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Louisiana State University Responds to Katrina:

Research and Research-to-Operations in the Wake of a Killer Storm

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Assessment and Remediation of Public Health Impacts from Hurricanes and Major Flooding

- **Over 20 investigators**
- **Advisory Board**

representing many disciplines and local, state, and federal agencies

Center for the Study of PUBLIC HEALTH IMPACTS of Hurricanes

Lt. Chris Bodet, LSP, discusses evacuation updates for New Orleans, LSU CSPHIH Advisory Board Meeting, April 2004

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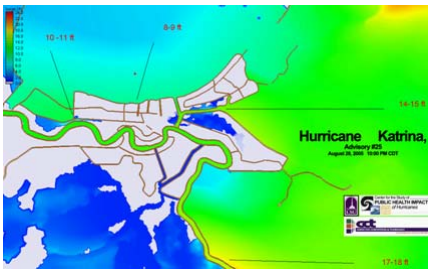
New Orleans Pilot Study

- Experimental Storm Surge Modeling (ADCIRC) [Westerlink-Notre Dame]
- Evacuation Studies
- Flood Casualty Modeling
- New Orleans Population Survey
- Wind Damage to Petrochemical Structures
- Water and air contaminant modeling
- Public health aspects
- Animal evacuation
- other study areas



Experimental storm surge modeling, Hurricane Katrina

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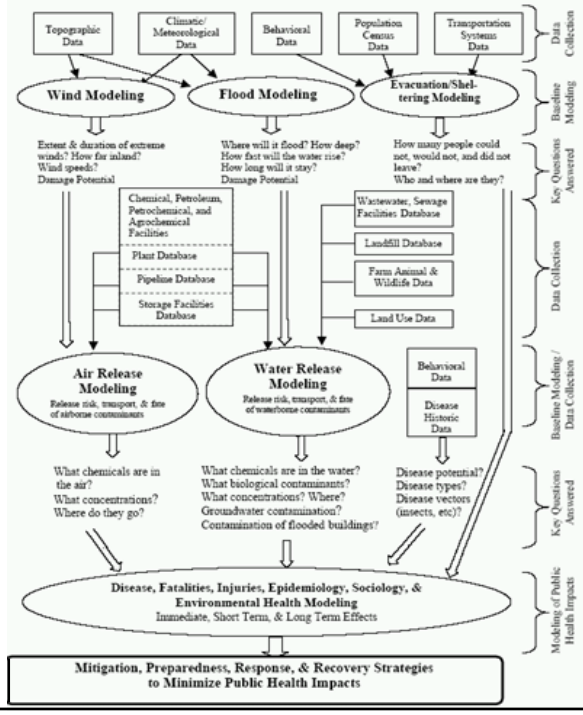
Flowchart of Research Activities



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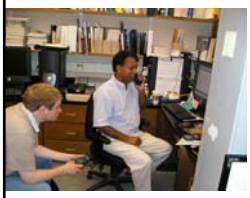
Hurricane Katrina Storm Surge Modeling and Validation



LSU Hurricane Center,
Natural Systems Modeling Group, CCT

Mashriqui, Kemp, van Heerden,Young Souk Yang, Scullin, Cunningham, Hyfield, Braud

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- ADCIRC Surge Model Forecasting
- Field Validation
  - Aerial Survey
  - Field Survey
- GIS Analysis
  - Flooding Extent and Depth
  - Water Volumes

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LSU Hurricane Center Ops Support Katrina

NHC Advisory	Date	Time CDT	Surge Analysis to OEP		Time Elapsed
16	Saturday August 27	4:00	Saturday August 27	14:31	10.5 hr
17	Saturday August 27	10:00	Saturday August 27	15:06	5.1 hr
18	Saturday August 27	16:00	Saturday August 27	22:07	6.1 hr
22	Sunday August 28	7:00	Sunday August 28	14:57	7.9 hr
25	Sunday August 28	22:00	Monday August 29	4:28	6.5 hr

Storm Landfall Sequence

	Date	Time CDT	Miles NO	Max Sust	Speed	NO Wind
	Monday August 29	2:00	130 mi. S	155 mph	12 mph	
	Monday August 29	4:00	90 mi. SSE	150 mph	12 mph	71 mph
Landfall LA	Monday August 29	6:00	60 mi. SSE	145 mph	15 mph	74 mph
Port Sulphur	Monday August 29	8:00	35 mi. SSE	135 mph	17 mph	76 mph
Mouth Pearl	Monday August 29	10:00	30 mi. ENE	125 mph	17 mph	
N. Gulfport	Monday August 29	12:00	50 mi. NE			

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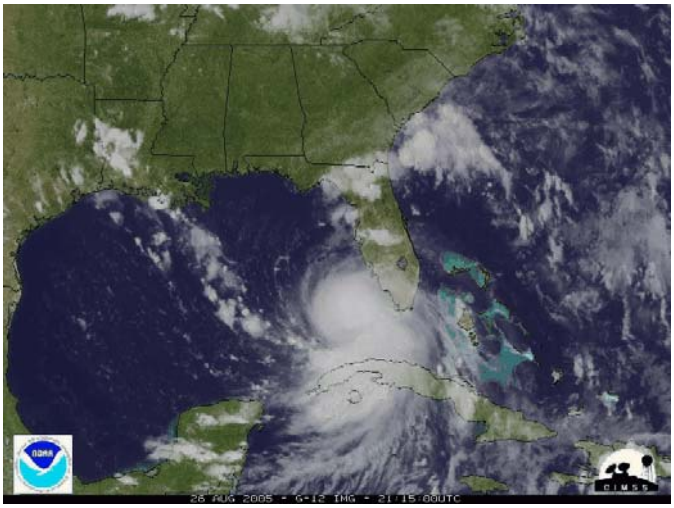

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Storm Surge Forecasting

- Track, Central Pressure, Maximum Sustained Winds from NHC Advisory
- Interpolation based on Unisys Data (0.5 hr)
- Run Planetary Boundary Layer Wind Model (1.5 hr)
- Initiate ADCIRC with Storm Near Florida
- Simulate 8 days on 240 processors in SuperMike (2.5 hr)
- Post-Processing (0.5 to 1.0 hr)
- Develop Maximum Storm Surge Graphic with SMS and Animation
- Submit Products to OEP and Post on www.hurricane.lsu.edu/floodprediction (0.5 to 1.0 hr)
- Total time elapsed 5 to 8 hr

