Geophysical Research Abstracts
Vol. 21, EGU2019-505-2, 2019
EGU General Assembly 2019

A virtual experiment to compare statistical vs. process-based methods for design flood estimation

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Abstract

Flood risk assessment and the design of protection measures often require the estimation of a design flood, which is the flood quantile with a given probability of exceedance (e.g. 1%), or return period (e.g. 1–in–100 year), from limited flow records. Two main approaches are presently used for such estimation: (1) statistical approach, which is based on fitting a probability distribution function (e.g. Gumbel distribution) to a record of annual maximum flows. The fitted probability model is then extrapolated to a flow magnitude (or flood quantile) corresponding to a given probability of exceedance; (2) rainfall–runoff modelling, which is based on the use of a mathematical model that describes the main processes influencing the transformation of rainfall to runoff at a given catchment. The latter approach often requires a coupling of a stochastic weather model with a rainfall-runoff model to derive synthetic discharges for which the flood quantile can be determined for a given probability of exceedance. The two approaches embed various sources of uncertainties and the propagation of these uncertainties in turn affect the reliability of estimated flood quantiles. Since the true flood quantile is not known, modellers can only hope that the selected methodology leads to a reliable result. In this study, a modelling exercise is framed such that the “true” flood quantile is known a priori, and the two aforementioned techniques are implemented respectively and their results compared with the true value. The study also explore uncertainties that arise due to choice of hydrological and probability models selected for estimation purposes, and also errors present in the hydroclimatic data. The result of the comparative study is an attempt to contribute to a broader understanding about the pros and cons of the two different approaches.