Northern Gulf of Mexico (NGOM) Ecosystem Change and Hazard Susceptibility Project

Hurricane Impact and Recovery Shoreline Change Analysis of the Chandeleur Islands, Louisiana, USA: 1855 to 2005

Research Summary

Results from historical (1855–2005) shoreline change analysis of the Chandeleur Islands, Louisiana, demonstrate that tropical cyclone frequency dominates the long-term evolution of this barrier-island arc (fig. 1). The detailed results of this study were published in December 2009 as part of a special issue of Geo-Marine Letters that documents early results from the Northern Gulf of Mexico (NGOM) Ecosystem Change and Hazard Susceptibility Project.

Shoreline change data documenting shoreline response to storm impacts of varying intensities and orientations were compiled for ten storms that affected the Chandeleur Islands between the years 1855 and 2005. Island area decreased at a rate of 0.16 square kilometers per year (km^2/yr) for the relatively quiescent time period up until 1996, when an increase in tropical cyclone frequency accelerated this island area reduction to a rate of 1.01 km^2/yr (fig. 2). Shoreline retreat rates were also affected by more frequent hurricanes increasing from 11.4 meters per year (m/yr) between 1922 and 1996 to 41.9 m/yr between 1982 and 2005. The erosional impact caused by the passage of Hurricane Katrina in 2005 is unprecedented. Between 2004 and 2005, the shoreline of the northern islands decreased by 201.5 m/yr, compared with an average rate of erosion of 38.4 m/yr between 1922 and 2004. A linear regression analysis of shoreline change predicts that the island arc will become completely submerged as early as 2013 if the storm frequency observed during the past decade persists. If storm frequency decreases to pre-1996 recurrence intervals, the predicted island submergence date is 2037 (fig. 3). Southern portions of the island chain behave as ephemeral islands that are destroyed after storm impacts and reemerge during extended periods of calm weather, a coastal behavior that will eventually characterize the entire island chain. Analysis of hurricane impacts and shoreline data indicates that a major hurricane (Category 3 or stronger) crossing immediately west of the islands causes the most shoreline erosion (fig. 4).

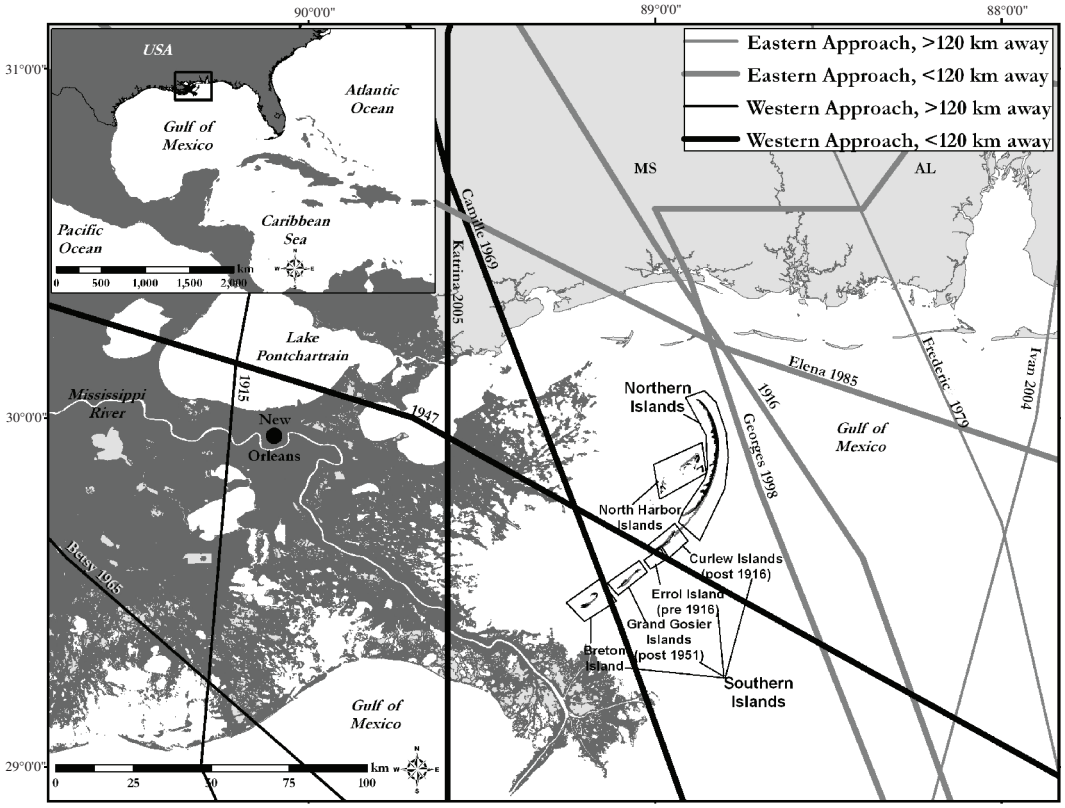

Figure 1. Map depicting storm paths of ten major storms impacting the Chandeleur Islands in southeastern Louisiana during the 20th and 21st centuries (Fearnley and others, 2009). The Chandeleur Islands are shown in black; individual islands that comprise the island arc are outlined in boxes and labeled.

