



## Facing the Realities of Resilience: Challenges and Opportunities

**M. Richard DeVoe**  
Executive Director  
South Carolina Sea Grant Consortium  
Charleston, SC

on behalf of the  
*Charleston Resiliency Network*

# S.C. Sea Grant Consortium

- **Free-standing State Agency**

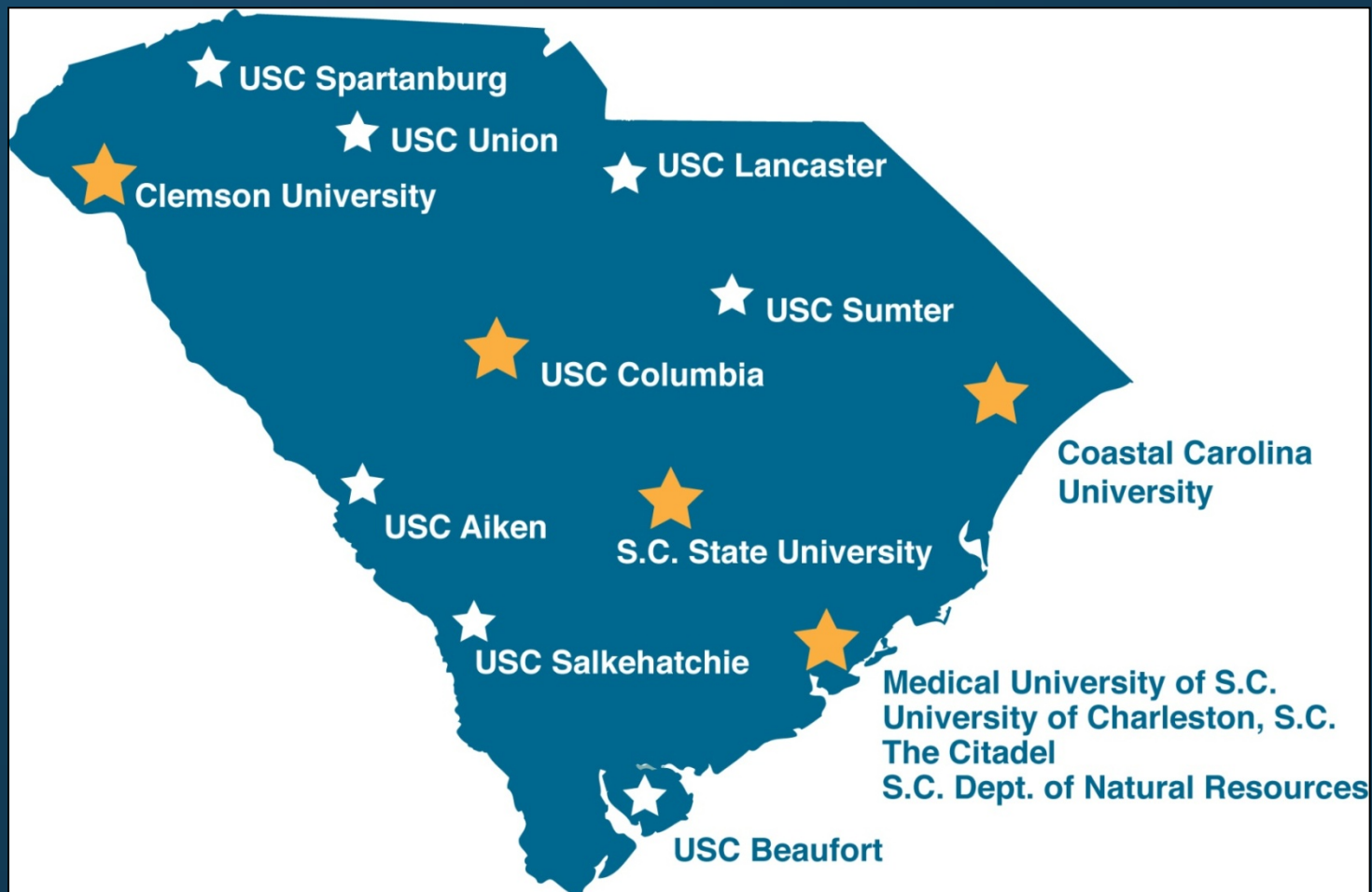
- Created 1978, Act No. 643
- Began operation 1980
- Certified by U.S. DOC

- **Functions**

- Scientific Research
- Extension and Outreach
- Education
- Communications
- "Facilitation"



# The Consortium in South Carolina





# NOAA National Sea Grant College Program



<http://seagrant.noaa.gov/Home.aspx>





# Consortium Mission



“The South Carolina Sea Grant Consortium generates and provides *science-based information* to enhance the *practical use and conservation of coastal and marine resources* that fosters a *sustainable economy and environment* for the state of South Carolina and its citizens.”

# Our Niche – in South Carolina

The Consortium is unique in that it provides mechanisms by which many interests can come together to **identify, discuss, generate, study, and share** information about our coastal and ocean environment and its economic, environmental, and sociological importance to the state.



# What is Resilience?

“The ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events” – NAS 2012



# What coastal resilience challenges does South Carolina face?

- Precipitation
- Hurricanes
- Sea Level Rise
- Flooding
- Coastal Growth



# Precipitation Trends

- Rainfall more variable
  - More intense/concentrated
  - More frequent floods
  - More frequent droughts



- Impacts/Effects
  - Water quality & quantity
  - Salinity/DO changes
  - Infrastructure
  - Public health

# Drought Impacts

- Repeated drought affects freshwater pond species
- Salinity intrusion from reduced flow
  - Tidal freshwater marsh habitat conversion
- Circulation changes lead to hypoxia events
- One of multiple stressors for marsh dieback
- Drainage, fire impacts on Carolina bays



