

Study of trends in the time series of flood runoff in the Tisza Basin Rivers within Ukraine

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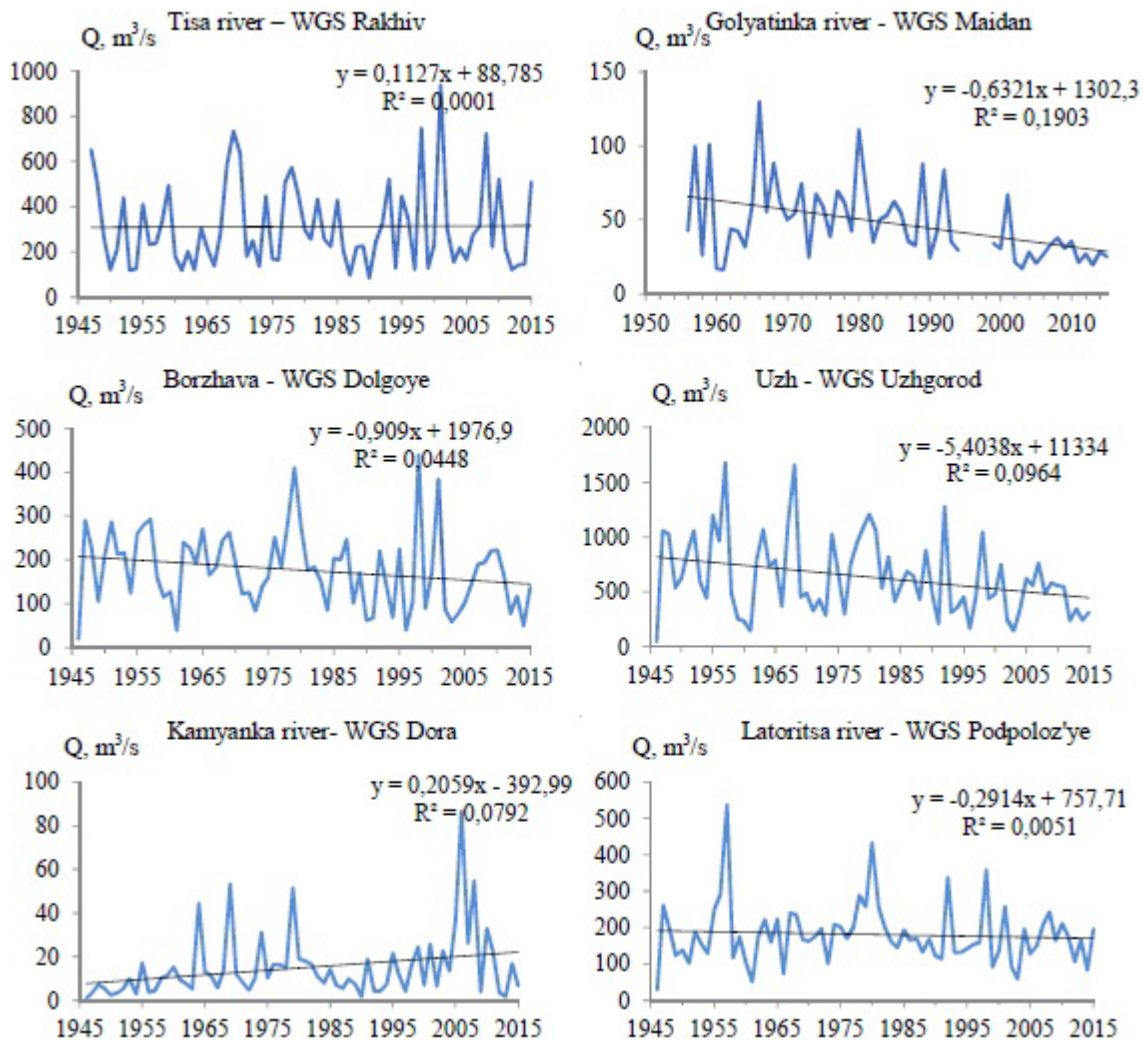
Introduction