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Results

- Advisory 16, Saturday 0400 CDT
- Advisory 17, Saturday 1000 CDT
- Advisory 17LSU (westerly track)
- Advisory 18, Saturday 1600 CDT
- Advisory 22, Sunday 0700 CDT
- Advisory 25, Sunday 2200 CDT
- Advisory 31, Tuesday 1000 CDT Hindcast

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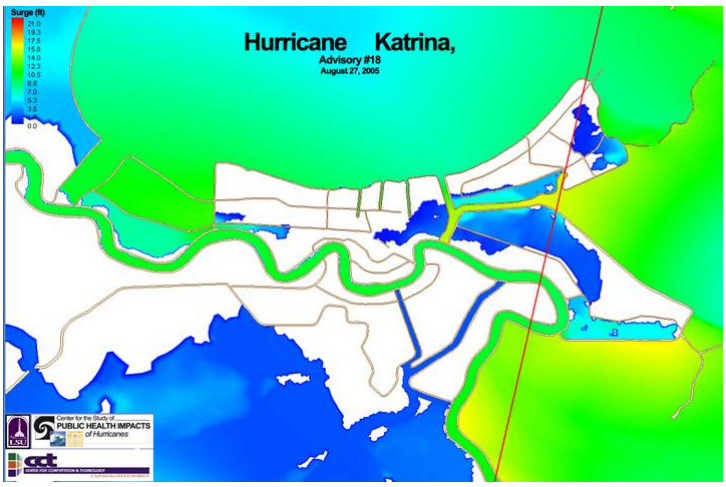

