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Coastal and Marine Geology Program and the National Assessment of Coastal Change Hazards

U.S. Department of the Interior
U.S. Geological Survey

USGS Coastal and Marine Geology Program

- Regional Cooperative Studies
- Coral Reef Studies
- National Coastal Change Hazards

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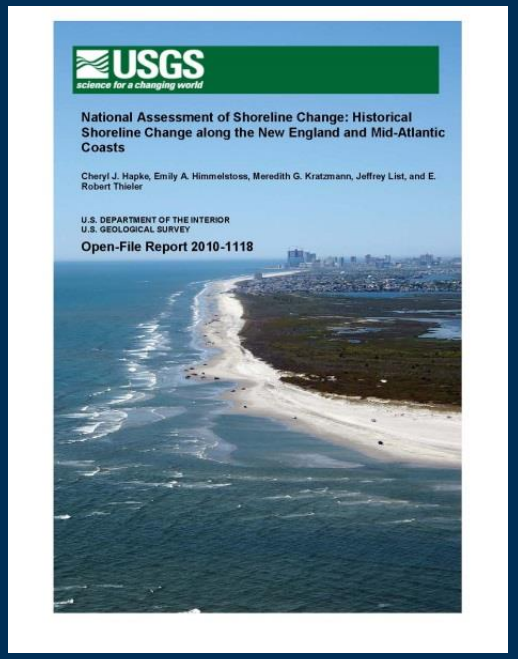
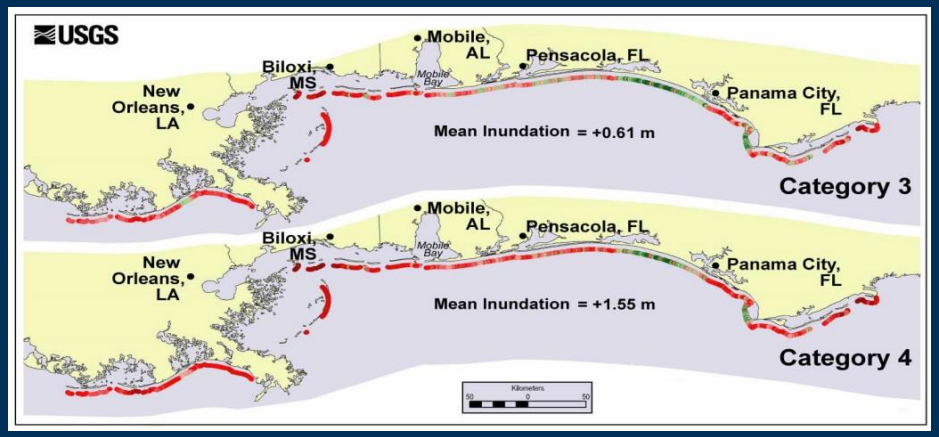
USGS Coastal and Marine Geology Program

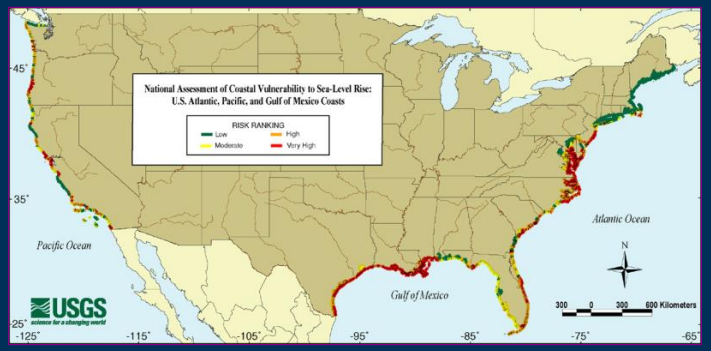
Building National Capacity to Anticipate and Respond to Coastal Change Hazards

Storms, Chronic Erosion and Climate Change

- Geologic, Geomorphic and Oceanographic Observations
- Research
- Models, Forecasts, and Assessments
- Delivery Mechanisms







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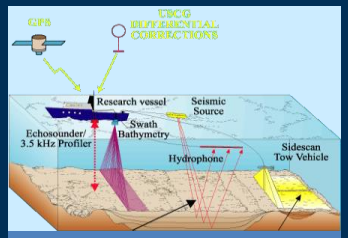
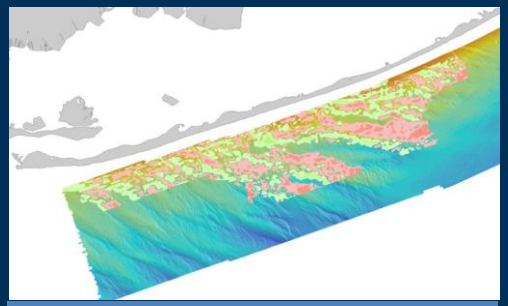
Regional Cooperative Studies

- Fire Island Coastal Erosion
- DelMarVa Coastal Erosion
- Gulf of Mexico Barrier Island Evolution
- California Coastal Change
- Florida/Caribbean Corals
- Hawaii/Pacific Corals
- Puget Sound Restoration

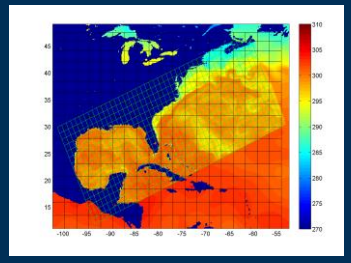


Seafloor Mapping

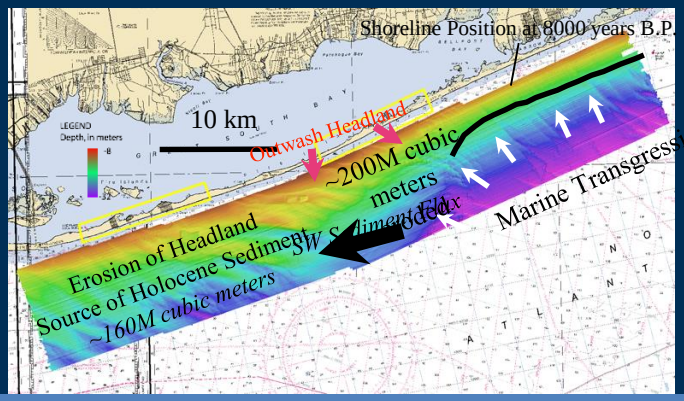


Comparison of modeled and observed sediment thickness change

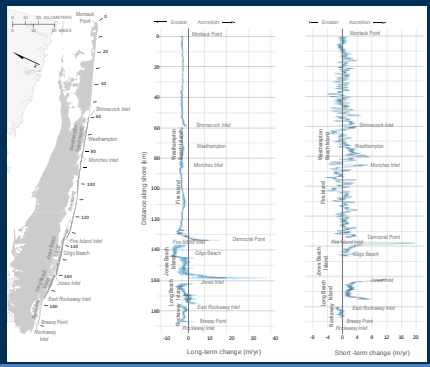
Oceanographic Deployments



Modeling



Integration of Geologic and Shoreline Structure and Change

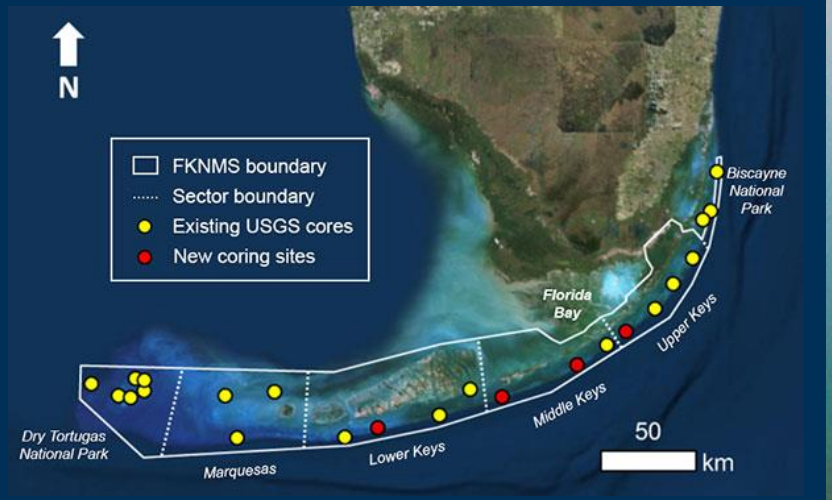


Long-term and hurricane-driven shoreline change

USGS Coastal and Marine Geology Program

Caribbean Coral Reef Studies

Reef history, geomorphology, geochemistry, calcification rates



Regional studies indicate increase in reef calcification in Dry Tortugas National Park, while loss at all other locations.

National Assessment of Coastal Change Hazards


Extreme erosion during Hurricane Irene
Rodanthe, NC


Long-term cliff erosion
Pacifica, CA

Goal: Identify, quantify, and model the vulnerability of the U.S. shorelines to coastal change hazards

Ongoing Tasks

- Impacts of severe storms & hurricanes
- Long-term shoreline change
- Coastal vulnerability to sea level rise

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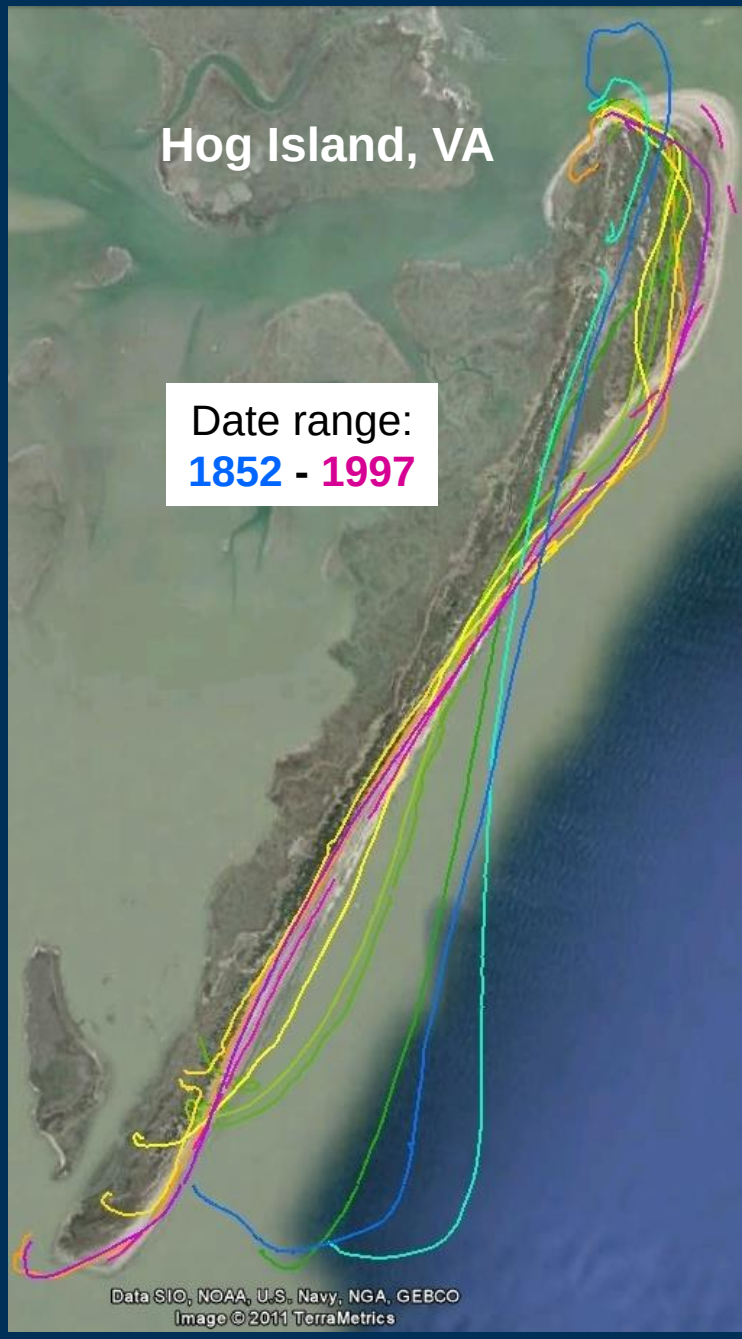
Long-term Shoreline Change

- A consistent ***national*** database of shoreline positions and rates of change
- Consistent methods applied nationwide
- Combine modern data (i.e. lidar – light detection and ranging) with historical data (maps, aerial photographs)
- Provide periodic updates
- Analyses of geology and processes in change trends



