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Detecting flood event trends assigned to changes in urbanisation levels using a bivariate copula model

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Flood frequency analyses based on stationary assumptions are usually employed for estimating design floods. However, more complex non-stationarity approaches are trying to be incorporated with the aim of improving such estimates. In this study, the effect of changing urbanisation on maximum flood peak (Q) and volume (V) series is analysed. The potential changes in an urbanised catchment and in a nearby hydrologically similar rural catchment in northwest England are investigated. The urbanised catchment is characterised by a noticeable increase of the urbanisation level in time, while the rural catchment has not been altered by anthropogenic actions. Winter, summer and annual maximum flood events are studied. With the aim of analysing changes in time, two non-superimposed time-windows are defined covering the periods 1976-1992 and 1993-2008, respectively.
A preliminary analysis of temporal trends in Q, V and Kendall's tau is visually done, being formal tested by a resampling procedure. Differences were found among winter, summer and annual maximum flood events. As annual maximum flood events are commonly used for designing purposes, the corresponding bivariate distribution (margins and copula) was obtained for the different time-windows. Trends regarding both time-windows were analysed by comparing bivariate return period curves in the Q-V space. Different behaviours were found depending on the catchment. As a result, the application of the proposed methodology provides useful information in describing changes in flood events, regarding different flood variables and their relationship. In addition, the methodology can inform practitioners on the potential changes connected with urbanisation for appropriate design flood estimation.