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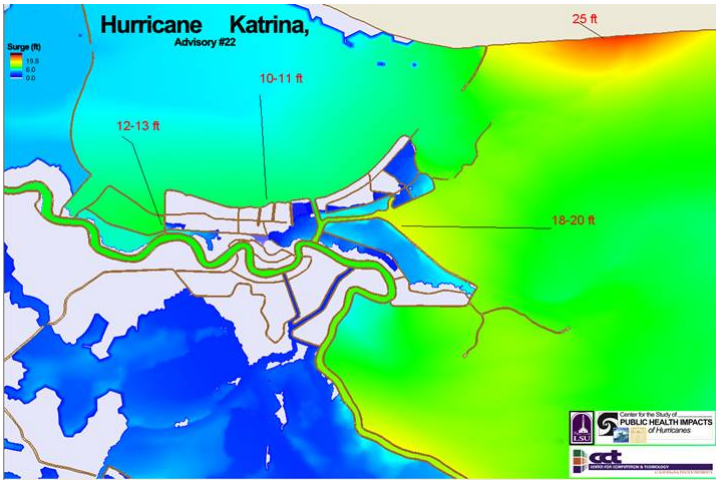
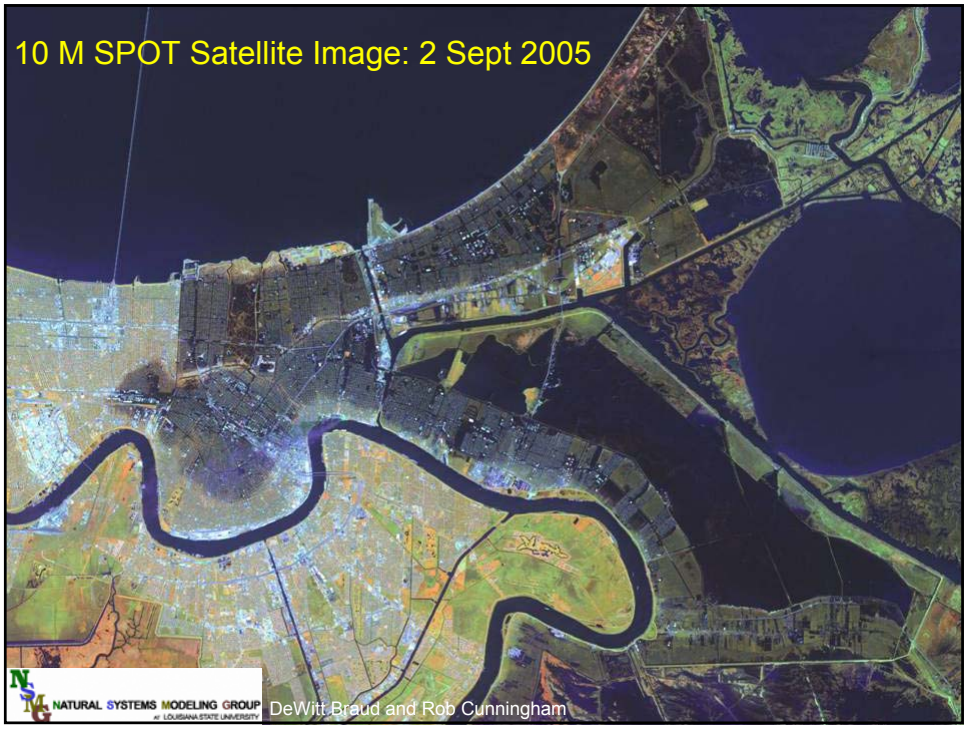
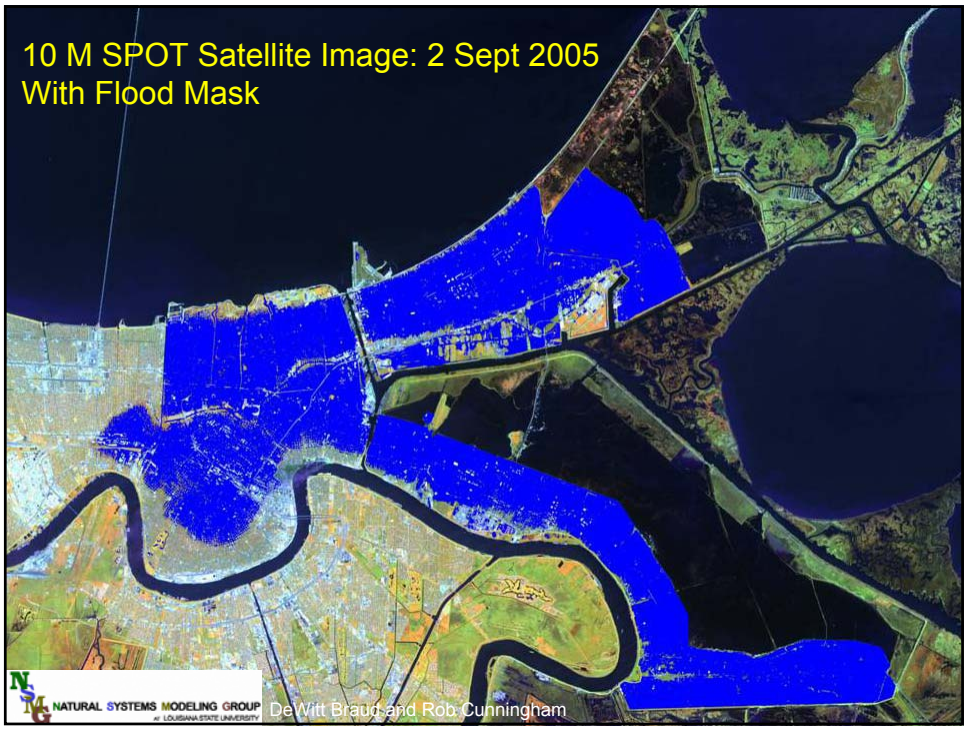
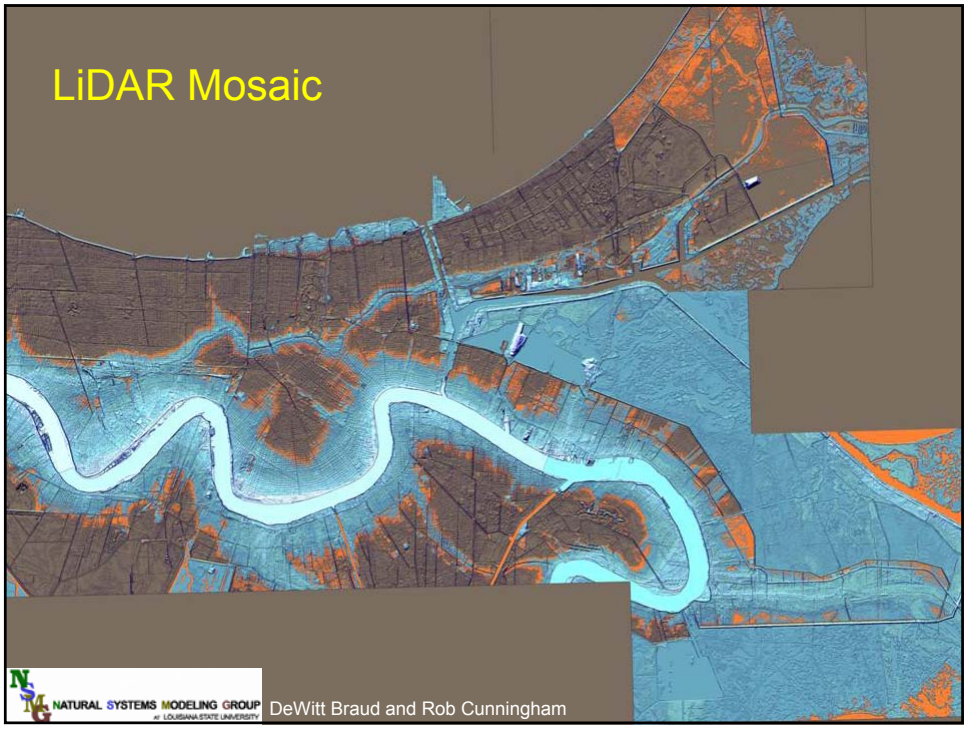
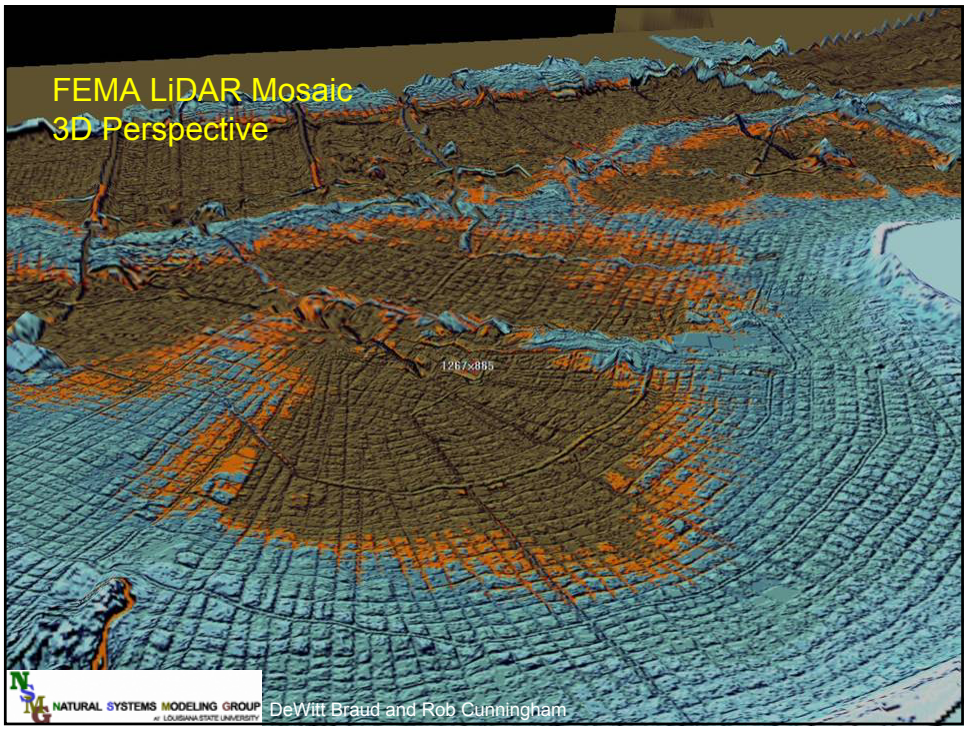
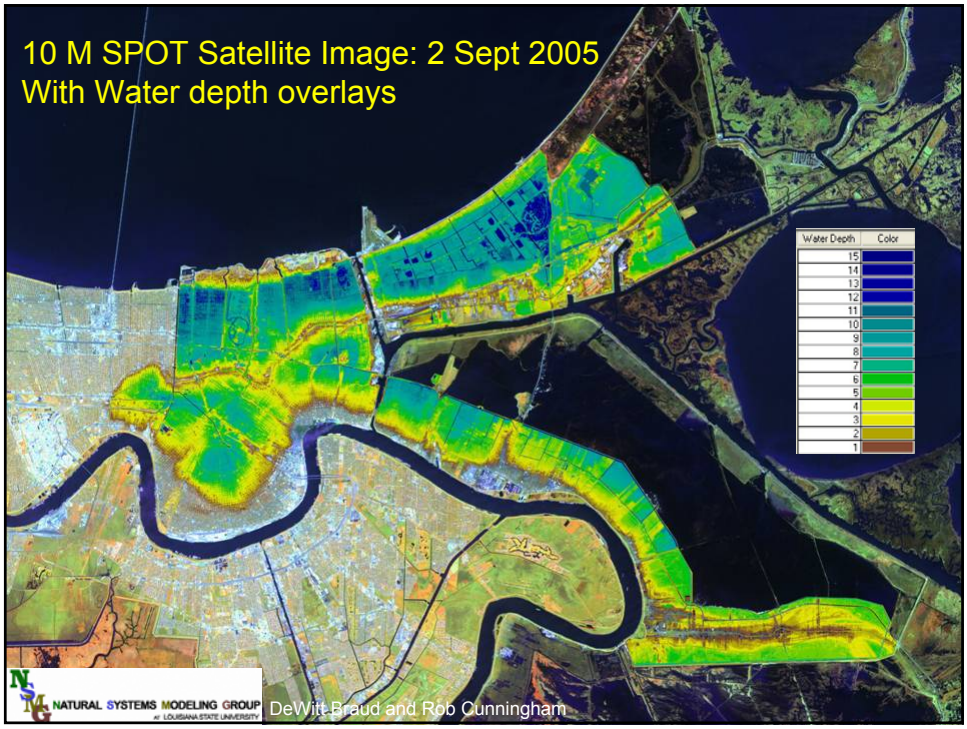