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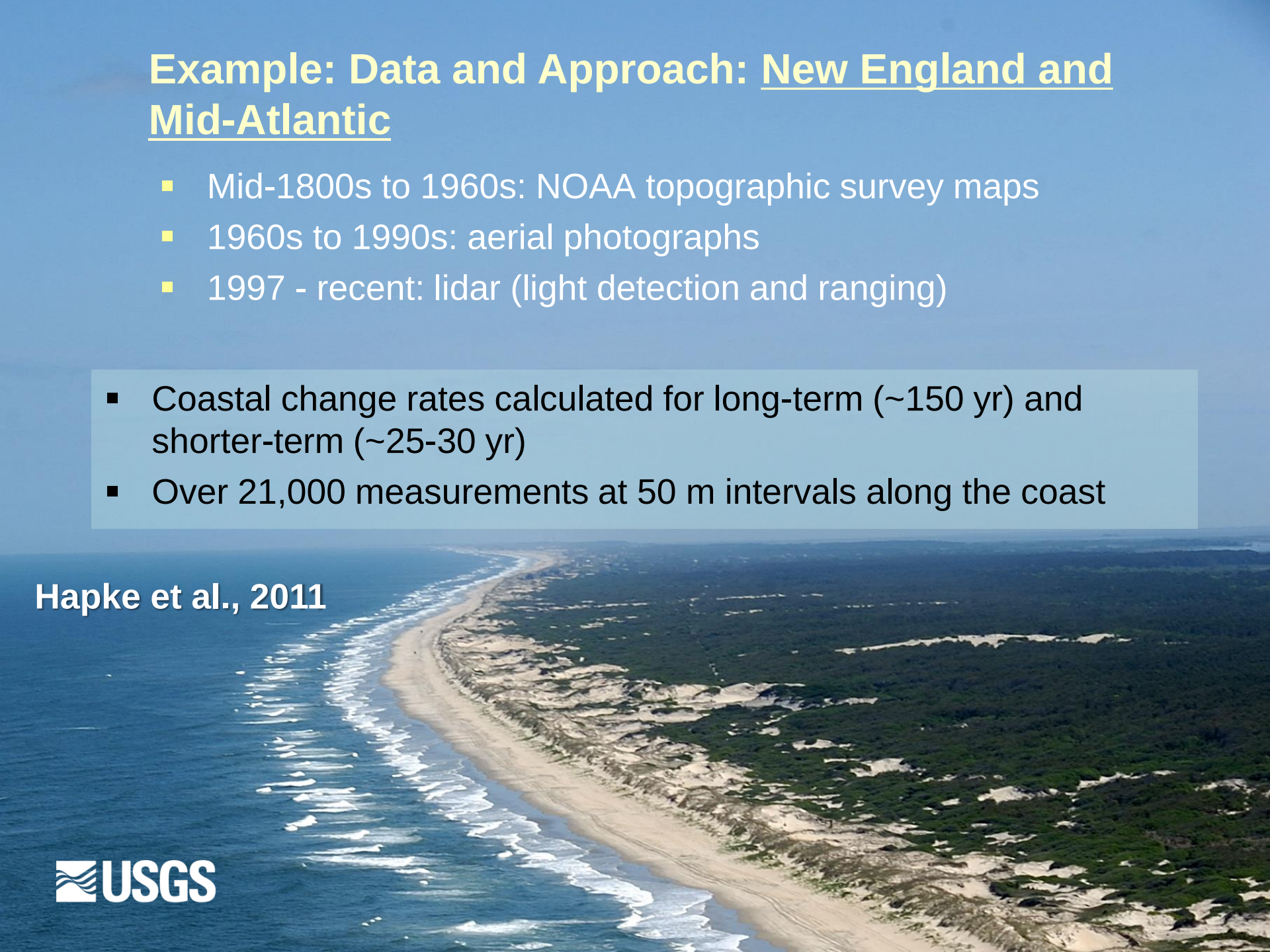
Example: Data and Approach: New England and Mid-Atlantic

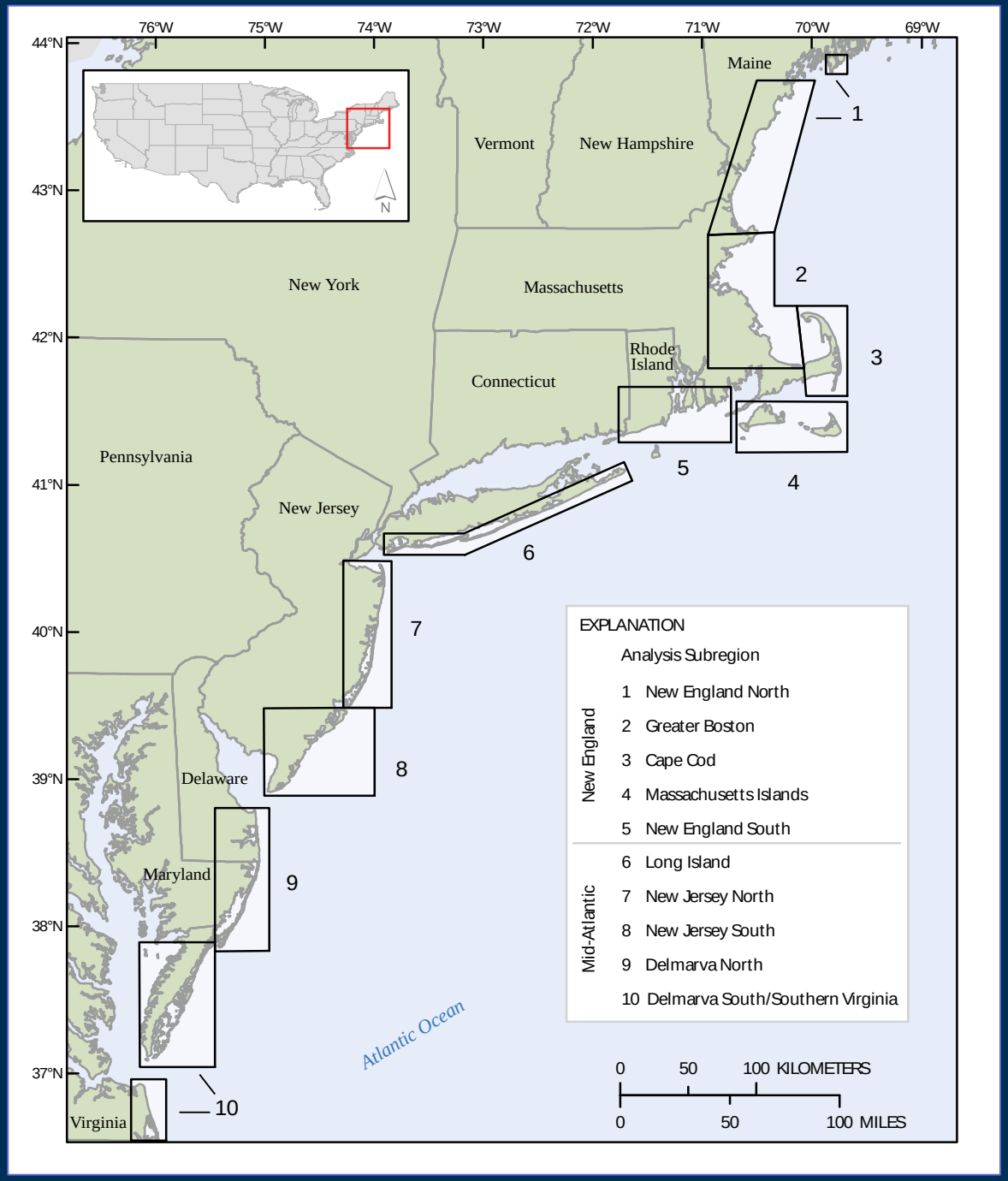
- Mid-1800s to 1960s: NOAA topographic survey maps
- 1960s to 1990s: aerial photographs
- 1997 - recent: lidar (light detection and ranging)

- Coastal change rates calculated for long-term (~150 yr) and shorter-term (~25-30 yr)
- Over 21,000 measurements at 50 m intervals along the coast

Hapke et al., 2011



Regional Studies



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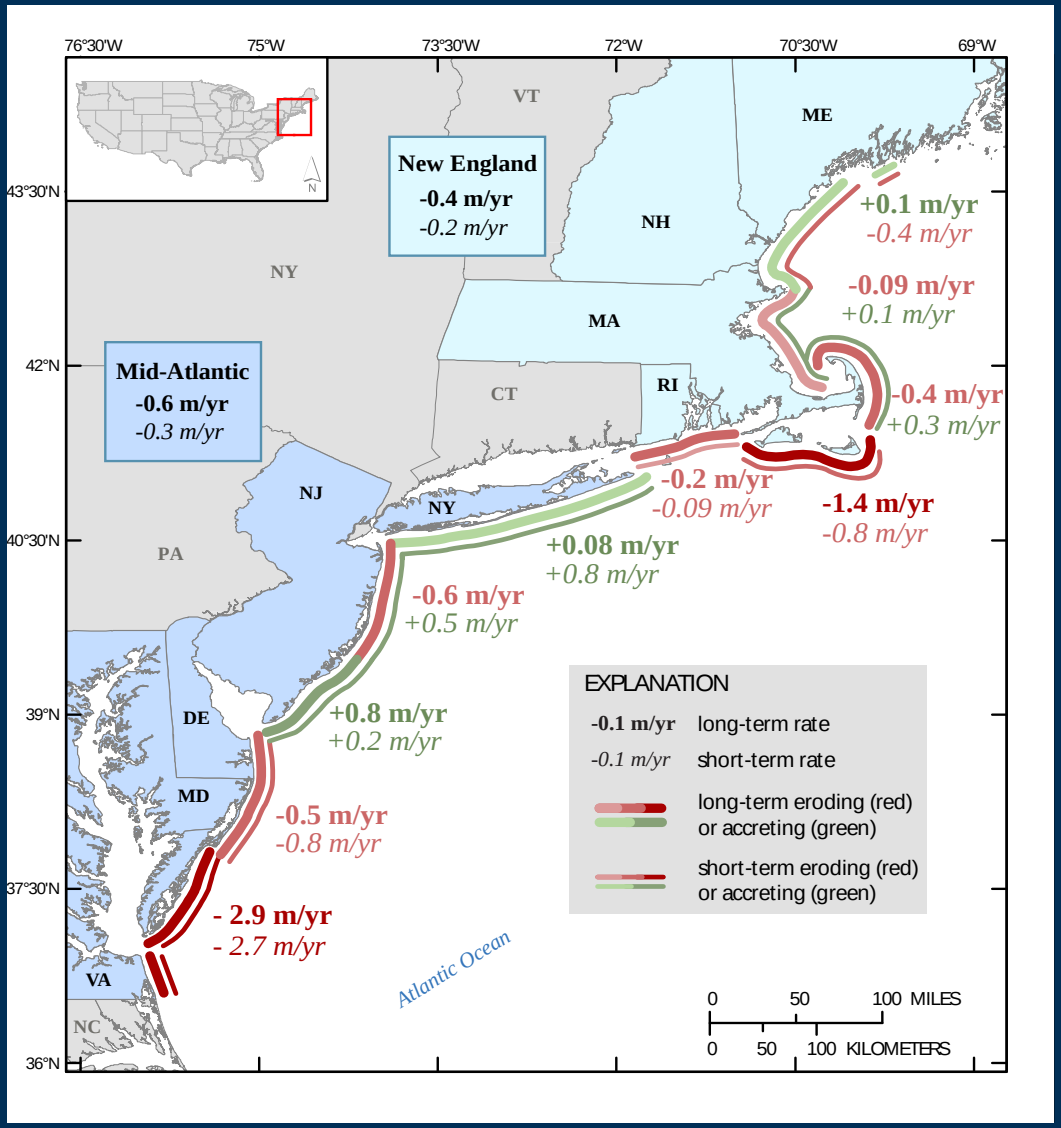
Regional Studies

Long-term (~150-yr) and short-term (~25 yr) rates of shoreline change
- continuous, comparable



