Attachment B

Presentation of Question 2; Jeff Williams, USGS

USGS
science for a changing world

CCSP SAP 4.1 Question 2

How does sea-level rise change the coastline? Among those lands with sufficient elevation to avoid inundation, which land could potentially erode in the next century? Which lands could be transformed by related coastal processes?

S. Jeffress Williams USGS/WHSC
E. Robert Thieler USGS/WHSC
Benjamin Gutierrez USGS/WHSC
Eric Anderson USGS/CSC

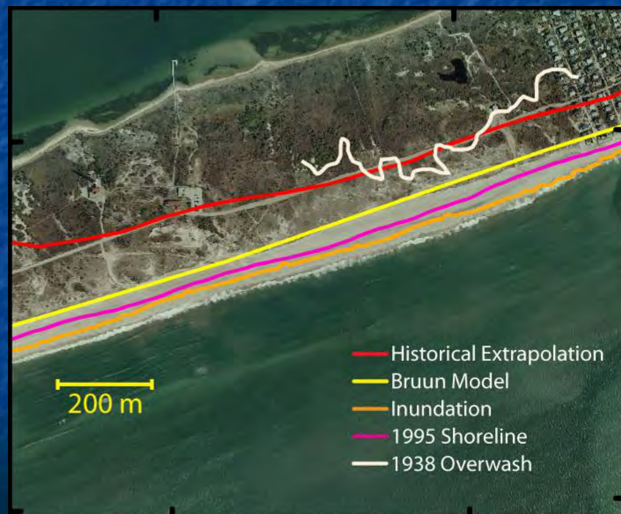
Assessing Potential Coastal Changes

- Question 2 focused on open-ocean coasts
  - Present shoreline physical setting: national, NY to NC
  - Current understanding of important geologic factors and oceanographic processes
  - Potential impacts and responses to SLR
- Review and test current models for predicting shoreline and coastal change
- Methodologies reviewed
  - Shore-line change/historic erosion-rate extrapolation
  - Bruun Rule
  - Inundation
  - Index-ranking based on physical criteria
- Review is guiding research plan development

E-rate, Bruun Rule, and Inundation Predictions for 2100

- Erosion-rate extrapolation → large change
- Bruun → small change
- Inundation → small *seaward* change

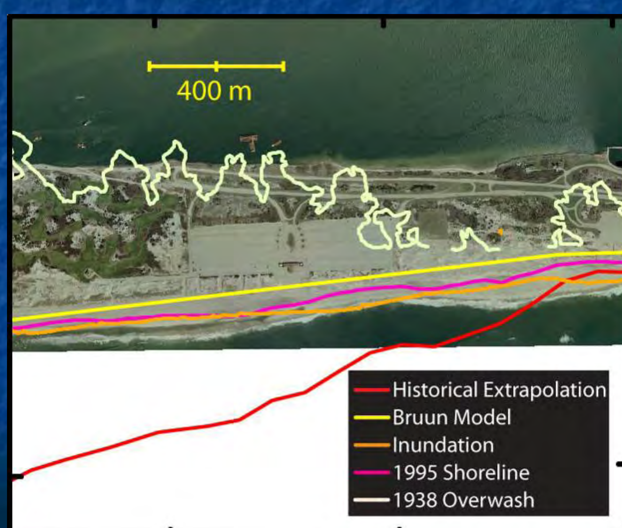
- **Western Fire Island, NY (near Saltaire)**
- **SLR = 59 cm = 48 cm IPCC + 11 cm local subsidence**
- **E-rate = long-term rate * 105 yr**



E-rate, Bruun Rule, and Inundation Predictions for 2100

- Erosion-rate extrapolation → large *seaward* change
- Bruun → small change
- Inundation → small change

- **Western Fire Island, NY (near Democrat Point)**
- **SLR = 59 cm = 48 cm IPCC + 11 cm local subsidence**
- **E-rate = long-term rate * 105 yr**



Bruun Model Assumptions:

1) the beach is eroded due to landward translation of the profile

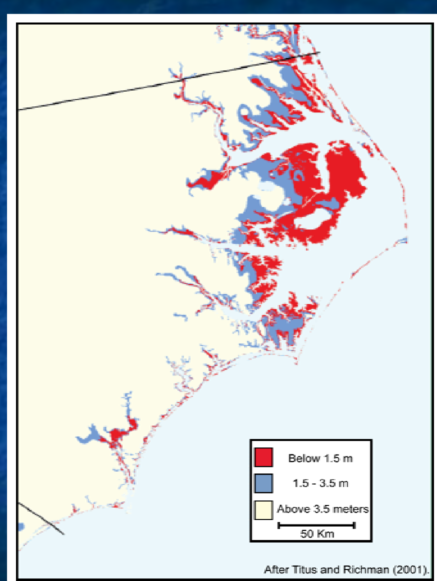
2) material eroded from the beach is transported offshore and deposited so that the volume eroded from the beach equals the volume deposited seaward of the shoreline

3) the rise in the nearshore seabed as a result of deposition is equal to the rise in sea level, maintaining a constant water depth

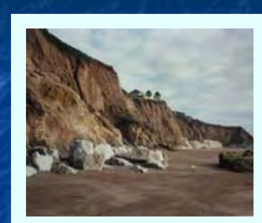
4) gradients in alongshore sediment transport are negligible

5) cross-shore sediment transport is negligible

Inundation Susceptibility Assessments



After Titus and Richman (2001).



