



Coastal Resilience in the Age of Climate Change



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Presentation Overview



- **Climate Change Adaptation and Hazards Management**
 - Hazard Mitigation
 - Disaster Recovery
- **Adapting to Climate Change: Lessons from Natural Hazards**
 - North Carolina and Mississippi Case Studies
- **Recommendations for North and South Carolina Coastal Managers**





Adapting to Climate Change: Lessons from Natural Hazards (Glavovic and Smith 2012, Springer)

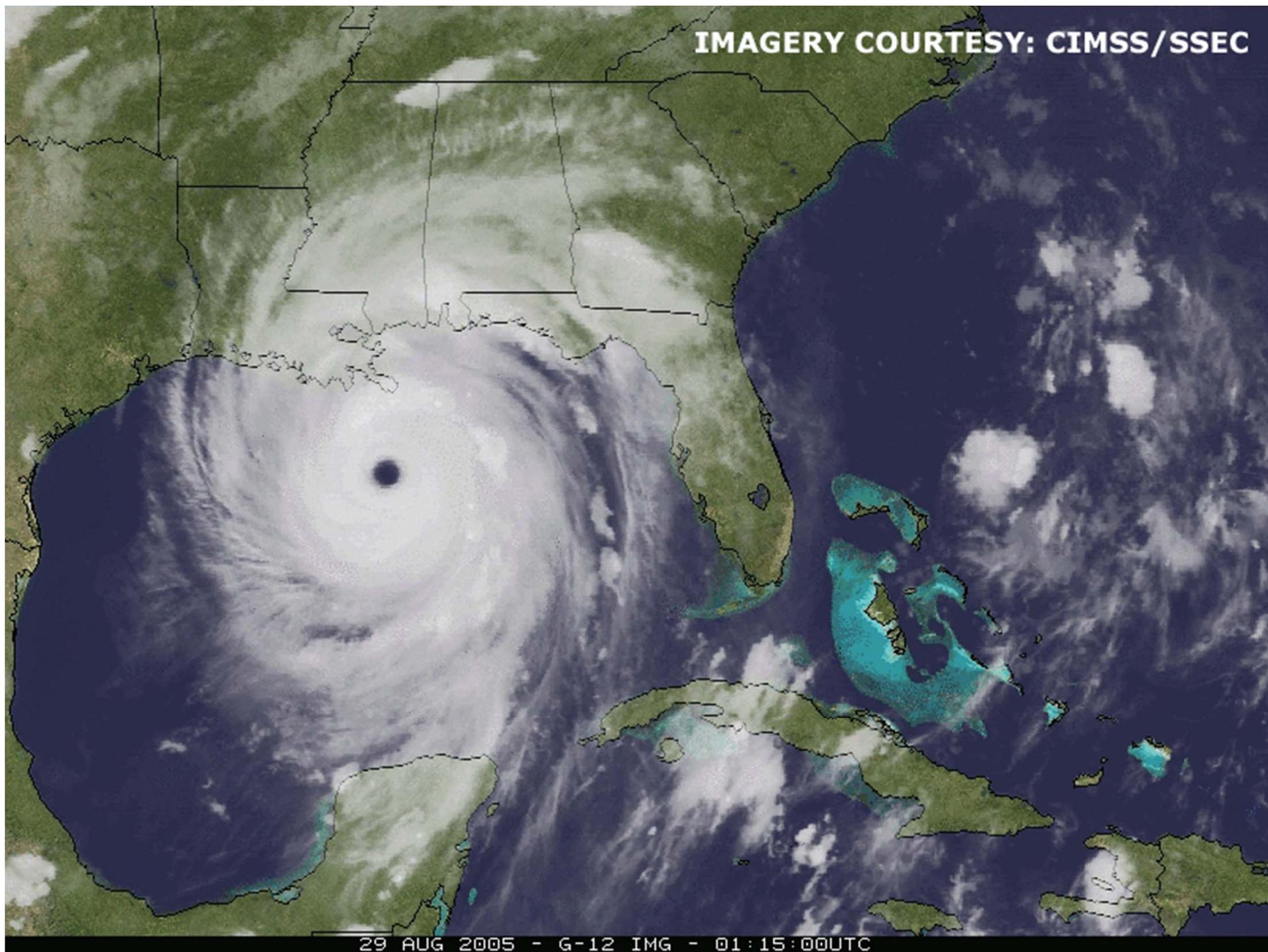
- **Introduction**
- **Climate Change Adaptation: Theory and Practice**
 - Synthesis of scholarship and experience
- **The Nature of Disasters and the Role of Natural Hazards in Building Resilient Communities**
 - Climate change adaptation and risk reduction in highland Peru (Anthony Oliver-Smith)
 - Castles on sand: the shifting sources of flood risk and the implications for flood governance (Iain White)
 - Planning for resilient coastal communities: the emerging practice and future directions (Tim Beatley)
 - Resilience and Adaptation: the emergence of local action in California, USA (Bill Simbieda)
 - Rising to the challenge: planning for adaptation in the age of climate change (Phil Berke)
- **Case Studies: Lessons from Natural Hazards**
 - Applying Hurricane Recovery Lessons in the U.S. to Climate Change Adaptation: Hurricanes Fran and Floyd in North Carolina, USA (Gavin Smith)
 - The Manawatu floods in New Zealand: Integrating flood risk reduction and climate change adaptation (Bruce Glavovic)
 - Drought and Bushfires in Australia (Karyn Bosomworth, John Handmer and Steven Dovers)
 - Natural coastal hazards planning: the 2009 tsunami and lessons for climate change adaptation in Samoa (Michelle Daly)
 - Disaster Recovery in Coastal Mississippi (USA): Lesson Drawing from Hurricanes Camille and Katrina (Gavin Smith)
 - New Orleans and Hurricane Katrina (Bruce Glavovic)
- **Conclusions: Action for Climate Change Adaptation**

