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

- Regional Cooperative Studies
- Coral Reef Studies
- National Coastal Change Hazards
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
USGS Coastal and Marine Geology Program

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

Comparison of modeled and observed sediment thickness change

Integration of Geologic and Shoreline Structure and Change

Oceanographic Deployments

Long-term and hurricane-driven shoreline change
Regional studies indicate increase in reef calcification in Dry Tortugas National Park, while loss at all other locations.
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
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

Hog Island, VA

Date range: 1852 - 1997
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
Regional Studies

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

Hapke et al., 2011
Regional Studies

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

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
Localized Studies

Hog Island, Virginia

Date range: 1852 - 1997
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
Components of Coastal TOTAL Water Levels

- Mean sea level
- Surge + tides
- Surge + tides + wave runup

Function of offshore waves and beach slope
Beach Erosion

Inundation

Dune Erosion

Overwash

Sallenger 2000
Storm Impact Prediction Models

MAXIMUM Waves & Water Levels

Last Measured Topo/Bathy

Response

Probability

low

high

medium
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.

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
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)
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
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.
USGS shoreline change research in Puerto Rico

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

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/