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Role of land-use-land-cover changes in the 2018 Mega-floods over Kerala (India)

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The southern state of Kerala is an important hotspot for India in terms of tourism, physiography, and biodiversity. Kerala received extremely heavy rainfall and subsequent flooding during August 2018, leading to massive loss and damage. In this study, we investigate the role of changing Land Use Land Cover (LULC) in last three decades on this flooding event. We first assessed the LULC changes for the period 1985 through 2018. We found the massive loss in forest cover during this period with the highest loss between 1995 to 2005. Specifically, many of the evergreen forests changed to either mixed forests or cropland. In the period 2005 to 2018, we found that grasslands and shrublands experienced significant reduction.

We did an offline coupling of the Weather Research and Forecasting model (WRF) with WRF-Hydro and investigated the impact of LULC changes on this flooding event. For this, we first calibrated WRF-Hydro against observed discharge over some distributed points based on data availability. The calibrated version of WRF-Hydro was then forced with meteorological inputs from WRF and rainfall from TRMM satellite (for August 2018) to investigate the LULC sensitivity. Using various statistical measures we found that the WRF-WRF-Hydro coupled model was able to simulate the discharge reasonably well. For the given meteorological forcing, different LULC conditions (1985, 1995, 2005, 2018) show varying degree of changes in various parameters of flooding, namely, discharge, depth, and inundation. The LULC changes from 1995 to 2005 show largest changes in flooding parameters, due to the massive loss in forest cover during the same period. Comparing 2005 to 1995, the high flow value (estimated by Q10) is found to have increased by more than 10% for many stations, and for few stations, the increase is even more than 30%. Over central Kerala, the largest increase in surface water head (as high as 40% over some grid points) and inundation extent were found between 1995 to 2005. Notably, LULC changes (and hence its impact on flooding) between 2005 to 2018 have not been as drastic as that between 1995 to 2005.