Hapke et al., 2011

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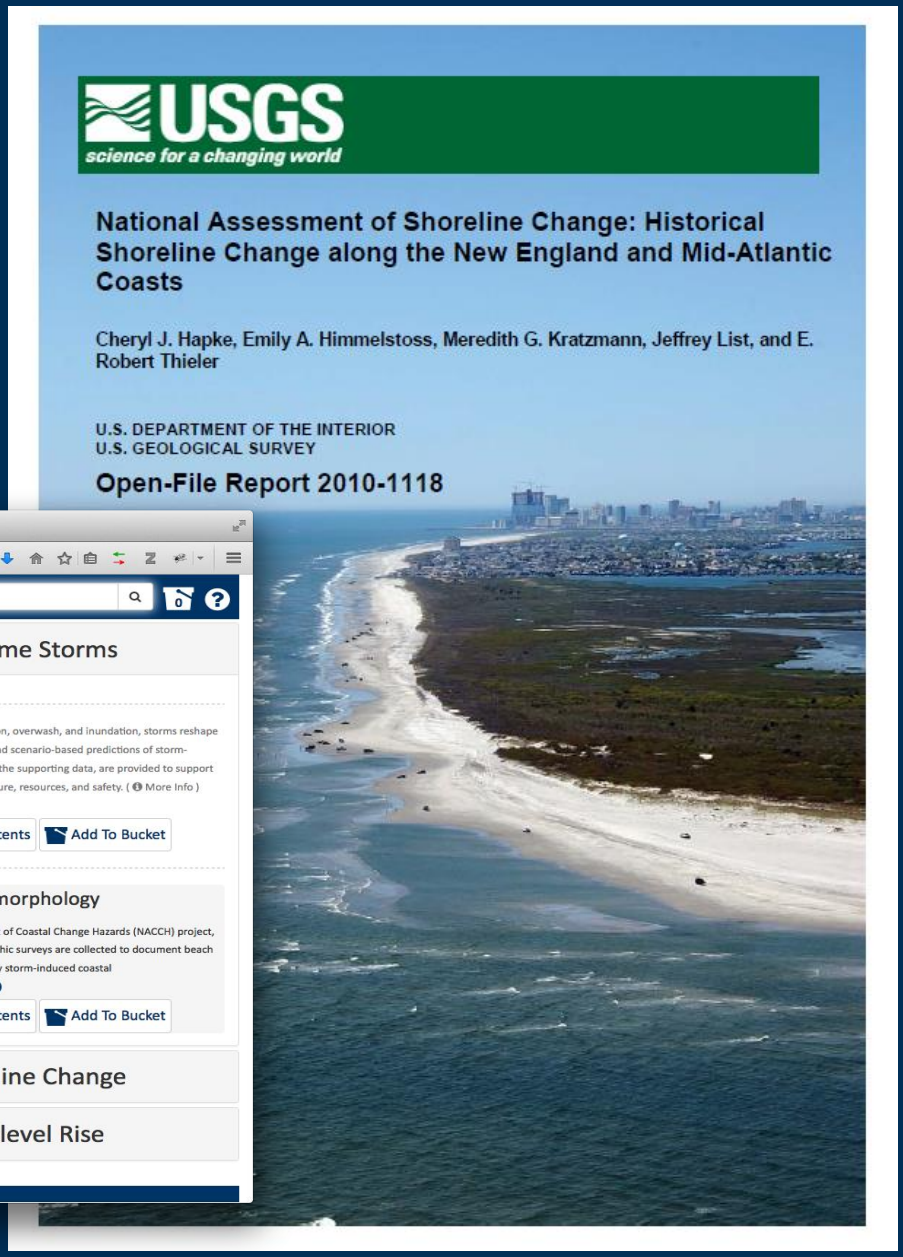
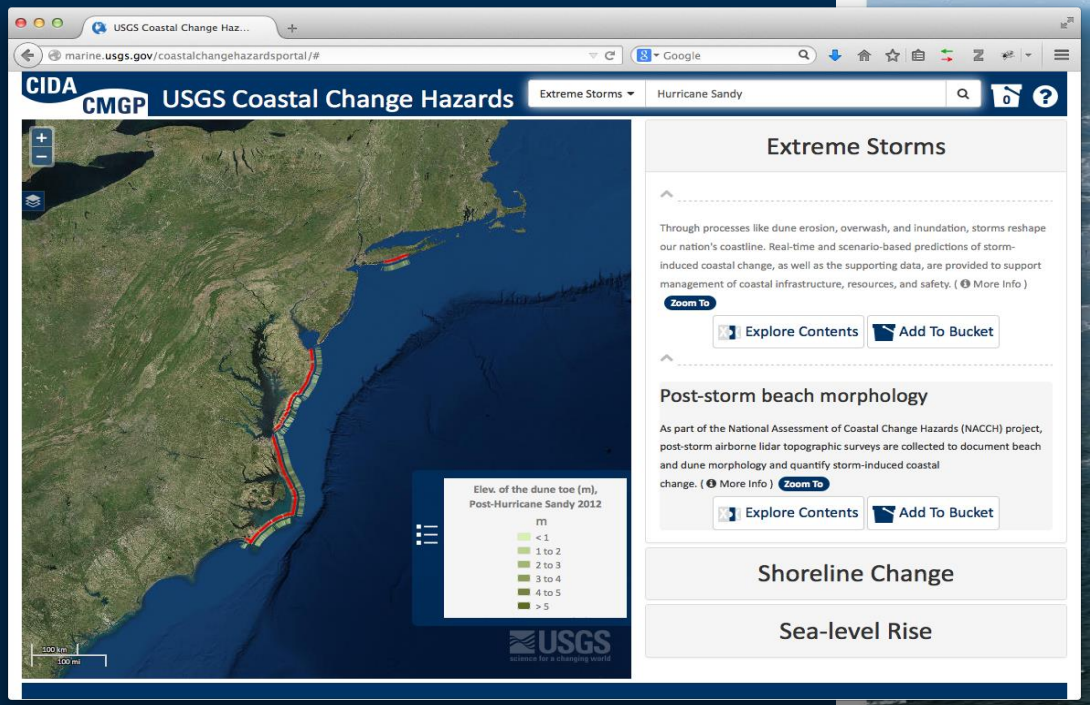
Regional Studies

- USGS Open-file reports
- All data and analyses accessible on Coastal Change Hazards Portal





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Localized Studies

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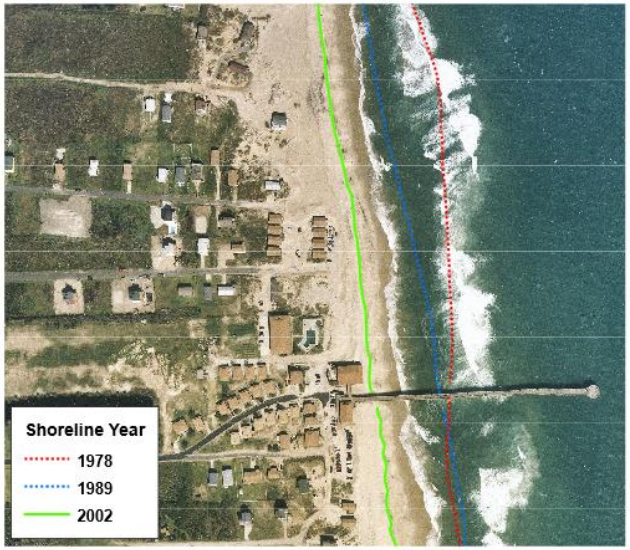
Quantification of Shoreline Change Along Hatteras Island, North Carolina—Oregon Inlet to Cape Hatteras, 1978–2002, and Associated Vector Shoreline Data

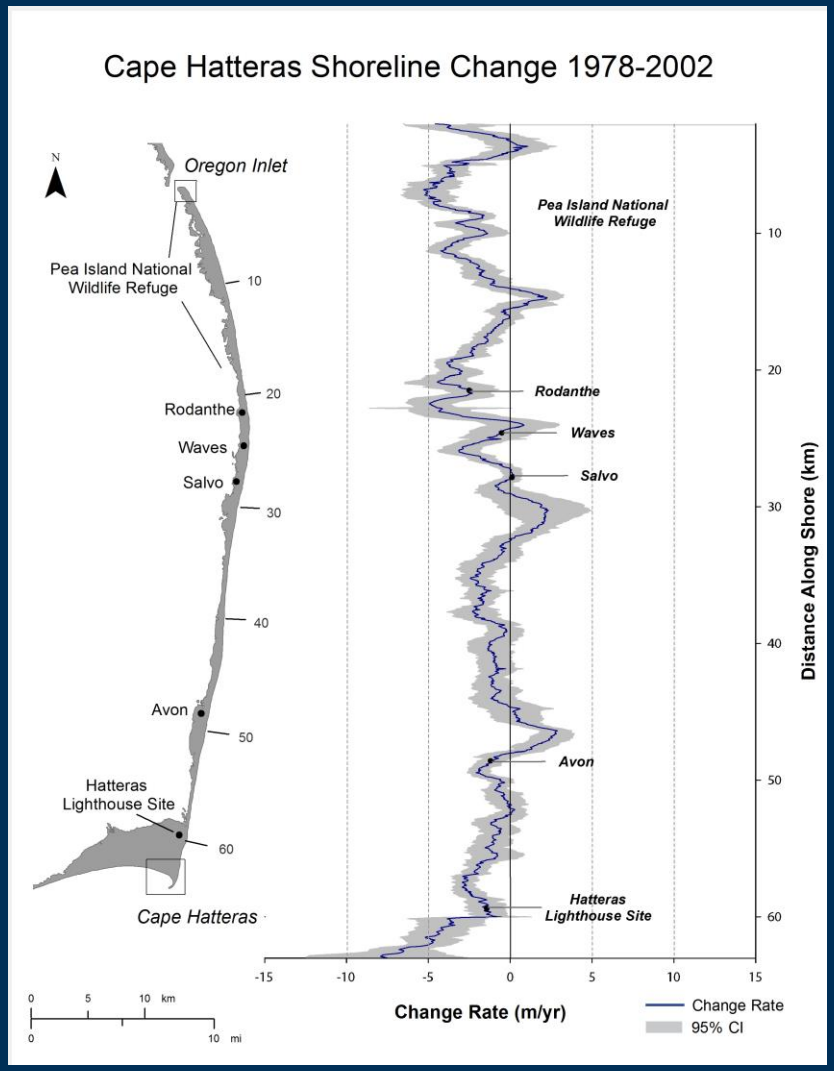
By Cheryl J. Hapke and Rachel E. Henderson