## The Impact of Drought on Coastal Ecosystems in the Carolinas

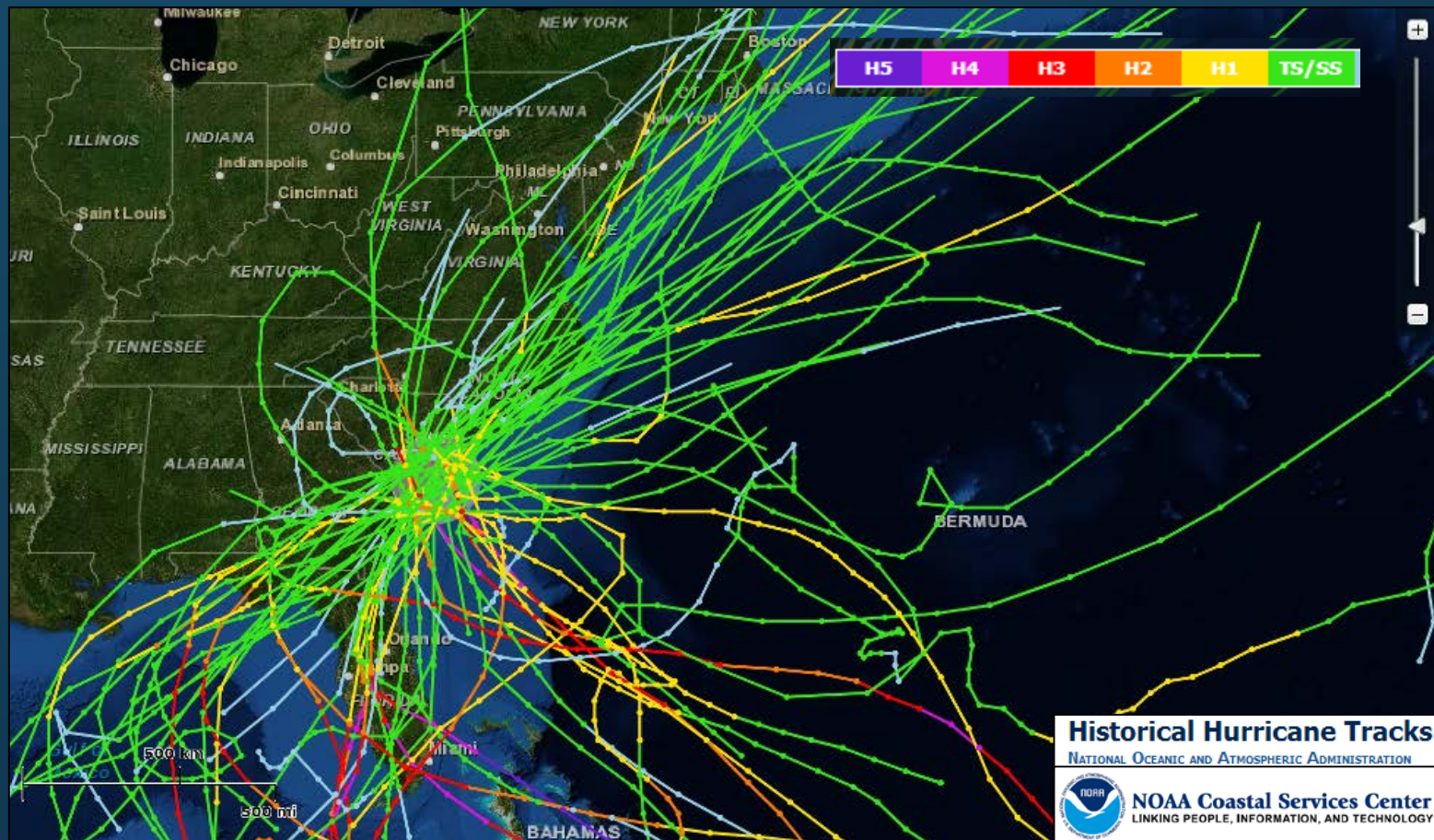
State of Knowledge Report January 2012

Steve Gilbert  
Kirsten Lackstrom  
Dan Tufford

**cisa** ■ ■ ■ ■ ■  
carolinas integrated sciences & assessments



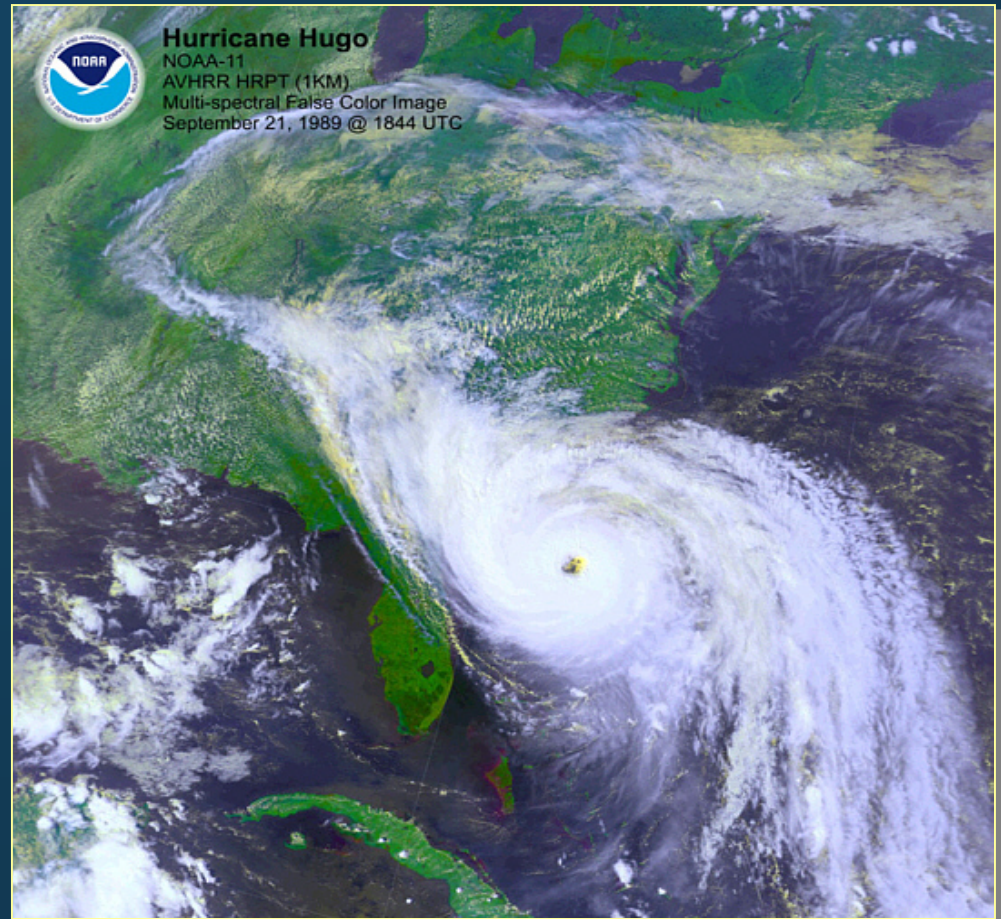
# Hurricanes/Tropical Storms 1900-2012





# Hurricane Hugo Approaching Landfall

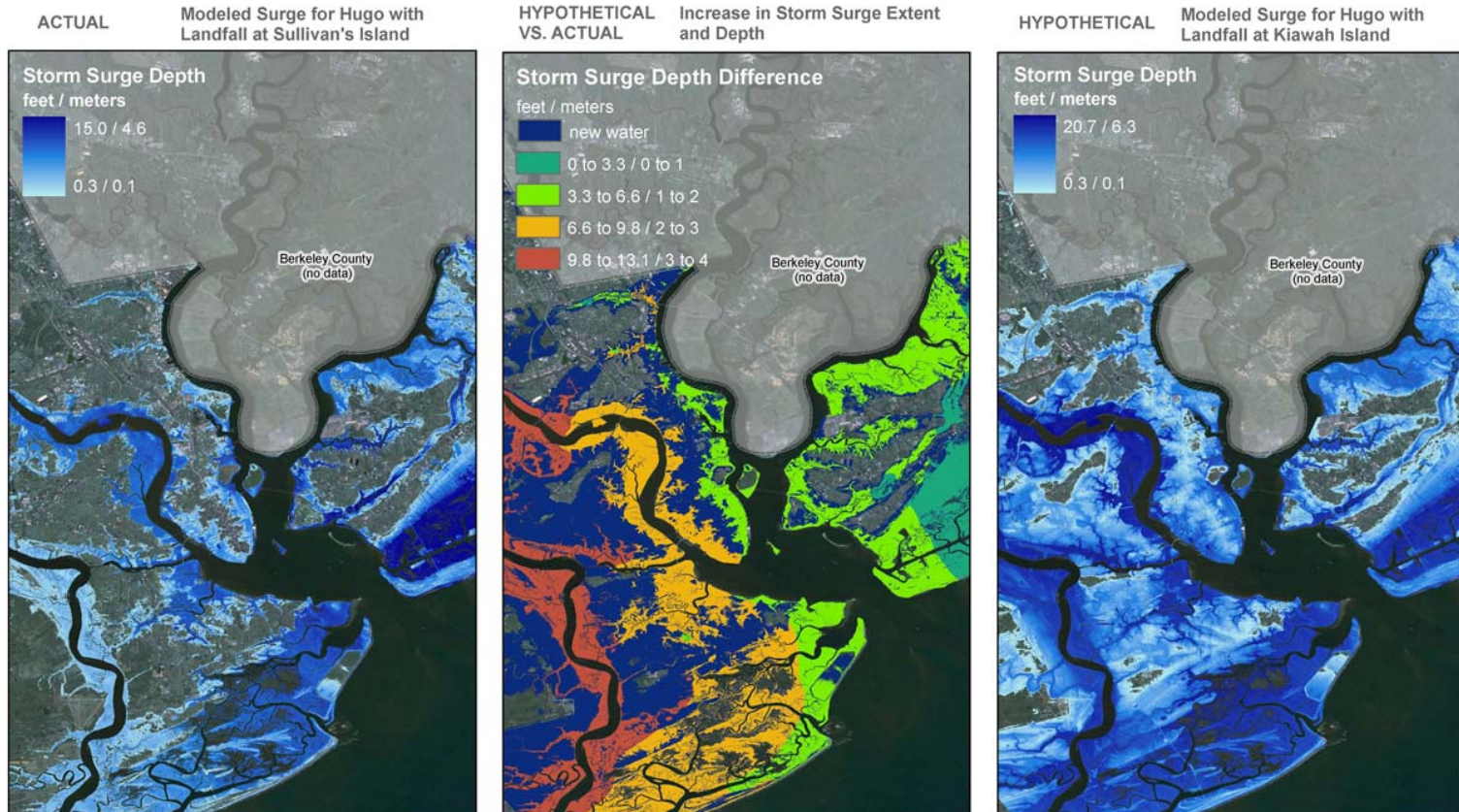
Charleston, SC  
September 21, 1989