Disaster Recovery in Coastal Mississippi (USA): Lesson Drawing from Hurricanes Camille and Katrina

- **Risk Communication**
- **Role of the Design Community in Recovery**
 - New Urbanists
 - Emergency Housing
- **Building Codes versus Land Use**
- **Community Resettlement and Transformation**

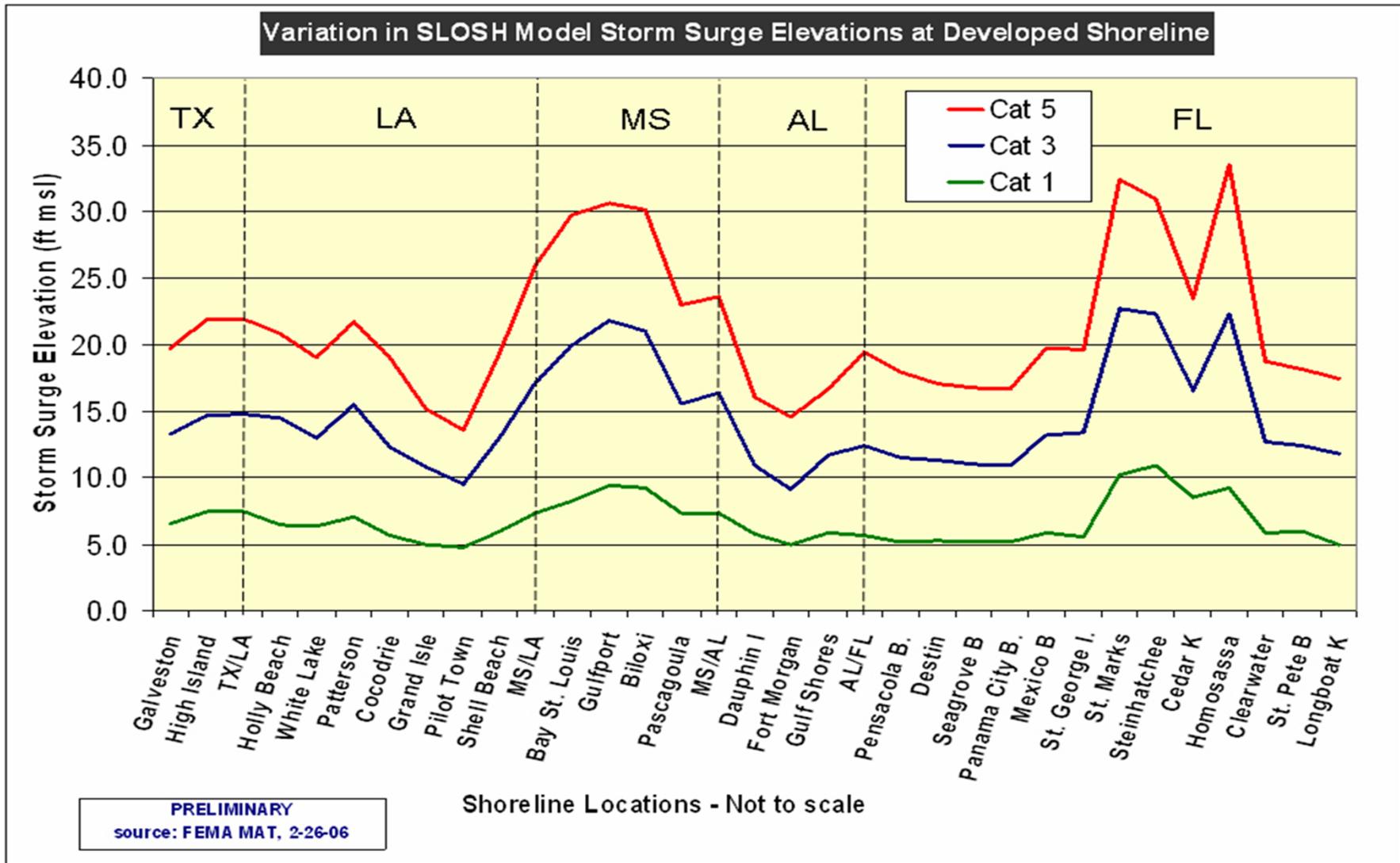


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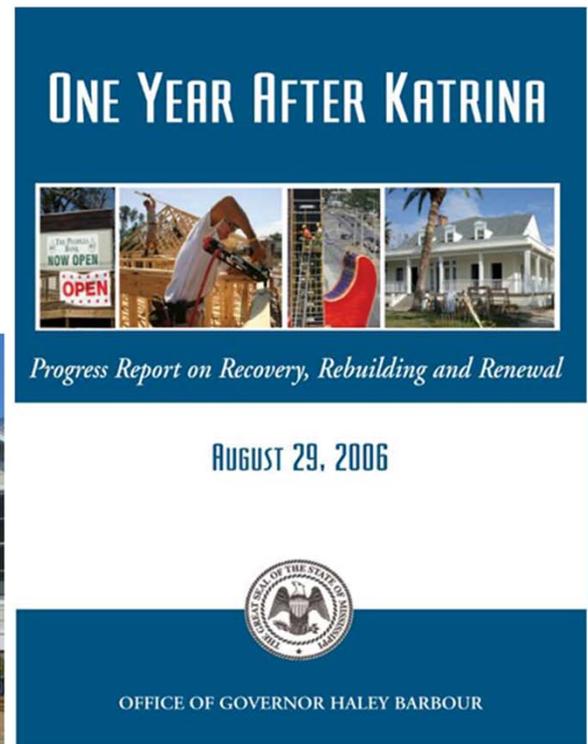
Use of Models to Inform the Public



Governor's Office of Recovery and Renewal



- Implementation Focus
- Institutionalizing State and Local Capability
- Beyond the Stafford Act
- Three Objectives
 - Identification of Funding
 - Policy Counsel
 - Education, Outreach, and Training