Open-File Report 2015–1002

U.S. Department of the Interior
U.S. Geological Survey

Hapke and Henderson, 2015



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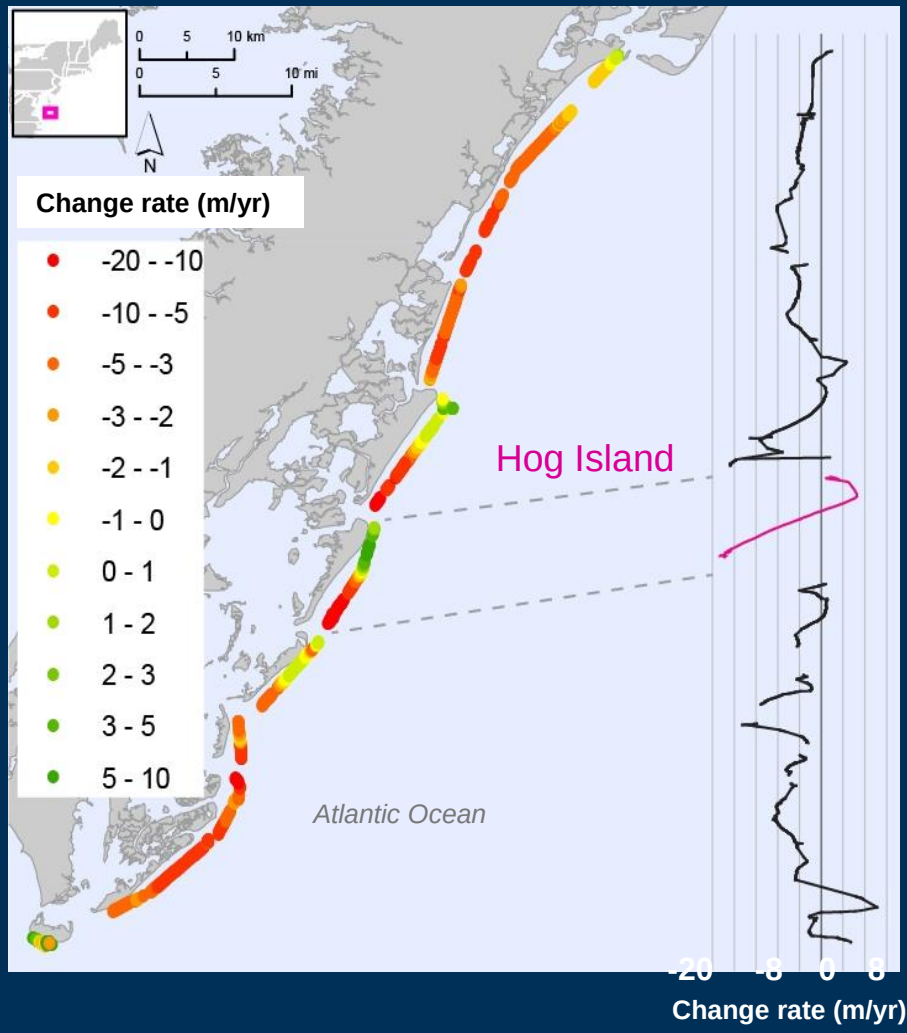
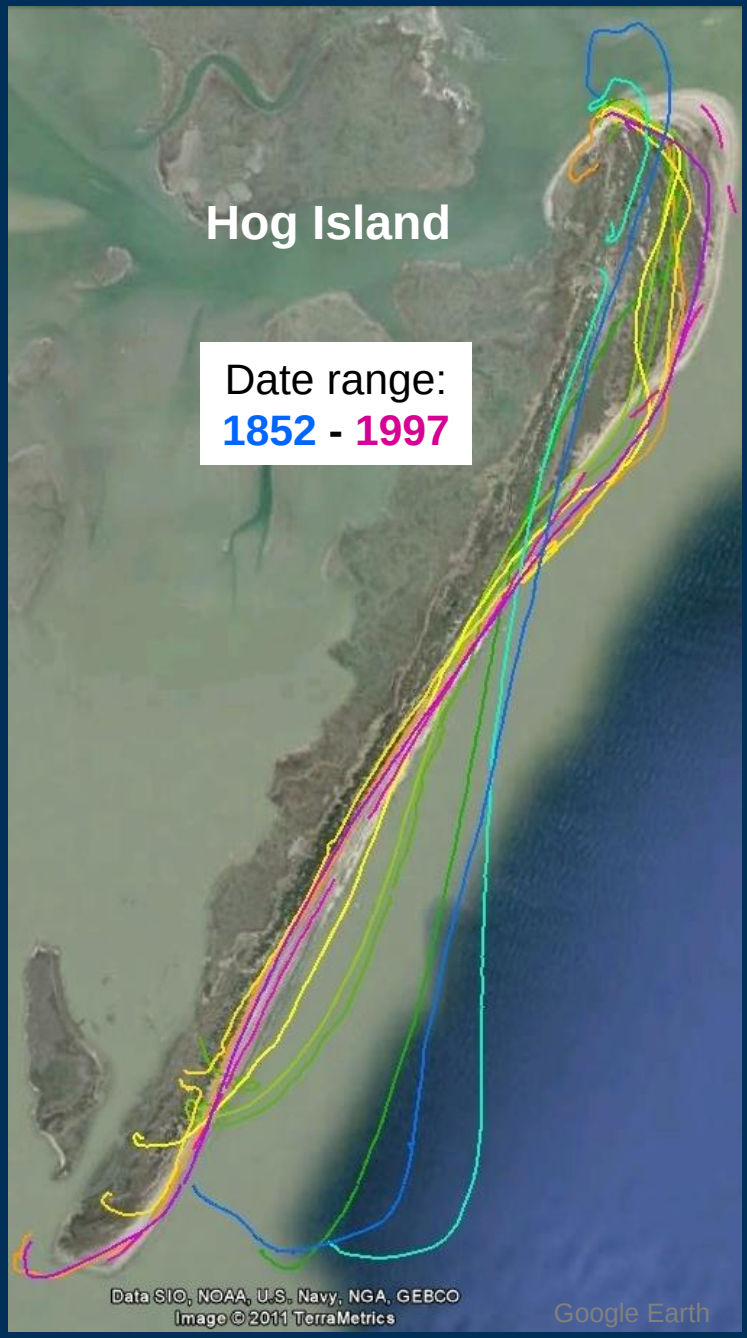
Localized Studies

Hog Island, Virginia





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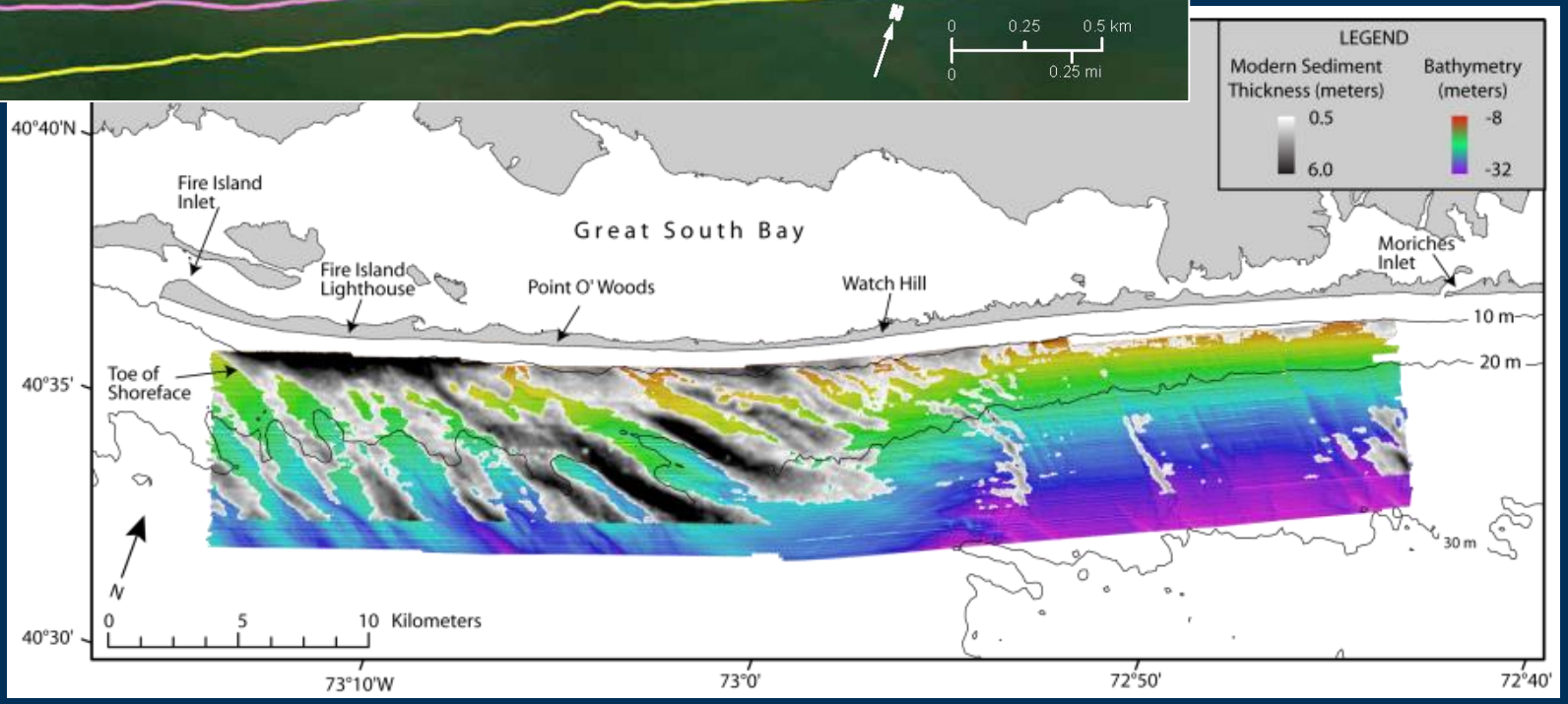
Coastal erosion is influenced by geologic processes

- Data
- Knowledge
- Tools
  - DSAS
  - ROMS



Forecasting Coastal Erosion Vulnerability to Storms

- Over a decade of research on hurricane-induced coastal change
- Development of models for forecasting future impacts
- Implementation and sharing with stakeholders

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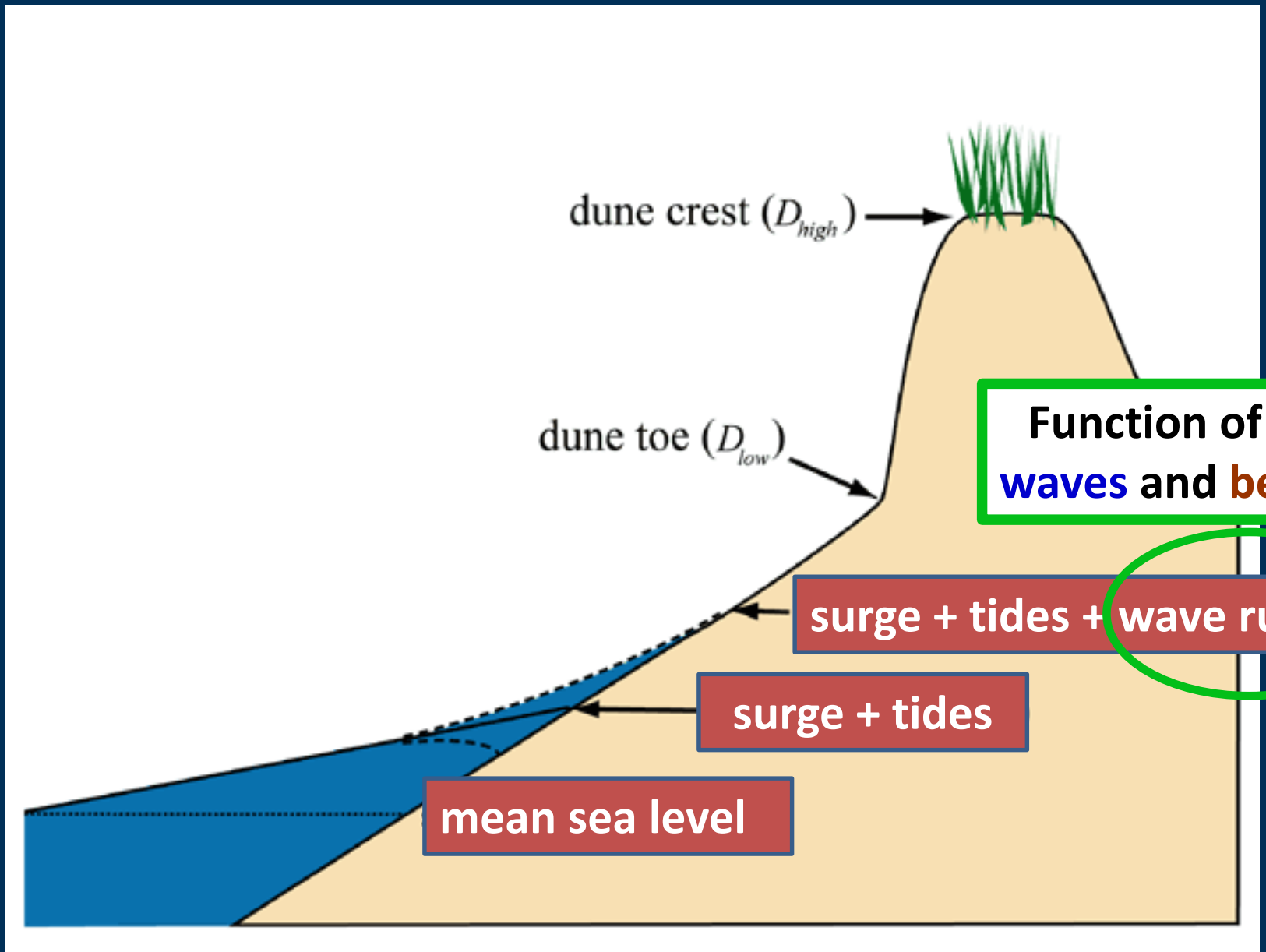
Beach Erosion

