Effects of Past and Recent Hurricanes on Gulf Coast Ecosystems: Implications for Future Climate Changes

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Project Objectives

This is a pilot study that integrates remote sensing, field ecology, and paleotempestology to study the effects of hurricanes on Gulf Coast ecosystems. This project aims at: (1) documenting the patterns of damage and recovery of coastal ecosystems after an intense hurricane strike, (2) deciphering the pollen signals of post-storm vegetation changes as recorded in coastal sediment cores, and (3) detecting post-storm vegetation changes by remote sensing techniques. The study site will be in Weeks Bay, Alabama, which was affected by Hurricanes Katrina (2005), Ivan (2004), and Frederic (1979) during the past 30 years. We will evaluate ecosystem responses to these recent hurricanes in the context of long-term records of hurricane activity and vegetation change revealed by paleotempestology.

Scope of Work

1. We will continue our detailed biodiversity survey along a coastal forest-to-marsh transect at Weeks Bay, ongoing since 2003, by means of replicated 100 m^2 sampling plots to monitor the post-Katrina ecological changes, to document the patterns and rates of vegetation changes in different coastal communities 4 years after Katrina and 5 years after Ivan. This ecological fieldwork will be conducted at least 3 times during the funding period.
2. We will collect new cores adjacent to our sampling plots for pollen analysis, so that the pollen data can be directly compared with the vegetation data from the same site. Pollen analysis will be conducted at close sampling intervals at the uppermost 10 cm of all cores, which should represent the sediment of the last 50-100 years including the storm deposits of Hurricanes Frederic and Ivan/Katrina. The pollen spectrum of the uppermost sediment layer in each core should represent the post-Katrina vegetation community.
3. We will use core-scanning technology and geochemical techniques, in addition to loss-on-ignition analysis, to help identify the Katrina, Ivan, and Frederic storm sediment-layers.
4. We will use Landsat-TM and aerial photo data to compare pre- and post-storm land-use/land-cover changes along our coastal forest-to-marsh transition at Weeks Bay to establish the ecological effects of these hurricanes at the landscape scale. The remote sensing data will be useful for interpreting the broad pattern of vegetation changes detected in the pollen data, such as reduction in forest and expansion of marsh habitats after a storm.

Expected Significance

This proof-of-concept study, which integrates paleohurricane proxy record with remote sensing and ecological field data, promises to develop a means to assess the responses of coastal ecosystems to recent and past hurricanes and, on that basis, to predict the ecological effects of future hurricanes, which are expected to increase due to global climate changes. This project is among the first that explicitly use pollen as a means of reconstructing ecosystem response to past hurricane strikes. The coupling of paleotempestology with ecological field surveys and remote sensing studies should provide a modern analog to aid in interpreting the fossil pollen record.