USGS
science for a changing world

Forecasting and Observing Coastal Erosion Hazards during Hurricane Matthew

Kara Doran
Hilary Stockdon
Justin Birchler
Joe Long
USGS Coastal and Marine Geology Program

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

USGS 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 Science Tasks

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

USGS

Forecasting Coastal Change during Storms

- Two decades of research on storm-induced coastal change
- Development of models for forecasting future impacts
- Implementation and sharing with stakeholders

USGS Photo credit: Mario Tama

Seaside Heights, NJ after Hurricane Sandy (2012)

Coastal response to Hurricane Isabel Hatteras, NC

USGS

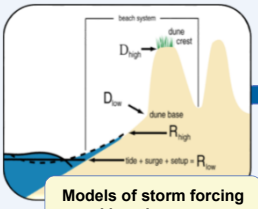
Predictions of Coastal Change during Storms

The beach response to storms is dependent, in part, on the interactions between local morphology and the offshore forcing.

These data are used by sophisticated models to simulate and predict the type/magnitude of coastal changes that may be expected during storms.

Approaching storm (waves, surge)

Beach morphology (slope, dune height)



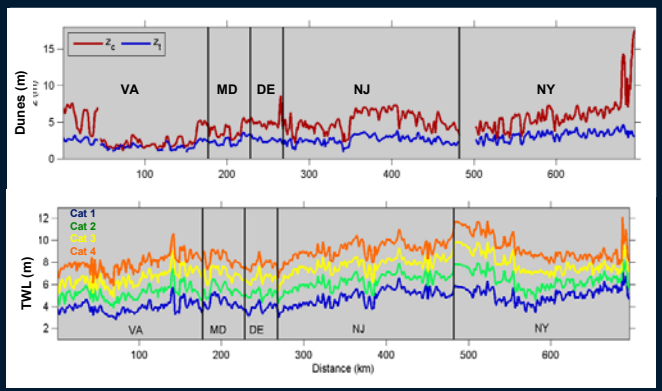
Models of storm forcing and beach response

Coastal change (overwash, erosion)

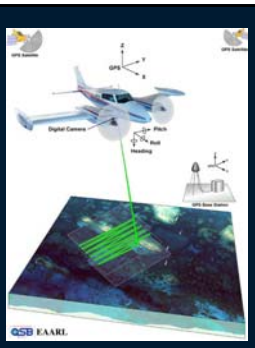
USGS

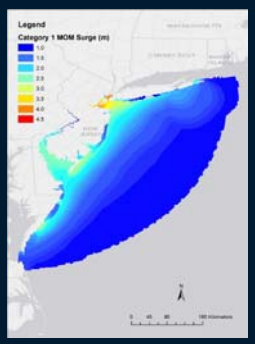
Elements of coastal change forecasts

Dune elevations - Lidar-based topography surveys (USGS, NOAA, USACE)



Total water levels - Wave and surge models (USGS, NOAA)





USGS

Probabilities of coastal change

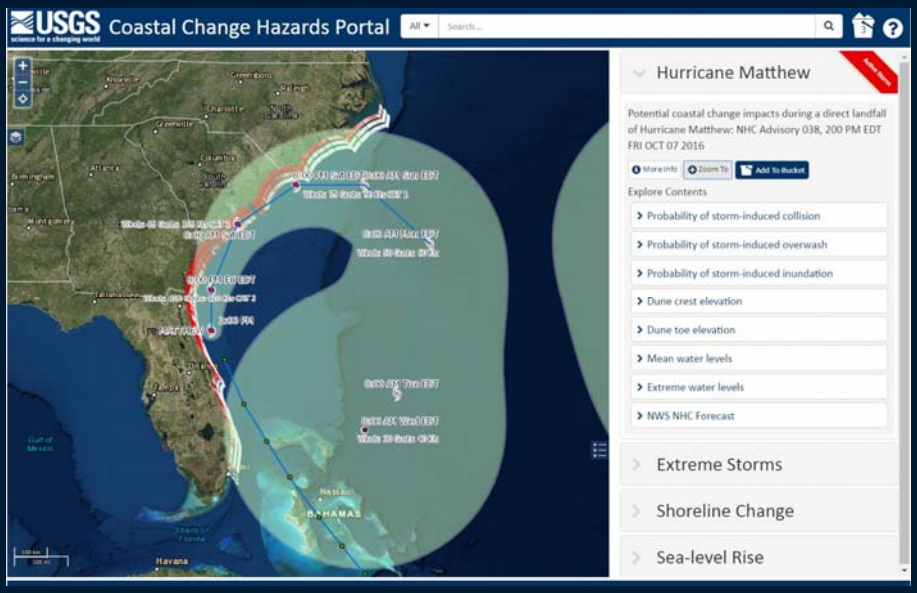
What is the likelihood that storm-induced total water levels will exceed the elevation of the base and crest of protective sand dunes?