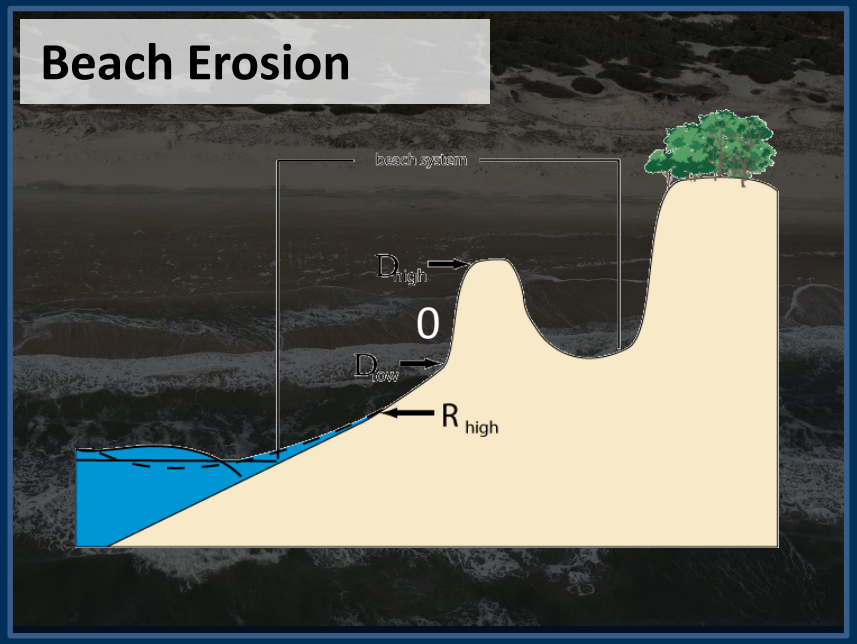

Dune Erosion

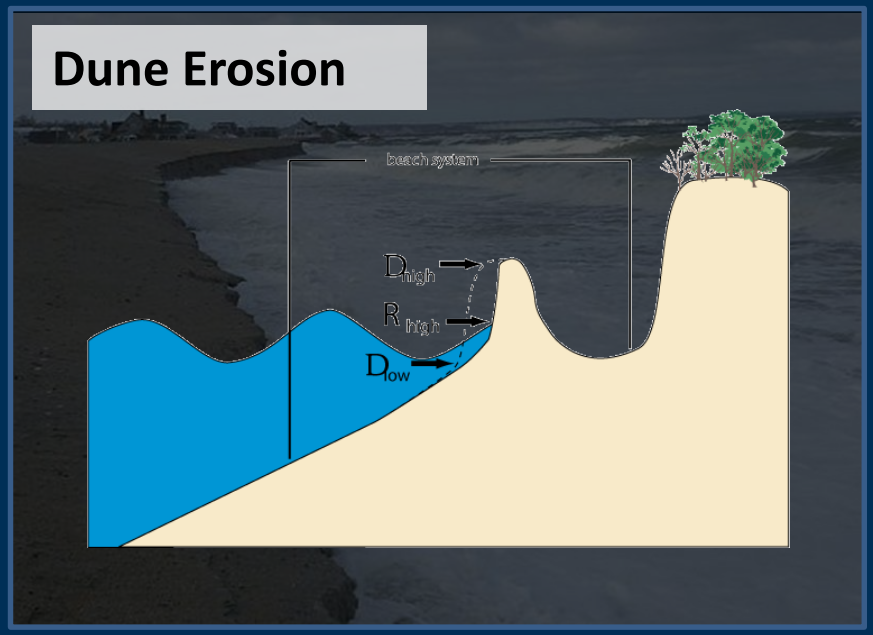

Overwash

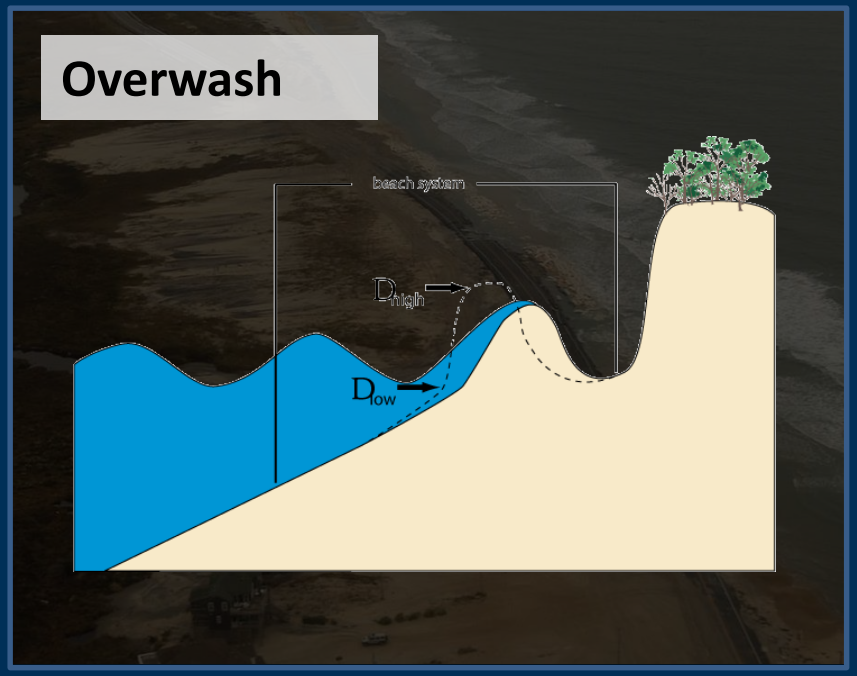

Inundation

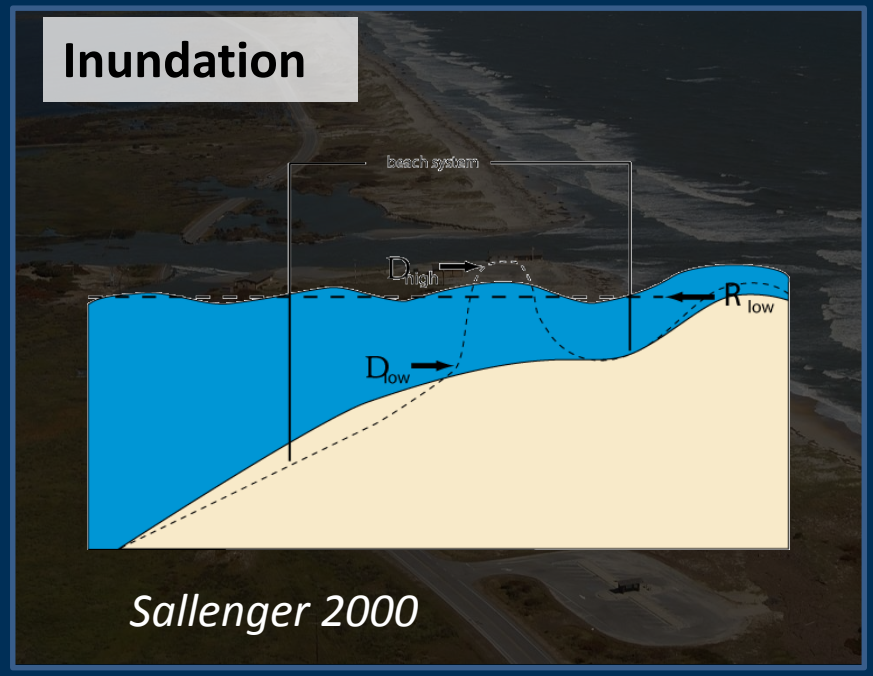
Components of Coastal TOTAL Water Levels