Risk Communication



Estimated Katrina Surge Elevations

24-25 ft

Advisory Base Flood Elevations

Open Coast: 18-27 ft

Back Bay: N/A

Effective Base Flood Elevations

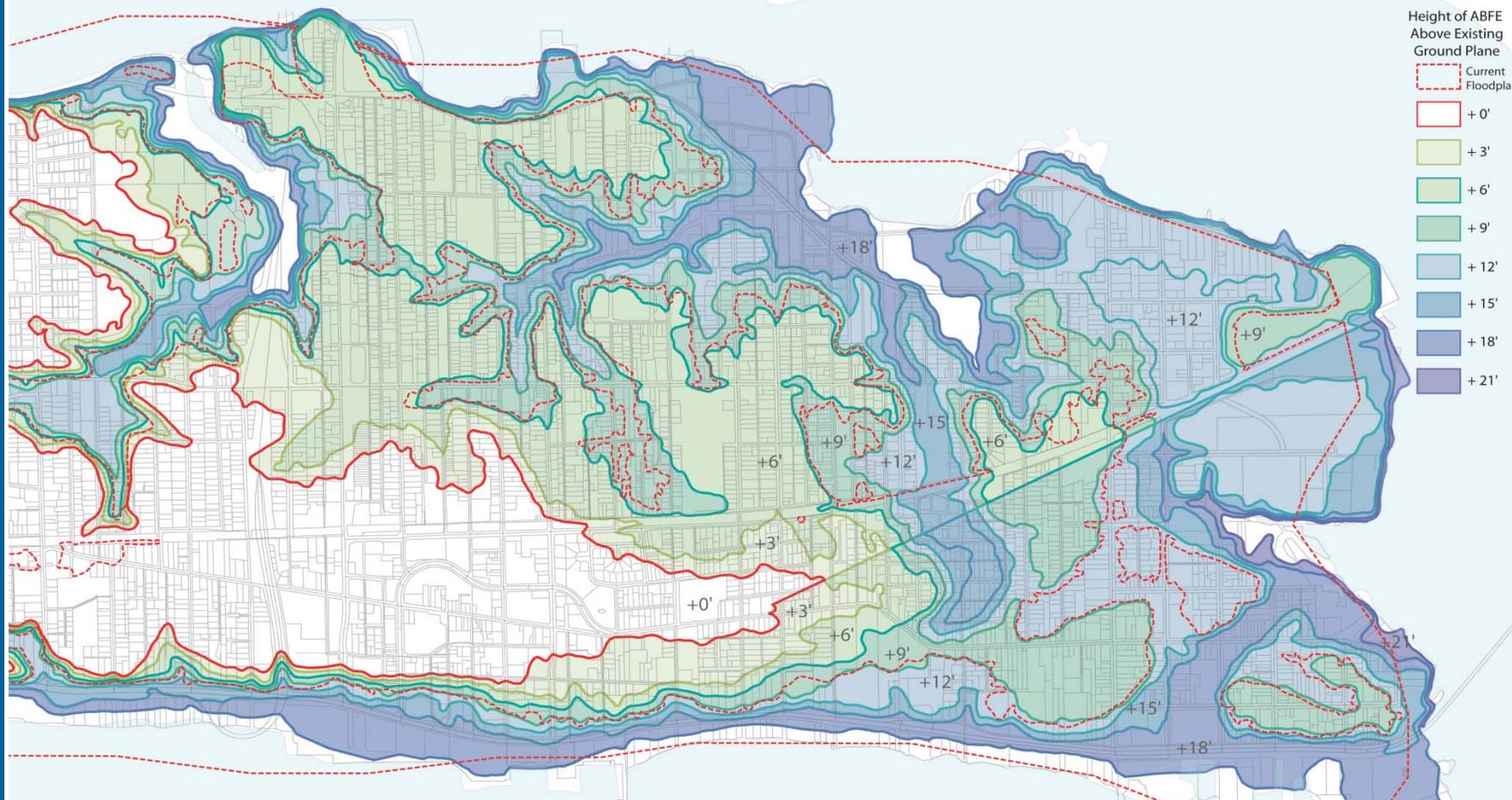
VE Zone: 14-18 ft

AE Zone: 12-13 ft

Legend

- | | | |
|-------------------------------------|-------------------------------------|------------------------------------|
| State Boundary | County Boundary | Flood Advisory-Related Data |
| Preliminary Indoor High Water Mark | ABFE Contours (1-foot intervals) | ABFE Inland Limit |
| Preliminary Outdoor High Water Mark | Approx. Limit of 1.5-foot Wave Zone | Approx. Limit of 3-foot Wave Zone |
| Preliminary Debris High Water Mark | Open Coast/Back Bay Boundary | Limit of ABFEs |
| Limit of Katrina Surge Inundation | | |

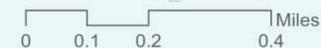