# It Could've Been Worse!: A Visualization of Storm Surge if Hurricane Hugo Had Made Landfall Just 20 Miles to the South

Hurricane Hugo Characteristics at Landfall: Category 4; Winds=120 knots (138 mph); Pressure=935 MB; Northwest Movement=23 knots (26 mph); Tide=0.6 m (2.1 ft)



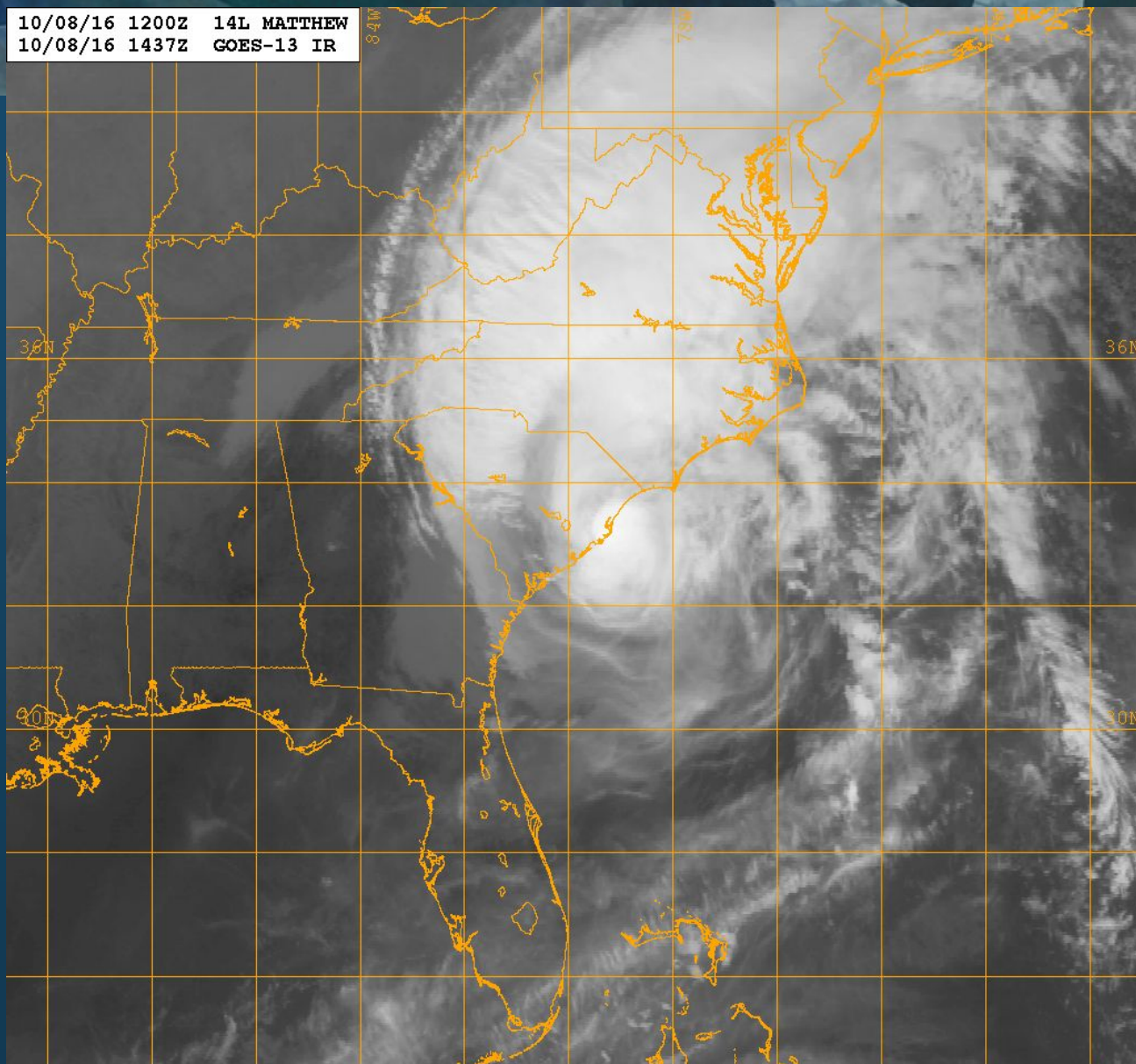
[http://www.erh.noaa.gov/chs/images/hugo/hugo\\_surgecomparison.jpg](http://www.erh.noaa.gov/chs/images/hugo/hugo_surgecomparison.jpg)



