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Land Area Change in Coastal Louisiana After the 2005 Hurricanes: Marsh Communities

Methodology

The U.S. Geological Survey (USGS) assessed changes in land and water coverage in coastal Louisiana within two months of Hurricanes Katrina and Rita (Aug. 29 and Sept. 24, 2005, respectively) by using Landsat Thematic Mapper (TM) satellite imagery. The purpose of this study is to provide preliminary information on land-water area changes in coastal Louisiana shortly after both hurricane landfalls and to serve as a regional baseline for monitoring wetland recovery following Hurricanes Katrina and Rita.

The USGS Center for Earth Resources Observation and Science (EROS) provided multiple Landsat images of coastal Louisiana that were acquired immediately before and after the hurricane landfalls. Land-water conditions before the storms were represented using imagery acquired between October 13 and November 7, 2004. A series of seven Landsat TM scenes acquired between October 16 and October 25, 2005, provided a snapshot of land-water area changes after the storms.

A standard methodology established in the Louisiana Coastal Area (LCA) Study (Barras and others, 2003) and in Morton and others (2005) was used to classify land-water conditions and identify changes between 2004 and 2005. According to Louisiana coastal use regulations (LOSR, 2002), fastlands are developed and agricultural areas surrounded by levees that are generally considered non-wetlands; thus, they were excluded from the trend analysis in the LCA Study. Likewise, they are not included in calculations of net land area change shown on the graph and in the tables. Fastlands comprise 1,670 mi^2 (4,325.30 km^2) of the 14,588 mi^2 (37,782.92 km^2) included in the entire LCA. The portion of the LCA used in this analysis (excluding the fastlands) is, thus, 12,918 mi^2 (33,457.62 km^2).

The 2004 and 2005 data sets were combined with a data set containing marsh vegetation community types in order to identify new land-water changes within marsh communities (Chabreck and others, unpub. data, 2001). A similar methodology was used in Twilley and Barras (2004) to integrate marsh type information with land-water data classifications. The portrayal of hurricane impacts on the map is based on interpretation of satellite imagery that was verified by several aerial assessments of impacted areas and by limited field investigations. The map depicts all gains or losses that occurred within the comparison interval. The graph and table 3, however, reference net area changes only and do not account for gross gains and losses between comparison dates. (The user is cautioned that these references to net changes in land area are subject to the data limitations described herein and that they merely capture snapshots of two points in time.)

Comparison of the 2004 and 2005 imagery showed a total increase in water area of 300 mi^2 (777 km^2), but this measurement includes 83 mi^2 (214.97 km^2) of flooded lands consisting of flooded burned marsh and flooded agricultural and developed areas occurring after the hurricanes. Adjusting for these flooded lands, the estimated increase in water area (and decrease in land) is 217 mi^2 (562 km^2). (Direct correlations of land and water area changes are assumed.)

The coastwide 217 mi^2 (562 km^2) area of new water occurring after the hurricanes contains: (1) land losses that may be permanent, caused by direct removal of wetlands by storm surge, and (2) transitory water area increases caused by the following: (a) remnant flooding of marsh and impounded areas, including agricultural and developed areas, (b) removal of floating and submerged aquatic vegetation, (c) scouring of marsh vegetation, and (d) water level variations caused by normal tidal and meteorological variation between images. The new land occurring after the hurricanes contains land gains caused by the following: (1) wrack deposition, (2) rearrangement of existing marsh areas moved by storm surge, (3) aquatic vegetation that is possibly misclassified, and (4) water level variations caused by normal tidal and meteorological variation between images. These transitory gains and losses are included in calculations of net land area change.

The distribution of new water areas after Hurricanes Katrina and Rita varied coast wide but followed a similar pattern in the southeastern and southwestern portions of Louisiana. Fresh and intermediate marsh communities located near to or east of the hurricane landfalls experienced detectable shearing at Landsat TM spatial resolutions. Brackish and saline marsh communities appear to be more resilient to shearing than fresh and intermediate marsh communities. Shears were often located in marshes fringing areas where land area decreased from 1956 to 2000 (Barras and others, 2003), but they also occurred in historically stable areas such as in the upper Breton Sound basin, the lower Pearl River basin, the marshes bordering the east bank of Freshwater Bayou, in the southwestern Teche/Vermilion basin, and the marsh just north of Johnsons Bayou and south of the Sabine National Wildlife Refuge in the Calcasieu/Sabine basin. Both hurricane surges caused shears in stable marsh areas that were often associated with the expansion of existing small ponds but were also observed in areas of contiguous marsh where vegetation was either partially or completely removed.

The surge-induced flooding present in the Chenier Plain in the fall of 2005 prevents definitive quantitative comparison with historical changes, although some areas where marsh material was removed by storm surge could be identified by imagery review. For example, the increase in water area of 62 mi^2 (161 km^2) between 2004 and 2005 in the Mermentau basin reflects some decreases in land area directly caused by Hurricane Rita's surge. This area also included persistently high water levels in some places that precluded their definitive identification as either flooded marsh or as marsh removed by storm surge.

Estimation of permanent losses from 2004 to 2005 cannot be made until several growing seasons have passed and the transitory impacts of the hurricanes are accounted for.

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