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of Engineers

Philadelphia District

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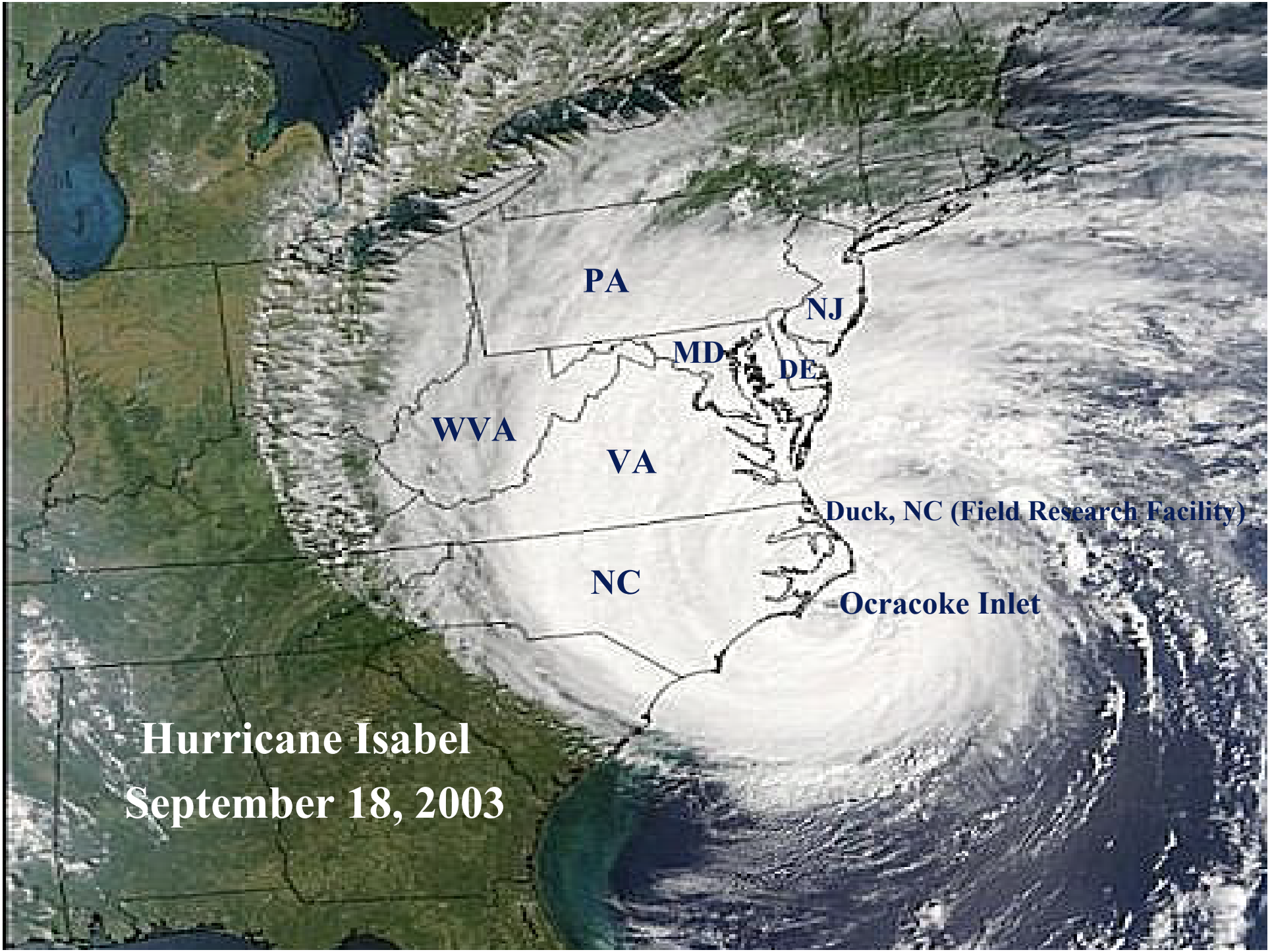
Hurricane Isabel Post-Storm Assessment

- Study Manager
  - Jane Jablonski (Coastal Planning Center of Expertise)
- Purpose
  - Evaluate Hurricane Isabel's impacts along coastal areas with and without Federal shore protection
- Study Team
  - Philadelphia District
  - Norfolk District
  - Wilmington District
  - Institute for Water Resources
  - Engineering Research and Design Center

