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A comparison of flood estimation methods in estuarine regions

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Flood preparedness in estuarine regions is important for long term economic growth and social resilience. A significant challenge in estimating the flood risk is being able to determine the likelihood of its occurrence, given that events having the greatest impact are also rare. The estimation of flood probability in estuarine regions is also complicated by the fact that estuarine floods can be caused by multiple inter-dependant processes, such as storm surge, high astronomical tide, upstream fluvial flooding and localized heavy rainfall. The dependence between these processes increases the likelihood of flood events compared to when the processes are considered independent.

Given the challenges in estimating flood probabilities, there is a variety of methods available but considerable discernment is required to identify the most relevant method for a given situation and to account for limitations when applying it. This work provides a comprehensive review of methods, including univariate frequency analysis, the bivariate design variable method, Monte Carlo methods and continuous simulation, especially focusing on the role of probability censoring. Censoring is a general technique for screening events according to their magnitude and is exploited in flood estimation to emphasize extreme events. Challenges of each method are identified including location of interest within the region, complexity of the method, data limitations, dynamic/timing effects influencing the composition of the extreme, accounting for all relevant sources of variability in the flood estimate, computational model requirements and whether or not the application is intended to estimate conditions under future climate scenarios.

A case study is used to compare methods. The study is located on the Swan River in Western Australia, which is the lower part of the Swan-Avon Basin, with an approximate area of 124,000 km2. A two-dimensional flexible mesh hydrodynamic MIKE21 model simulates water levels within the estuary, extending approximately 50 km upstream and 19 locations are selected within the region for analysis. 25 years of continuous, 15-minute, flood level data is available at a mid-reach location that is influenced by both the lower tidal boundary and the upper streamflow boundary. The performance of the studied methods is evaluated at this location to demonstrate the challenges and opportunities of each and to develop improved guidance on the estimation of flood probabilities in estuarine regions.