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A Basis Function Approach to Simulate Storm Surge Events for Coastal Flood Risk Assessment

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Storm surge is a significant contributor to flooding in coastal and estuarine regions, especially when it coincides with other flood producing mechanisms, such as extreme rainfall. Therefore, storm surge has always been a research focus in coastal flood risk assessment. Often numerical models have been developed to understand storm surge events for risk assessment (Kumagai et al. 2016; Li et al. 2016; Zhang et al. 2016) (Bastidas et al. 2016; Bilskie et al. 2016; Dalledonne and Mayerle 2016; Haigh et al. 2014; Kodaira et al. 2016; Lapetina and Sheng 2015), and assess how these events may change or evolve in the future (Izuru et al. 2015; Oey and Chou 2016). However, numeric models often require a lot of input information and difficulties arise when there are not sufficient data available (Madsen et al. 2015). Alternative, statistical methods have been used to forecast storm surge based on historical data (Hashemi et al. 2016; Kim et al. 2016) or to examine the long term trend in the change of storm surge events, especially under climate change (Balaguru et al. 2016; Oh et al. 2016; Rueda et al. 2016). In these studies, often the peak of surge events is used, which result in the loss of dynamic information within a tidal cycle or surge event (i.e. a time series of storm surge values).
In this study, we propose an alternative basis function (BF) based approach to examine the different attributes (e.g. peak and durations) of storm surge events using historical data. Two simple two-parameter BFs were used: the exponential function and the triangular function. High quality hourly storm surge record from 15 tide gauges around Australia were examined. It was found that there are significantly location and seasonal variability in the peak and duration of storm surge events, which provides additional insights in coastal flood risk. In addition, the simple form of these BFs allows fast simulation of storm surge events and minimises the complexity of joint probability analysis for flood risk analysis considering multiple flood producing mechanisms. This is the first step in applying a Monte Carlo based joint probability method for flood risk assessment.