# Hurricane Matthew – October 8-9, 2016



10/08/16 1200Z 14L MATTHEW  
10/08/16 1437Z GOES-13 IR



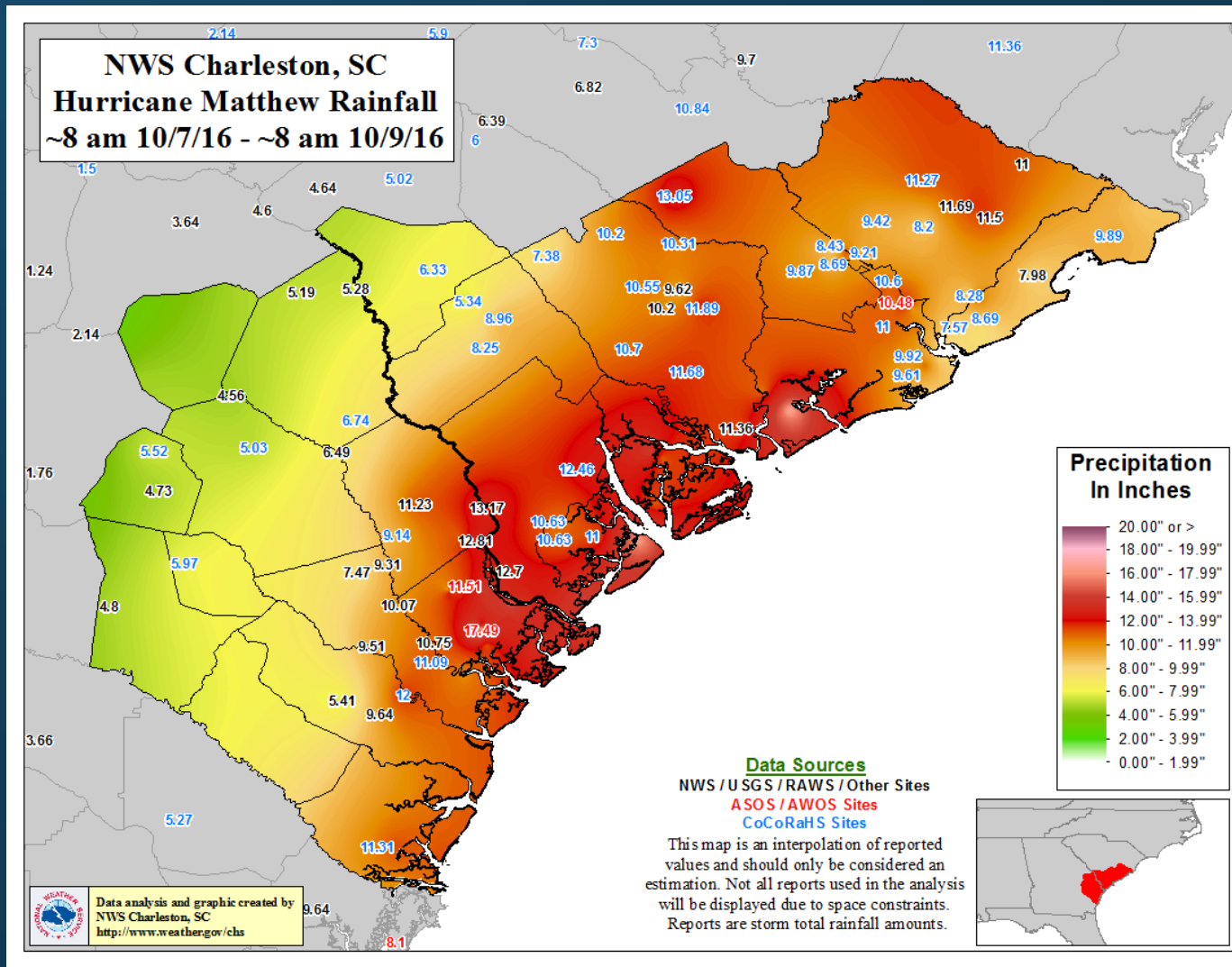
*South Carolina*

Naval Research Lab [http://www.nrlmry.navy.mil/sat\\_products.html](http://www.nrlmry.navy.mil/sat_products.html)  
<-- IR Temperature (Celsius) -->

-70 -60 -50 -40 -30 -20 -10 0 10 20

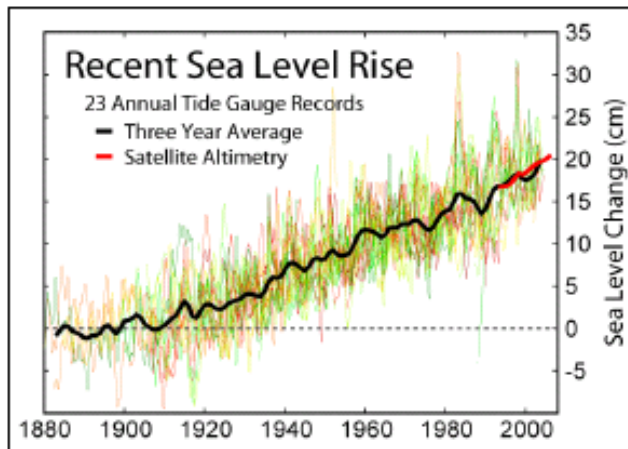
**South Carolina Sea Grant Consortium**



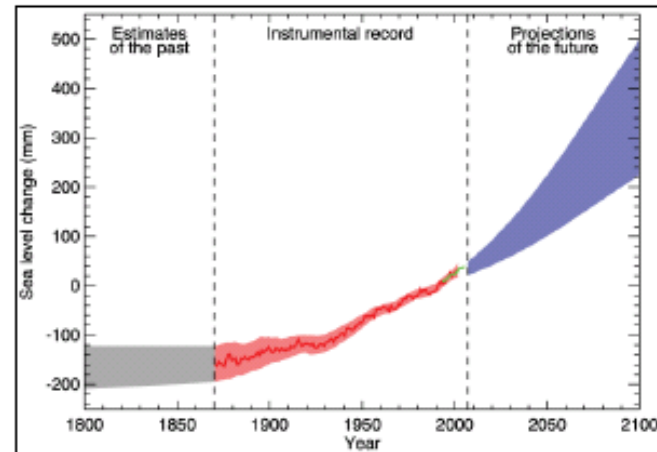




# Actual and Projected Sea Level Rise



(a) Historical sea level rise



(b) Projections of accelerated sea level rise

Figure 1(a-b): *Historical rates of sea level rise and projections of accelerated sea level rise.*  
*Sources: NOAA CO-OPS, 2009; IPCC, 2007.*