10 M SPOT Satellite Image: 2 Sept 2005
NATURAL SYSTEMS MODELING GROUP
DeWitt Braud and Rob Cunningham


10 M SPOT Satellite Image: 2 Sept 2005
With Flood Mask
NATURAL SYSTEMS MODELING GROUP
DeWitt Braud and Rob Cunningham


LiDAR Mosaic
NATURAL SYSTEMS MODELING GROUP
at LOUISIANA STATE UNIVERSITY
DeWitt Braud and Rob Cunningham


FEMA LiDAR Mosaic
3D Perspective
1267x885
NATURAL SYSTEMS MODELING GROUP
at LOUISIANA STATE UNIVERSITY
DeWitt Braud and Rob Cunningham


10 M SPOT Satellite Image: 2 Sept 2005
With Water depth overlays
Water Depth
Color
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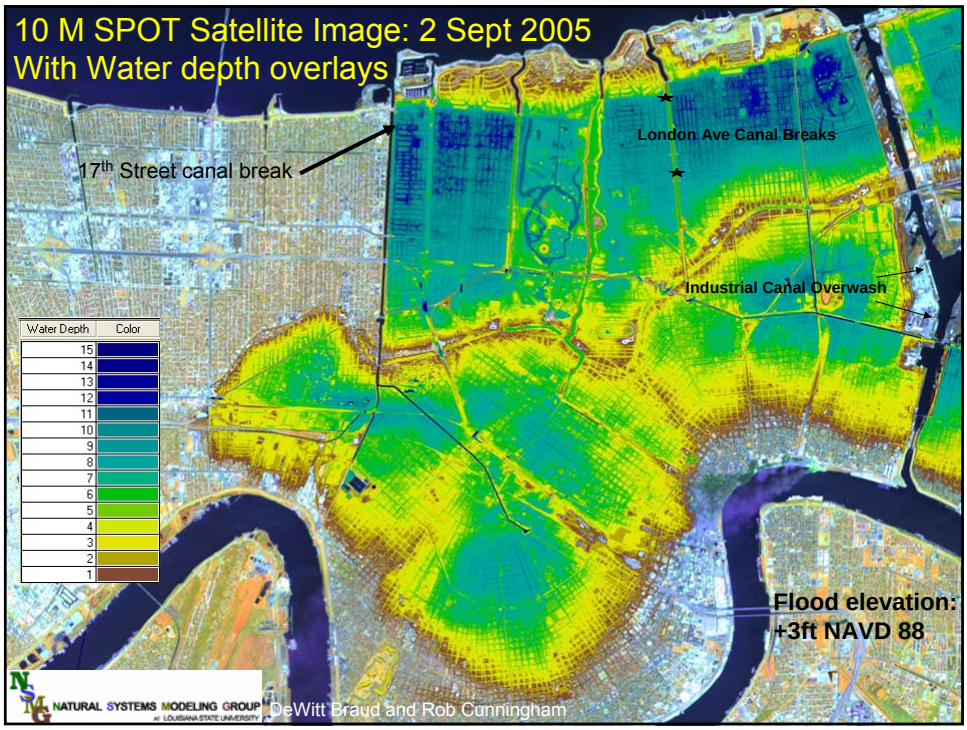
NATURAL SYSTEMS MODELING GROUP
DeWitt Braud and Rob Cunningham


10 M SPOT Satellite Image: 2 Sept 2005
With Water depth overlays
17th Street canal break
London Ave Canal Breaks
Industrial Canal Overwash
Water Depth
Color
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2
1
Flood elevation:
+3ft NAVD 88
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- 4 Levels of Levee Failures:
  - Sand boils
  - Structural
  - Overtopping
  - Erosion