Risk Communication



- Height of ABFE Above Existing Ground Plane
- Current Floodplain
 - +0'
 - +3'
 - +6'
 - +9'
 - +12'
 - +15'
 - +18'
 - +21'

IMPACT OF ADVISORY BASE FLOOD ELEVATIONS ON EAST BILOXI

Gulf Coast Community Design Studio, March 2007
Source: FEMA Advisory Base Flood Elevations. Note: This is not an official FEMA map.



Role of the Design Community in Recovery: Mississippi Renewal Forum



Research Lead: The University of North Carolina at Chapel Hill

Education Lead: Jackson State University, Mississippi

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Post-Disaster Emergency Housing: The Mississippi Alternative Housing Program



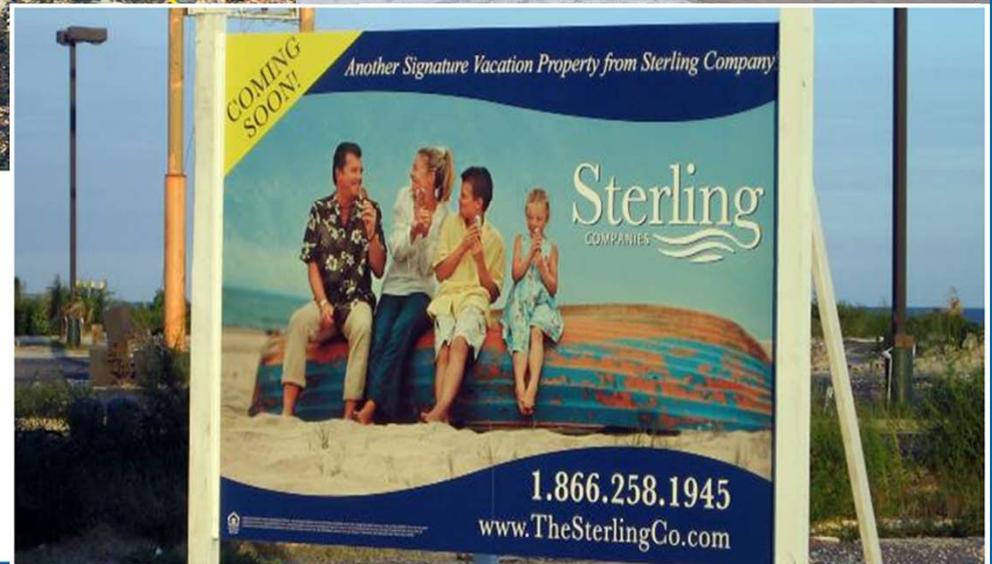
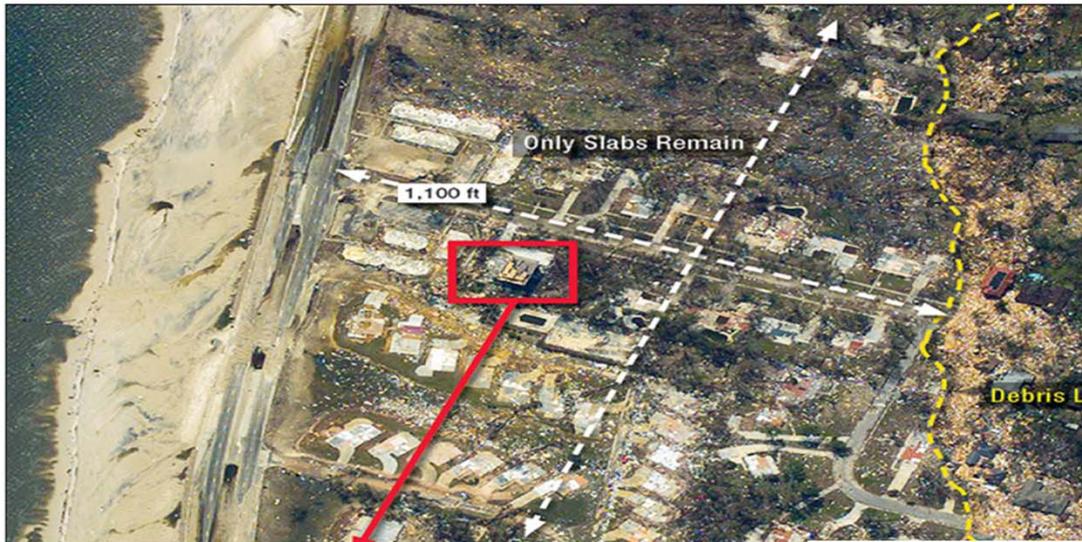
Research Lead: The University of North Carolina at Chapel Hill