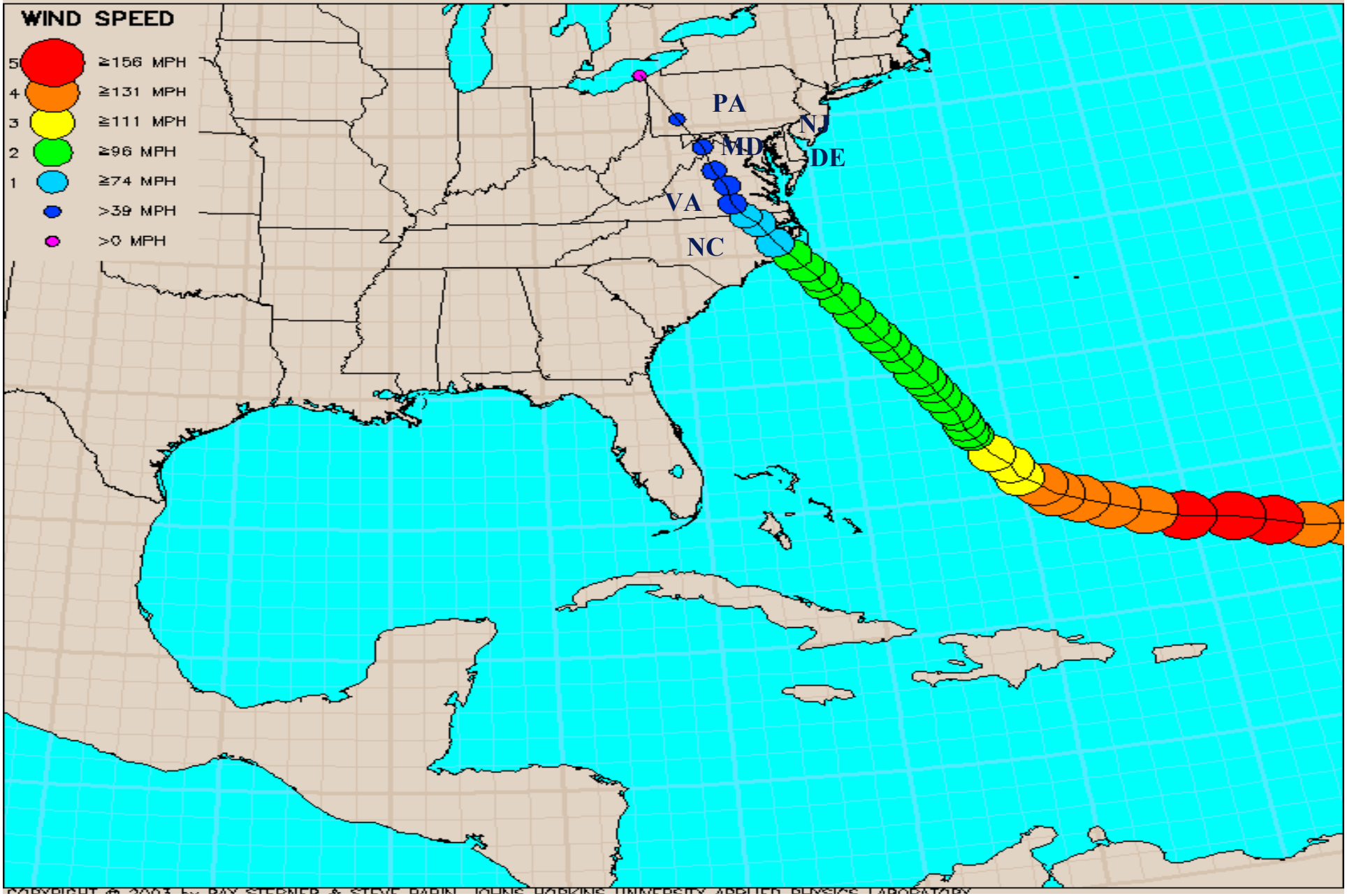

PA
NJ
MD
DE
WVA
VA
Duck, NC (Field Research Facility)
NC
Ocracoke Inlet
Hurricane Isabel
September 18, 2003


ARGUS2.1 snap ArgusUza Thu Sep 18 15:00:08 2003 EST(5EDT F: 1063915608
Duck Pier height of storm...17-18 ft waves at piers end!!
C: 1 S: 1 Inc: 0 Qual: 80