Beach Erosion
beach system
D high
0
D low
R high

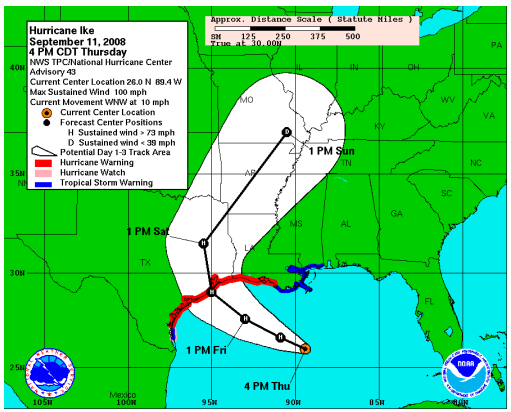

Dune Erosion
beach system
D high
R high
D low

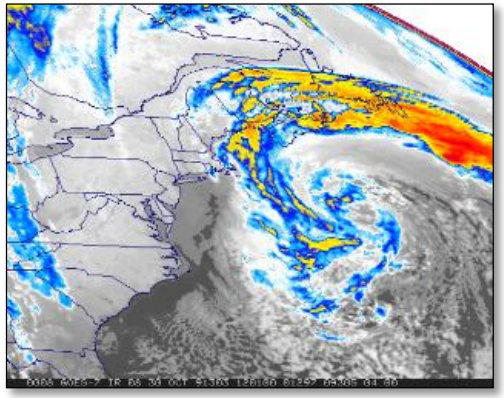

Overwash
beach system
D high
D low


Inundation
beach system
D high
R low
D low
Sallenger 2000

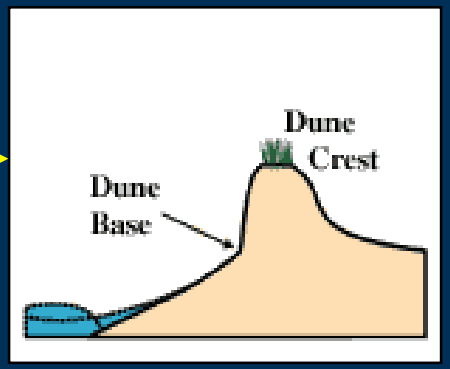
Storm Impact Prediction Models

MAXIMUM Waves &
Water Levels

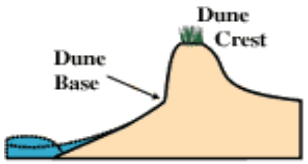


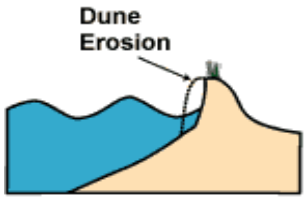


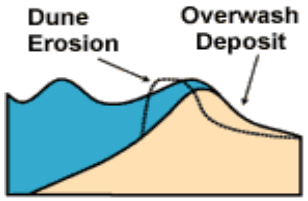
Last Measured
Topo/Bathy



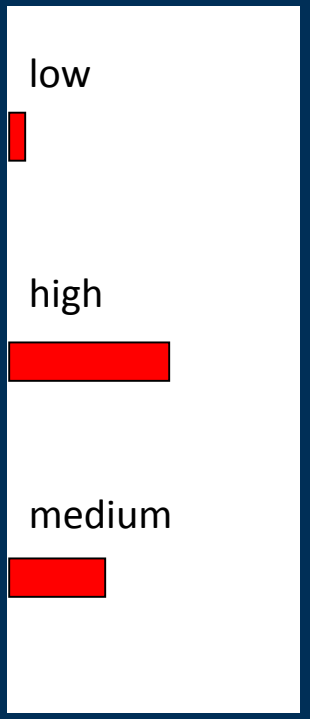
Response







Probability



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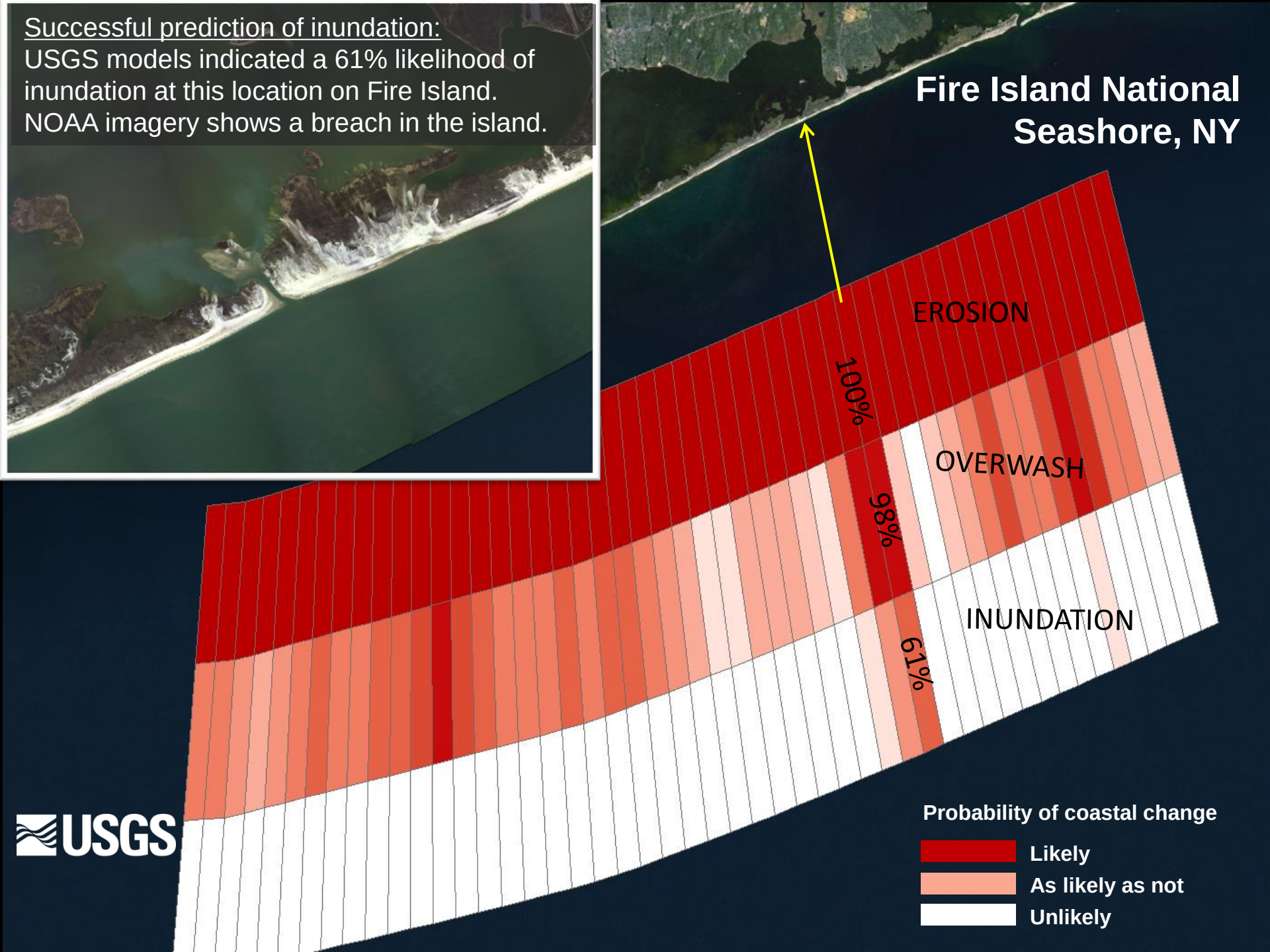
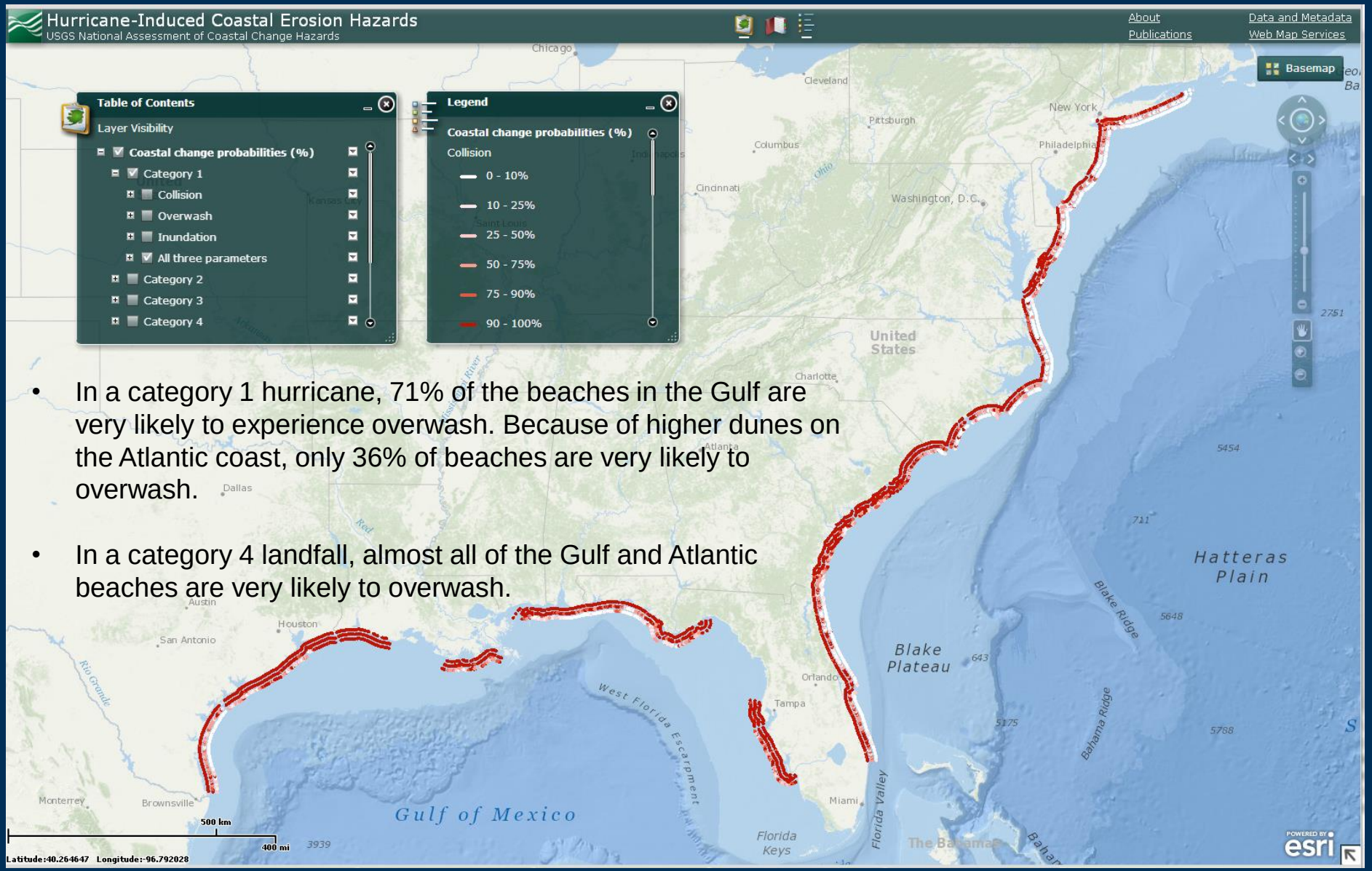

Successful prediction of inundation:
USGS models indicated a 61% likelihood of inundation at this location on Fire Island.
NOAA imagery shows a breach in the island.
Fire Island National Seashore, NY
EROSION
100%
OVERWASH
98%
INUNDATION
61%
USGS
Probability of coastal change
Likely
As likely as not
Unlikely

Forecasted Vulnerability



- In a category 1 hurricane, 71% of the beaches in the Gulf are very likely to experience overwash. Because of higher dunes on the Atlantic coast, only 36% of beaches are very likely to overwash.
- In a category 4 landfall, almost all of the Gulf and Atlantic beaches are very likely to overwash.

http://olga.er.usgs.gov/hurricane_erosion_hazards/

Building and Testing an Operational Model for Total Water Levels in the U.S

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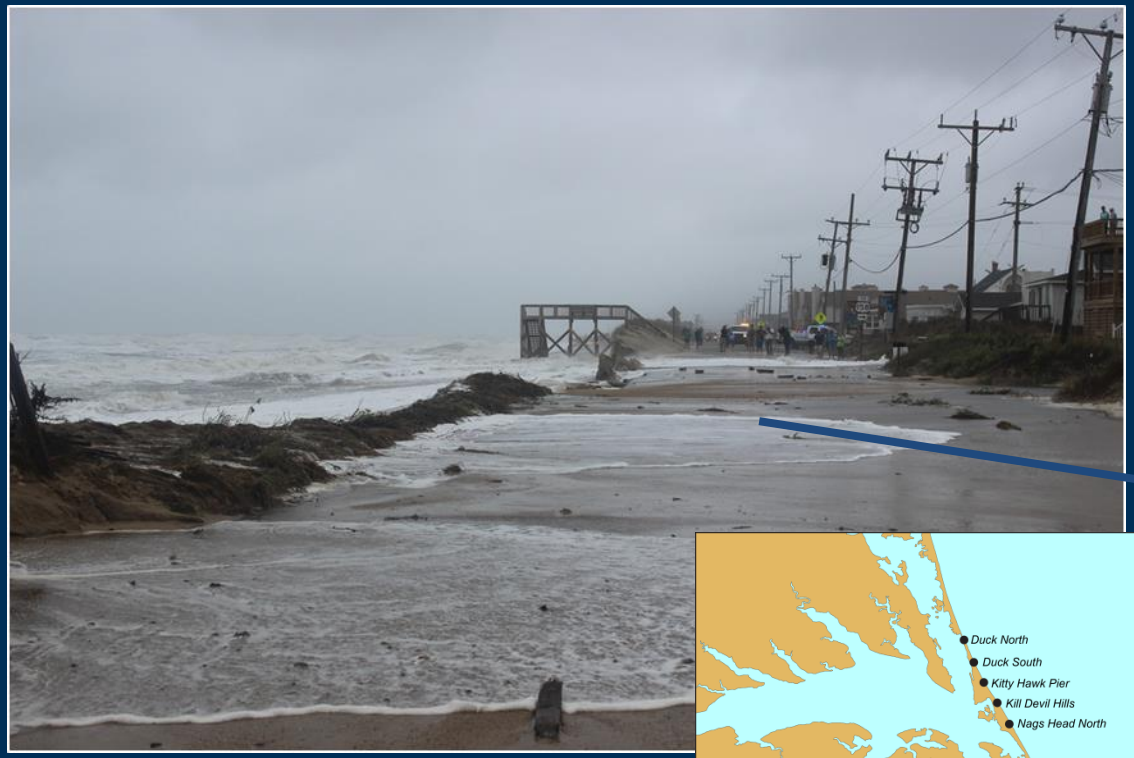
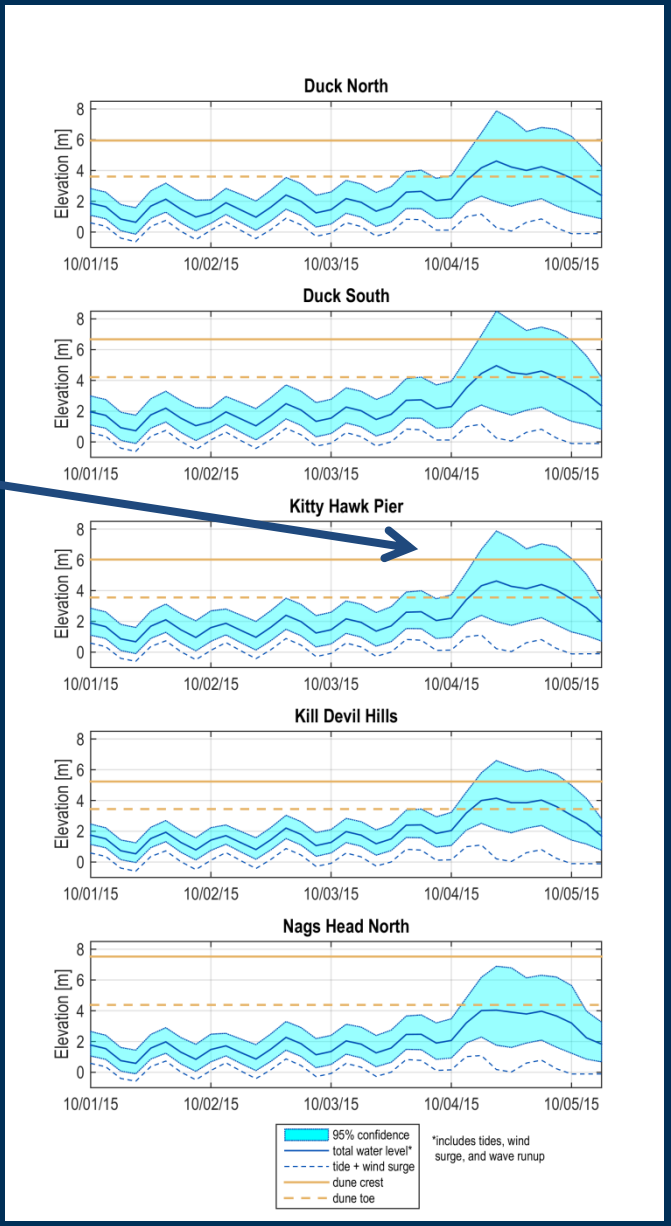
USGS-NOAA: Operational Total Water Level Model





Operational forecasts of total water levels can warn local officials of potential overwash, such as that observed along HWY 12 in Kitty Hawk.

