PARTNERS

XXIX CONFERENCE OF THE DANUBIAN COUNTRIES
ON HYDROLOGICAL FORECASTING AND HYDROLOGICAL BASES
OF WATER MANAGEMENT
September 6 - 8, 2021

ÚSTAV HYDROLÓGIE SAV
INSTITUTE OF HYDROLOGY SAS

Estimation of design discharges in terms of seasonality and length of time series

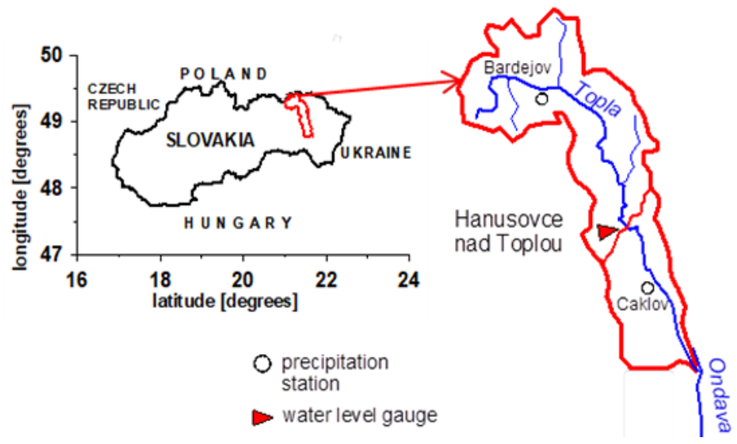
Veronika Bačová Mitková
Institute of Hydrology SAS, Dúbravská cesta 9, 841 04 Bratislava, Slovakia

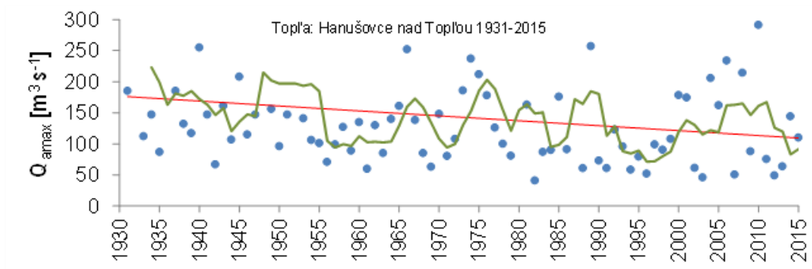
Introduction

All statistical methods which are used to estimate the floods with a very long return period are associated with great uncertainties. Such uncertainty is associated with several factors e.g. time series length, inclusion/non-inclusion of the historical floods into the time series, river regime or type of theoretical probability distribution. The paper deals with the effect of two factors on the accuracy of T-year discharge estimation resp. fluctuations in the estimation of these discharges. The AM method was used to analyze the effect of the time series length and seasonality (winter, summer) on the accuracy of T-year maximum discharges estimation.

Material

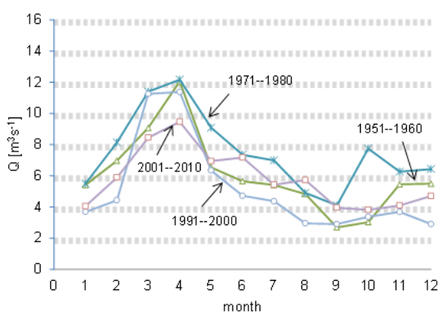
The series of daily discharges and annual maximum discharges Q_{amax} on the Topľa River at Hanušovce nad Topľou for the period of 1931-2015 were used as input data. The maximum annual discharges (AM) method was used with theoretical probability distributions Log-Pearson III, Gamma and Log-Normal. The Topľa is upland/lowland type of river in eastern Slovakia. The catchment drainage area is 1 506 km² with length of 129.8 km.

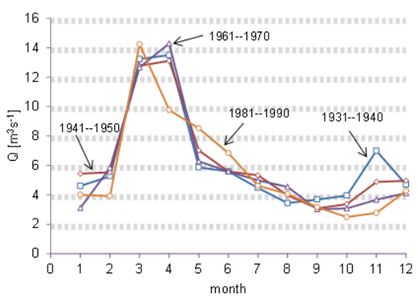


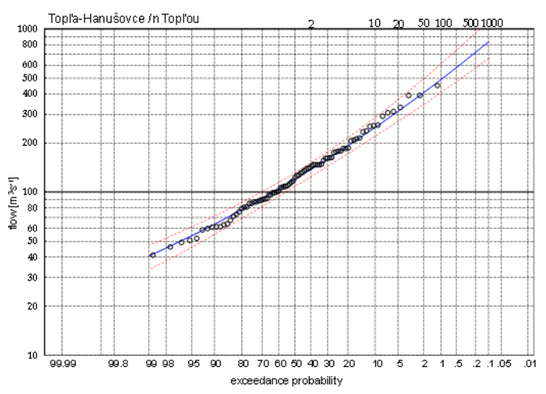


Methods

In our analysis we use one type of the theoretical probability distribution the Log-Pearson distribution type III (LP III). The advantage of this particular technique is that extrapolation can be made of the values for events with return periods well beyond the observed flood events. Subsequently, the LP III probability distribution was compared with other recommended probability distributions (Gamma and Log-normal) according to OTN ŽTP 3112-1: 03. To verify the accuracy of theoretical distributions, we used a non-parametric Kolmogorov-Smirnov goodness of fit test for the significance level α = 0.05.







Results

- The estimated T-year maximum discharge according LPIII distribution showed relatively small differences compared with two selected types of theoretical probability distributions used in hydrological analyses of extremes in Slovakia. The lowest values of estimated T-year maximum discharges, achieved Gamma theoretical probability distribution, especially for discharges with high return periods.