Charleston Harbor RSLR (1921 - 1999):

1.08 ft / 100 yrs

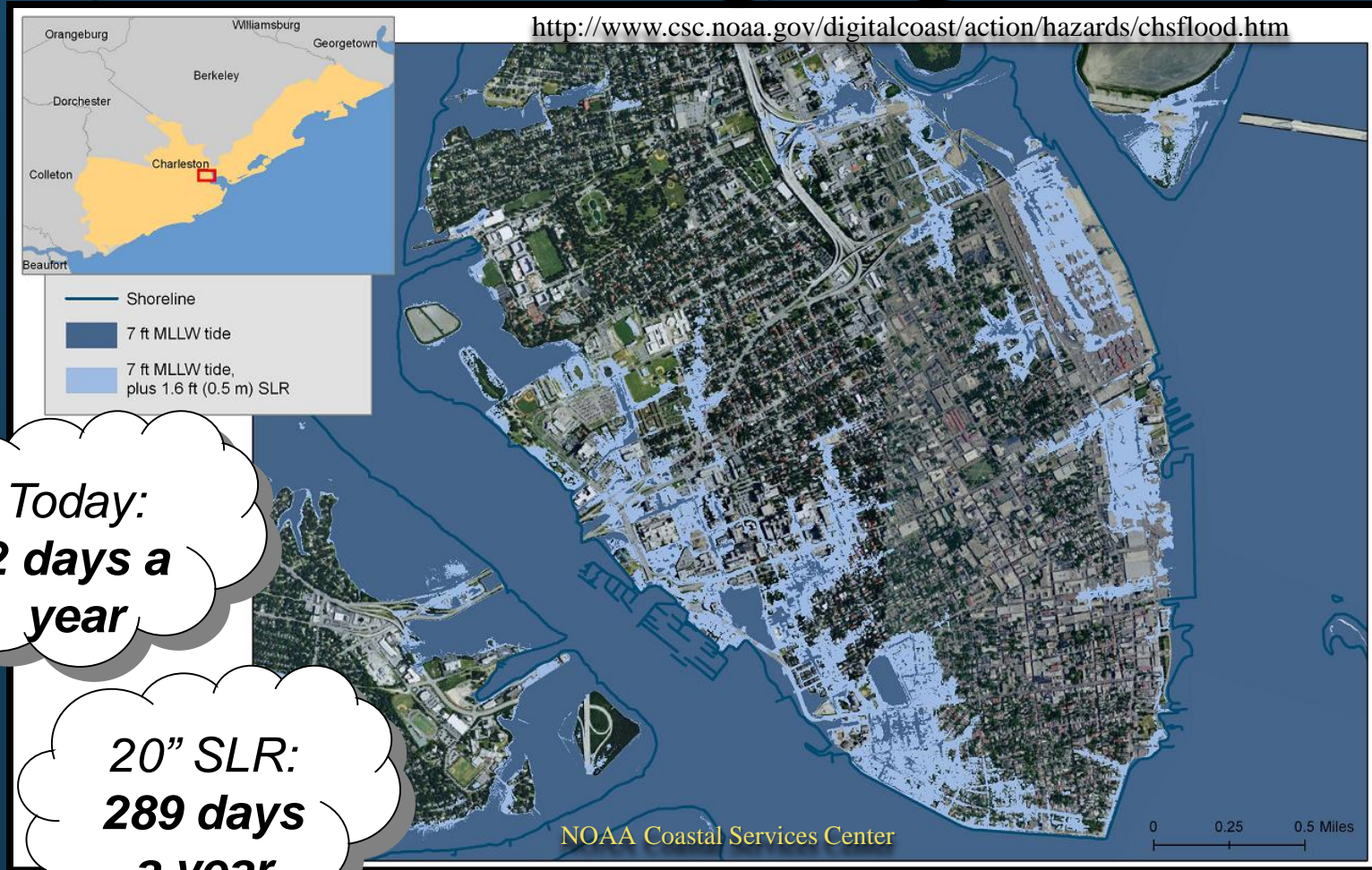
Springmaid Pier RSLR (1957 - 1999):

1.7 ft / 100 yrs

# SLR Impacts Before Loss of Land Area

- Altered flooding patterns
  - Changing floodplains
  - Shallow coastal flooding at high tides
  - Higher storm surge
- Changing erosion patterns
- Marshes moving inland
- More frequent salt water intrusion events

# SLR, Nuisance Flooding, King Tides





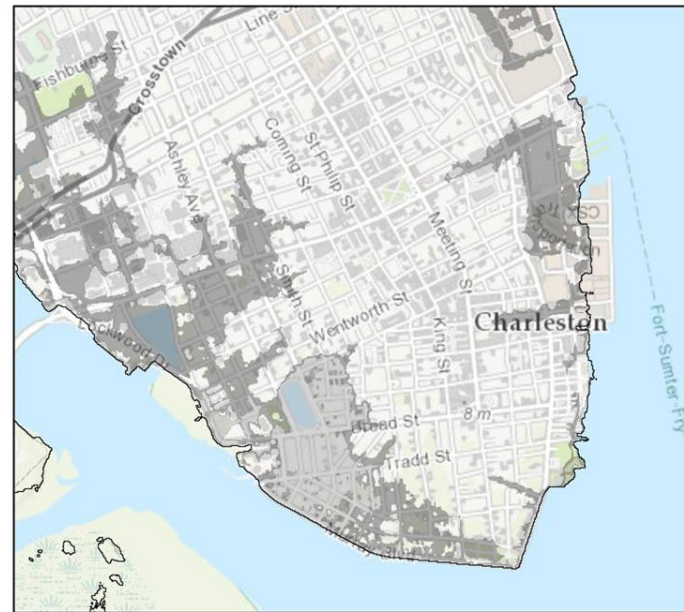
## Sea Level Rise and Artificial Fill in Charleston, SC



Historic Map (1849)



