Hurricane Ike Field Investigation

A Report of Field Observations on October 3–6, 2008

ASCE

Edited by

Billy Edge, Ph.D., P.E.
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COPRI COASTS, OCEANS, PORTS AND RIVERS INSTITUTE

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[1] Formerly Texas A&M University

In Memory

Dr. Donald Keith Stauble (1947-2009)

This report is dedicated to the memory of Dr. Don Stauble, a research scientist and coastal geomorphologist at the US Army Engineer Research and Development Center's (ERDC's) Coastal and Hydraulics Laboratory (CHL). Don was a significant contributor to the Hurricane Ike Field Investigation Team. His thoughtful insights to the coastal processes, identification of process signatures in the field and his detailed contribution to this report underscore his importance to this effort.

Don began his career with an appointment in the Department of Oceanography and Ocean Engineering at the Florida Institute of Technology from 1978 to 1987. In addition to educating students he conducted extensive research on the engineering aspects of beach restoration projects in Florida. The guidelines for these projects still remain a component of the current design guidance. In 1987, Don joined the Coastal Engineering Research Center (CERC) which later became CHL. Don's work at the CHL achieved national and international recognition for his research in coastal processes, inlets, response to hurricanes and tropical storms and management of coastal risks. His geomorphological interests extended from the Great Lakes to the Gulf coast to the outer limits of the United States. Don's expertise and contributions to the profession will continue to be shared through the students he has guided, his colleagues and his many scholarly publications. The words of Ms. Joan Pope, a colleague who worked for several years with Don at the CHL said what we all think about Don,

> *He was a quiet, kind, and gentle man, generally unflappable, and a good friend to all who might cross his path. When on the beach with shovel and sample bag in hand, Don would revert to an excited kid. He would collect samples and explain to any and all what they showed about this most complex of geological settings.*

Contents

Chapter 1: Introduction

Hurricane Ike made landfall at 2:10 a.m. on September 13, 2008, as a Category 2 hurricane. The eye of the hurricane crossed over the eastern end of Galveston Island, and a large region of the Texas and Louisiana coast experienced extreme winds, waves, and rising water levels, resulting in significant damage from overtopping, overwash, wind and wave forces, and flooding. Figure 1-1 shows the track of the storm and its location along this part of the coast. Major damage observed during the investigation was located between Freeport and Port Arthur, Texas. The effects of the hurricane force winds existed over thirty miles from the coast in Texas and Louisiana and the storm continued over land causing more damage and loss of life as it turned northeast and continued its 1,600-mile path of destruction across the United States.

The sustainability and resilience of engineering designs are continuously improved by reviewing the performance of existing designs and processes. The Board of Governors of the Coasts, Oceans, Ports and Rivers Institute of the American Society of Civil Engineers (COPRI of ASCE) recognized the opportunity to gain information from observing the performance of structures affected by Hurricane Ike. Three weeks after the storm, COPRI organized a field survey team to visit Galveston, Tex., and collect perishable data. The team received financial support from ASCE and worked in cooperation with the GEO Institute. This report provides a written record of observations and lessons learned for use by coastal, port, and civil engineers in future coastal development. COPRI has previously sponsored teams for similar assessments after Hurricane Katrina (ASCE 2006) and the 2004 Indian Ocean Tsunami (ASCE 2008).

The purpose of the Hurricane Ike field investigation was to survey, examine, document, and report the effects of Hurricane Ike on coastal landforms, buildings, coastal structures, infrastructure, marinas, and ports. Although COPRI intended to provide three field teams—one focusing on port facilities and the other two on coastal buildings, infrastructure, and processes—only the latter two were able to conduct their field investigations. The ports team was organized but could not gain access to the area ports to review and document damages.

The time available for the COPRI/GEO teams was limited, and many of the areas receiving extensive damage could not be covered in this short time. For example, the Bob Hall Pier at Corpus Christi, Tex., well to the south of the eye of the storm, experienced extensive damage. Additionally, areas that survived well, such as the levees along the Sabine River, were not observed, but their safety was noted.

Observations

On October 3, 2008, the two COPRI coastal field teams assembled in Galveston for four days of coastal investigations. The teams collected perishable data, made observations, and documented conditions. The coastal teams focused on beaches, small buildings, marinas, shoreline structures, bridges, and other civil infrastructure. The teams covered the Texas coastal areas as far east as Sabine, including Bridge City, and as far west as Surfside Beach. The teams also made observations on the western side of Galveston Bay. The survey area is shown in Figure 1-1and includes coastal areas on both sides of the hurricane path. Communities both east and west of the eye had significant damage.

