

Mapping dependence between extreme rainfall and storm surge across the Australian coastline using ROMS

Wenyan Wu (1), Seth Westra (1), Michael Lenord (1), and Kathleen McInnes (2)

(1) School of Civil, Environmental and Mining Engineering, University of Adelaide, Adelaide, Australia, (2) Climate Science Centre, CSIRO Oceans and Atmosphere, Melbourne, Australia

Storm surge caused by a combination of wind action and low pressure acting on the ocean's surface is a significant contributor to flooding in coastal and estuarine regions. When coincided with other flood-producing mechanisms such as extreme rainfall, the consequences can be devastating. Therefore it is important to understand the interaction between extreme storm surge and extreme rainfall. Previously, the dependence between extreme storm surge and extreme rainfall in Australia has been investigated using observed data from 49 tide gauges along the Australian coastline and statistically significant dependence has been observed for the majority of the locations (Zheng et al. 2013). However, in order to assess the flood risk due to coincident extreme surge and rainfall along coastal regions, more detailed mapping (e.g. including locations where there is no tide gauge) of the dependence between the two flood producing factors is required. There is also a need to quantify changes in dependence under climate change in order to understand future flood risk. Therefore, it is important to be able to quantify the dependence between extreme storm surge and extreme rainfall using modelled data.

In this study, we investigated the dependence between extreme storm surge and extreme rainfall using modelled storm surge data from the Regional Ocean Modeling System (ROMS) (Shchepetkin and McWilliams 2005). Storm surge data from 551 locations along the Australian coastline (at 30 km intervals) between the 1st of January 1981 and the 7th of May 2013 were used. These locations were paired with daily rainfall from gauges within a 30 km radius. A bivariate logistic threshold-excess model was employed to quantify the dependence between extreme daily storm surge and extreme daily rainfall. The results were compared with dependence values calculated using observed storm surge at 79 tide gauges around Australia.

Promising results were obtained. The dependence calculated using modelled storm surge data matched well with that calculated using observed data in most regions of Australia, while being able to in-fill storm surge information at ungauged locations. There is significant dependence between extreme storm surge (modelled using ROMS) and extreme rainfall along most of the Australian coastline, as found in the previous study. The most significant dependence was found in the north and north west coast of Australia, followed by some locations on the north east coast of Australia. This is most likely due to the frequent tropical cyclones in these regions that bring both extreme rainfall and storm surge. There seems to be high dependence between modelled storm surge and extreme rainfall in the south west coast of the state of Victoria (i.e. south west coast of south east Australia). Although, there is no gauged surge data to confirm this observation, this high dependence is most likely due to the frontal systems that often bring both rainfall and storm surge in this region in winter (McInnes et al. 2009).