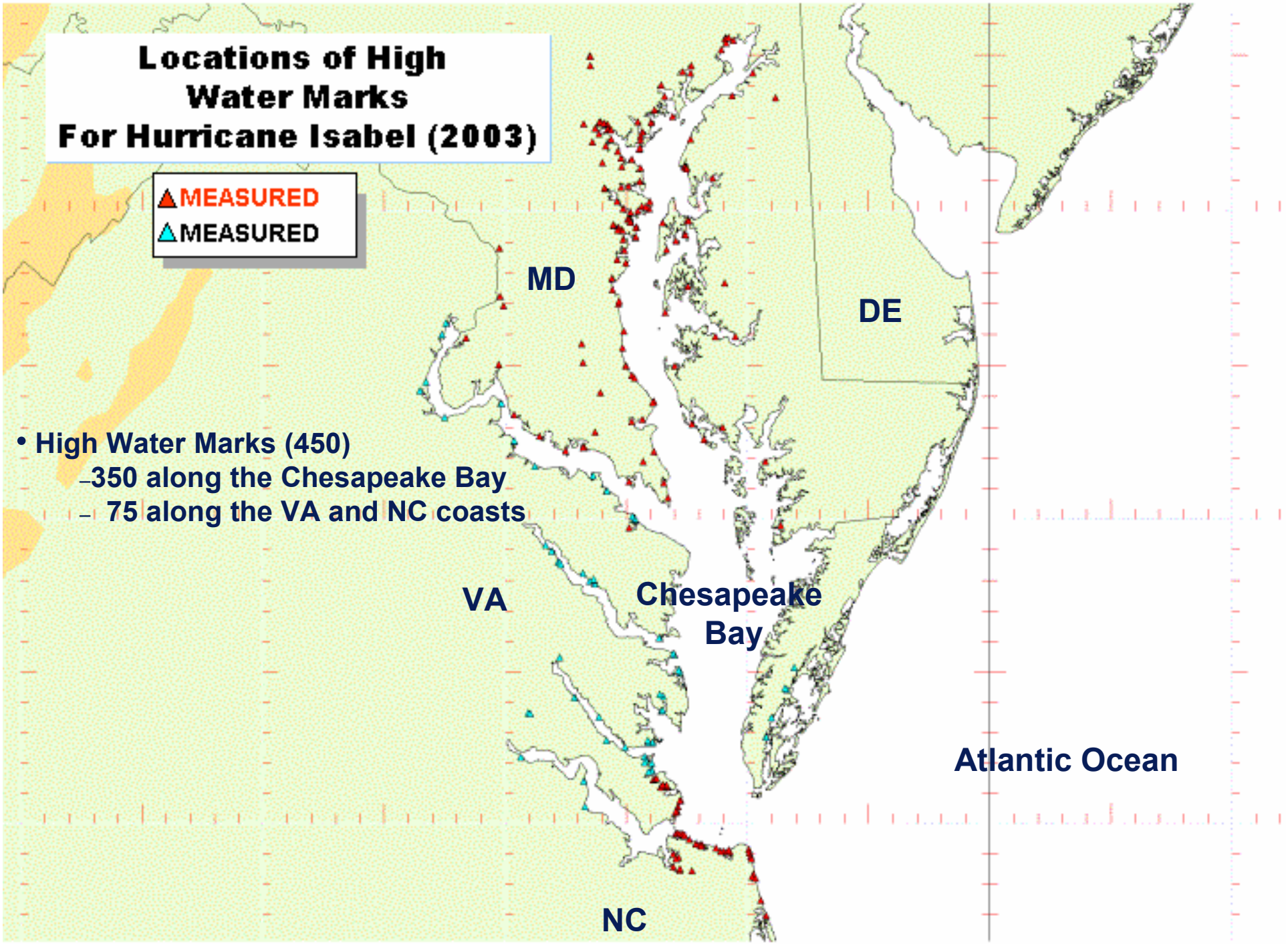

ARGUS2.1 snap ArgusU2a Fri Sep 19 15:00:08 2003 EST(5EDT) F: 1063998008
Duck Pier the next day!
C: 1 S: 1 Inc: 0 Qual: 80

Hurricane Isabel

13:00 Sat September 6, 2003 to 15:00 Fri September 19, 2003 UTC




75°00'W
DELAWARE CITY, DE
REEDY POINT, DE
Baltimore
BALTIMORE, FORT MCHENRY, MD
CHESAPEAKE CITY, MD
ATLANTIC CITY, NJ
TOLCHESTER, MD
SHIP JOHN SHOAL, NJ
Annapolis
BRANDYWINE SHOAL LIGHT, DE
Washington D.C.
U.S. NAVAL ACADEMY, MD
CAPE MAY, NJ
WASHINGTON, DC
LEWES, FT. MILES, DE
CAMBRIDGE, MD
Potomac River
OCEAN CITY INLET, MD
SOLOMONS ISLAND, MD
COLONIAL BEACH, VA
LEWISETTA, VA
Chesapeake Bay
9/19/03
0300 UTC
Richmond
WINDMILL POINT, VA
HURRICANE ISABEL
18-20 SEPT 2003
WACHAPREAGUE, VA
GLOUCESTER POINT, VA
KINGSMILL, VA
KIPTOPEKE, VA
SCOTLAND, VA
CHESAPEAKE BAY BRIDGE TUNNEL, VA
SEWELLS POINT, VA
James River
MONEY POINT, VA
9/18/03
23:00 UTC
Norfolk
Atlantic Ocean
DUCK, NC
OREGON INLET, NC
Raleigh
9/18/03
19:00 UTC
CAPE HATTERAS, NC
35°00'N
BEAUFORT, NC
9/18/03
15:00 UTC
Path of Hurricane Isabel
CO-OPS Water Level Gauges
75°00'W