Collision	Overwash	Inundation
		
Waves/surge collide with the dune base, leading to erosion.	Waves/surge overtop dune crest, moving sand landward.	Surge is higher than dune crest, submerging beach system.

1) Real-time mode for approaching storms
2) Scenario-based approach for generalized storms

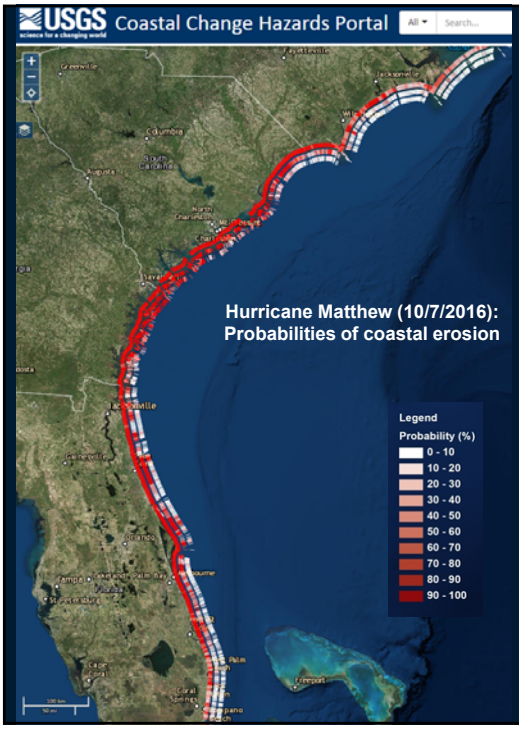
USGS

Real-Time Coastal Change Forecast: Matthew (2016)



USGS

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



USGS National Assessment of Coastal Change Hazards project responded to Hurricane Matthew with forecasts identifying the probability of ***dune erosion, overwash,*** and ***inundation*** for a large multi-state region.

Investments from Hx Sandy resulted in:

- ***Efficient, updated, real-time*** forecasts of potential coastal change.
- Forecasts and model inputs (dune heights, water levels) published in the ***Coastal Change Hazards Portal***.
- Web mapping services that allow forecasts to be ingested by and provide guidance to multiple ***local, state, and federal agencies***.
- Development of an interagency, ***operational*** model for tides, wind surge, and ***wave runup*** at select pilot sites.

Real-Time Coastal Change Forecast: Matthew (2016)

