runoff coefficients is determine through the coefficients of runoff formation, which are generalized in the form of a map and taking into account the coefficients of the influence of the size of the catchments on the losses of the runoff in the spring flood period.

The characteristics of the slope influx, which are an important component of the calculation scheme, are represented by the maximum slope modulus, which in turn is determined by the coefficient of unevenness of the sloping influx, the duration of the flow into the channel network and the total water supplies to the catchments. All listed parameters are valided for the studied territory, in particular, to determine the influence of intra-zonal factors on the duration of the sloping influx, they was zoning within the limits of physical geographic zones and separate river basins was carried out.

The transformation of the maximum slope modulus is represented by functions that take into account the channel time, flood-plain regulation and the impact of flowing lakes and reservoirs. For the determination of the transformation function and the coefficients of flood-plain regulation, the equations of exponential form are derived, with separate parameters in physical geographic zones and for small catchments (with an area up to 100 km2).

For the plain rivers of Ukraine the author's modified version of the calculating method for determining the characteristics of spring flood in climate change conditions has implement. The implementation of the proposed calculation option using different models and scenarios has shown that the results differ significantly, but in practically all cases up to 2050 It is forecasted a significant decrease in the runoff of spring flood (from 10-20% in the north of the investigated area and 40-50% in the south).

As an example, Figure 2 show the results of modeling the change in the maximum runoff of spring floods in two scenarios of RCP 4.5 and RCP 8.5 according to the model RACMO2.

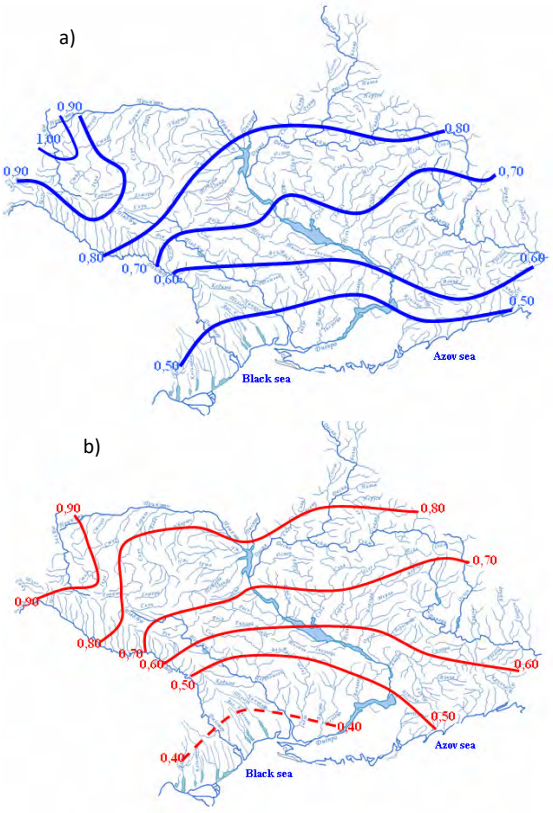

Figure 2. Distribution of the coefficients of influence of climate change on the maximum runoff of spring flood on the plain territory of Ukraine (model RACMO2, scenario RCP4.5 (a) and RCP8.5 (b) for the period up to 2050, relative to 2010.

4. Conclusions

Verification of the modified methodic taking into account climate change has shown the possibility of its application for the assessment of changes in water content during the spring flood on the flat rivers of Ukraine, both in the framework of the basic scheme and in the form of separate calculations using climate data as an option for implementing the design scheme under climate change conditions..

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