

NSF Engineering and Hurricane Research



**National Science Foundation
Directorate for Engineering**

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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



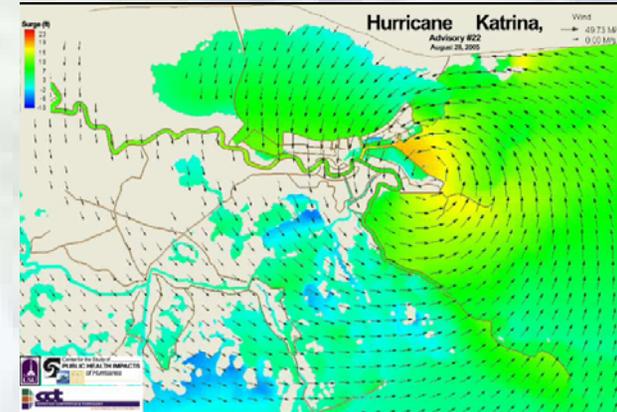
Current Areas of Related Research

- 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.



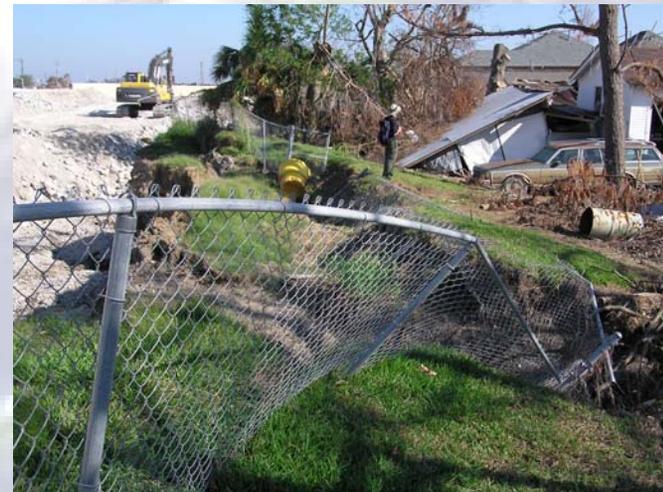
ENG Response to Katrina

- 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.

