

# NSF Engineering and Hurricane Research



**National Science Foundation  
Directorate for Engineering**

**Acting Assistant Director for Engineering  
Richard O. Buckius**

# Topics

- Current Areas of Related Research in ENG
  - ◆ Program activities
  - ◆ Response to Katrina
- Research Challenges in ENG
  - ◆ Fluid-structure interactions
  - ◆ Infrastructure
  - ◆ Environmental engineering
  - ◆ Material flow



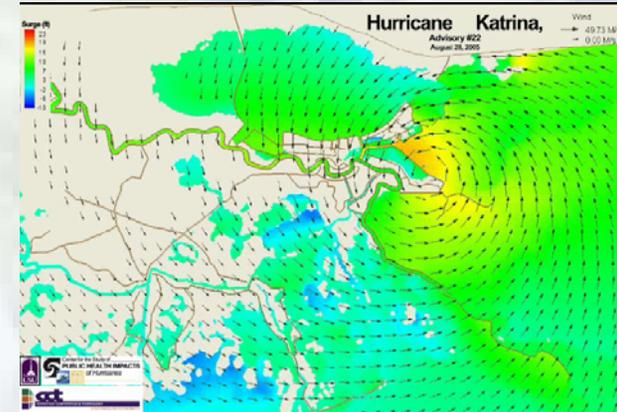
# Current Areas of Related Research

- Structures and Hazard Mitigation
- Infrastructure and Hazard Response
- Geotechnical Systems
- Electrical and Communications Systems
- Environmental Engineering



# Structures and Hazard Mitigation

- Recent awards have focused on effects of hurricane-force winds on:
  - ◆ Long-span bridges;
  - ◆ Tanks; and,
  - ◆ Fiberglass reinforced windows.
- Modeling and simulation of wind load for wind hazard mitigation also underway.
- Study on the uplift forces on residential construction during hurricanes (with the International Hurricane Research Center, NIST, NOAA, and various Florida-state institutions).



# Infrastructure and Hazard Response

- Research addresses the impact of natural, technological, and human-induced hazards upon community infrastructure
- Brings together engineers and social scientists to improve the mitigation of, preparedness for, response to, and recovery from disasters. Challenges include:
  - ♦ **Mitigation** – relative effectiveness and benefit/cost characteristics of various structural and non-structural mitigation measures
  - ♦ **Preparedness** – improving warning and evacuation models and systems
  - ♦ **Response** – management models for coordinating disaster response across multiple organizations and jurisdictions
  - ♦ **Recovery** – analyzing the link between recovery from disaster and the mitigation of future disasters



# Geotechnical Systems

- Topics include geotechnical earthquake engineering and strong ground motions, scouring, tsunamis, landslides and debris flows, forest fires, droughts and floods
  - ◆ Research is not directed to hurricane effects, yet some of the research on levees and embankments, erosion and scour, floods, and tsunamis has applications for hurricanes as well
- Post-Katrina investigations have identified adjacent levees with different heights; inadequate transitions between adjacent levees; inadequate, incorrect, or missing as-built drawings, and other problems



# Electrical and Communications Systems

- Research includes the analysis and improved design of communication and electric power infrastructures during catastrophic weather events, such as the recent Gulf Coast hurricanes.
- ENG recently funded research in power and telecommunication system failure modes; damage assessment of power infrastructure for distribution, telecommunications, and back-up; estimation of disruption and its causes of power quality; mapping the coverage islands of wireless base stations; and network damage assessment.



# Environmental Engineering

- In addition to infrastructure and property damage, Katrina also caused severe environmental damage.
- ENG awarded a number of small grants on the environmental topics related to flood water, water quality and bacterial communities.
- Soil and sediment removal strategies are also being investigated, as well as mold damage in New Orleans buildings and the impact of mold on the integrity of structural materials.



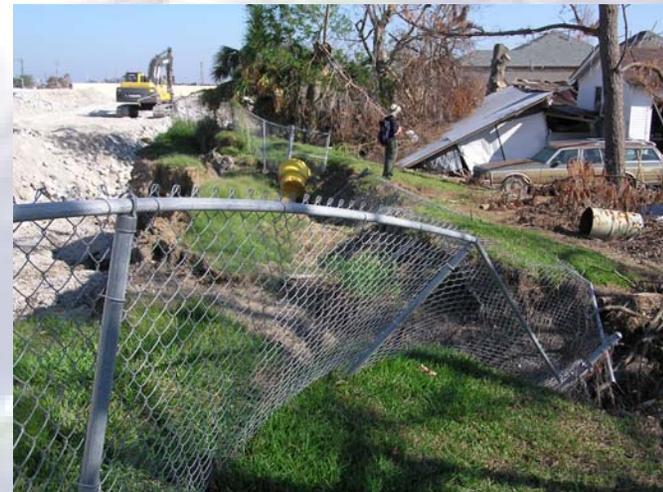
# ENG Response to Katrina

- The solicitation, review, and awarding of grants were completed in September 2005 due to the need for rapid response.
- Program directors developed an open competition for SGERs.
- Target date for submitting proposals through FastLane was September 15, 2005.
- In the two weeks prior to the target date, program directors in BES, CMS, and ECS received in excess of 350 inquiries.
- More than 200 drafts of SGER proposals were submitted for consideration.
- Of these, 113 were submitted through FastLane for formal review and 32 awards were made.



# ENG Response to Katrina

## Gathering Perishable Data



# Research Challenges in ENG



# Fluid Dynamics and Structural Engineering

- Many research challenges are in the development of predictive methods for structural response to hurricanes.
- Knowing how a building, levee, and infrastructure system responds to extreme climatic events will enable better engineering solutions, more adaptive design strategies, and more effective responses in the aftermath of a major disaster.
- Research along these lines would address topics in modeling of water-foundation-structure interactions, which is critical to:
  - ◆ Levee design and assessment;
  - ◆ Prediction of storm-surge forces on structures (has broad application in tsunami research); and,
  - ◆ Levee design, construction, maintenance, evaluation, and rapid repair (address loss mitigation and strategic response planning).



# Infrastructure and Hurricane Research

- Research in infrastructure may focus on designs and technologies for communications and electric power infrastructures.
- Also will enable more accurate prediction and warning systems, more resilient communication networks following hurricane disasters, and a more stable power grid to ensure continued services to hospitals, utilities, and individual homes.
- Topics may include portable distributed generators and power stations; mobile communications systems; alternative and renewable energy sources; and next-generation devices with reduced power consumption.



# Infrastructure and Hurricane Research

- One of NSF's major cyberinfrastructure investments, NEES, will produce data valuable for hurricane research.
- Distributed network of experimental tools, including shake tables, and wave basins, can be use to model the effects of hurricanes, high winds, and water damage on buildings and infrastructure.



# Ecological and Environmental

- Ecological and environmental impact of a hurricane can go well beyond the damage caused by extreme wind and water conditions.
- Chemical and biological contamination of water, soil, air, and dwellings caused by Katrina-like disasters require fundamental understanding of the impact of contamination on both human habitats and the extended ecology.



# Material Flow Analysis

- Hindering reconstruction efforts in the aftermath of a major hurricane, the flow of goods and services to a devastated region can be seriously compromised.
- Basic reconstruction materials are in critical demand, and supplies and delivery systems will be impacted on the regional, national, and international levels.

