

A New Approach to Monitoring Coastal Marshes for Persistent Flooding

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Many areas in coastal Louisiana are below sea level and protected from flooding by a system of natural and man-made levees. Flooding is common when the levees are overtopped by storm surge or rising rivers. Many levees in this region are further stressed by erosion and subsidence. The floodwaters can become constricted by levees and trapped, causing prolonged inundation. Vegetative communities in coastal regions, from fresh swamp forest to saline marsh, can be negatively affected by inundation and changes in salinity. As saltwater persists, it can have a toxic effect upon marsh vegetation causing die off and conversion to open water types, destroying valuable species habitats. The length of time the water persists and the average annual salinity are important variables in modeling habitat switching (cover type change). Marsh type habitat switching affects fish, shellfish, and wildlife inhabitants, and can affect the regional ecosystem and economy. There are numerous restoration and revitalization projects underway in the coastal region, and their effects on the entire ecosystem need to be understood. For these reasons, monitoring persistent saltwater intrusion and inundation is important. For this study, persistent flooding in Louisiana coastal marshes was mapped using MODIS (Moderate Resolution Imaging Spectroradiometer) time series of a Normalized Difference Water Index (NDWI). The time series data were derived for 2000 through 2009, including flooding due to Hurricane Rita in 2005 and Hurricane Ike in 2008. Using the NDWI, duration and extent of flooding can be inferred. The Time Series Product Tool (TSPT), developed at NASA SSC, is a suite of software developed in MATLAB® that enables improved-quality time series images to be computed using advanced temporal processing techniques. This software has been used to compute time series for monitoring temporal changes in environmental phenomena, (e.g. NDVI times series from MODIS), and was modified and used to compute the NDWI indices and also the Normalized Difference Soil Index (NDSI).

Coastwide Reference Monitoring System (CRMS) water levels from various hydrologic monitoring stations and aerial photography were used to optimize thresholds for MODIS-derived time series of NDWI and to validate resulting flood maps. In most of the profiles produced for post-hurricane assessment, the increase in the NDWI index (from storm surge) is accompanied by a decrease in the vegetation index (NDVI) and then a period of declining water. The NDSI index represents non-green or dead vegetation and increases after the hurricane's destruction of the marsh vegetation. Behavior of these indices over time is indicative of which areas remain flooded, which areas recover to their former levels of vegetative vigor, and which areas are stressed or in transition. Tracking these indices over time shows the recovery rate of vegetation and the relative behavior to inundation persistence. The results from this study demonstrated that identification of persistent marsh flooding, utilizing the tools developed in this study, provided an approximate 70-80 percent accuracy rate when compared to the actual days flooded at the CRMS stations.