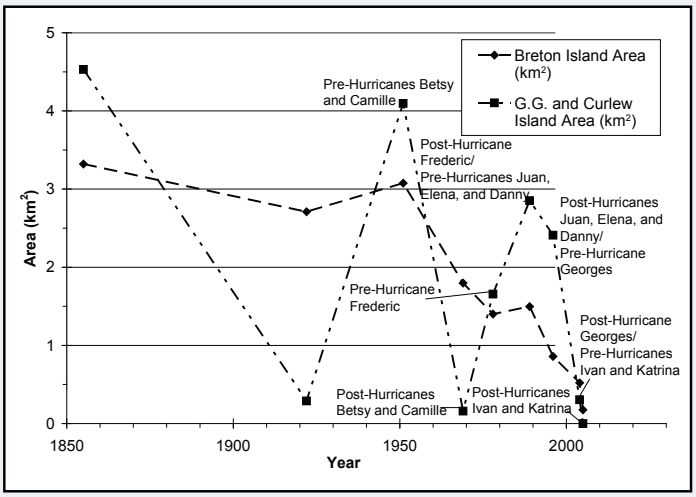

Figure 2. The southern Chandeleur Islands (Breton, Grand Gossier (G.G.), and Curlew) average island area in square kilometers, based on the measured average annual amount of land change between 1869 and 2005 (Fearnley and others, 2009). Major storm impacts result in almost complete island destruction and conversion into inner shelf shoals. During extended periods of calm weather, new islands reemerge along this sector.

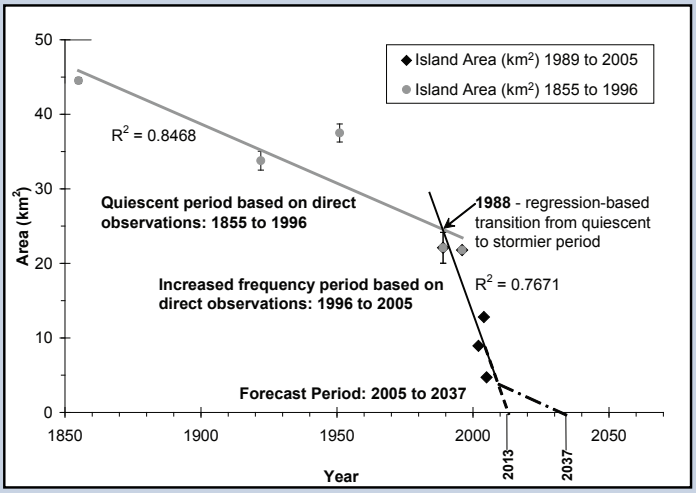

Figure 3. Northern islands area (in square kilometers) versus trend lines for two time periods: 1855 to 1996 (gray line) and 1989 to 2005 (black line) (Fearnley and others, 2009). Extrapolated from the latter are two different trajectories forecasting barrier-island transgressive submergence based on frequency of storm activity. The dash-dot-dash line depicts the trajectory of the islands under lower frequency storm conditions such as existed during the earlier half of the 20th century. The dashed line depicts the trajectory of the islands under a hurricane impact frequency similar to that observed during the past decade. Once the transgressive submergence threshold conditions are met, it is predicted that the northern Chandeleur Islands will be characterized by ephemeral island/shoals that exhibit coastal behavior similar to that of their more southern counterparts (see fig. 2).

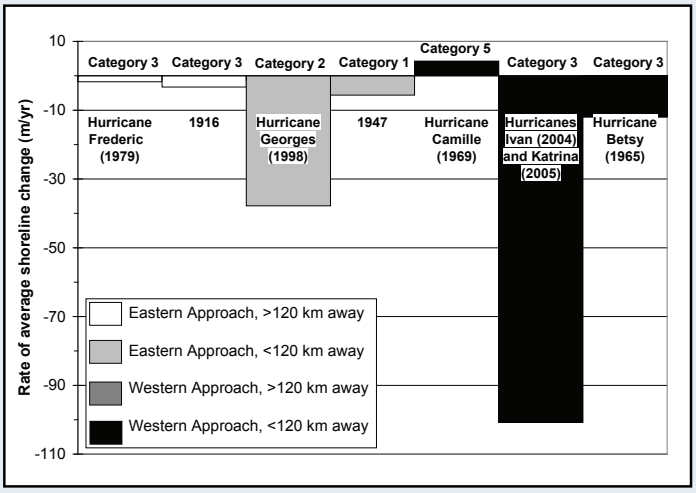

Figure 4. Northern islands average shoreline change (in meters per year) of storms of varying intensities and storm tracks (Fearnley and others, 2009). The analysis of hurricane impacts and shoreline data indicates that storms passing directly over or immediately to the west of the islands are the most devastating, and storms passing to the east result in the least amount of shoreline erosion.

Reference Cited

Fearnley, S.M., Miner, M.D., Kulp, M.A., Bohling, C., and Penland, S., 2009, Hurricane impact and recovery shoreline change analysis of the Chandeleur Islands, Louisiana, USA: 1855 to 2005: Geo-Marine Letters, v. 29, no. 6, p. 455-466.

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