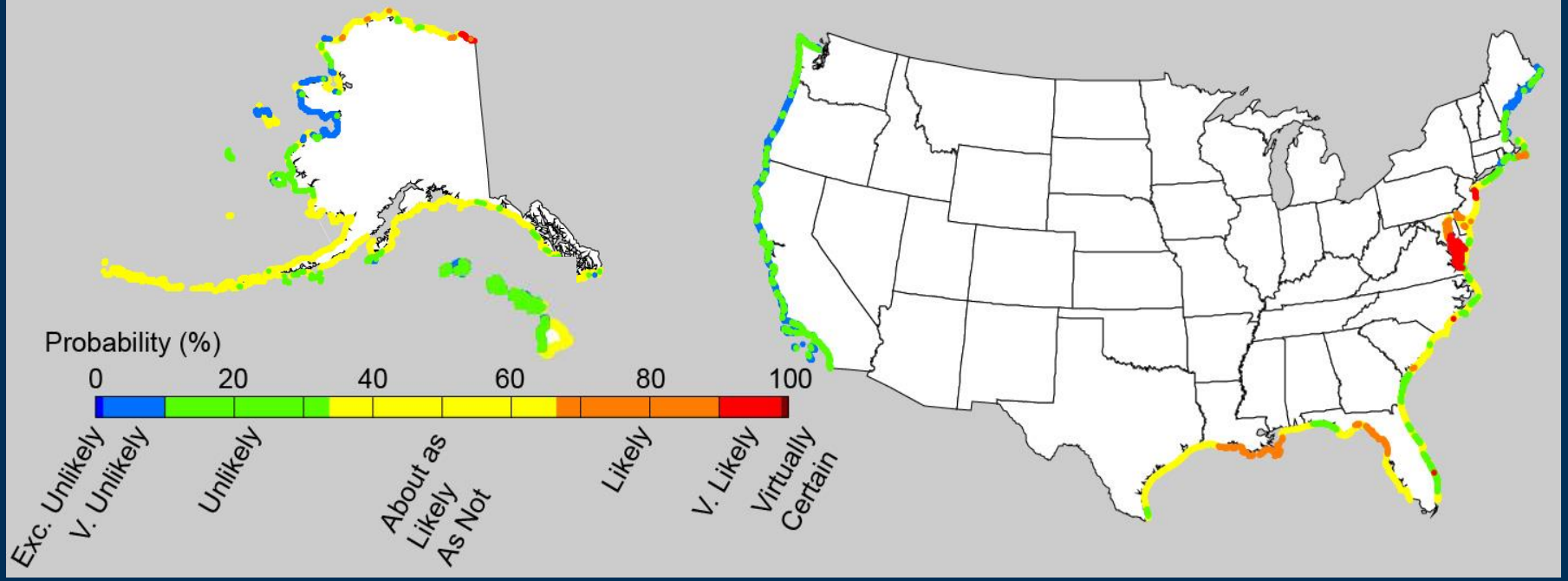
(USGS collaboration with NWS and NCEP)

Photo credit: Dare County Emergency Management

Predicting sea-level rise impacts

- Bayesian Network uses climate forcing and geologic constraints
- Prediction and uncertainty maps identify where better information is needed (input data, process understanding)
- Provides scientific knowledge context for decision makers
- Can use to focus research resources

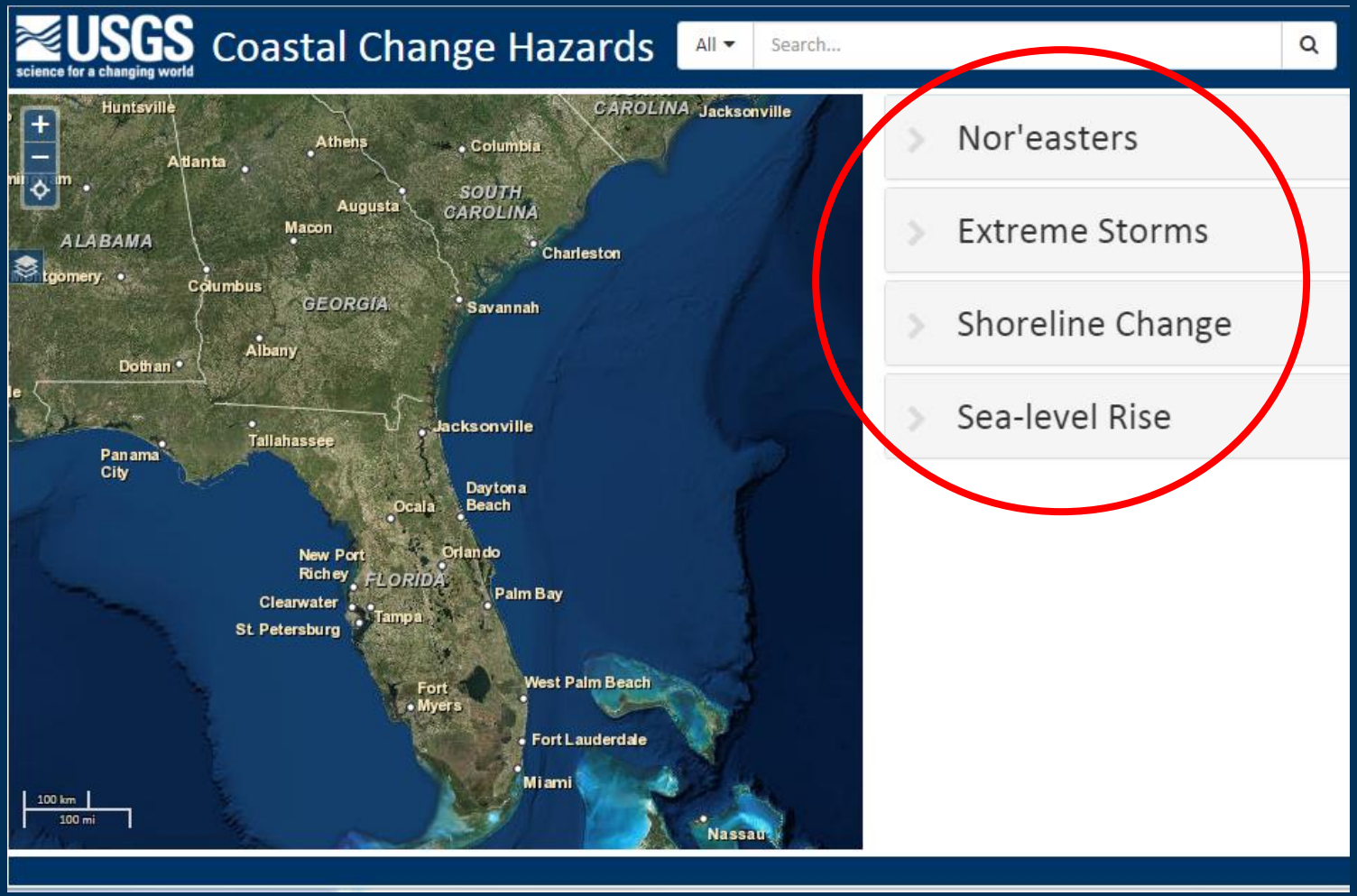
Probability of coastal erosion >1 m/yr



(Gutierrez et al., 2011; USGCRP NCADAC report, in review)

Coastal Change Hazards Portal

- Products are easily searchable and shareable
- Interactive tools integrate across time, space, and hazards
- Others can build products that support their particular requirements



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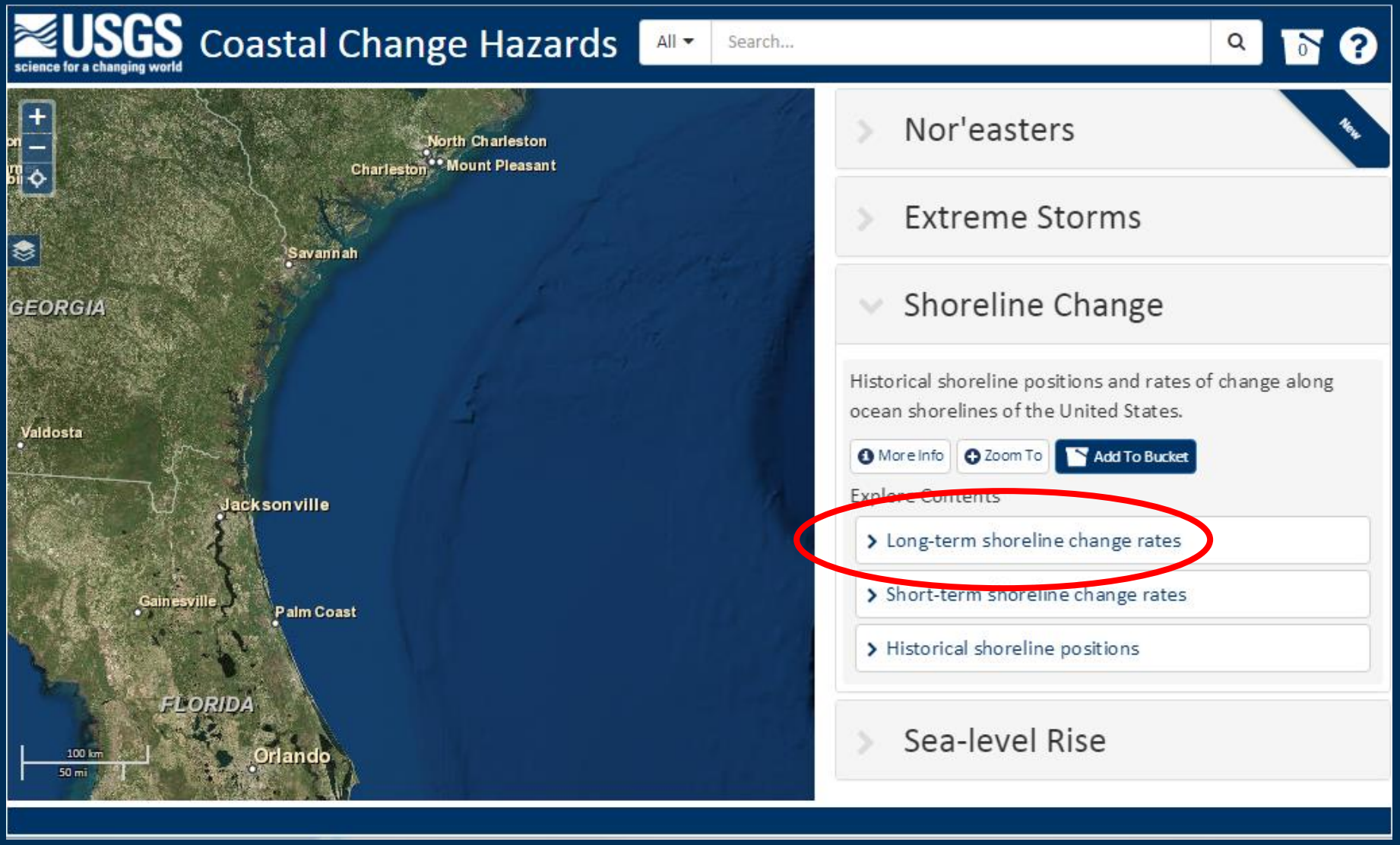
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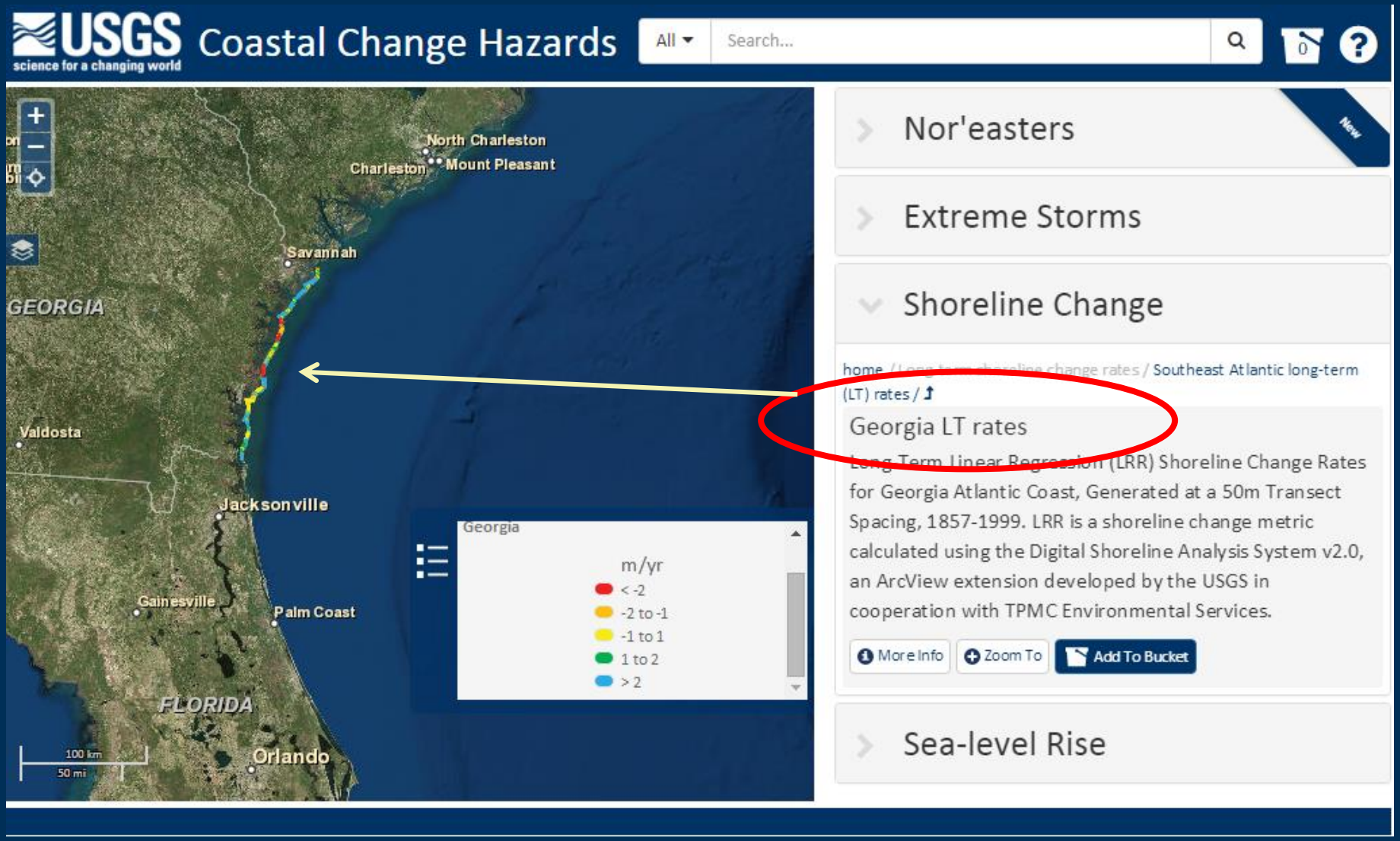
Coastal Change Hazards
All
Search...
0
North Charleston
Charleston
Mount Pleasant
Savannah
GEORGIA
Valdosta
Jacksonville
Gainesville
Palm Coast
FLORIDA
Orlando
100 km
50 mi
Nor'easters
New
Extreme Storms
Shoreline Change
Historical shoreline positions and rates of change along ocean shorelines of the United States.
More Info
Zoom To
Add To Bucket
Explore Contents
Long-term shoreline change rates
Short-term shoreline change rates
Historical shoreline positions
Sea-level Rise

