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Flood magnitude detection using satellite-based land surface temperature

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Floods can result in significant damages and loss of life especially in remote communities and in developing countries. People living in such areas frequently lack flood warning information to prepare for floods in advance due to sparse hydrological measuring networks and delays in accessing field data. Recently, it has been suggested that the large-scale spatial coverage and near-real time availability of remote sensing data may be suitable to identify potential flooding during extreme events and in data-scare regions. While water levels, river morphologies and inundation extents can be measured directly from space, river discharge cannot be monitored directly from satellite sensors. Tremendous efforts have been devoted to estimate river discharge from these variables using rating curves, hydraulic models or hydraulic geometry. The ratio between brightness temperature at a land pixel and at a water pixel has also been used to estimate river discharge. However, an accurate, fast and universally robust method to estimate river discharge or flood flows from satellites has not yet been developed for use in ungauged and sparsely gauged areas.

Here we demonstrate a new approach that uses the difference in day and night land surface temperature (ΔLST) derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) products for flood detection. In previous work, ΔLST has been assessed along with flood inundation qualitatively demonstrating that low ΔLST values are associated with flood events while dry seasons typically had high ΔLST values. We extend this analysis to quantify the relationship between flood flows and ΔLST values and understand the flood prediction potential of ΔLST. Flood flows were derived from 222 hydrological reference stations at unregulated catchments across contrasting hydro-climate conditions in Australia. The relationship between flood flows and ΔLST values was modelled using a regression tree technique governed by climate conditions, catchment properties and hydrograph characteristics. The results reveal that the ΔLST – flow relationships mainly depend on local climate conditions and catchment properties. Strong and moderate negative correlations were found in hot humid and cool temperate regions. Small positive correlations happened in mild temperate regions while strong positive correlations occurred in hot dry regions. The findings highlight conditions where ΔLST will be useful for river discharge estimation, flood predictions and flood warning system in sparsely gauged and ungauged regions.