The effect of time series length on the T-year discharge estimation:

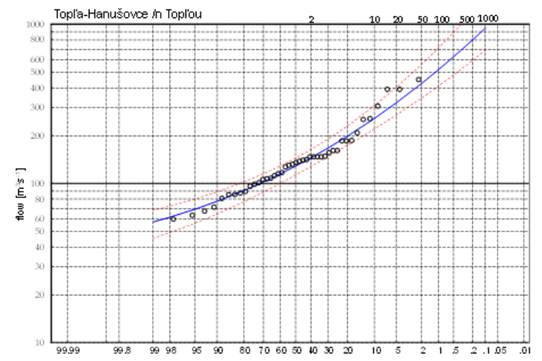
- For analyzing the effect of the length of the data series on the estimation of T-year discharges, the period 1931-2015 was divided into two shorter periods: 1931–1973 and 1974–2015. We had chosen this approach because for the frequency analysis is recommended the length of the observation series 5T.

The effect of the seasonality on the T-year discharge estimation

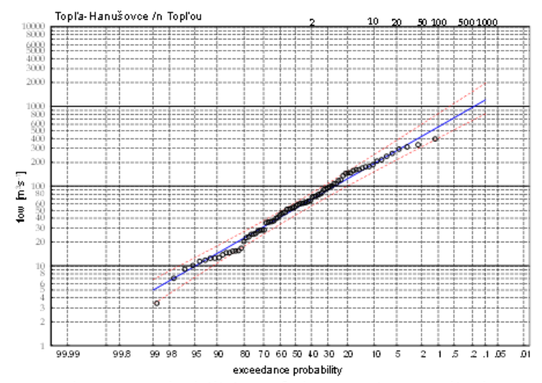
- For dividing the year into seasons, we proceeded from the analysis of the occurrence of floods and from the evaluation of the Topľa runoff regime during the year. In terms of the type of runoff regime, Topľa belongs to the highland-lowland area with rain-snow runoff with the culmination of river runoffs in the month of March, respectively April. The measured data were divided into two seasons:

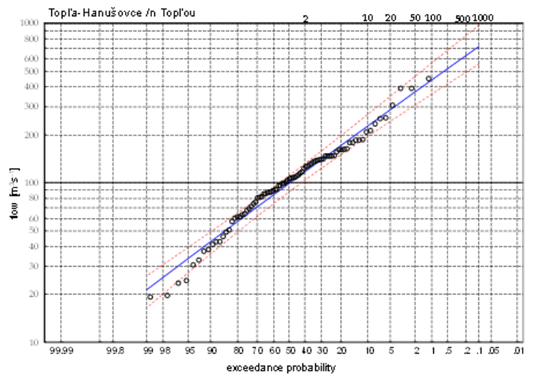
-Summer season is from May to October, when peak discharges occur only from heavy rainfall.

-Winter season is from November to April, when peak discharges occur by combining heavy rainfall in the form of snow and rain as well as snow melting in the area.

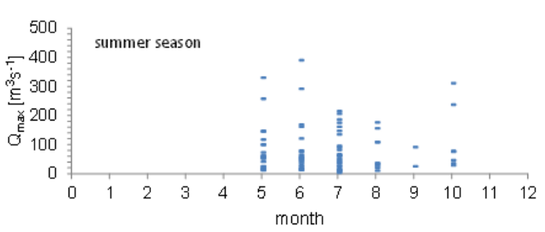


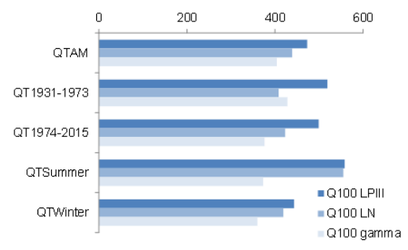
Exceedance probabilities of the annual maximum discharges according to Log-Pearson Type III. probability distribution (LPIII) left) period 1931–1973 and right) period 1974–2015 on the Topľa River: Hanušovce nad Topľou.

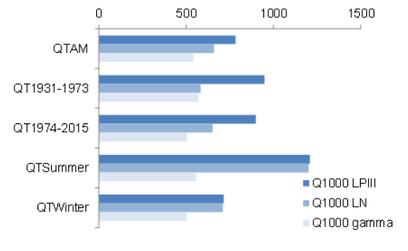




Exceedance probabilities of the maximum discharges according to Log-Pearson Type III. probability distribution (LPIII) a) summer season and b) winter season on the Topľa River: Hanušovce nad Topľou.







Discussions & Conclusions

Estimation of flood magnitudes to be used as a basis to design the hydraulic structures and flood control management is therefore of crucial importance. Therefore, the paper also presented an estimation of the T-year maximum discharges by the AM method and analysed the effect of the time series length and seasonality (winter, summer) on the accuracy of T-year maximum discharges estimation. Results showed that not only the selection of the distribution function to estimate T-year discharges but also the processing of the statistical series affect the results of the estimation. The shorter periods showed higher estimations of the T-year discharges. The highest estimated values according the LPIII distribution was achieved for summer season. The lowest estimated value according the LPIII distribution was achieved for winter season. When interpreting the results, it should be borne in mind that the T-year maximum discharges are related to the length of the analyzed series and therefore estimated values with very high return periods are extrapolated and that each statistical method is burdened with some uncertainty that may be caused by alone method, but also the data, which may be burdened by a certain measurement error.

Acknowledgements

This work was supported by the project VEGA No. 2/0004/19 “Analysis of changes in surface water balance and harmonization of design discharge calculations for estimation of flood and drought risks in the Carpathian region”.