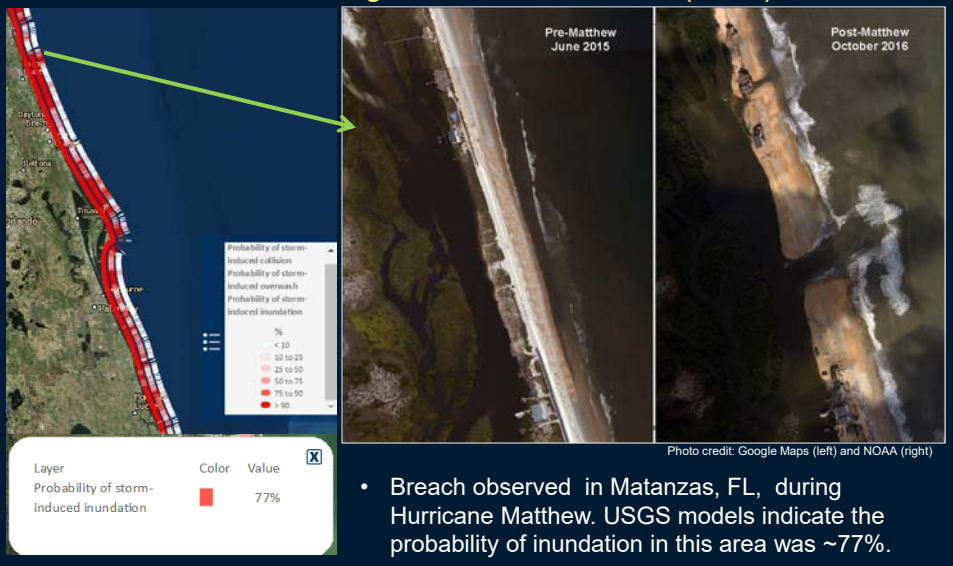
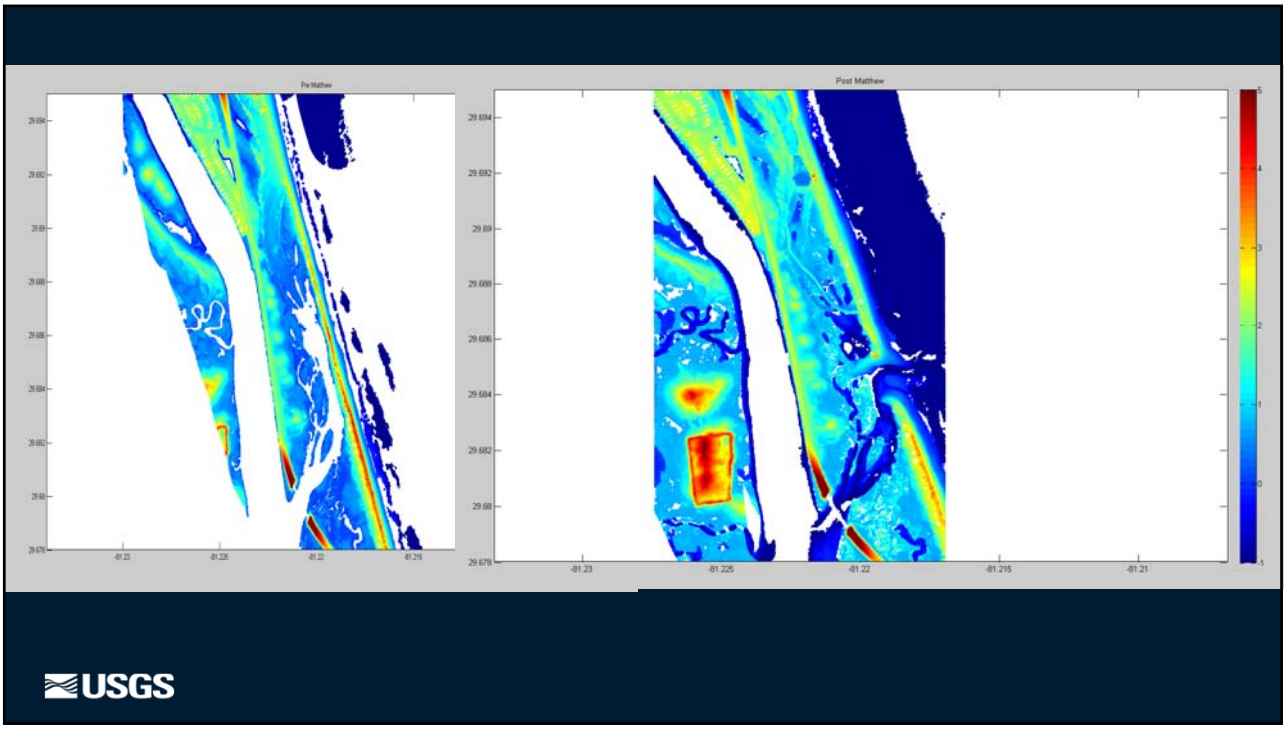


Photo credit: Google Maps (left) and NOAA (right)

- Breach observed in Matanzas, FL, during Hurricane Matthew. USGS models indicate the probability of inundation in this area was ~77%.
- Extensive erosion was also observed, consistent with model forecasts indicating that the probability of dune erosion was >95% for the entire region.