Education Lead: Jackson State University, Mississippi

Post-Disaster Resettlement



Building Codes and Land Use



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Hazards Management Lessons in Mississippi

- **The Remapping of Mississippi's Coastal Floodplains: Implications for Risk Communications, Hazard Mitigation, Disaster Recovery, and Adaptation.**
- **Secondary policy impacts, migration of coastal residents, and the construction of new inland communities.**
- **The role of the design community in disaster recovery, hazard mitigation, and climate change adaptation.**
- **The adoption of new building codes and flood ordinances is not enough; these techniques should be coupled with land use measures.**
- **The Widespread use of Post-Disaster Temporary and Transitional Housing.**
- **Creating and Sustaining a State Disaster Recovery Organization Committed to Hazards Management and Related Elements of Climate Change Adaptation.**

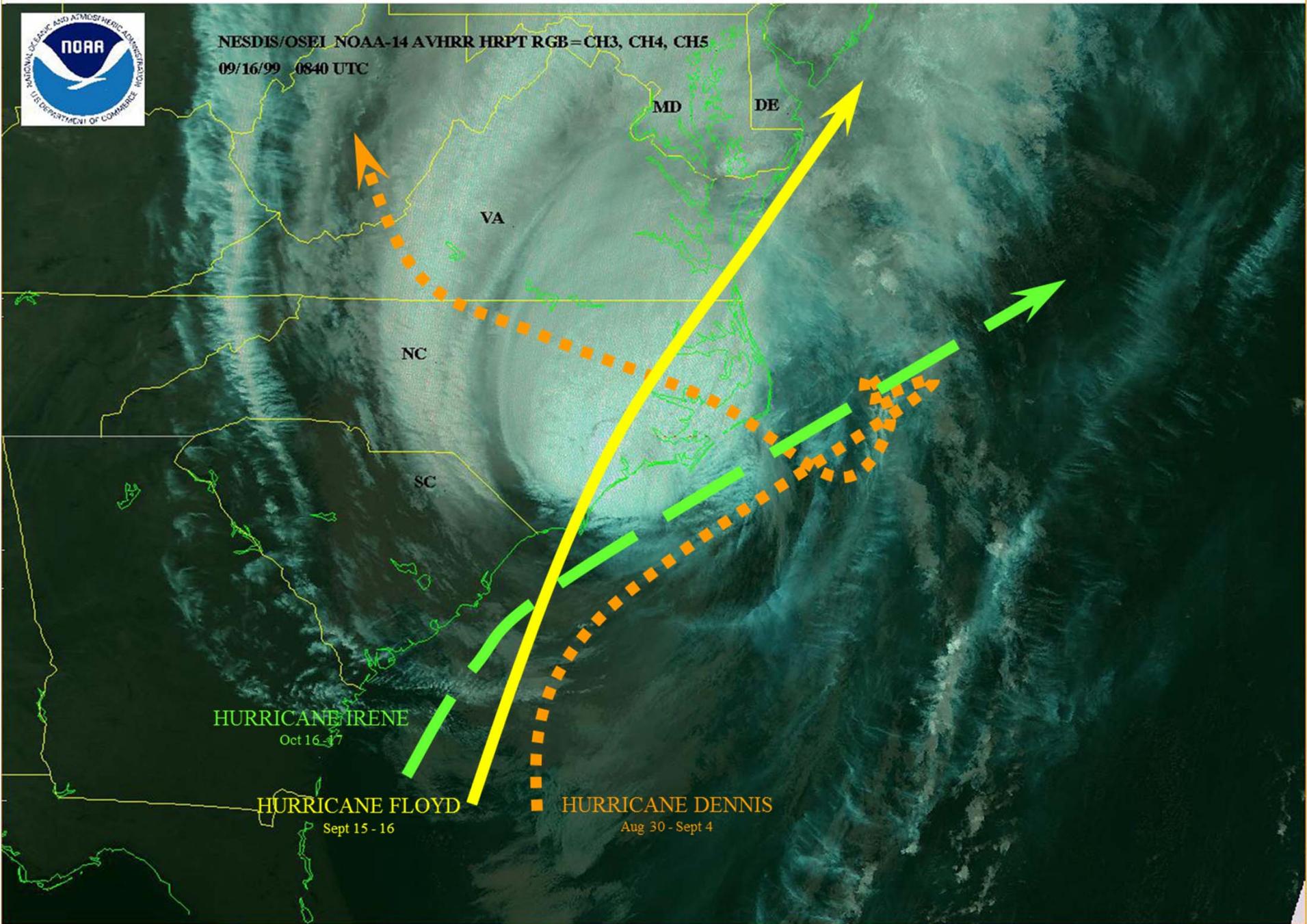


Applying Hurricane Recovery Lessons in the U.S. to Climate Change Adaptation: Hurricanes Fran and Floyd in North Carolina, USA

- **Hurricanes Fran (1996) and Floyd (1999)**
- **State Recovery Programs**
- **Hazard Mitigation in North Carolina: the Relocation and Elevation of Flood-Prone Housing**
- **Land Use and Hazards**