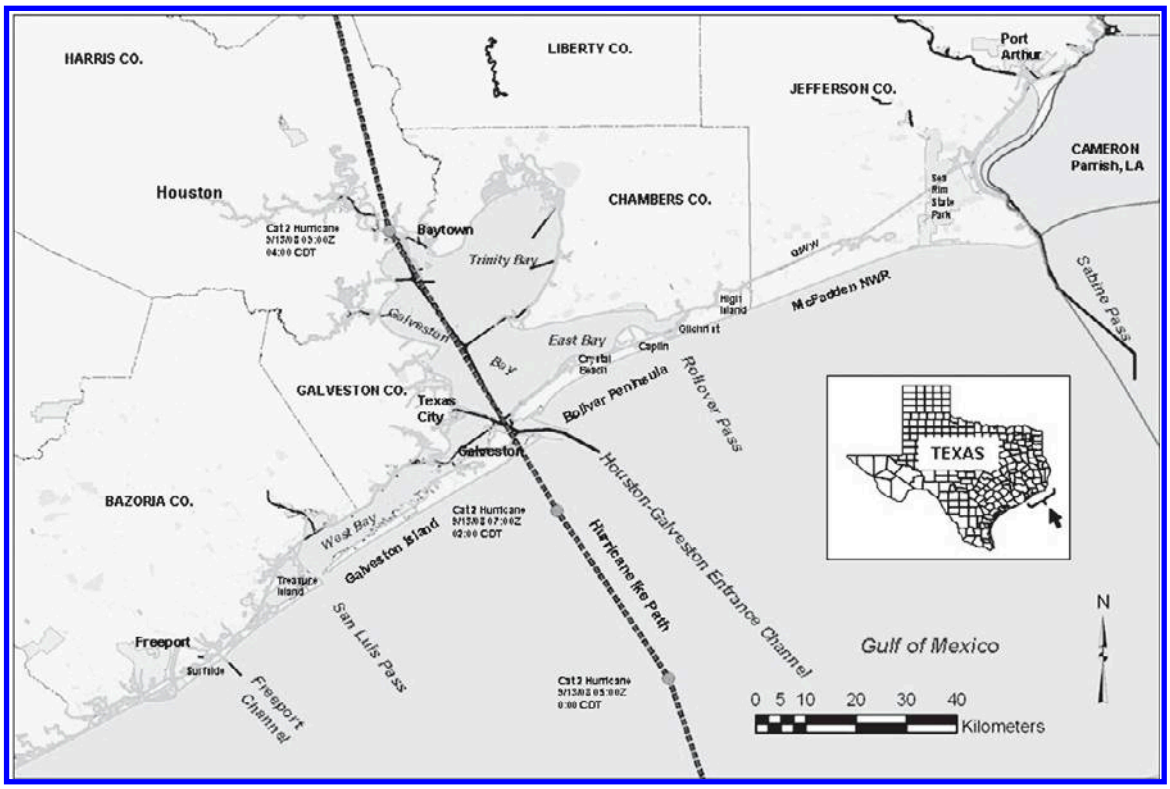

Figure 1-1. Location map of upper Texas coast impacted by Hurricane Ike, showing the hurricane path and points from National Hurricane Center

Scour was apparent throughout most of the damage areas, and floating and wind-blown debris was broadly spread. Large overwash fans were often observed inland of the first row of houses and the seaward road. Beach and dune systems were highly eroded, with flattened or significantly deflated dunes. Utilities and infrastructure exhibited extensive damage, water and sewer lines were broken, roads were undermined or buried in sand and debris, and telephone and electric lines had collapsed. Community water towers appeared to be undamaged. The well-built floating docks observed were undamaged, except for one dock area in a covered boat shed. Older fixed-pier systems typically suffered more damage. Much of the damage to small commercial and pleasure craft was observed at these older fixed-pier systems.

There was a broad variety of building types in the storm area—ranging from older slab-on-grade development and elevated buildings built to early flood standards to those meeting current flood standards and a significant number of above-standard or "fortified" homes. With a few exceptions where conditions exceeded the design standards, structures built to current or fortified standards performed fairly well. For Hurricane Ike, elevation seems to be the main factor for building defense. Many of the surviving buildings had deep piles, and the main living area was above wave height. Breakaway walls and lower-level stairs detached from the main building and functioned as expected. Slab foundations had extensive damage. Pile foundation failure was observed from inadequate pile penetration, design defects, and wave forces. On both Bolivar Peninsula and Galveston Island, the survey teams were able to identify the high-water level from marks on buildings and piles or from debris lines. Watermarks on fixed structures were noted, elevations were estimated, and coordinates were recorded. Perishable data were collected and subsequent Federal Emergency Management Agency (FEMA) teams or LIDAR efforts were able