Potential Impact of Sea Level Rise



0 0.325 0.65 1.3 Miles

### Legend



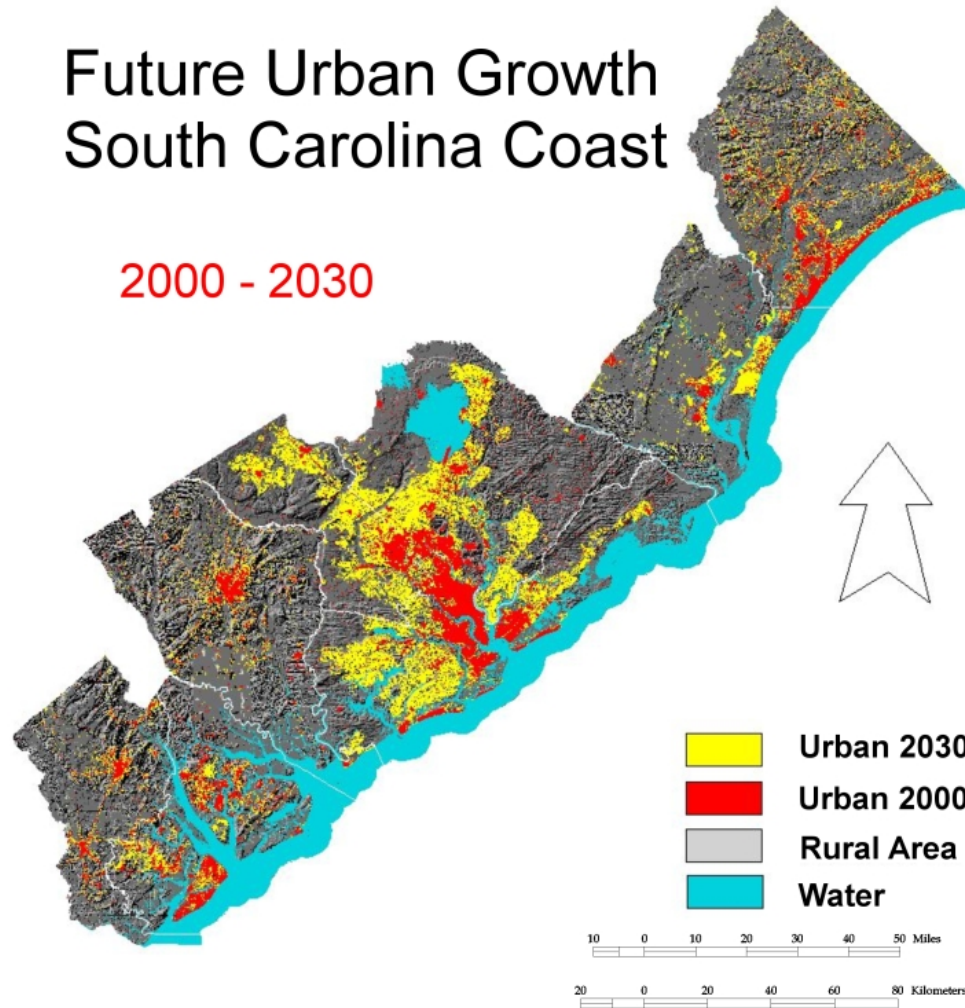
Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

# Land Use Change



## Future Urban Growth South Carolina Coast

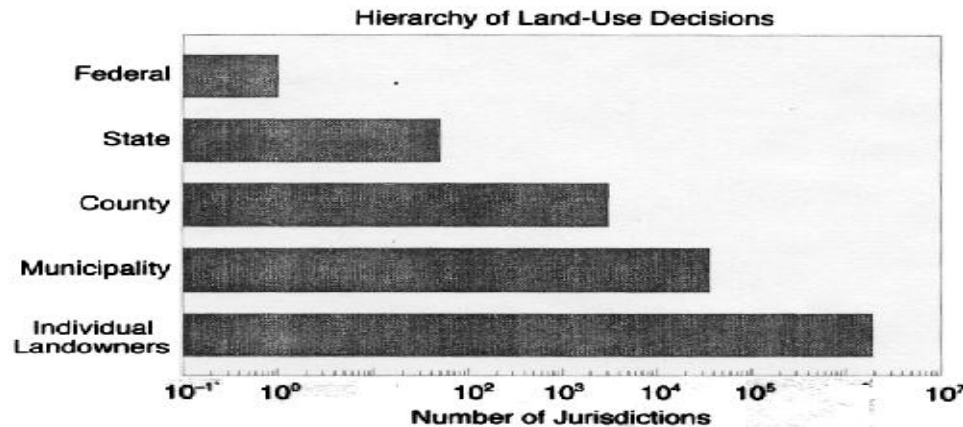
2000 - 2030



Source: STI, Clemson University



# Land Use Decision-making



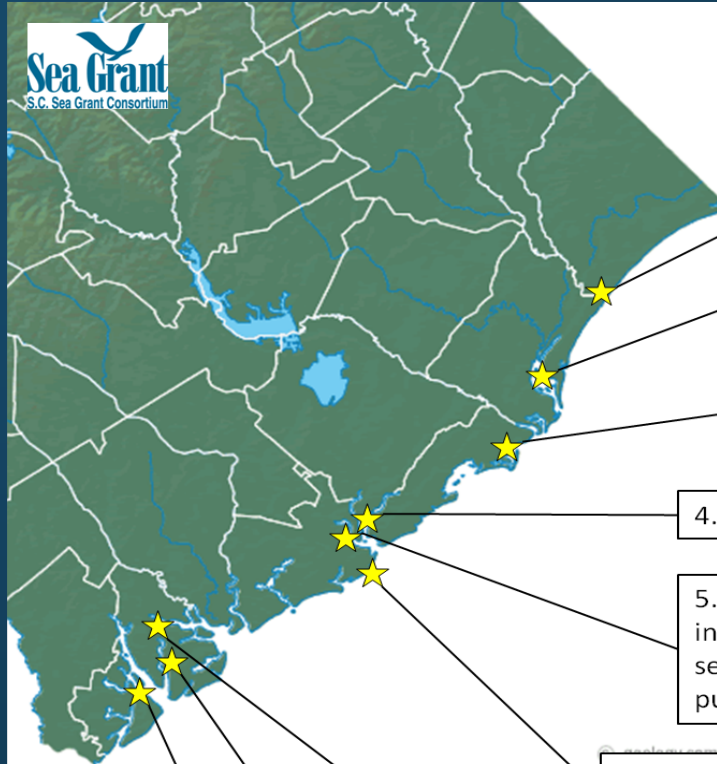
**FIG. 5. Hierarchy of domains of influence of decision makers who regulated land use in the United States during 1992. Most authority for land-use choices is vested in the lower levels of the hierarchy: individual landowners and local governments. In this figure, the number of landowners is the number of individual farms in the United States. Data are from the U.S. Bureau of the Census and the U.S. Census of Agriculture (U.S. Department of Commerce, 1975, 1977, 1991, 1996). Note logarithmic scale.**

