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Resolution Enhancement of MODIS-derived Water Indices for Studying Persistent Flooding

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Monitoring coastal marshes for persistent flooding and salinity stress is a high priority issue in Louisiana. Remote sensing can identify environmental variables that can be indicators of marsh habitat conditions, and offer timely and relatively accurate information for aiding wetland vegetation management. Monitoring activity accuracy is often limited by mixed pixels which occur when areas represented by the pixel encompasses more than one cover type. Mixtures of marsh grasses and open water in 250m Moderate Resolution Imaging Spectroradiometer (MODIS) data can impede flood area estimation. Flood mapping of such mixtures requires finer spatial resolution data to better represent the cover type composition within 250m MODIS pixel. Fusion of MODIS and Landsat can improve both spectral and temporal resolution of time series products to resolve rapid changes from forcing mechanisms like hurricane winds and storm surge. For this study, using a method for estimating sub-pixel values from a MODIS time series of a Normalized Difference Water Index (NDWI), using temporal weighting, was implemented to map persistent flooding in Louisiana coastal marshes. Ordinarily NDWI computed from daily 250m MODIS pixels represents a mixture of fragmented marshes and water. Here, sub-pixel NDWI values were derived for MODIS data using Landsat 30-m data. Each MODIS pixel was disaggregated into a mixture of the eight cover types according to the classified image pixels falling inside the MODIS pixel. The Landsat pixel means for each cover type inside a MODIS pixel were computed for the Landsat data preceding the MODIS image in time and for the Landsat data succeeding the MODIS image. The Landsat data were then weighted exponentially according to closeness in date to the MODIS data. The reconstructed MODIS data were produced by summing the product of fractional cover type with estimated NDWI values within each cover type. A new daily time series was produced using both the reconstructed 250-m MODIS, with enhanced features, and the approximated daily 30-m high-resolution image based on Landsat data. The algorithm was developed and tested over the Calcasieu-Sabine Basin, which was heavily inundated by storm surge from Hurricane Ike to study the extent and duration of flooding following the storm. Time series for 2000-2009, covering flooding events by Hurricane Rita in 2005 and Hurricane Ike in 2008, were derived. High resolution images were formed for all days in 2008 between the first cloud free Landsat scene and the last cloud-free Landsat scene. To refine and validate flooding maps, each time series was compared to Louisiana Coastwide Reference Monitoring System (CRMS) station water levels adjusted to marsh to optimize thresholds for MODIS-derived time series of NDWI. Seasonal fluctuations were adjusted by subtracting ten year average NDWI for marshes, excluding the hurricane events. Results from different NDWI indices and a combination of indices were compared. Flooding persistence that was mapped with higher-resolution data showed some improvement over the original MODIS time series estimates. The advantage of this novel technique is that improved mapping of extent and duration of inundation can be provided.