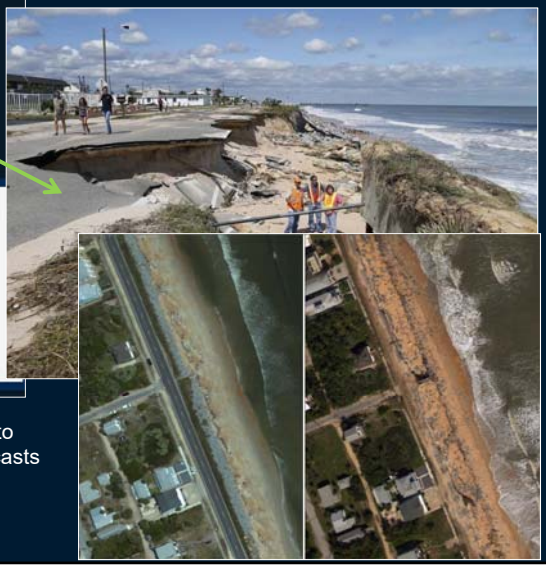
USGS



USGS

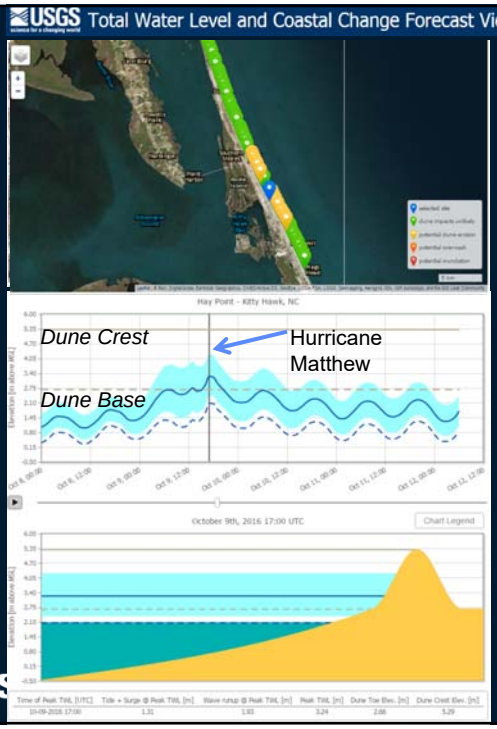
Real-Time Coastal Change Forecast: Matthew (2016)

Flagler Beach, FL



- Coastal highway was undermined due to extensive erosion, consistent with forecasts of dune erosion and ovewash.

USGS



USGS/NOAA/NWS Wave Runup Forecasts

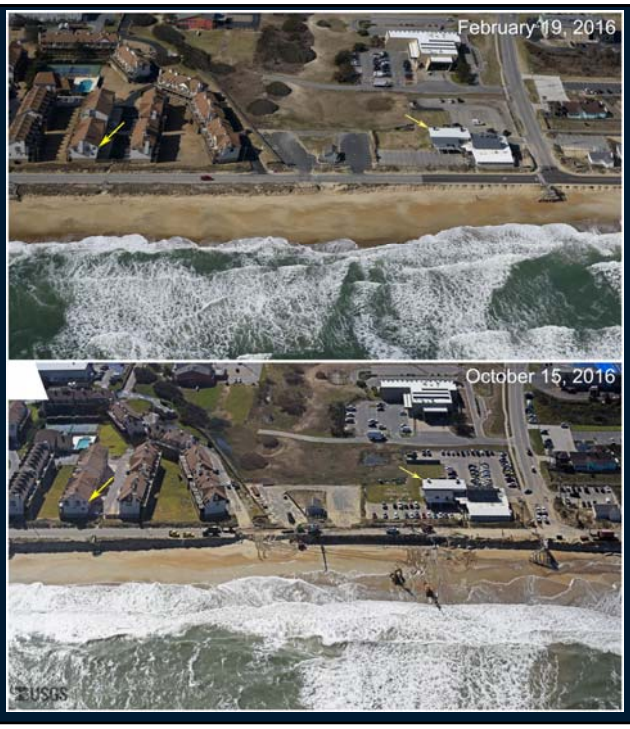
- Interagency effort providing forecasts every 300-500 meters along the coast.
- Forecasts include combination of tides, wind surge, and ***wave runup***.
- Predicts the ***magnitude***, ***timing***, and ***duration*** of water level impacts
- Provides ***operational*** predictions that can trigger local coastal change warnings for all storm events (tropical and extratropical storms)
- Fully operational at five pilot sites; methodology designed to ***scale nationally***

coastal.er.usgs.gov/hurricanes/research/twlviewer

Storm response activities

- Pre- and post-storm photo comparisons
- Qualitative validation of coastal change forecast using NOAA imagery
- Oblique aerial photography of the coast from Port St. Lucie, Florida to Kitty Hawk, North Carolina collected October 13-15, 2016.
- Post-storm airborne lidar survey of open coast shoreline from Florida to Virginia, collected October -December, 2016 (in collaboration with U.S. Army Corps of Engineers).
- Ground surveys – with help from SAWSC

https://coastal.er.usgs.gov/hurricanes/matthew/



Future work

- Quantitative validation of coastal change forecast using lidar
- Coastal Change Hazards forecast improvement
- Total water level and coastal change forecast viewer will cover most of the U.S. Atlantic coastline this fall.

USGS