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End of “Funnel”, Industrial Canal
Looking North, September 2

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Overtopping and Floodwall Breaching West Bank of the Industrial Canal

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Breaks in 17th Street and London Canals

September 2, 2005

September 14, 2005

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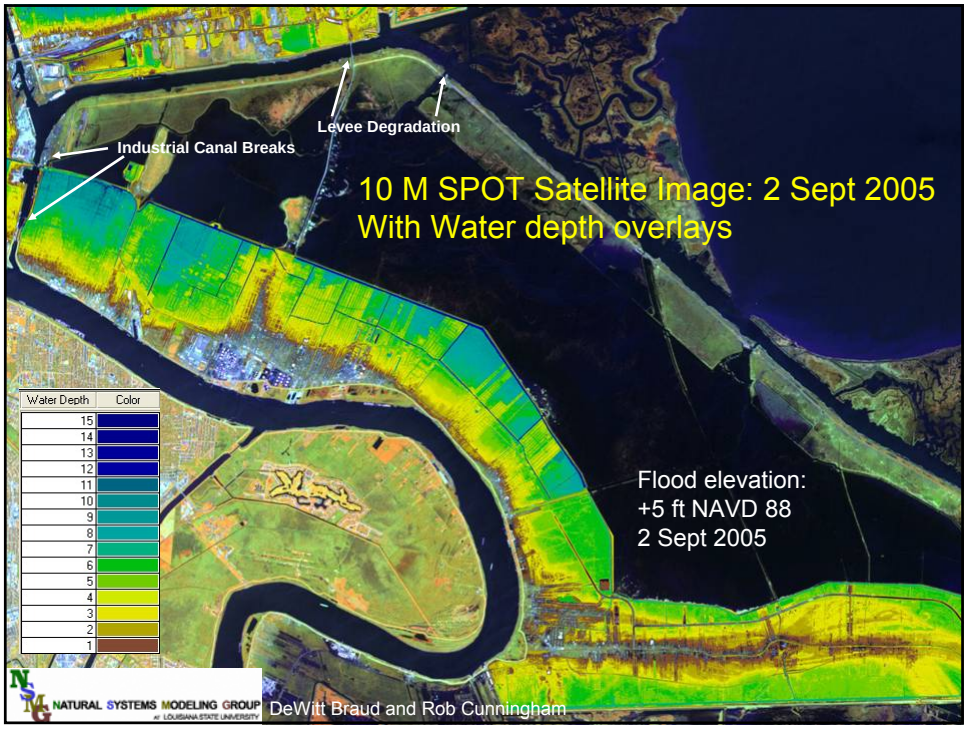
Surge on Lakefront west of 17th St. Canal 11 to 12 ft


Levee Degradation
Industrial Canal Breaks
10 M SPOT Satellite Image: 2 Sept 2005
With Water depth overlays
Water Depth
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Flood elevation:
+5 ft NAVD 88
2 Sept 2005
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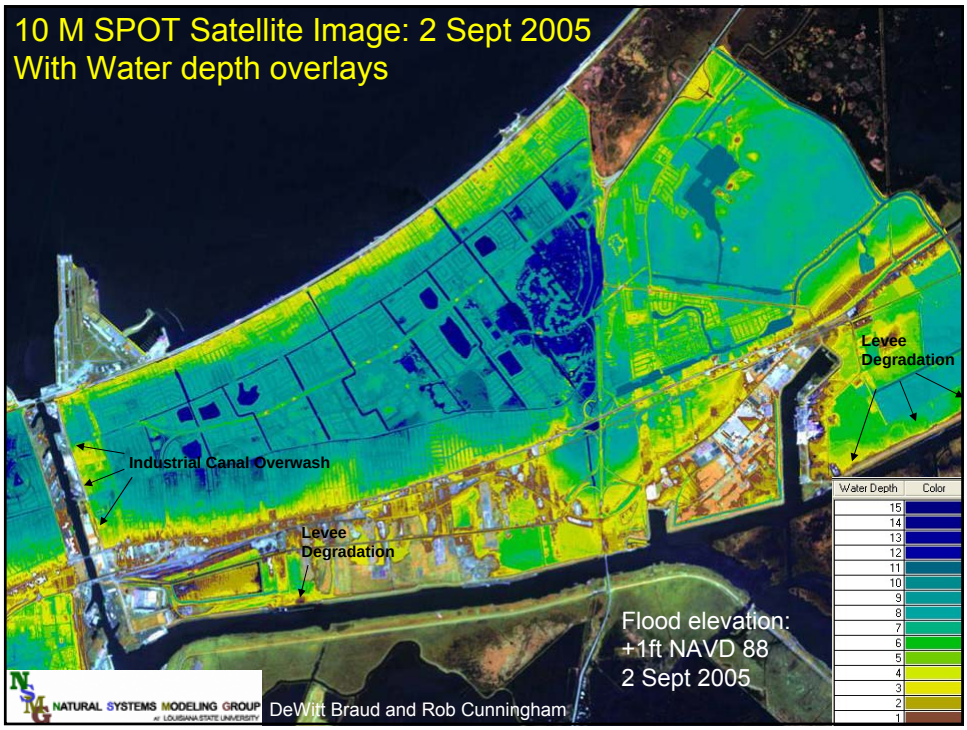
10 M SPOT Satellite Image: 2 Sept 2005
With Water depth overlays
Levee
Degradation
Industrial Canal Overwash
Levee
Degradation
Water Depth
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Flood elevation:
+1ft NAVD 88
2 Sept 2005
NATURAL SYSTEMS MODELING GROUP
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Other Surge Measurements
Diamondhead >25 ft, Biloxi 22 ft, Slidell 12.3 ft

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Surge Modeling Observations

- ADCIRC model is practical for emergency operations support
- Field observations support forecast surge elevations
- More work needed to reduce time lapse from advisory to surge forecast
- Model provides powerful tool for understanding patterns of overtopping and failure

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Modeling Status

- Field investigations of levee failures have provided information on breaches and degradations to the system
- This data has now been incorporated into the model grid
- Hurricane Rita run with damaged levee state on LSU Supercomputer last week