The rivers of the Tisza basin are characterized by a flood regime and flow through the territory of Western Ukraine, where the mountain system of the Eastern Carpathians is located, which is subdivided into the Outer Eastern Carpathians (the Carpathian rivers within the Dniester and Prut basin) and the Inner Eastern Carpathians (the Transcarpathian rivers – the Danube basin, namely the Tisza with tributaries). Almost all considered Mountain Rivers of Transcarpathia belong to the category of small rivers, however, the length of the studied rivers in 90% cases more than 10 km. The catchments are characterized by significant slopes (from 7.8 ‰ to 111 ‰) and an average elevation from 310 to 1100 m. The Ukrainian Carpathians are densely covered with forests, therefore, the forest cover of catchments on the rivers of Transcarpathia is 40–87%, but there are almost no swamps and lakes in the studied catchments. At the study territory, catastrophic floods are periodically observed, which lead to significant economic losses, and sometimes to human casualties. The floods of 1911, 1913, 1957, 1969, 1998, 2001, 2008 and 2020 can be classified as exceptionally high on the territory of the Ukrainian Carpathians (Margaryan et al., 2020).

Methodology. To analyze the initial information, the method of mathematical and statistical analysis, spatial generalization, extrapolation and correlation was used. To assess the statistical homogeneity of the initial information used three criteria: F-test (Fisher criterion), Student's t-test and Wilcoxon criterion. The assessment of cyclical fluctuations of maximal runoff is performed using the time series trends, and statistical processing using the method of moments and maximum likelihood.

Results

The water gauge station (WGS) on river of Transcarpathia have an observation period from 56 to 103 years, up to 2015 inclusive. According to the existing time series of observation of the maximum runoff in the territory of the Ukrainian Carpathians, the absolute values of the maximum water discharge in Transcarpathia vary from $86.7 \text{ m}^3 / \text{s}$ (Kamenka river - Dora village, $A = 18.1 \text{ km}^2$) to $5200 \text{ m}^3 / \text{s}$ (Prut - Chernivtsi, $A = 8690 \text{ km}^2$). To study temporal trends in chronological series of maximum runoff, chronological graphs of annual maximum water discharge on the rivers of the Tisza basin within Ukraine (Fig. 1) were constructed. Their analysis shows that both an increase (3 cases or 21%) and decrease in runoff (10 cases or 72%), and in some cases - invariability (1 case or 7%) in fluctuations in the maximum annual water discharge. Thus, there is no definite regularity in the distribution of trends in maximal runoff at the Transcarpathian region; for 3 catchments, there is a statistically significant trend towards a decrease in runoff and, for only 1 catchment, to an increase. The final stage of the work was the study of the patterns of change in the maximum annual discharge from the factors of the underlying surface - the areas of catchments and their average elevations. Analyzing the obtained dependences, it can be noted that for the rivers under consideration there is a regular decrease in the absolute maximum runoff modules with an increase in the catchment areas, the dependences are linear and are confirmed by significant correlation coefficients. On the other hand, taking into account that a mountainous region is being considered, the dependence of the investigated value on the average elevations of catchments was built - here there is a regular increase in the maximum runoff modules with an increase in the terrain elevation. The presence of such dependences opens up prospects for further research on the development of regional methods for determining the maximum annual runoff of ungauged rivers.



Conclusion

- Studying the regularities of the formation of the maximum river runoff under the conditions of regional and global climate changes is an urgent task of modern hydrology;
- Analysis of data on annual flow maximums showed that for the Tisza basin within Ukraine, floods can be observed throughout the entire calendar year;
- Time trends in the multiyear maximum water discharges are not unambiguous. On the territory of Transcarpathia, in 70% of cases, there are trends insignificant to an increase or decrease, in 21% - a significant negative trend, and only at the Kamenka river - Dora village ($A = 18.1 \text{ km}^2$) there is a significant positive trend;
- The presence of stable relationships between the annual maximums and the catchment areas of the rivers shows the possibility of developing a methodology for determining the maximum discharge of unexplored rivers in Transcarpathia.

References

Margaryan VG, Ovcharuk VA, Goptsiy MV, Borovskaia GA, (2020), Comparative analysis and estimate of the long-term fluctuations of the river maximum runoff of the mountain territories of Armenia and Ukraine under of global climate change, *Sustainable Development of Mountain Territories*, **12** (1), pp. 61–75