- High Water Marks (450)
  - 350 along the Chesapeake Bay
  - 75 along the VA and NC coasts

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Hurricane Isabel

- Hurricane Isabel was the 6th most significant hurricane in U.S. history in terms of FEMA disaster relief funding up to that point in time .
  - More significant events in descending order included Hurricanes Georges (’98), Andrew (’92), Hugo (’89), Floyd (’99), and Fran (’96).
  - Does not include 2004 hurricanes.
- Presidential disaster declarations in Washington, DC; DE; MD; NC; VA; and WV.
  - FEMA disaster assistance estimated at $558.4 million.

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Flood Insurance Claims by State

State	Total # of Claims	Total Building ($)	Total Content ($)
Pennsylvania	166	1,387,527	131,573
West Virginia	50	279,390	45,517
Delaware	60	648,724	553,716
Washington, D.C.	8	216,138	84,345
Maryland	2,292	50,645,374	7,046,633
Virginia	11,040	184,159,838	25,165,007
North Carolina	6,435	81,063,587	13,529,785
Total	20,051	318,400,578	46,556,576


Potomac River near Fredericksburg, VA


Baltimore (Inner Harbor)


Baltimore (Inner Harbor)


Baltimore (Fells Point)


Baltimore (Fells Point)

Annapolis,MD (Market Place)

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Hurricane Isabel Post-Storm Assessment Primary Objectives

- For protected coastal areas, address physical and economic performance of existing COE shore protection projects impacted by Isabel
  - Virginia Beach-VA BEC & HP
  - Sandbridge-VA BEC & HP
- For unprotected coastal areas, address potential damages that could have been prevented during Isabel had the proposed COE shore protection project been in place
  - Dare County, NC Beaches Project
    - Kitty Hawk, Kill Devil Hills, Nags Head


Federal Shore Protection Project at Virginia Beach
▪$120 M shore protection project completed by the Norfolk District in 2002
▪ 300 foot-wide beach (tripled existing beach)
▪ seawall at elev. +13.5 ft NGVD along the southern half of project
▪berm at elev. +10.0 ft NGVD
▪dune w/ a top elev. +18.0 ft NGVD along northern half of project
▪ 4 M cy sand over 6.3 miles of shoreline
▪ southern 4 miles of shoreline contains the "resort strip"
Virginia Beach, VA

Virginia Beach, VA

Without Project Damages	$107,521,000
With Project Damages	$ 614,000
Damages Prevented	$106,907,000

(Oct 2003 Price Level)

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Economic Damage Assessment Virginia Beach

Without Project Damage Analysis

- Current total value for properties along the oceanfront
  - Residential property ($408,100,000) (incl. high rise condos)
    - » Oceanfront property not available for less than $1,250,000
  - Commercial property ($357,000,000)
  - Government property ($20,400,000)

- Historical stage-damage data used in the original justification of the project was updated using appropriate growth indices and then related to the estimated storm frequency of Isabel (60 yr event)

- Based on a HWM (still water-no wave runup) near an inlet adjacent to the project, an elevation of +8.0 ft NGVD was used as an index of damage

- Total Without Project Damages estimated at $107,521,000
  - Residential ($74,103,000)
  - Commercial ($21,673,000)
  - Utilities/Bulkheads ($11,745,000)

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Economic Damage Assessment Virginia Beach

With Project Damage Analysis

- Actual damages during Isabel relatively minor and limited to a few structures (one structure accounted for 70% of the damages)
- City of Virginia Beach was primary source of storm damage info as well as flood insurance claims data
- Total With Project Damages estimated at $614,000

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Economic Damage Assessment Virginia Beach

Damages Prevented during Isabel

– Without Project Damages		$107,521,000
– With Project Damages	-	$ 614,000
– Damages Prevented		$106,907,000


Sandbridge, VA
(prior to Federal project)
Hurricane Gordon-1994

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Sandbridge, Virginia

Federal Shore Protection Project at Sandbridge

- $11 M shore protection project completed by the Norfolk District in 1998
- 50 foot-wide berm at elevation +7.0 feet NGVD
- 1.1 M cy sand over 5 miles of shoreline

Storms threaten property and infrastructure.

