

Design flood estimation in ungauged basins: probabilistic extension of the design-storm concept

Mario Berk (1), Olga Špačková (2), and Daniel Straub (3)

(1) Engineering Risk Analysis Group, TU München, Munich, Germany (mario.berk@tum.de), (2) Engineering Risk Analysis Group, TU München, Munich, Germany (olga.spackova@tum.de), (3) Engineering Risk Analysis Group, TU München, Munich, Germany (straub@tum.de)

Design flood estimation in ungauged basins is an important hydrological task, which is in engineering practice typically solved with the design storm concept. However, neglecting the uncertainty in the hydrological response of the catchment through the assumption of average-recurrence-interval (ARI) neutrality between rainfall and runoff can lead to flawed design flood estimates. Additionally, selecting a single critical rainfall duration neglects the contribution of other rainfall durations on the probability of extreme flood events.

In this study, the design flood problem is approached with concepts from structural reliability that enable a consistent treatment of multiple uncertainties in estimating the design flood. The uncertainty of key model parameters are represented probabilistically and the First-Order Reliability Method (FORM) is used to compute the flood exceedance probability. As an important by-product, the FORM analysis provides the most likely parameter combination to lead to a flood with a certain exceedance probability; i.e. it enables one to find representative scenarios for e.g., a 100 year or a 1000 year flood. Possible different rainfall durations are incorporated by formulating the event of a given design flood as a series system. The method is directly applicable in practice, since for the description of the rainfall depth-duration characteristics, the same inputs as for the classical design storm methods are needed, which are commonly provided by meteorological services.

The proposed methodology is applied to a case study of Trauchgauer Ach catchment in Bavaria, SCS Curve Number (CN) and Unit hydrograph models are used for modeling the hydrological process. The results indicate, in accordance with past experience, that the traditional design storm concept underestimates design floods.