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Monitoring of Flood and Inundation Dynamics in Coastal Texas and Louisiana Using Airborne UAVSAR Data and Deep Learning Classification Techniques

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Floods and inundations caused by storm surges and prolonged heavy precipitation frequently affect the Gulf Coast of the United States. During the Atlantic hurricane season, many of the streams and bayous in this region may overflow or break their banks, resulting in severe damage to private properties and public facilities. Reliable information on the spatial distribution and temporal variation of flood and inundation extent is fundamental to the design and implementation of effective disaster preparedness, response, recovery, and mitigation activities. This research aims to develop new algorithms for improved characterization of flood and inundation dynamics using airborne repeat-pass SAR data acquired by NASA/JPL's polarimetric L-band UAVSAR system. A series of UAVSAR data collected over southeast Texas and southwest Louisiana in summer 2019 are processed to extract surface water extent before and after Tropical Storm Imelda, the fifth-wettest tropical cyclone on record in the continental United States that brought heavy rain and catastrophic flooding. Various metrics derived from polarization decomposition of the quad-polarized radar signals constitute the feature space. Deep learning (DL), a powerful state-of-the-art technique for image classification and big data analytics, is applied and multi-level DL frameworks are established to separate water and partial inundated from land areas. Results show that using fine-tuned 2-D convolutional neural networks (CNNs) with convolutions in both polarimetric and spatial domains can lead to improved classification accuracies over those achieved by conventional machine learning algorithms such as support vector machines (SVMs). Inundation changes with respect to different land-cover/land-use (LCLU) types are also analyzed, and more extensive inundated areas are observed in emergent and non-vegetated wetlands close to the coast. The approaches developed in this study have the potential to assist in future flood and inundation monitoring and impact analysis, and the classified maps created will largely facilitate the investigation of local hydrological processes and water storage assessment.