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The dependence study between extreme rainfall and storm surge in the coastal zone

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During flood events in coastal catchments, extreme rainfall can occur during periods of extreme storm surge as these two processes are often driven by the common meteorological forcings, such as cyclonic systems. The flood magnitude for such a joint event is normally larger than the case when flooding is caused by only an extreme rainfall or an extreme storm surge event in isolation, so that it is necessary to understand the dependence between these two variables in order to evaluate the probability of flooding for the coastal zone. Given that coastal catchments are also likely to be affected by sea level rise as a result of anthropogenic climate change, understanding the interaction of these two processes will become increasingly important in the future if we are to understand future flood risk in the coastal zone.

This research quantifies the dependence strength between the extreme rainfall and extreme surge by using the most comprehensive record of storm surge collected along the Australian coastline to-date. A bivariate logistic threshold-excess model is used to conduct the dependence analysis in this study. A map of dependence values along the Australian coastline is generated and the temporal and spatial variation of the dependence strength is also examined.

Based on results, the following observations can be made:

1. The dependence between extreme rainfall and storm surge along the Australian coastline is generally statistically significant, although spatial variation of the dependence strength is also observed. It was shown that the probability of an extreme storm surge event occurring during an extreme rainfall event (or vice versa) can be up to eight times greater than the situation under which there is no dependence, suggesting that failure to account for these interactions can result in a substantial underestimation of flood risk for coastal catchments.

2. The dependence decreases as the spatial distance between the rainfall gauge and tide gauge increases, although a statistically significant dependence can also be detected over a spatial distance of up to several hundred kilometers, with the strong dependence found when the rainfall occurs within approximately 100 km of the tide gauge. This indicates that dependence issues need to be considered when assessing the flood risk for low-lying catchments within 100 km of the coastline.

3. A clear link between the strength of the dependence and the storm burst duration has been detected, with increasingly strong dependence occurring as the duration increases from one hour to 24 hours, followed by an approximately constant strength from 24 hours up to 7 day durations.