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Land subsidence correlated with flooding during Hurricane Harvey and the assessment of future flood hazards for Houston & Galveston Texas

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In August 2017, Hurricane Harvey brought record rainfall, elevated storm tide, flooding and socioeconomic devastation to southeastern Texas. Using the radar backscattering difference between Sentinel-1A/B satellite acquisitions, a snapshot of standing water at the time of the satellite acquisition is provided and compared with designated flood hazard zones.

Next, Vertical land motion (VLM) is found by combining GNSS with multitemporal interferometric processing of SAR datasets acquired by ALOS and Sentinel-1A/B satellites. Land subsidence is observed up to 49 mm/yr during the ALOS acquisition period (Jul-2007–Jan-2011) and 34 mm/yr for the Sentinel-1A/B (Dec-2015 to Aug-2017) acquisition periods. Of the flooded area, 85% subsided at a rate > 5 mm/yr supported by the Chi-square test of independence.

Hurricane Harvey and other recent storms highlight potential vulnerabilities of flood resilience plans in coastal Texas that will degrade with climate change and rising seas. Combining VLM with sea-level rise (SLR) projections and storm surge scenarios for the years 2030, 2050, and 2100, we quantify the extent of flooding hazards for the Houston and Galveston areas. VLM is resampled and projected on LIDAR high-resolution topographic grids, then multiple inundation and flooding scenarios are modeled. By the year 2100, over 76 km^2 are projected to subside below sea level from VLM. Holding other variables constant, subsidence increases the area of inundation over SLR alone by up to 39%. Under the worst-case composite scenario of an 8-m storm surge, subsidence, and the SLR RCP8.5, the total affected area is 1,156 km^2. These composite scenarios produce model maps which can improve flood resiliency plans.