USGS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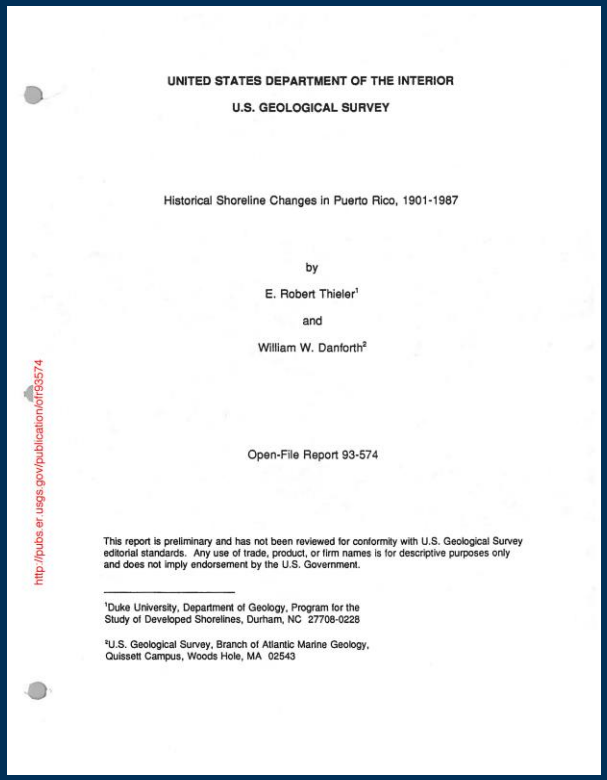
science for a changing world
Coastal Change Hazards
All
Search...
North Charleston
Charleston
Mount Pleasant
Savannah
GEORGIA
Valdosta
Jacksonville
Gainesville
Palm Coast
FLORIDA
Orlando
100 km
50 mi
Georgia
m/yr
< -2
-2 to -1
-1 to 1
1 to 2
> 2
Nor'easters
New
Extreme Storms
Shoreline Change
home / Long-term shoreline change rates / Southeast Atlantic long-term (LT) rates /
Georgia LT rates
Long-Term Linear Regression (LRR) Shoreline Change Rates for Georgia Atlantic Coast, Generated at a 50m Transect Spacing, 1857-1999. LRR is a shoreline change metric calculated using the Digital Shoreline Analysis System v2.0, an ArcView extension developed by the USGS in cooperation with TPMC Environmental Services.
More Info
Zoom To
Add To Bucket
Sea-level Rise

USGS

USGS shoreline change research in Puerto Rico

- Systematic study island-wide
- Focused studies in Rincón
- Both provide a basis for future work



UNITED STATES DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Historical Shoreline Changes in Puerto Rico, 1901-1987

by

E. Robert Thieler[1]

and

William W. Danforth[2]

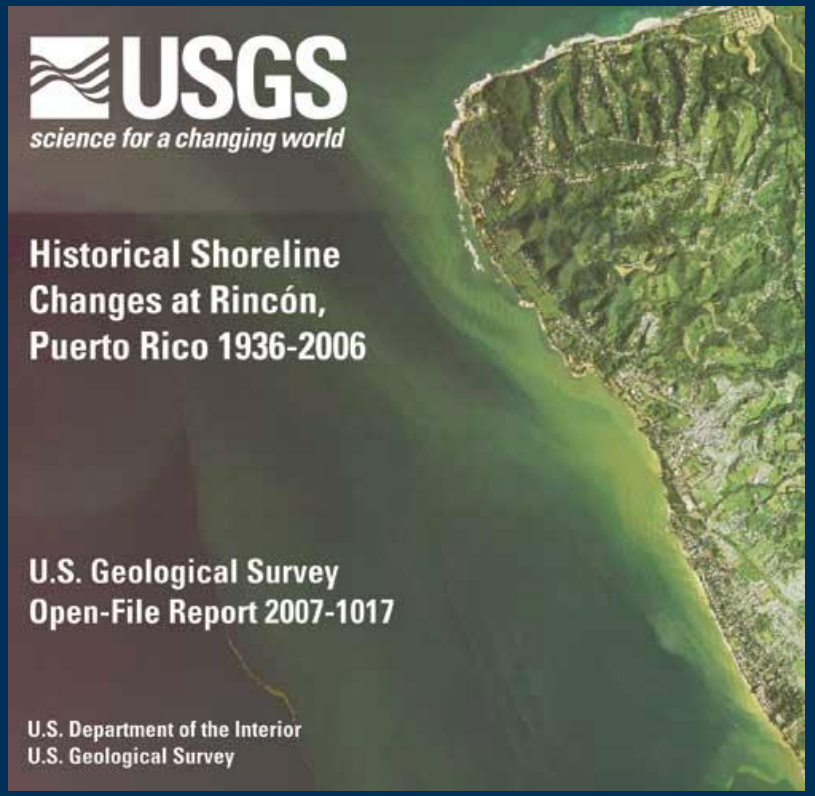
Open-File Report 93-574

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards. Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

[1]Duke University, Department of Geology, Program for the Study of Developed Shorelines, Durham, NC 27708-0228

[2]U.S. Geological Survey, Branch of Atlantic Marine Geology, Quissett Campus, Woods Hole, MA 02543

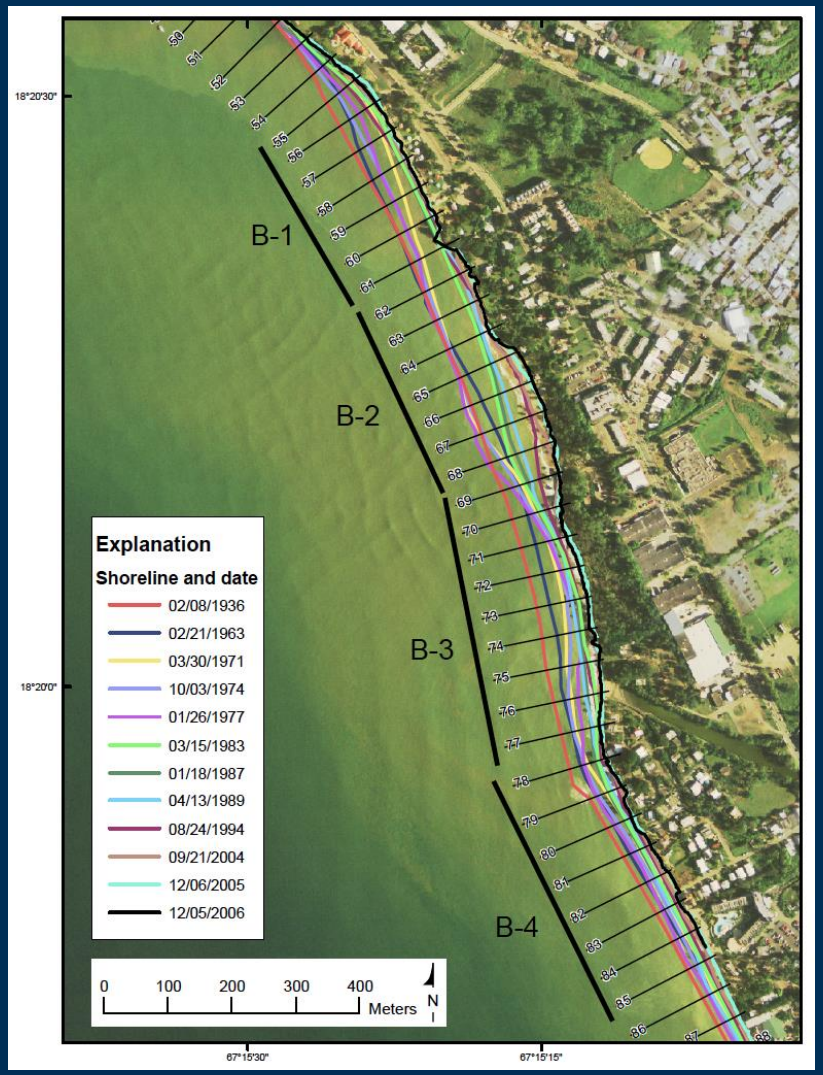
- 1901-1987
- Digital data, but not accessible
- Can be 'rescued'

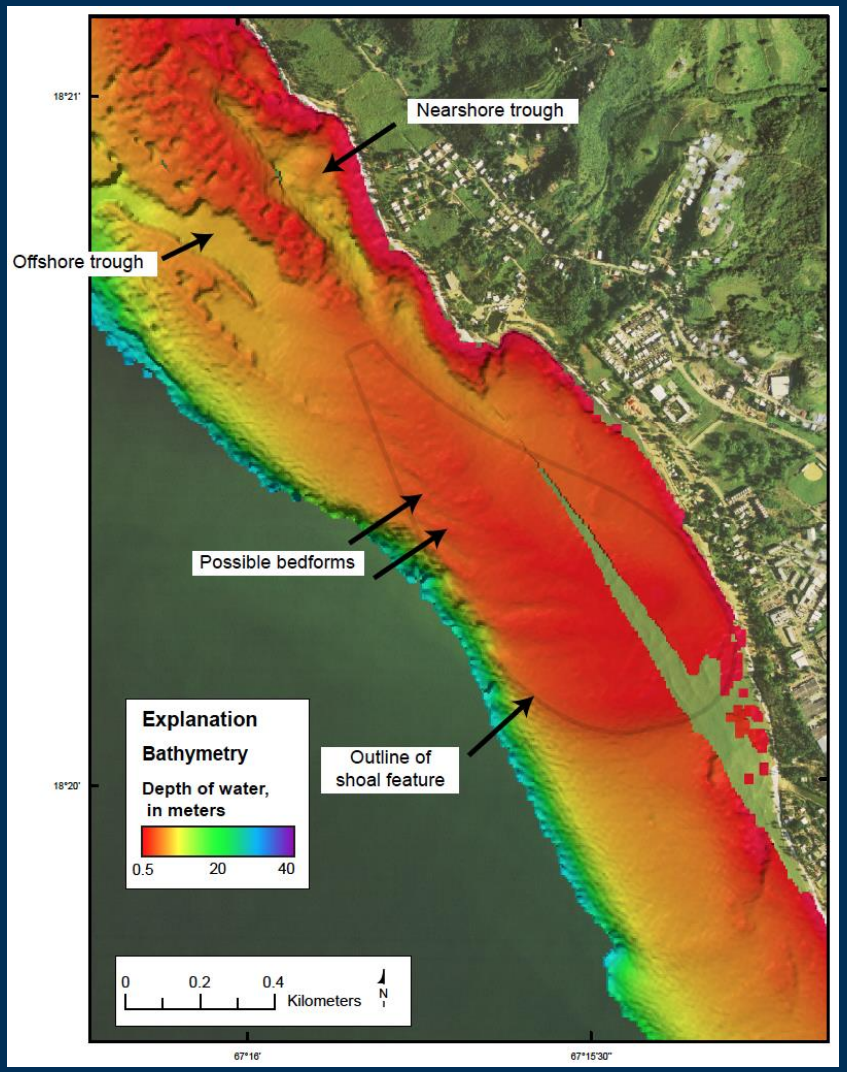


- Update of earlier focused work (1994)
- Digital data, fully accessible
- Uses shoreline change to pose geologic and oceanographic questions for management applications

Rincón case study

- Shoreline change patterns may be driven by waves, currents and amount of sediment (including dredging of marina)
- Can use scientific information to identify viable management responses





http://marine.usgs.gov/coastalchangehazards/

http://marine.usgs.gov/coastalchangehazardsportal/

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