Prior to beachfill- Dec 1994

After beachfill- July 2000


Without Project Damages $29,454,000
With Project Damages $ 2,990,000
Damages Prevented $26,464,000
(Oct 2003 Price Level)
Sandbridge, VA

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Economic Damage Assessment Sandbridge, VA

Without Project Damage Analysis

- Primarily residential properties w/ interspersed publicly-owned lands
  - About 1,000 homes along the oceanfront (incl. first two rows of structures)
    - » Range from small traditional beach cottages to large multi-family homes
    - » Older homes valued at $750,000, newer homes valued at $1,500,000
    - » Large number of homes are vacation rentals
  - 236 oceanfront land parcels (206 parcels contain residential structures)
  - No commercial properties along oceanfront

- Current total value for properties along the oceanfront
  - Residential (incl. first two rows of structures) ($212,500,000)

- Historical stage-damage data used in the original justification of the project was updated using appropriate growth indices and then related to the estimated frequency of Isabel (60 yr event)

- Based on a HWM (still water-no wave runup) near the project, an elevation of +8.0 ft NGVD was used as an index of damage

- Total Without Project Damages estimated at $29,454,000
  - Residential ($9,169,000)
  - Utilities/Bulkheads ($20,285,000)

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Economic Damage Assessment Sandbridge, VA

With Project Damage Analysis

- More damage at Sandbridge than at Virginia Beach
- Source of actual damage information
  - personal interviews
  - comprehensive questionnaire survey
    - » 440 surveys distributed to homeowners along the first two blocks of oceanfront property (45.5% response rate)
  - FEMA flood insurance claims
- Total With Project Damages
  - Surveys: $2,990,000 (used in analysis)
  - FEMA: $1,383,967

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Economic Damage Assessment Sandbridge, VA

Damages Prevented during Isabel

- Without Project Damages $29,454,000
- With Project Damages - $ 2,990,000
- Damages Prevented $26,464,000

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Economic Damage Assessment Summary Virginia Beach and Sandbridge, VA

Total Damages Prevented during Isabel

Virginia Beach	$106,907,000
Sandbridge	$ 26,464,000
Total	$133,371,000


Kitty Hawk, NC

•Data from over 400 building inspections and 130 residential surveys are being used to develop erosion, wave, and inundation damage relationships for use in economic models

Kitty Hawk, NC

Nags Head, NC during Isabel


Nags Head, NC

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Dare County, NC Damage Estimates

- Dare County, NC had over $167 M in structural damage (mostly residential property)
  - $96.8 million on Hatteras Island
  - $25.2 million in Nags Head
  - $20.6 million in Kitty Hawk
  - At least 133 structures were destroyed and over 1,000 structures suffered major damage

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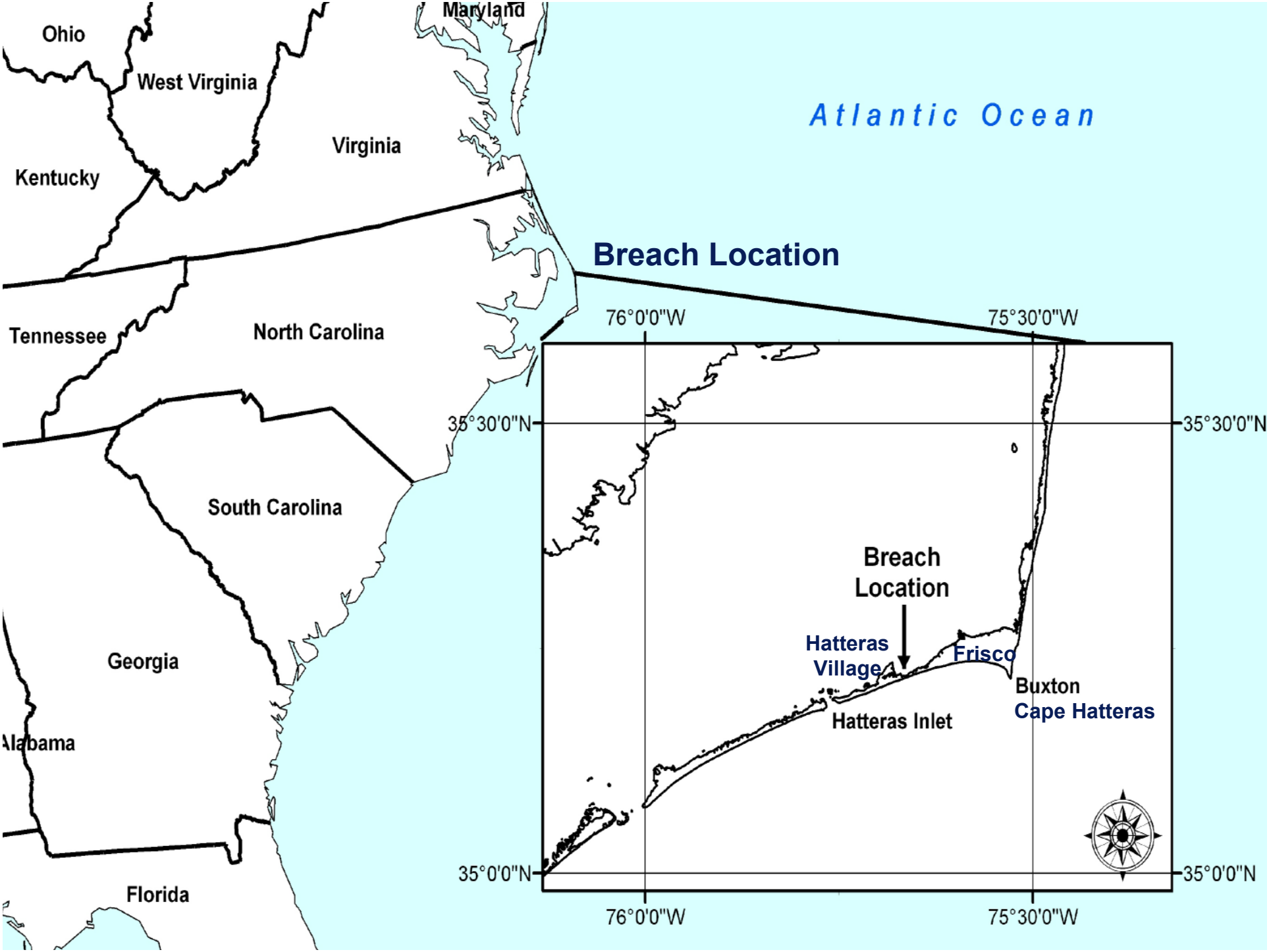
- North Carolina Statewide Public Assistance following Hurricane Isabel (about $87 M)
  - $44.1 million in Debris Removal
  - $20.2 million in Protective Measures
  - $16.6 million in Public Utilities
  - $4.5 million in Recreation Facility Repair
  - $1.5 million in Roads and Bridges