 - Hazard Mitigation Planning Initiative
- **Reassessment of Flood Hazard Risk**
 - Floodplain Mapping Program
 - Integrated Hazard Risk Management
 - NC Sea Level Rise Study

Hurricane Floyd at 4:40 AM EDT, about 2 hours after making landfall near Cape Fear NC. Wind gusts to 135 knots were measured at the shore. Floyd is expected to continue on a northeasterly course and maintain minimal hurricane strength as it crosses the Delmarva Peninsula.

CREDIT: NOAA



Hurricane Floyd North Carolina Recovery Programs



- 836 million dollars (22 state programs)
 - Floodplain Mapping Program
 - State Acquisition and Relocation Fund
 - Acquisition of hog farms and junkyards
 - State match to federal grant programs
- No State Recovery Plan



Education Lead: Jackson State University, Mississippi

Research Lead: The University of North Carolina at Chapel Hill

Acquisition and Elevation of Flood-Prone Housing and Infrastructure

- **Hurricane Fran and Floyd**
 - 6,000 homes acquired
 - 800 homes elevated
- **State Acquisition and Relocation Fund**
- **Infrastructure Relocation**
 - Wastewater Treatment Plants
 - Schools
 - Critical Public Facilities
- **Land Use Integration**



The Complexity of Hazard Mitigation Choices

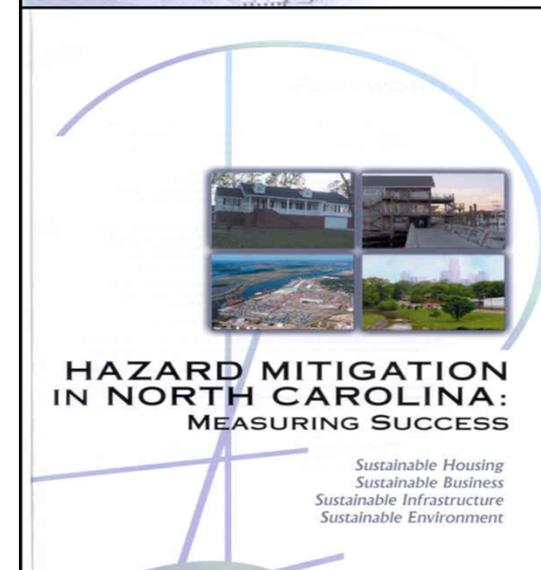
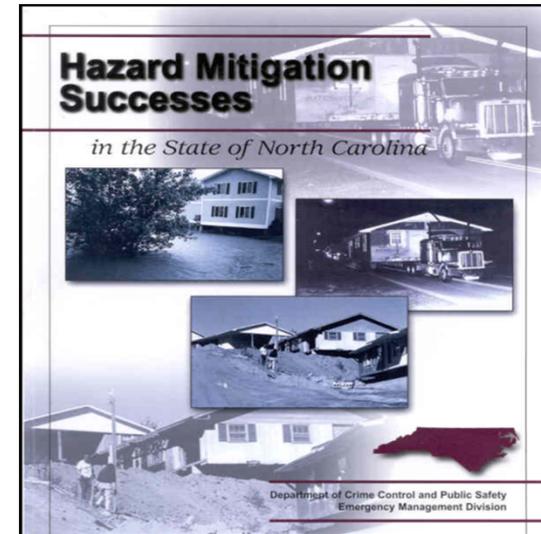


