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An improved regional flood frequency analysis approach at the global scale

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Design flood estimation in data-poor regions is a fundamental task in hydrology. In this paper, we propose a regional flood frequency analysis approach to estimate design floods anywhere on the global river network. This approach involves two stages: (i) clustering global gauging stations into subareas by a K-means model based on twelve globally available catchment descriptors and (ii) developing a regression model in each subarea for design flood estimation using the same descriptors. Nearly 12,000 discharge stations globally were selected for model development and a benchmark global index-flood method was adopted for comparison. The results showed that: (1) the proposed approach achieved the highest accuracy for design flood estimation when using all catchment descriptors for clustering; and the regression model accuracy improved by considering more descriptors in model development; (2) a support vector machine regression showed the highest accuracy among all regression models tested, with relative root mean squared error of 0.67 for mean flood and 0.83 for 100-year return period flood estimations; (3) 100-year return period flood magnitude in tropical, arid, temperate, continental and polar climate zones could be reliably estimated with relative mean biases of -0.18, -0.23, -0.18, 0.17 and -0.11 respectively by adopting a 5-fold cross-validation procedure; (4) the proposed approach outperformed the benchmark index-flood method for 10, 50 and 100 year return period estimates; We conclude that the proposed RFFA is a valid approach to generate design floods globally, improving our understanding of the flood hazard, especially in ungauged areas.