



## Open-File Report 2006-1274

### Land Area Change in Coastal Louisiana After the 2005 Hurricanes: A Historical Perspective (from 1956)

#### 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.

Historical land-water conditions in 1956 were represented by a data set including wetland habitat classifications interpreted from large-scale panchromatic aerial photographs (Wicker, 1980). The area covered by the 1956 habitat data is based on the Louisiana Coastal Zone Boundary (CZB) as defined in the State and Local Coastal Resources Management Act of 1978 (Act 361). The CZB only partially overlaps the Louisiana Coastal Area (LCA), with a common area of 12,272 mi<sup>2</sup> (31,784.48 km<sup>2</sup>), which is 2,316 mi<sup>2</sup> (5,998.44 km<sup>2</sup>) less than the 14,588 mi<sup>2</sup> (37,782.92 km<sup>2</sup>) comprising the entire LCA.

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. The 2004 and 2005 data sets were matched to the 1956 data covering the common area of the CZB and LCA to ensure compatible comparisons between data sets.

A standard methodology established in the 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 here in calculations of net land area change shown on the graph and in the tables. Fastlands comprise 837 mi<sup>2</sup> (2,167.83 km<sup>2</sup>) of the 12,272 mi<sup>2</sup> (31,784.48 km<sup>2</sup>) included in the common area of the CZB and LCA (1956, 2004, and 2005 data, respectively). The portion of the LCA (excluding fastlands) used in the trend analyses of historical changes between 1956 and 2004 and after the 2005 hurricanes is, thus, 11,435 mi<sup>2</sup> (29,616.65 km<sup>2</sup>). This area is 1,483 mi<sup>2</sup> less than the 12,918 mi<sup>2</sup> (33,457.62 km<sup>2</sup>) comprising the entire LCA, excluding fastlands.

The depiction of land-water changes on the map is based on three data points representing two time periods: 1956 to 2004 (historical) and 2004 to 2005 (before and after the hurricanes). The 1956 to 2004 comparison provides historical land-water changes over a 48 year interval. Intervening land-water changes, during the 1956 to 2004 period, such as those caused by prior hurricanes or other events, are not specifically identified. The 2004 to 2005 period

represents land-water changes occurring over a period of approximately one year rather than decades and primarily analyzes the immediate impacts of the two hurricanes.

All measurements of area changes provided in the tables and graph list net changes only and do not account for gross gains and losses between comparison dates. The 1956 to 2004 comparison showed a net increase in water area of 1,149 mi<sup>2</sup> (2,975.91 km<sup>2</sup>). The net increase in water area in the LCA (excluding fastlands) from 2004 to 2005 was 295 mi<sup>2</sup> (764.28 km<sup>2</sup>). This latter measurement, however, includes 77 mi<sup>2</sup> (200.18 km<sup>2</sup>) 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) from 2004 to 2005 is 218 mi<sup>2</sup> (564.10 km<sup>2</sup>). (Direct correlations of land and water area changes are assumed.)

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. 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.

Hurricane Rita's surge removed remnant marsh from areas with historical land loss caused by the rapid collapse of the marsh surface during the mid-1960s to the mid-1970s in western Barataria basin and in central and eastern Terrebonne basin (Morton and others, 2005). Surge impacts increased in severity westward to Rita's landfall near Johnsons Bayou. Similar patterns were observed on the west bank of Freshwater Bayou, due east of Pecan Island in the southwestern Teche/Vermilion basin; south of Sweet Lake in the Mermentau basin; due east of Deep Lake in the Mermentau basin; and north of Mud Lake in the Calcasieu/Sabine basin. Hurricane Katrina's surge had similar impacts in areas of historical land loss in the Pontchartrain basin, along the north shore of Lake Pontchartrain and in the Labranche wetlands; however, shears and scoured marsh were also present between the more historically stable area of the Gulf Intracoastal Waterway and the west shoreline of Lake Borgne, just east of Alligator Point. Remnant contiguous marsh located between areas of historical loss and the Gulf of Mexico shoreline on the eastern side of the Mississippi River Delta was also removed by Hurricane Katrina's surge. Hurricane surge from both storms 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 64 mi<sup>2</sup> (165.76 km<sup>2</sup>) 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.

The coastwide 218 mi<sup>2</sup> (564.10 km<sup>2</sup>) area of new water occurring after the hurricanes within the common LCA 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.

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

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