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Modeling Directions

- Probabilistic surge estimations
- Multiple simultaneous runs
  - (LSU CCT in discussions with NCSA)
- Improve use as decision support tool
- Integrate outputs with other models
  - Casualty, damage, search and rescue, etc

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Water Quality Assessment for Immediate Response & Research

Goals:

- Public Health\ Exposure Assessment
- Long Term Research Agenda: Fate Transport of Flood Borne Contaminants
- Data Sharing with EPA & Contractors
- Emerging Issues: Antibiotic Resistant Staph in N.O. Flood Waters

The Louisiana Water Resources Research Institute & The Hazardous Research Center S/SW

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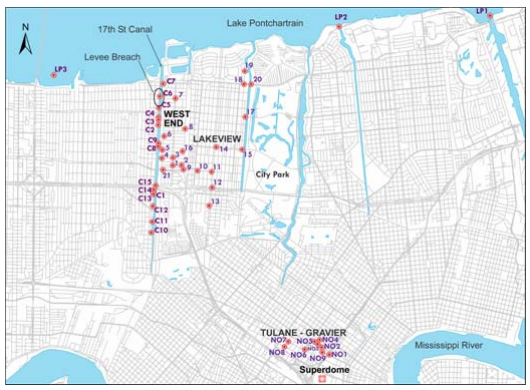
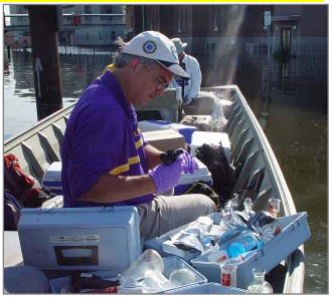
The Louisiana Water Resources Research Institute and The Hazardous Research Center S/SW





Dr. John Pardue - Taking water samples
Left: Water sampling locations

- testing for conventional, toxic and microbial contaminants
- detailed sampling during peak of flood
- emerging issues: aerosols, antibiotic resistant pathogens

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Far-field Transport of Contaminants by Aerosolized Water And Mold from Reconstruction Activities.

(Prof. K. T. Valsaraj's group in Chemical Engineering)

-Water borne contaminants and molds can be aerosolized during reconstruction activities in New Orleans and can pose significant health issues.

-Our group has current ongoing work on transport by fog water droplets.

-Supported by NSF – Atmospheric Chemistry Division

Gordon A. and Mary Cain Louisiana State University

Department of Chemical Engineering

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- Field work on collecting, characterizing and analyzing for aerosols in the N.O. zone during reconstruction activities.
- Assessing (modeling) far-field transport of pollutants and mold associated with aerosols.

Gordon A. and Mary Cain Louisiana State University

Department of Chemical Engineering

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Evacuation Planning & Operations Research

LSU Transportation Laboratory

Goals:

- Evaluate Existing Evacuation Plans
- Assess Regional Spatiotemporal Movement of Evacuees
- Develop & Model Potential Improvements & Innovations

Long Term Research Agenda:

- Anticipatory Evacuation Modeling, Integration of Transit Assets

Emerging Issues:

- Evacuation of Low Mobility Populations, Post-Event Evacuations, Pedestrian Evacuations, Emergency Signal Network Control

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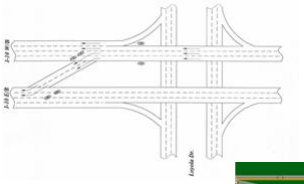
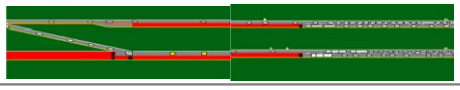
LSU Transportation Laboratory





Research and simulation conducted by in 2001 Dr. Wolshon identified and quantified shortcomings in the 2000 Louisiana regional evacuation plan. These problems were demonstrated in Hurricane Ivan 2004. Afterward, he served as a consultant to the LA DOTD and State Police to revise their plan in the months prior to Katrina. The highway evacuation of southeast Louisiana was one of the few success during the entire Katrina event.

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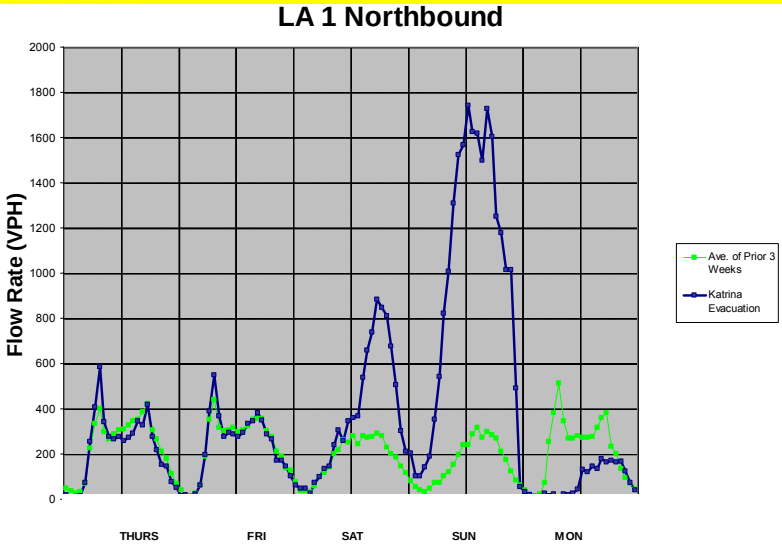

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Flood Casualty Modeling

- The flood fatality model has three components:
  - The Exposed Population: Residents - Evacuees
  - The Flood Depth: Tide Height – Elevation
  - The Flood Fatality Rate: Function of flood depth.
- Limited data meant that a number of assumptions were necessary.
  - Example: A few parish officials provided rough estimates of the percent evacuated for their parish. For other parishes, no data was available and values were assumed.

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Initial Fatality Estimate

- Used census data and evacuation estimates to estimate the number of non-evacuees for each blockgroup
- Identified flood regions using SPOT satellite image
- Obtained tide height data from USGS website. However, only 1 gauge had a complete record that spanned the event.
- Using LIDAR elevation data and tidal data, estimated the average flood depth for each blockgroup.
- Calculated the expected fatality rate for each blockgroup using a flood fatality function.
- Multiplied the fatality rate by the exposed population to get the expected number of deaths.