Ohio
West Virginia
Maryland
Virginia
Kentucky
Tennessee
North Carolina
South Carolina
Georgia
Alabama
Florida
Atlantic Ocean
Breach Location
76°0'0"W
75°30'0"W
35°30'0"N
35°0'0"N
Breach Location
Hatteras Village
Frisco
Buxton
Cape Hatteras
Hatteras Inlet

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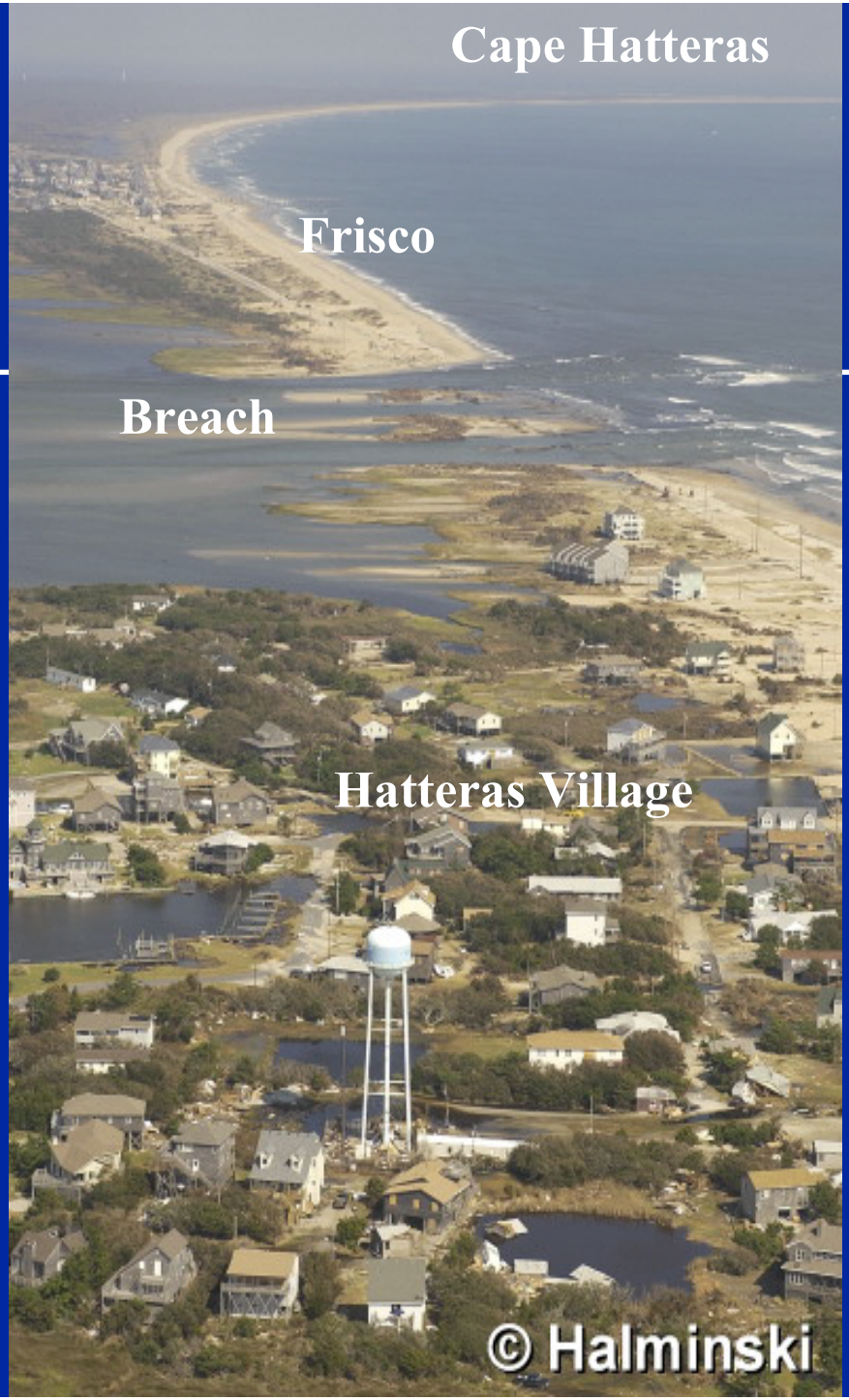
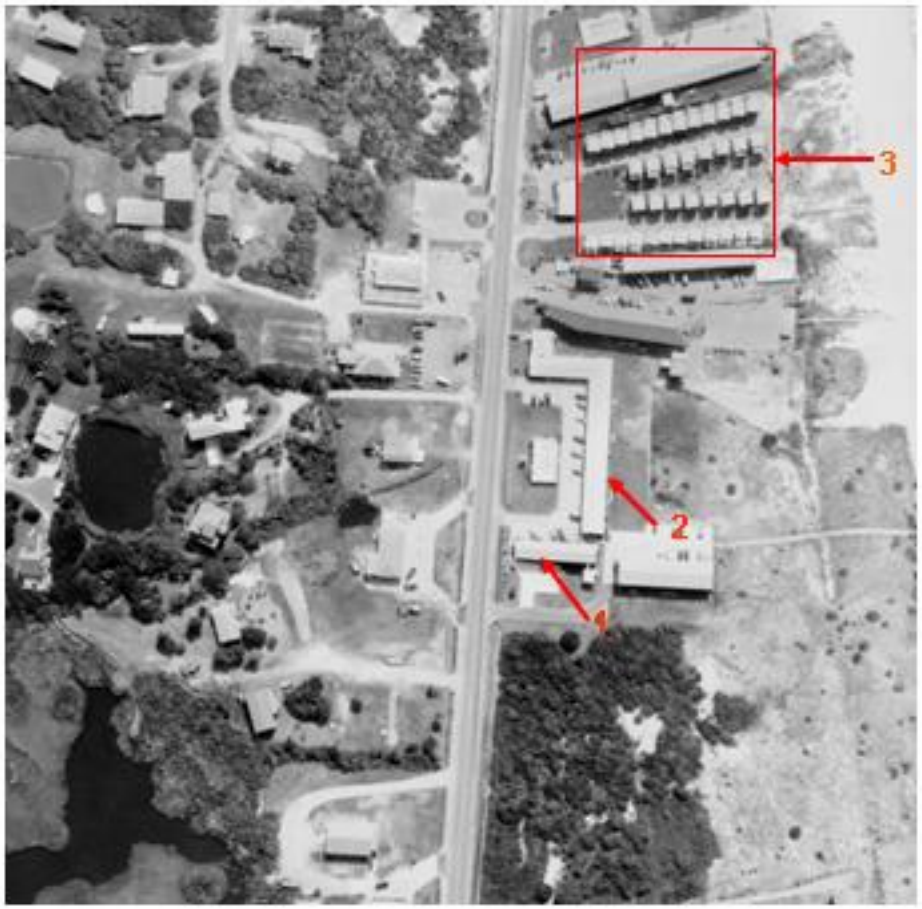


