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Analysis of short-term rainfall time structure by half-time concentration indexes

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Abstract

Because of the enormous variability of short-term rainfall time structures, we suggested a methodology for designing synthetic hyetographs in several variants with respect to the course of precipitation intensity.

Reference 6-hour rainfall episodes were extracted from radar-derived precipitation time series (May – September; 2002 – 2011) with a time resolution of 10 minutes, adjusted by daily data from rain gauges (Bližňák et al., 2018). Based on the 10-minute adjusted radar-based precipitation intensity data, we created their accumulations within moving time windows of various lengths. A representative set of maximum precipitation episodes was collected from 39 radar pixels where Czech synoptic weather stations are located; the number of considered episodes was 50 x 39 = 1950.

To distinguish variants of rainfall time structure, we suggested a set of three so-called half-time concentration indexes. They express the time concentration of 6-hour rainfall in four time-steps. In general, the indexes compare precipitation totals during gradually shortened time periods, namely 6, 3, 2, and 1 h. The form is a normalized ratio between two precipitation totals within different time windows, the first one having a half-length than the second one. Each of the indexes reaches values between 0 and 1 representing steady precipitation intensity and precipitation concentrated into one-half of the considered time step or less, respectively. Six clusters of episodes (cA – cF) were distinguished this way (Figure 1).

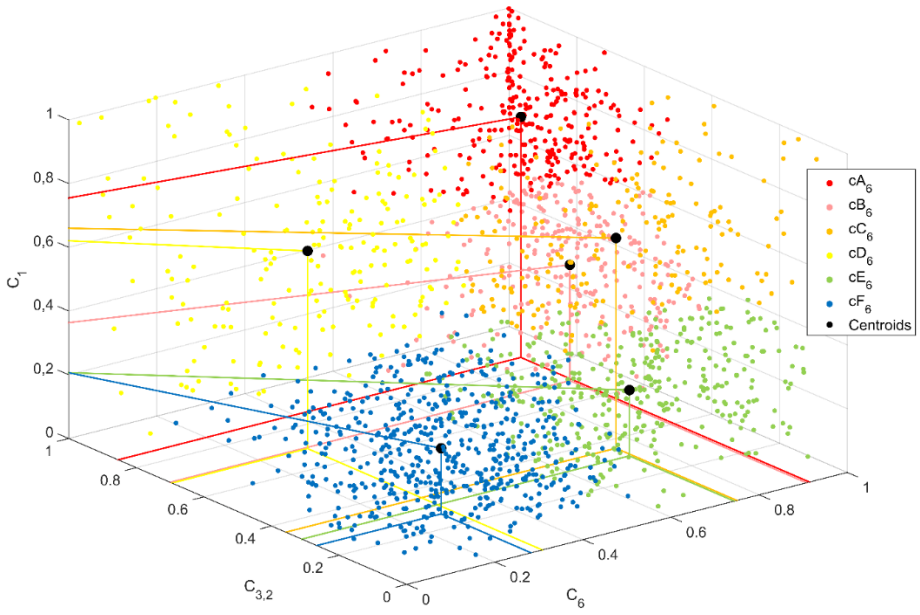

Fig 1: Clustering of reference 6-hour precipitation episodes into six variants (cA – cF) by the half-time concentration indexes C_6, $C_{3,2}$, and C_1. Black dots represent centroids of the clusters.

The distinguished variants were further characterized by synthetic hyetographs representing the average course of precipitation intensity in the cluster. First, the episodes were disaggregated with respect to the precipitation intensity into main 30-minute sections and adjacent side sections. Averaging the characteristics of the sections provided the means for designing synthetic hyetographs called camel hyetographs because of their typical shapes (Figure 2). One hyetograph represents episodes with steady precipitation intensity during the entire episode, and three others distinguish variants of more concentrated episodes; the two remaining "two-humped" hyetographs represent episodes characterized by a substantial temporary decrease in precipitation intensity or even its interruption during the episode.

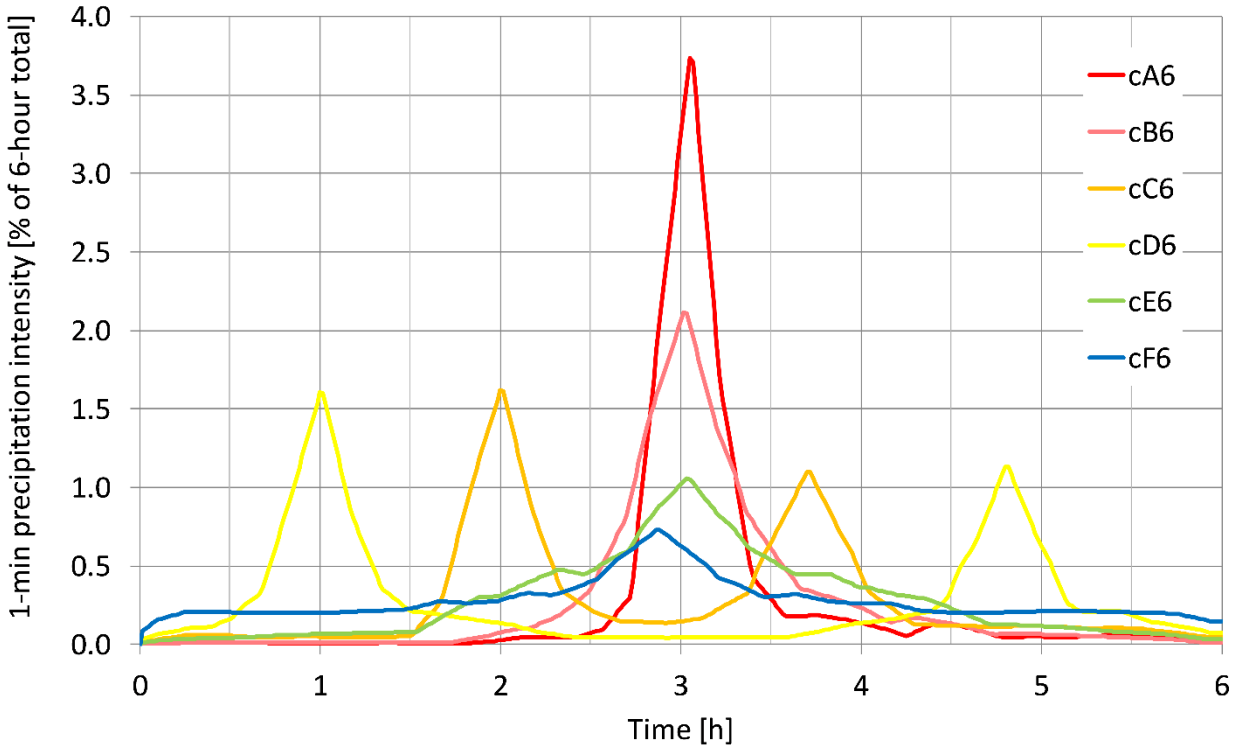

Fig 2: Synthetic hyetographs for 6 variants of 6-hour precipitation episodes. The standardized 1-minute precipitation intensity is depicted as the percentage of the 6-hour total.

The distinguished variants of precipitation episodes well correspond with the nature of precipitation, namely stratiform, convective, and mixed ones. As the result, we detected substantial differences in representation of the variants in various regions of Czechia. The results will enable the improvement of design hydrographs of small streams where runoff is basically influenced by the rainfall time structure.

References

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