*Source: Dale et al. 2001*

**~80% of all land use decisions are made at the municipal level**

# S.C. Sea Grant Consortium Efforts





*“Coastal Science Serving South Carolina”*

1. Supporting North Coast resilience

2. Assessing the impacts of saltwater intrusion in the Carolinas

3. Understanding the public’s perceptions of climate change in McClellanville

4. Charleston Resilience Network

5. Assessing vulnerable water infrastructure to storm surge and sea level rise and the cascading public health impacts

6. Pro-active beach and marsh management on Folly Beach

7. Participatory approach to preparing for sea level rise in Beaufort County

8. Citizen-driven sea level rise task force in Beaufort and Port Royal

9. Drought impacts on the blue crab fishery – citizen science to help support a predictive tool



# Investigating Climate Change Vulnerability and Resilience in McClellanville, SC

**Goal:** Develop an adaptation outreach plan for McClellanville, SC

Educational panels that provide outreach information on local hazards, future climate projections, and adaptation options to be placed outside town hall.

*Partners: Kitchen Table Climate Study Group of McClellanville, Oregon Sea Grant*



# Identify and address climate change vulnerability on the barrier island of Folly Beach

**Goal:** Provide hazard and climate vulnerability information to help update Folly Beach’s local comprehensive beachfront management plan and comprehensive plan

*Partner: City of Folly Beach*

# A participatory approach to preparing for sea level rise in Beaufort County, SC

Sea Level Rise Adaptation Report  
Beaufort County, South Carolina



March 2015

S.C. Sea Grant Consortium Product #SCSGC-T-15-02



**Goal:** Provide a participatory opportunity for Beaufort County to begin the process of engagement and learning that will lead to the development of plans for building community adaptive capacity.

*Partners: Beaufort County Planning Department, Social and Environmental Research Institute, North Carolina Sea Grant*



# Assist blue crab fishermen in identifying ways to adapt to a changing climate

**Goal:** Identify components of the blue crab fishery most affected by a changing climate and encourage fishermen participation in data collection to fill in data gaps useful in resource management.

*Partners: CISA, SERI,  
NC Sea Grant, ME Sea Grant*



# Low Impact Development Manual for Coastal S.C.

**Goal:** Develop a LID manual that includes updated best stormwater management practices to accommodate climate change

*Partners: ACE Basin CTP (lead),  
NI-WB NERR CTP,  
Center for Watershed Protection*