Hurricane Isabel Damage Assessment

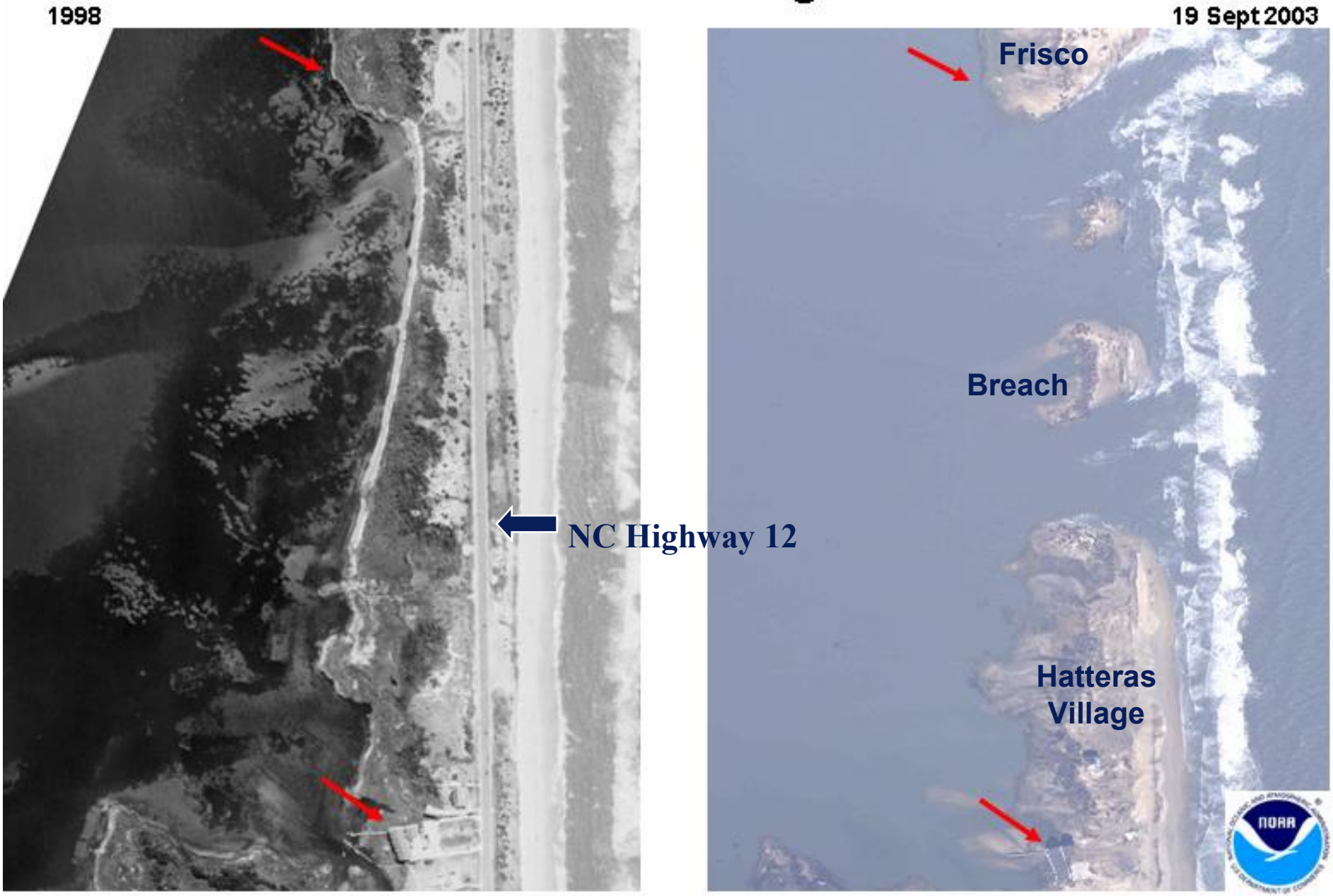
Hatteras Village, North Carolina

1998



September 19, 2003

Hurricane Isabel Damage Assessment



Cape Hatteras National Seashore, North of Hatteras Village, NC.


Hatteras
Village
Frisco
Breach


Breach


Breach Closed
© Halminski

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Hurricane Isabel Post-Storm Assessment Primary Objectives

- Tell the story of the Breach
  - Emergency measurements made to characterize the breach (tides, currents, morphologic response) will be analyzed to quantify and document the formation and evolution of the breach
  - Document the process of closing the breach
  - Lessons learned

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Hurricane Isabel Post-Storm Assessment Primary Objectives

- Establish Coastal Storm Damage Relationships for Inundation, Waves, and Erosion
  - Determine coastal storm damage relationships based on post-storm damage data collection in Dare County, NC
  - Use damage functions in GRANDUC (Generalized Risk and Uncertainty-Coastal) coastal storm damage model to determine damages that could have been prevented during Isabel

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Hurricane Isabel Post-Storm Assessment Primary Objectives

- Document Storm Characteristics and Morphologic Responses to Isabel
  - Storm Characteristics (combination of modeling, measured data, and data analysis)
    - storm meteorology hindcast (wind and atmospheric pressure fields)
    - wave hindcast
    - water level hindcast
  - Morphologic Response Parameters (pre- and post-storm topography and bathymetry)
    - shoreline change
    - dune retreat
    - beach and dune volume loss
    - offshore gains and losses

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Hurricane Isabel Post-Storm Assessment Primary Objectives

- Address Model Performance
  - Wave model performance (WAM)
  - Water level (tides/surge) model performance (ADCIRC)
  - Storm-induced beach profile response model performance (SBEACH)