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Flood Frequency Analysis Using Continuous Simulation of Catchment Runoff

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In the last decade a substantial effort has been put into the development of new methods for flood frequency analysis (FFA), which would utilize continuous simulation of catchment runoff. Recent trend in FFA is trying to combine the advantages of stochastic weather generators used to generate synthetic time series of meteorological and climatic variables and rainfall-runoff models enabling their transformation to catchment runoff. This approach enables to estimate design floods even in places with short or no historical records of flows at all. This work presents a new methodology for extreme flood estimation, combining a single site stochastic weather generator enabling the generation of daily precipitation amounts and air temperatures and a conceptual lumped rainfall-runoff model. The weather generator takes into account seasonality and complies with the two-part model scheme of Todorovic and Woolhiser (1975), where the precipitation occurrence and amount are generated separately. The model of precipitation amounts generates precipitation amounts for the whole rainfall events. These amounts are further disaggregated into individual days of these events according to a newly proposed method of fragments. In order to avoid a complicated generation of precipitation amounts at multiple sites, the weather generator was used to generate mean areal precipitations and air temperatures calculated using geostatistical methods. The rainfall-runoff model used in the methodology brings an innovative approach of separate simulation of low and extreme flows, which significantly improves the simulation of extreme flows while maintaining a satisfactory simulation of low and medium flows. The newly proposed methodology was used to estimate extreme floods of selected return periods in several mountainous catchments in Slovakia. The results of the analysis showed that the weather generator preserved the selected statistical characteristics of observed precipitation and air temperature time series. The introduction of two regimes into the simulation of catchment runoff also proved to be very efficient when the simulation of extreme flows improved rapidly compared to traditional modelling scheme. The uncertainty of the whole methodology was assessed by calibrating 100 hydrological models used to transform synthetic inputs into flows. These were further used to construct cumulative distribution functions from which design floods were estimated.