The assessment of the hydrological regime of the Torysa River by the flashlines index

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Abstract. Climate change has a significant impact on the local and regional hydrological regime. In this study, the hydrological regime and variability of flows in the Torysa river basin were investigated for the period 1973-2020. The flows were evaluated by the RBI index. The results showed that the Torysa river has a large flow variability.

1 Introduction

Climate change has a significant impact on the local and regional hydrological regime, which affects social and environmental systems [1–3]. Researching the development of the frequency of hydrometeorological variables on the longest possible timescales provides information on hydrometeorological characteristics and, consequently, on the probability of their occurrence in the future [4–8] e.g. for water management, the period of low flows limits the use of surface waters, the abstraction of water for various purposes, the use of flows for energy purposes, navigation, etc.

This study evaluates the spatial and temporal variability of flow and identifies flood periods using daily flow values from the upper reaches of Torysa (Slovakia) for the period 1973-2020. The flashlines index, also known as the Richard-Baker index (RBI), was used to assess the hydrological regime and flow variability of the Torysa River.

2 Material and Methods

2.1 Study area

The investigated area covers the Torysy mountain basin in eastern Slovakia (Fig. 1). Torysa is a river in eastern Slovakia, an important left-hand tributary of the Hornád. It drains a basin of 1,349 km², has a length of 129 km and is an upland-lowland type of river. It springs in the Levočské vrchy below Škapová, about 5 km northwest of the village of

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Torysky, at an altitude of about 1,080 m a.s.l. m. At first it flows to the southwest, later it turns to the north and soon to the east. Near Lipany, it leaves the Levočské vrchy, gradually turns to the southeast and continues through the valley between Čergov (in the northeast) and Bachurňa (in the southwest). In Prešov, it takes on its most important tributary, the Sekčov, and flows through the Košice basin to the south, already in the form of a lowland river with many meanders. Southeast of Košice, near the village of Nižná Hutka, it flows to the left into Hornád. There are 3 hydrological stations on the river: Prešov, Sabinov and Brezovica – Torysa [9].

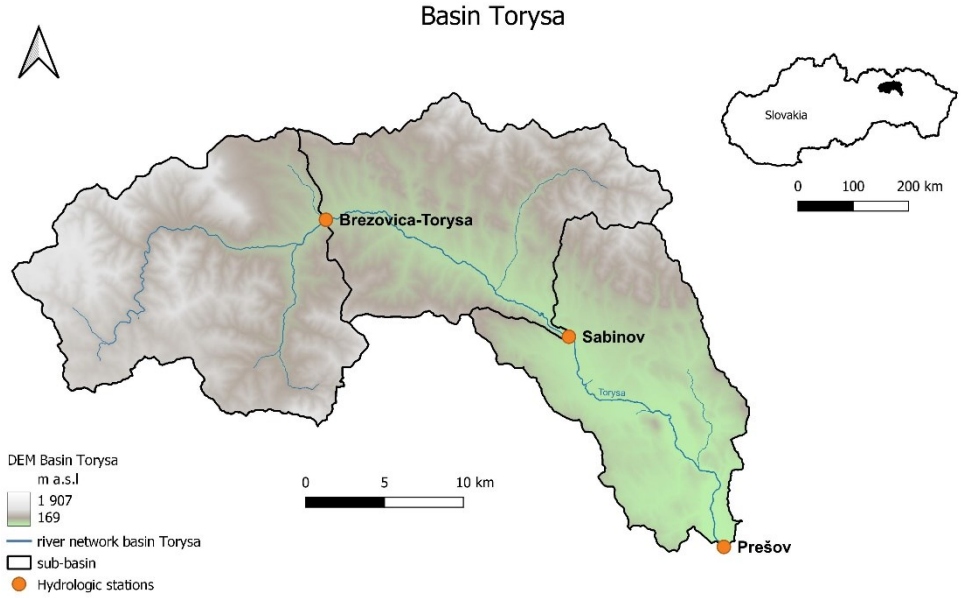

Fig. 1 map basin Torysa.

Table 1. Basin Torysa elevation.

Hydrological station	Catchment area (km²)	Elevation of the catchment area (m a.s.l.)		
		maximum	median	minimum
Prešov	667.34	1261.08	599.59	236.28
Sabinov	476.19	1261.08	698.59	319.99
Brezovica-Torysa	263.50	1261.08	796.85	421.73

2.2 Methods

The variability of the flows of the upper section of the Torysa was investigated on the basis of data obtained from the Slovak Hydrometeorological Institute. The data included daily flow values obtained for 3 hydrological stations: Prešov, Sabinov and Brezovica-Torysa for the period 1973-2020. Based on daily values, quarterly values were calculated according to seasons. The degree of volatility of flows in seasonal terms was determined based on the volatility of flows *Cv* and the flashliness index, Richard-Bakes Index (RBI), which characterizes the short duration of the phenomenon. The flow variation index *Cv* was calculated as the standard deviation of all daily flow values for each season divided by the

mean annual flow. The flamboyance index proposed by Baker et al. [10] was used to determine the rate of change in short-term flows, which according to the authors is called the RB Index (RBI).

$$RB\ index = \frac{\sum_{i=n}^{n}|q_i - q_{i-1}|}{\sum_{i=1}^{n} q_i} \quad (1)$$

Where: q - average daily flow, i - day, n = 365 (366)

RBI is a dimensionless index that ranges from 0 to 2 [10]. Zero represents constant flow, while a higher index value indicates increased flow frequency. Statistical calculations were performed using the 'R' program. The aim of this study was to analyze the long-term changes in the flow of the Torysy River for the period 1973-2020. The degree of seasonal flow variability was determined based on the flow variability index *C*v and the flare index (RBI), which characterizes the short duration of the phenomenon.