# Case Study of Lessons Learned

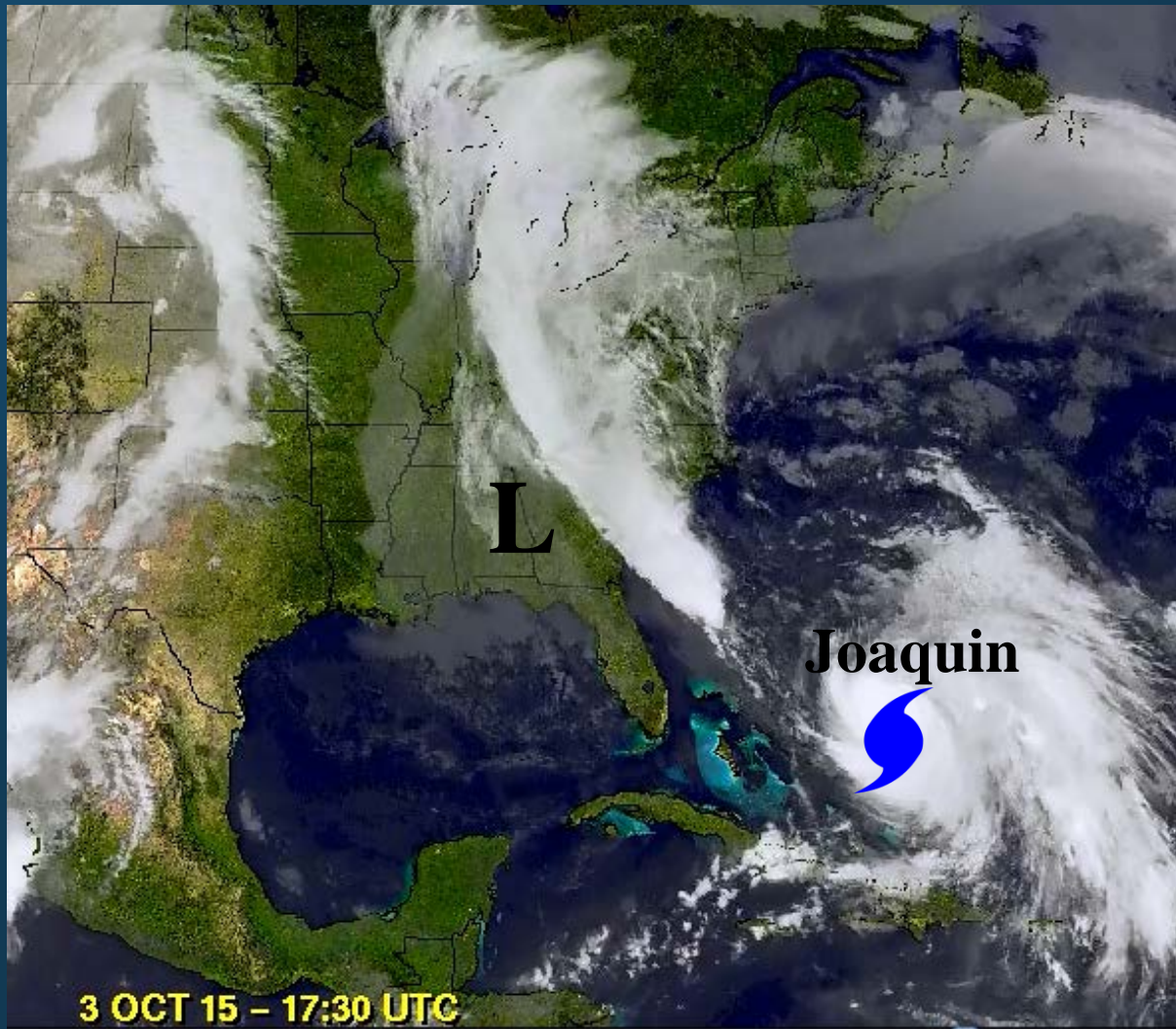




# The 2015 South Carolina Rain/Flood “Event”

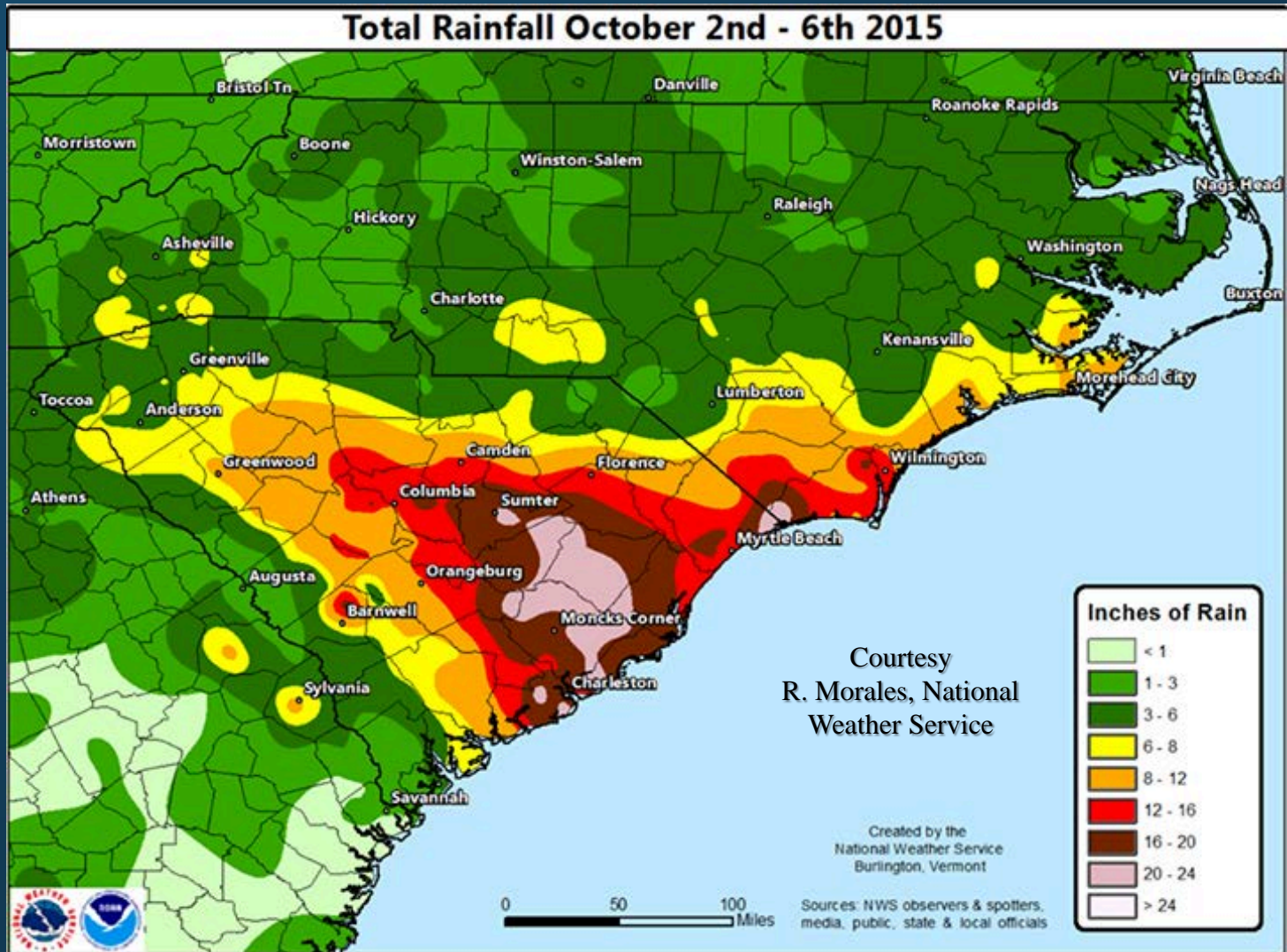


Photo courtesy of Nicole Carey



Courtesy  
R. Morales, National  
Weather Service







# "Understanding the 2015 Charleston Floods"

A Symposium Hosted by the Charleston Resilience Network  
in Partnership with the National Academy of Sciences

February 23, 2016

- Sectors:
  - Critical Infrastructure
  - Public Health/Safety
  - Business/Economics
- Questions addressed:
  - What worked?
  - What didn't work?
  - Lessons learned and recommendations?
- Moving forward:
  - A panel of local leaders to discuss future resilience issues



## *Charleston Resilience Network*



A volunteer-based effort composed of public and private sector stakeholder organizations within the Charleston, South Carolina, metropolitan area that have a collective interest in the resilience of communities, critical infrastructure and socio-economic continuity to episodic natural disasters and chronic coastal hazards.

[www.charlestonresilience.net](http://www.charlestonresilience.net)



# Realizations and Observations...

- Resiliency is not new to the South Carolina coastal region; we have a foundation to build upon – Hugo was our wake-up call
- Our region has benefitted from the work of many institutions and organizations on resiliency issues; we need to continue to take advantage of the multitude of resources that are at our disposal
- The science (e.g., of “flooding”) and information (e.g., design standards) we use in decision-making must be refined and applied at appropriate time & spatial scales
- We must think a bit further into the future when making decisions; and decisions we make should be made with a bit more caution than in the past





# Take-Homes...

- Partnerships – Build, Develop, Nurture, Expand, Enhance
- Relationships – “Never do anything by yourself”
- Leveraging – Resources, Information, Tools, Technologies, People
- Learning – Research, Education, Experience, Training
- Messaging – Technical, Risk, Ramifications, Prevention, Mitigation, Response
- Awareness – Audiences, Pathways, Methods
- Communications – Consistent, Proactive, Continuous
- Planning – Preparation, Practice, Implementation
- Responsibility – All need to take Ownership



# Moving Ahead...

- Develop coalitions and connections at grass-roots level
- Discuss and align common goals, themes, and messaging
- Identify information and capability gaps
- Cultivate resources to accomplish priority needs
- Don't wait until it's an emergency
- Anticipate future events ("How you do business every day is how you will do business during an event")
- Plan for multiple scenarios – be prepared for multiple outcomes
- Need to begin to look at future flood risks



# Practicing (we think...) what we preach...

The SC Sea Grant Consortium, on behalf of CRN, secured two awards:

- **NOAA-NOS Regional Coastal Resiliency Grant**
  - Parcel-level flood mapping and community engagement within four selected communities/neighborhoods in Charleston, SC region
- **DHS-NIPP Security and Resilience Challenge**
  - Development of multi-hazard coastal resiliency assessment and adaptation indices and tools applicable at local scales
  - Pilot is Charleston, SC region; to be expanded





# Practicing (we think...) what we preach...

- Attributes of both programs:
  - Community/neighborhood scale studies and information transfer
  - Citizen/stakeholder engagement beginning-to-end and across diverse populations
  - Pilots for possible application to other neighborhoods along coast
  - Capacity building and “awareness raising” among local leaders
  - Result in an integrated network of all “service providers” for all coastal populations





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