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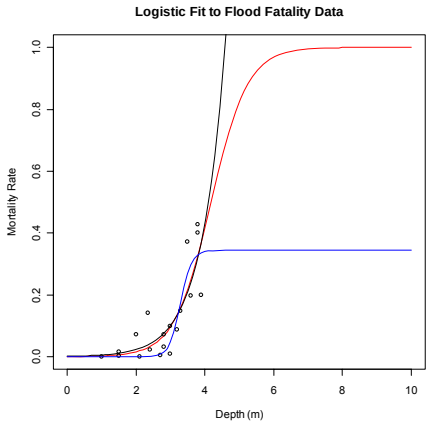
Flood Fatality Function



Blue Line Provides the Best Fit

Other Important Factors

Rate of Rise

Flow Velocity

Housing Stock

Search & Rescue

Exposure Time

Ability to Reach High Ground or Shelter

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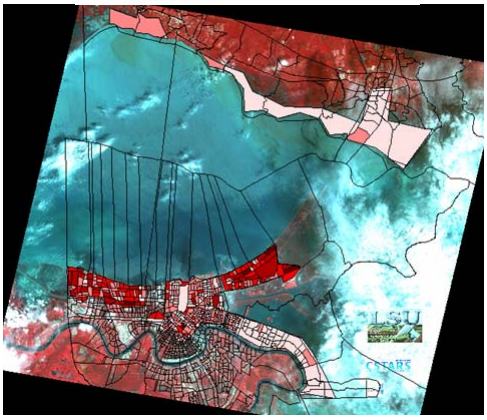

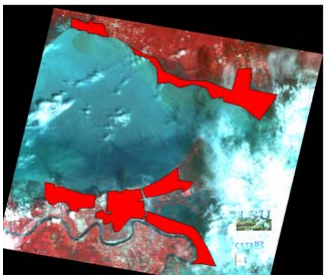

Above – Flood regions.
Right – Distribution of flood fatalities.

Estimated Number of Fatalities per Parish:

Jefferson: 1,650
Orleans: 10,498
St. Bernard: 1,343
Total: 13,500

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The impact of a hurricane on family functioning: An interdisciplinary mixed-method and multi-level approach

Goals:

- Investigate **family** resilience;
- Discern **family** strengths, challenges, and barriers to recovery;
- Examine community influences on **family resilience**

Families & Disasters (FAD) Research
LSU Schools of Human Ecology & Social Work

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The impact of a hurricane on family functioning: An interdisciplinary mixed-method and multi-level approach

Study Populations
--Families from vulnerable and non-vulnerable populations
--Families of 1st responders
--Community Leaders
Multiple Data Collection Times
Current Support
Quick Response Grant (QRG), Natural Hazards Center (NRC)
USDA/CSREES, LSU AgCenter
LSU Faculty Research Grant
Planned Support
SBE, NSF

FAD Research Team
M. E. Betsy Garrison, PhD
Loren Marks, PhD
Diane Sasser, PhD
Michelle Livermore, MSW, PhD

Contact: Garrison at hcgarr@lsu.edu; (225) 578-2081, (225) 223-7005 (cell)

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Family Decision Making & the Evacuation Experience (QRG from NHC)

53 on-site interviews of adult evacuees housed in a shelter
3 day period; September 3-5, 2005
Sample Characteristics
Gender: 59% females, 41% males
Age: 18-74 years of age; mean=42.65
Race: 74% African-American, 23% white
Marital status: 34% single, 34% married, 18% divorced
Education: 34% high school graduate, 23% some college
Household size: 1-9; mean=3.72
Employment status (pre-storm): 60% employed; 42% full time

Preliminary Findings

Evacuation "Stops:" 11% one stop; 28% two stops; 26% three stops; 32% four stops; 2% six stops

Definitional issues with "evacuate"

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Hurricane Katrina Research

Integrated Systems and
Landscape Ecology (ISLE) lab
Louisiana State University
Dr. Stephanie Moret
Dr. Margaret Reams

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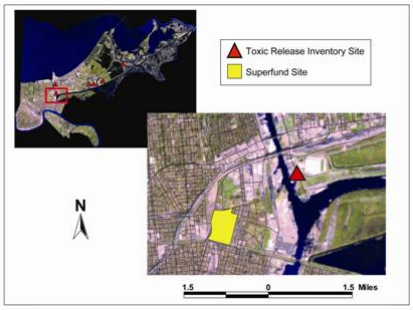
Spatial Distribution of Anthropogenic Environmental Hazards in Coastal Louisiana: Implications for Hurricane Katrina Response & Ecosystem Restoration

This project (in progress) seeks to develop an interactive GIS database focused on 5 flooded parishes in Louisiana combining 8 federal and 2 restricted environmental hazard databases for immediate use in disaster relief efforts



Integrated Systems and
Landscape Ecology (ISLE) lab
Louisiana State University
Dr. Stephanie Moret
Dr. Margaret Reams

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Risk Perception and Disaster Preparedness

- Moret and Reams conducted pre and post surveys of Baton Rouge, LA residents to learn more about risk perception and disaster preparedness.
- Such information included
  - what sources of information are most utilized and highly regarded by a vulnerable population,
  - the faith that this population has in emergency management systems,
  - Preparation details
  - Perceived risks
  - how socioeconomic factors contribute to these perceptions.
- The analysis of these data will play a useful role in hurricane relief and adaptive management efforts.

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Returning Home: Factors Influencing the Intentions of Hurricane Katrina Evacuees

- Survey data will be collected from evacuees in Houston, Baton Rouge and Little Rock to identify the key factors that may influence the decisions of evacuees' to return to hurricane affected areas along the Gulf Coast.

