HURRICANE RISK ASSESSMENT FOR COASTAL LOUISIANA AND THE NORTHERN GULF OF MEXICO: THE NEED FOR A LONG-TERM PERSPECTIVE

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INTRODUCTION

The northern Gulf of Mexico coastal region including Louisiana and Texas are susceptible to natural hazards such as hurricanes and storm surges, floods, droughts, and wildfires. Extreme events like Hurricane Katrina have profoundly affected the biophysical as well as societal systems of the Gulf Coast. How should society prepare for a catastrophic event like Katrina? This is a question that concerns many stakeholders in the Gulf Coast region, particularly emergency response officials, civil engineers, risk managers, and insurance companies. For example, how high should the levees be built around New Orleans in order to adequately protect the city from the next major hurricane? How strong should a new Mississippi River bridge be in order to withstand the winds and storm surges brought about by hurricanes in the next 50 years? What building code should be adopted for coastal communities like Galveston, Texas, or Mobile, Alabama, in the face of possibilities for hurricane-force winds? How much should an insurance (or reinsurance) company charge their customers for hurricane insurance premium at a place like New Orleans, compared with a place like Tampa, Florida? Answers to these questions hinge on one critical number—the return periods of intense hurricanes like Hurricanes Katrina (category 3), Audrey (1957, category 4), and Camille (category 5). In theory, the return period of each category of hurricanes at each coastal location can be estimated from the historical record of hurricane strikes at that location, which basically spans the last century and half back to 1851 (Liu, 2007). However, these extreme storms (especially the category 4 or 5 storms) are so rare that most coastal locations have not been directly hit by any of these during the historical period, so that their return periods cannot be quantitatively estimated. In other words, the returns period of the category 4 or 5 storms may be longer than the length of the historical record, so that we will need to extend the period of storm observations from 150 years to several centuries or even millennia in order to realistically estimate the probability for any given coastal location to be directly hit by these extremely rare storms. Thus, the only way to establish an empirical record of hurricane strikes through centuries and millennia is by means of the geological record. Paleotempestology is a young field of science that reconstructs past hurricane activity by the use of geological proxy techniques, particularly on coastal sediment cores (Liu, 2004, 2007; Nott, 2004). In this paper I will use a few examples from my own research projects to illustrate what paleotempestology can offer in terms of hurricane risk assessment for the northern Gulf of Mexico coast.

2. DETECTION OF STORM DEPOSITS

The most commonly used method in paleotempestology involves the identification of storm deposits in sediment cores taken from coastal lakes or marshes (Liu, 2004). An example is provided by Hurricanes Gustav and Ike, which affected the coastal areas of southern Louisiana within a 2-week period on September 1 and 13, 2008, respectively. Sediment cores taken from Bay Champagne, a brackish-water lake situated behind a low (< 1 m) barrier beach near Port Fourchon, Louisiana, before and shortly after these storms reveal that a storm deposit up to 17 cm thick was deposited by these storm surges in the lake (Liu et al., 2011). Recent storm deposits like this can be used as a guide to help identify evidence for paleo-storm events in the sedimentary record. Once a stratigraphic record of past hurricane strikes has been established in a core, the ages of these storm deposits can be estimated by means of radiocarbon dating or other chrono-stratigraphic techniques.

3. PROXY RECORDS OF PALEO-HURRICANE ACTIVITY FROM THE GULF COAST

Paleotempestology proxy records from the Gulf Coast show that return periods for catastrophic hurricanes like Camille (category 5) or Audrey (category 4) are in the order of 300 years. They also reveal that hurricane activity on the Gulf Coast has varied significantly on the centennial and millennial timescale over the last 5,000 years, with a "hyperactive" period occurring during 3,800-1,000 years ago sandwiched between relatively quiescent periods (Liu and Fearn, 1993, 2000). These findings have important implications for hurricane risk assessment for Louisiana and Texas, as well as for global change researchers who are interested in understanding the climate mechanisms controlling the ups and downs and tropical cyclone activities in the past and in the future. However, it should be pointed out that high-quality proxy records from the Gulf Coast region are still too few in number and spatially too unevenly distributed to provide adequate regional risk assessment. For example, a long-term record is still lacking from the coastal region of northern to central Texas including the Houston-Galveston area.

4. HURRICANE-FIRE INTERACTIONS

Population centers and rural communities along the Gulf Coast are not only susceptible to hurricanes but also wildfires. In late August and September of 2011, a marsh fire near New Orleans burned for days and weeks before it was put out, causing significant problems in air quality and becoming a public health issue. Wildfires can occur with or without hurricanes, but ecologists have postulated that the risk of major wildfires increases significantly after a hurricane strike due to the accumulation of dead biomass (a fuel source) on the forest floor—the "hypothesis of hurricane-fire interactions" (Myers and van Lear, 1998). This hypothesis cannot be tested under modern conditions in our technologically advanced society due to human intervention of the natural fire regime, but paleotempestology can be used to reveal the relationships between hurricanes and fires under prehistoric, more natural conditions. A sedimentary record from Little Lake in coastal Alabama reveals that the site was struck by intense hurricanes 7 times in the last 1,200 years. Palynological analysis indicates that a peak in microscopic charcoal particles occurs immediately above some of the prominent storm deposits, thus suggesting that without human intervention major wildfires tended to occur after major hurricane strikes on the Gulf Coast (Liu et al., 2008).

5. CONCLUSIONS

By extending the observational record of hurricane activity to many centuries and millennia, paleotempestology can provide a long-term perspective that is vital for estimating the return period of the very rare but extremely powerful hurricanes like Audrey and Camille. A long-term perspective is also important for understanding the climate mechanism controlling hurricane activity, which is vital for predicting future hurricane activity in the face of global climate changes. When coupled with paleoecological techniques like pollen and charcoal analyses, paleotempestology can shed light on long-term ecosystem response to hurricane disturbances, such as hurricane-fire interactions and vegetation succession after these disturbance events. Such a long-term perspective should be incorporated in all environmental decision-making and in the development of coastal management plans for the Gulf Coast region.

6. ACKNOWLEDGEMENTS

Our paleotempestology research projects have been supported by grants from the National Science Foundation (NSF), the Inter-American Institute for Global Change Research (IAI), the Risk Prediction Initiative (RPI) of the Bermuda Institute of Ocean Sciences (BIOS), and the National Institute for Climate Change Research (NICCR) Coastal Center.

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