# Oral Testimony to the Senate Committee on Commerce, Science and Transportation Concerning "America's Natural Disaster Preparedness: Are Federal Investments Paying Off?"

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Thank you, Mr. Chairman, and members of the Committee for the opportunity to speak with you today.

My name is Clint Dawson. I am a professor at the University of Texas at Austin (UT Austin). I am also the head of a research group called the Computational Hydraulics Group which is housed in the Institute for Computational Engineering and Sciences at UT Austin. Our research efforts are focused primarily on modeling and simulation of processes in the coastal ocean. The primary sources of federal funding for this work are the National Science Foundation, the Department of Defense and the Department of Homeland Security. My group collaborates with a number of researchers at other universities, government laboratories and state agencies. These include the University of Notre Dame, the University of North Carolina-Chapel Hill, the US Army Corps of Engineers Engineer Research and Development Center, and the State of Texas Division of Emergency Management. We utilize the computational resources of the National Science Foundation Teragrid, and the Texas Advanced Computing Center (TACC) at UT Austin. My collaborators have partnerships with the National Oceanographic and Atmospheric Administration (NOAA) and we use NOAA products and data extensively in our research.

One of the main applications of interest of this research is the predictive simulation of storm surges due to hurricanes and tropical storms. By "predictive simulation" I am referring to the development of computer models which can be used in real-time to forecast storm surge as hurricanes approach land, to study the impacts of historical hurricanes and attempt to reproduce actual measurements which were taken during the storm, and to study future scenarios for reasons which I will discuss below. The computer model we have developed is called ADCIRC, which stands for Advanced Circulation model. For hurricane storm surge simulations, ADCIRC takes inputs from various sources and computes water levels and currents driven by hurricane force winds and waves. ADCIRC has been used to study hurricanes for over a decade. ADCIRC was used extensively in forensic studies of Katrina as part of the Interagency Performance Evaluation Task Force (IPET) study. ADCIRC was able to match the data from this storm incredibly well, particularly high-water marks, which are measurements of maximum water level taken at various locations. Since 2005, the amount of data collected during Gulf storm events has increased substantially, and ADCIRC has been used to study several major storms, including Rita, Gustav and Ike.

As I mentioned, predictive simulation of storm surge can fall into three categories: forecasts, forensic studies, and future scenarios. Let me elaborate.

In forecast mode, the ADCIRC model uses supercomputers such as the Ranger computer at TACC to generate a high resolution forecast typically within an hour. These forecast simulations utilize the information coming from the National Hurricane Center, and are automated so that each time the hurricane forecast is up-dated, new storm surge predictions are generated. For a storm approaching Texas or Louisiana, this data is transmitted to the State Operations Center in the Texas Governor's Division of Emergency Management, which is responsible for emergency response, evacuation, search and rescue, and other operations. We work closely in this regard with Dr. Gordon Wells, who analyzes the results of forecast models to assist decision makers in the State Operations Center.

In forensic mode, the ADCIRC model is used to analyze historical hurricanes. Here we attempt to match the output of the model with measured data, as was done for Hurricane Katrina. These hindcast studies help validate the predictive capabilities of the model, help to build understanding of complex physical processes which occur during hurricanes, help to quantify the vulnerability of coastal regions to storm surge, and can be used to understand the success or failure of various protection systems. Hurricane Ike is a very interesting example where new physical insight has been gained through hindcasting. Ike produced a storm surge "forerunner" of about 6 feet along the upper Texas coast 24 hours before landfall. A similar phenomenon was documented during the Galveston hurricanes of 1900 and 1915. Hurricane Ike was very similar in track and intensity to these hurricanes. The forecast models used as Ike approached landfall did not predict this surge, it was only after careful hindcasting using the ADCIRC model that the cause was discovered. Now that this phenomenon is understood, future forecasts of similar storms will be able to predict forerunner surge and alert the public to the possible danger.

Finally, ADCIRC is run under various hypothetical scenarios to facilitate the planning and design of future protection systems and to help quantify risk in low-lying areas of the coast. These studies are used to develop Digital Flood Insurance Rate Maps (DFIRMS), for example, which determine eligibility for federal flood insurance. Future protection systems include "soft" options, such as wetlands restoration and restrictions on land use practices, and "hard" options, such as the construction of seawalls, levees and storm gates. ADCIRC has been used to model the effectiveness of all of the new levees which are currently under construction in Louisiana. In the aftermath of Hurricane Ike, many different options are being considered for protecting the Houston-Galveston region. One option is the so-called "Ike Dike," which was proposed by Prof. William Merrill at Texas A&M University at Galveston. Other options which have been proposed include building gates which would protect the Houston Ship Channel, designating large parts of the coastal region around Galveston and Bolivar as a National Seashore and Recreational Area, building oyster reefs offshore near critical infrastructure, just to name a few. We are working with the Severe Storm Prediction, Education, and Evacuation from Disasters (SSPEED) Center at Rice University to study these various protection systems, using high fidelity numerical simulations and hypothetical hurricane scenarios.

**Are Federal Investments Paying Off?** Government funding of fundamental research in coastal ocean modeling can reap tremendous benefits by enhancing economic activity, promoting healthy and sustainable coastal environments, improving the safety and well-being of coastal populations, and protecting critical infrastructure located on the coast. There are several future research directions which are critical to advancing the science. Government funding of the computational infrastructure available through the NSF Teragrid, and basic research funding in computational science and engineering has paved a path toward revolutionizing the modeling of storm surge, and we are already reaping benefits in this area. As I mentioned above, we are now able to do high resolution storm surge predictions within the time frame required by emergency managers. This would have been impossible five years ago. Overall however, in my experience federal funding for coastal ocean modeling research has been piecemeal across different agencies and focused more on short term projects rather than long term priorities. I would welcome any effort to promote longer-term, focused, sustained funding of research in this area.

With respect to storm surge forecasting, the standard hydrodynamic model which has been used throughout the United States has been the Sea, Lake and Overland Surge from Hurricanes (SLOSH) model which is run at the National Hurricane Center. SLOSH was developed many years ago. Currently, NOAA is re-evaluating SLOSH along with other computer models, including ADCIRC, to determine which model or models to use for future storm surge forecasting. It is my opinion that future forecast models should be performed at the highest fidelity possible given the computational resources available and the uncertainties inherent in any hurricane forecast. We must attempt to quantify these uncertainties where possible. It is also important that we work closely with emergency management personnel to understand the type of information that is needed and to develop ways in which risk can best be conveyed to the public.

There is still basic research to be done to improve our understanding of winds, waves and currents and their interaction with coastal features and coastal structures. The ability of natural and man-made systems to withstand and possibly mitigate surge is not well understood, nor is the long-term impact of hurricanes on coastal ecosystems, geomorphology, and energy, communication and transportation infrastructure. The coastal population and economic activity along the coast continue to grow and expand, and policies for managing coastal development are required sooner rather than later. If recent history is any indication, no coastal protection system will be completely fail-safe over the long term, and in the event of disaster the resilience of coastal communities will determine their future. All of these challenges are best met through knowledge and experience gained by theoretical research, experiments and computation, in collaborations that involve multidisciplinary teams of investigators, with connections to government laboratories, state and federal agencies and private industry.

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