3 Results

The analysis of average periods of RBI values showed that in the period from 1973 to 2020, the RBI values at the Prešov, Sabinov and Brezovic-Torysa hydrological stations ranged from 0 to 0.53, while at the Prešov and Brezovica stations the RBI indicator ranged from 0 to 0.53, which indicated. high changes in short-term flows. In the analyzed multi-year period 1973-2020, the highest RBI values were recorded in the summer period. The lowest RBI values were recorded in the winter period.

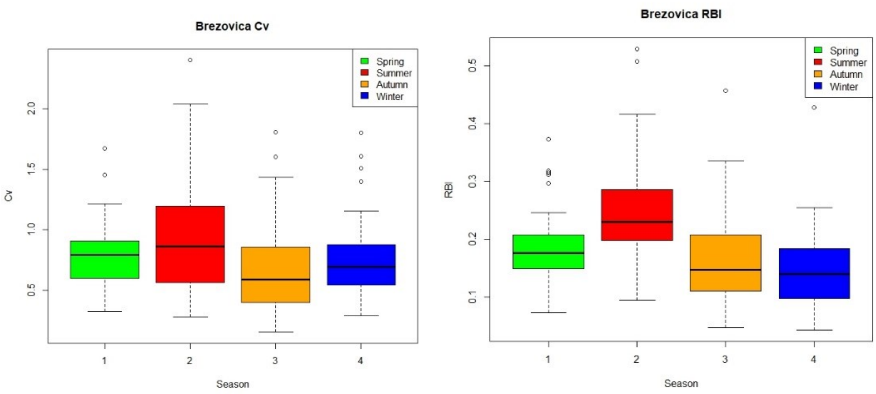

Fig. 2. Broezovica CV and RBI.

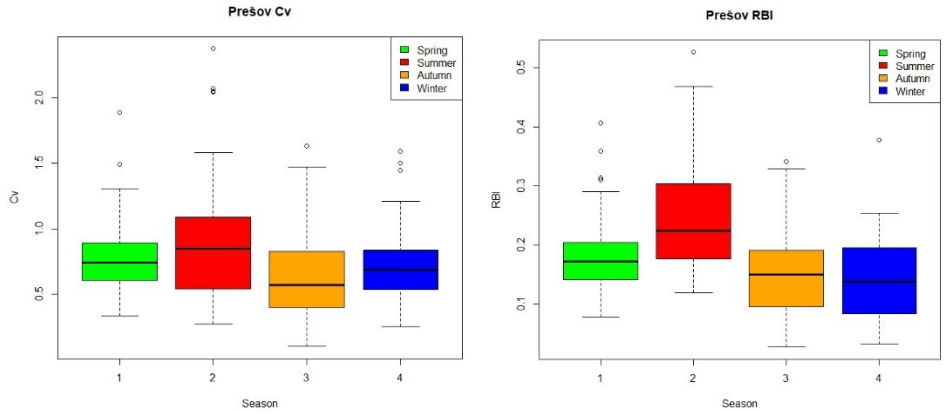

Fig. 3. Prešov CV and RBI.

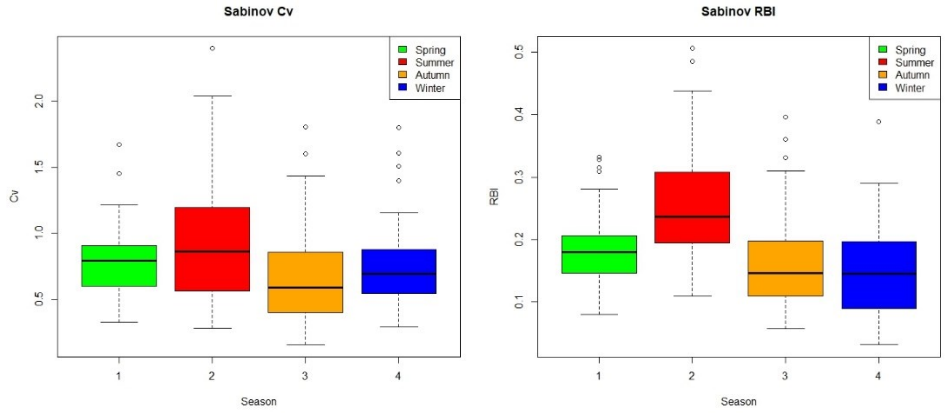

Fig. 4. Sabinov CV and RBI.

Figures 2-4 show the distribution of *C*v and RBI index for seasonal periods. y (RBI> 0.4) recorded in summer at all observed stations.

4 Conclusion

The study examined the variability of flows in the Torysy river basin in three hydrological stations where daily flows were studied, according to the seasons. The data covered the years 1973-2020, on a daily basis. The RBI index was used for evaluation. Higher annual amplitudes of RBI values were recorded in the summer period. The result shows that the Torysa river has the character of a hot river and has a great variability of flows.

This work has been supported by Slovak Research and Development Agency under the Contract no. APVV-20-0281 and SK-SRB-21-0052 Innovative approaches to the assessment and management of drought risk due to climate change.

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