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Katrina's Impact on Young Children and Implications for Early Childhood: Short-Term Goals

1. Assist in providing care and education for young children who were evacuated

2. Gather and archive young children's memories about and perceptions of Katrina

LSU School of Human Ecology and
College of Education
Katrina Research Team

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Katrina's Impact on Young Children and Implications for Early Childhood: Long-Term Goals

1. Develop effective teaching practices and curriculum for young children after catastrophes

2. Gather data on young evacuee's stress-related behaviors in child care programs

LSU School of Human Ecology and
College of Education
Katrina Research Team

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Wind-Borne Debris Assessments:

- Document damage due to wind-borne debris
- Identify debris sources
- Collect perishable debris trajectory data

During Hurricane Katrina, roof structure becomes source of wind-borne debris

Rafters and roof panels impact ground 120 feet downwind of their source

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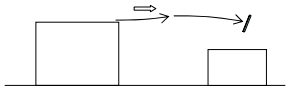
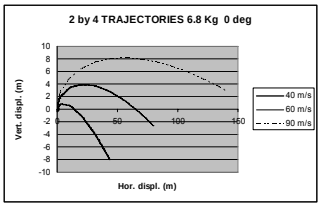
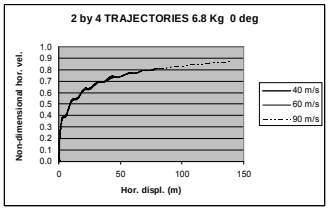
Immediate Research Goals:

- Verify numerical models of trajectories of wind-borne debris, developed at LSU Hurricane Center
- Improve predictability of wind-borne debris behavior







Wind-borne debris can travel long distances and reach high velocities before impacting a building or the ground

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The LSU Hurricane Center

Debris Research Supports Long-Term Goals to:

- Improve safety of building occupants
- Improve standards for hurricane shelter construction
- Improve performance of hurricane protection systems
- Reduce damage to building envelopes and contents

Wind-borne debris damage to windows, followed by failure of roof

Penetration of wall by flying debris

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The LSU Hurricane Center

Support for Katrina Response - Prelandfall

LSU Hurricane Center activated Saturday morning Aug 27

- Satellite storm tracking
- Meteorological support
- Storm surge modeling
- Damage estimates
- Consultation on evacuation and sheltering decisions
- Briefings every 2-3 hours

LSU Research & Operations Support - Katrina

The LSU Hurricane Center

Support for Katrina Response – Post Landfall

Staffed the 'LSU' workstation at the Louisiana Emergency Operations Center 24/7 for next 3 weeks

- Post-Landfall Activities
  - Stood up GIS/Remote Sensing/Mapping capability in less than 24 hours
  - Meteorological support
  - Upgrading surge model to account for levee damage state
  - Water quality sampling – results shared with EPA
  - FEMA Data Clearinghouse – LSU allocated 20 Terrabytes of space

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GIS Mapping and Imagery Support Collaborating LSU Centers

- **LSU Center for the Study of Public Health Impacts of Hurricanes (CSPHIH)**
- **Louisiana Geological Survey**
- **LSU CADGIS lab**
- **LSU World Health Organization Collaborating Center (WHOCC)**
- **LSU Hurricane Center**
- **LSU Coastal Studies Institute**
- **LSU Earth Scan Lab**
- **Southern Regional Climate Center**

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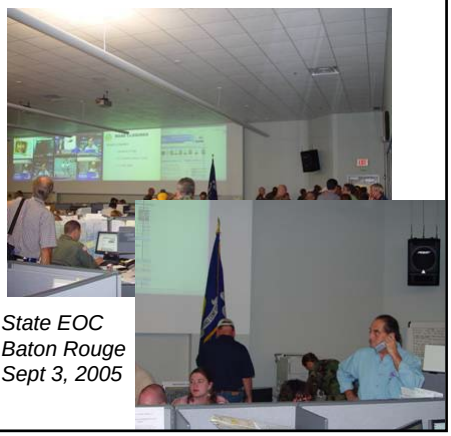
GIS Mapping and Imagery Support Louisiana State EOC (Sept 1-16, 2005)

- GIS data, maps, and high resolution satellite imagery provided to requesting agencies on-site
- Base Layers from LSU CSPHIH New Orleans GIS database and collaborating LSU Centers
- Additional data and layers provided by NGA, FEMA, USGS and others



State EOC Baton Rouge Sept 3, 2005

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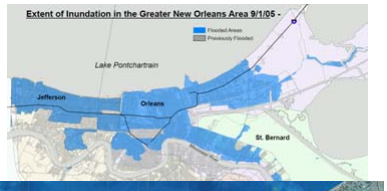
GIS Mapping and Imagery Support Completed Map Requests

- 911 calls on indexed New Orleans atlas for FBI and state police
- Extent of flooded and damaged areas with road overlay
- Hospital and nursing home locations with lat/longs
- Pumping stations and levee failures
- Hostile areas
- Shelters, staging areas and aid station locations
- Docking areas
- State Lands, Topographic maps, New Orleans maps, many more



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GIS Mapping and Imagery Support Agencies served

- FEMA
- Louisiana Governor's Office
- Military (National Guard, Army, and others)
- FBI
- Louisiana State Police
- ARC
- EMAC
- LOSCO
- EMS
- US Public Health Service
- EOC Command Team
- NWS
- NO S&WB
- LA Dept of Recreation, Culture & Tourism
- LA Dept of Agriculture
- USGS & LWF
- many others

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Sample Education Activities

Numerous service learning activities

Landscape Architecture Senior thesis
class project refocused to design of rebuilding efforts

Mechanical Engineering Sophomore Design
Design of attic escape kit, assuming no power available, must include communications

Disaster Science and Management Activities

Hurricane Engineering www.HurricaneEngineering.lsu.edu
Forensic engineering project

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Questions/Opportunities Raised

- Role of Higher Education in Emergency Preparedness and Mitigation
  - Unique expertise and capabilities
  - Technology transfer
  - Coordination with state and local EM agencies before disaster wrt capabilities

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Questions/Opportunities Raised

- Role of Higher Education in Operational Disaster Support
  - Unique expertise and capabilities
  - Surge capacity
  - Invaluable learning experience for students, faculty and research staff

LSU Research &
Operations Support - Katrina
The LSU Hurricane Center
Louisiana State University Responds to Katrina:
Research and Research-to-Operations
in the Wake of a Killer Storm
Questions?