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Documentation of Losses Avoided

Area	#	Average Cost	Losses Avoided			B/C	
			Building	Contents	Displacement		
Washington							
Elevation	15	\$25	\$657	\$103	\$186	\$946	2.48
Acquisition	14	\$37	\$412	\$86	\$103	\$601	1.17
Belhaven							
Elevation	32	\$20	\$662	\$320	\$344	\$1,326	2.11
Kinston							
Acquisition	101	\$42	\$3,897	\$1,123	\$1,367	\$6,387	1.51
Total	162	\$36	\$5,628	\$1,632	\$2,000	\$9,260	1.61



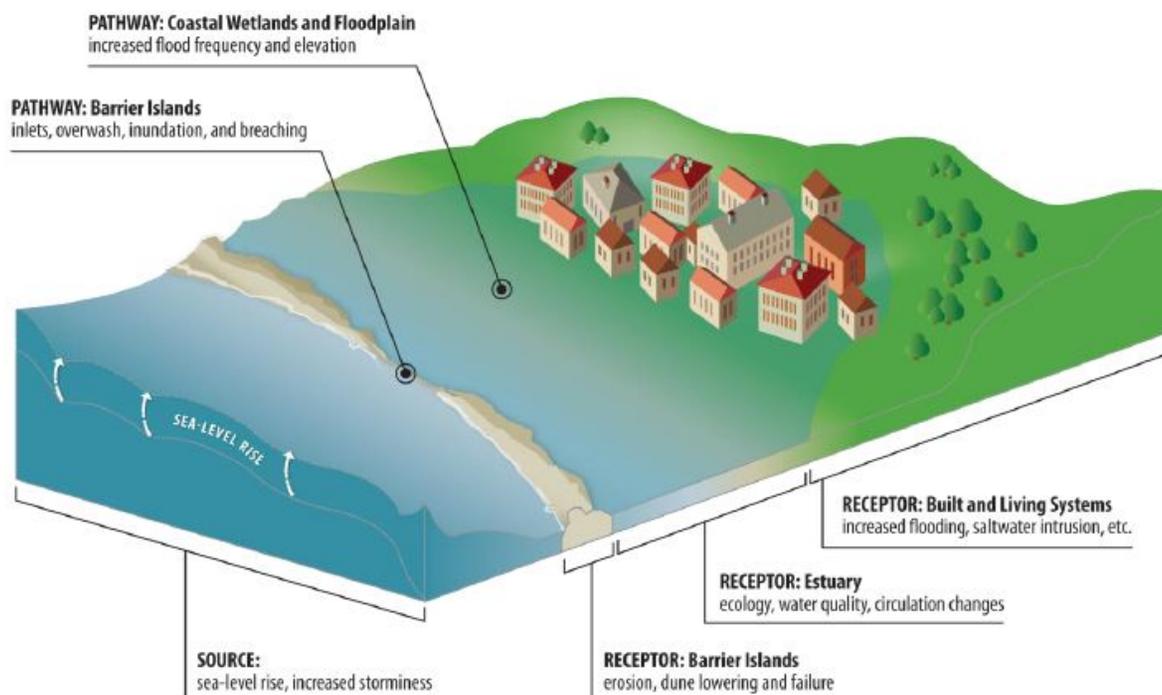
Hazards Management Lessons in North Carolina



- **Developing and sustaining flexible state-level recovery programs that address gaps in federal assistance should inform the nature of future climate change adaptation policies and programs.**
- **The post-disaster remapping of floodplains and other high hazard areas requires a strong champion, a clear risk communication strategy, and should be used to inform hazard mitigation, disaster recovery, and climate change adaptation.**
- **Emphasize the implementation of post-disaster hazard mitigation programs, including the adoption of new land use measures.**
- **Create a state recovery plan (under development).**
- **Create and sustain a state disaster recovery organization committed to hazards management and related elements of climate change adaptation.**
- **Integrate state hazard mitigation and disaster recovery planning into state climate change adaptation policy.**

North Carolina Sea Level Rise Impact Study

- Capability Assessment
- Adaptation Case Studies
- Flood Impact Management Strategies (FIMS)
- FIMS Evaluation





North Carolina Sea Level Rise Impact Study

Adaptation Case Studies

- **Florida**

- **“Given the recent reversal in state policy, regional organizations and universities have emerged as the predominant actors...”**

- **Maryland**

- **“...the state has taken a proactive approach in dealing with sea level rise, engaging multiple state-level agencies, encouraging local action, and initiating policy decisions.**

- **California**

- **“Despite its progressive image, California has had to battle with opposition within the state over the acceptance of climate change and the need for broader approaches and regulations to address and prepare for its effects.”**

North Carolina Sea Level Rise Impact Study



Draft Goals

- Build and support the ability the State to create policies, practices, and programs for adaptation that are based on the latest understanding of climate change.
- Create more resilient coastal infrastructure and critical public facilities.
- Reduce the vulnerability of coastal economies and future development.
- Protect and enhance the natural environment and the resources which depend on a healthy ecosystem.
- Protect public safety through the application of new and existing hazards management policies and programs.



North Carolina Sea Level Rise Impact Study



Evaluating Flood Impact Management Strategies

Feasibility: Technical, Administrative, Political, Legal, Fiscal, Environmental

Benefit: Land, Ecological, Agriculture / Aquaculture, Buildings, Infrastructure, Social

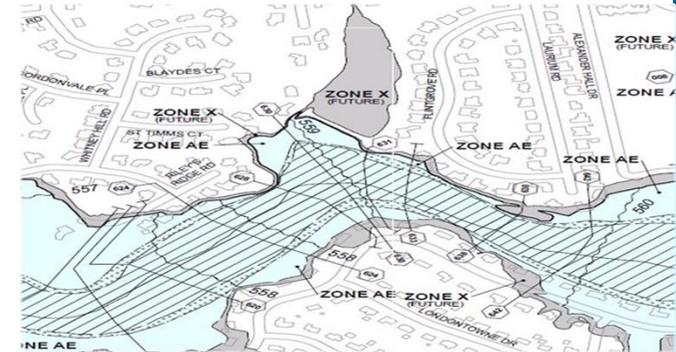
	Feasibility											Total	Receptor					
	Technical		Administrative		Political		Legal		Fiscal		Environment		Land	Ecological	Agriculture / Aquaculture	Buildings	Infrastructure	Social
Considerations of Feasibility (right) for Policy Options (below)	Access to Needed Tools	Complexity	Staffing	Maintenance	Political Support	Public Support	Consistent with State/Fed Laws	Potential Legal Challenges	Cost	Funding Availability	Limited Environmental Consequences	Consistent with State Environmental Goals						
Assess how state and national parks in NC will be affected by sea level rise	0	0	0	1	1	1	1	1	1	0	1	1	0.67	1	1			
Increase regulations for development in 100-year floodplain above NFIP standards	1	1	1	1	0	0	1	0	1	1	1	1	0.75		1	1	1	

Hazards Management, Climate Change Adaptation and Issue Salience



Hazards Management, Climate Change and Coastal Managers: Key Points of Intervention

- Large-Scale Resettlement in Coastal Communities and Cities (State and Local Coastal Management)
- Documentation of Coastal Change (State Coastal Management, Sea Grant, NOAA)
- Coordination with the Research Community (Sea Grant, NOAA)
- Outreach and Engagement (Sea Grant)
- Application of Risk Assessment and Analytical Tools (NOAA)
- Linking Coastal Management, Climate Change and Hazards Management Programs (NOAA, Sea Grant State Coastal Management)
 - Extension Disaster Education Network (EDEN)





FEMA and Climate Change Adaptation

- **To enhance climate research, monitoring, and adaptation capabilities, FEMA will continue to establish partnerships with other agencies and organizations that possess climate science and climate change adaptation expertise.**
- **FEMA will continue to study the impacts of climate change on the National Flood Insurance Program (NFIP) and incorporate climate change considerations in the NFIP reform report.**
- **FEMA will evaluate how climate change considerations can be incorporated into grant investment strategies with specific focus on infrastructure and evaluation methodologies or tools such as benefit/cost analysis.**
- **FEMA will seek to understand how climate change will impact local communities and engage them in addressing those impacts.**
- **FEMA will promote building standards and practices, both within FEMA programs and in general, that consider the future impacts of climate change.**
- **Through partnerships with the climate science community, FEMA will evaluate the potential impact climate change may have on existing risk data and the corresponding implications for Threat Hazard Identification Risk Assessment (THIRA) development and operational planning.**
- **FEMA will continue to pursue a flexible, scalable, well equipped, and well trained workforce that is educated about the potential impacts of climate change.**



Recommendations for North and South Carolina Coastal Managers

- **Integrate Hazard Mitigation Plans , Climate Change Adaptation Plans, Coastal Management Plans, Land Use Plans, and Disaster Recovery Plans**
- **Pre-Event Planning for Post-Disaster Recovery**
 - Planning
 - Funding
 - Window of Opportunity to Enact Change
- **Multi-Objective Planning and Coalition Building**
 - Episodic versus slow onset, potentially catastrophic disaster
 - The Salience of Climate Change

Human Settlements, Natural Hazard Risk and Climate Change: Are We Learning from our Mistakes?



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