Inundation Susceptibility Assessments

Limitations:

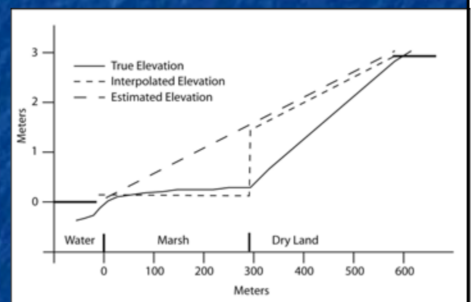
1. Poor-resolution in low-lying regions.

2. Overly Simplistic:

a) Implies that coastal regions will simply be flooded.

b) Neglects the effects of shoreline erosion and sediment supply.

c) Difficult to attach a time-scale to expected changes.



Coastal Vulnerability Index

National Assessment of Coastal Vulnerability to Sea-Level Rise
Thieler and Hammar-Klose (2000)

http://woodshole.er.usgs.gov/project-pages/nps-cvi/
http://pubs.er.usgs.gov/

CVI Methodology

VARIABLES	SOURCE
GEOMORPHOLOGY	Aerial Photography from MassGIS and USGS; http://edcwww.cr.usgs.gov/ http://www.state.ma.us/mgis/
SHORELINE EROSION/ACCRETION (m/yr)	USGS Administrative Report: The Massachusetts Shoreline Change Project: 1800s -1994 (Thieler et al., 2001); http://www.state.ma.us/czm/shorelinechange.htm
COASTAL SLOPE (%)	NGDC Coastal Relief Model Vol 01 12/17/1998; http://www.ngdc.noaa.gov/mgg/
RELATIVE SEA-LEVEL CHANGE (mm/yr)	NOAA Technical Report NOS CO-OPS 36 SEA LEVEL VARIATIONS OF THE UNITED STATES 1854-1999 (Zervas, 2001); http://www.co-ops.nos.noaa.gov/publications/techrpt36doc.pdf
MEAN SIGNIFICANT WAVE HEIGHT (m)	North Atlantic Region WIS Data (Phase II) and NOAA National Data Buoy Center; http://bigfoot.wes.army.mil/u003.html http://seaboard.ndbc.noaa.gov/
MEAN TIDE RANGE (m)	NOAA/NOS CO-OPS Historical Water Level Station Index; http://www.co-ops.nos.noaa.gov/station_index.shtml?state

- Utilize existing data for six geological and physical process variables:

a) Geomorphology
b) Historic shoreline change
c) Coastal Slope
d) Relative sea-level rise rate
e) Mean sig. wave height
f) Mean tidal range

VARIABLES	VERY LOW	LOW	MODERATE	HIGH	VERY HIGH
	1	2	3	4	5
GEOMORPHOLOGY	Rocky, cliffed coasts Fjords	Medium cliffs Indented coasts	Low cliffs Glacial drift Alluvial plains	Cobble Beaches Estuary Lagoon	Barrier beaches, Sand beaches, Salt marsh, Mud flats, Deltas, Mangroves, Coral reefs
SHORELINE EROSION/ACCRETION (m/yr)	> 2.0	1.0 - 2.0	-1.0 - 1.0	-2.0 - -1.0	< -2.0
COASTAL SLOPE (%)	> 1.20 >1.90	1.20 - 0.90 1.90 -1.30	0.90 - 0.60 1.30 - 0.90	0.60 - 0.30 0.90 - 0.60	< 0.30 <0.60
RELATIVE SEA-LEVEL CHANGE (mm/yr)	< 1.8	1.8 - 2.5	2.5 - 3.0	3.0 - 3.4	> 3.4
MEAN WAVE HEIGHT (m)	< 0.55 < 1.10	0.55 - 0.85 1.1 - 2.0	0.85 - 1.05 2.0 -2.25	1.05 - 1.25 2.25 - 2.60	> 1.25 > 2.60
MEAN TIDE RANGE (m)	> 6.0	4.0 - 6.0	2.0 - 4.0	1.0 - 2.0	< 1.0

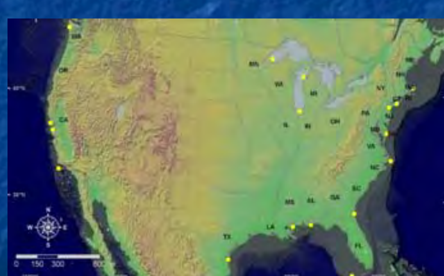
- Data are scored using a simple ranking system, so that the variables can be expressed in a quantifiable manner.

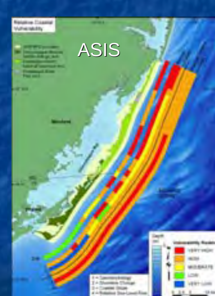
- Once the data are complete in a GIS, an equation can be applied to calculate the CVI.

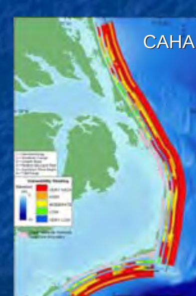
$$CVI = \sqrt{\frac{(a \times b \times c \times d \times e \times f)}{6}}$$

USGS-NPS CVI Project

- Applied to 25 NPS units in U.S. and abroad
- Higher-resolution than national study (~1.5 km coastal cell)







- 4 NPS units in SAP focus area

Pendleton et al. (2004- 2007)

USGS
science for a changing world

Expert Panel on Sea-level Rise and Shoreline Change in the Mid-Atlantic Region
April 12-13, 2007

Context

The U.S. Climate Change Science Program is undertaking an effort to conduct a synthesis and assessment of the state-of-science regarding sea-level rise and the potential effects on coastal regions. The USGS, EPA, and NOAA are lead agencies preparing the report and are coordinating input and review from the scientific community. The USGS authors have been asked to address the following question:

How does sea-level rise change the coastline? Among those lands with sufficient elevation to avoid inundation, which land could potentially erode in the next century? Which lands could be transformed by related coastal processes? (Key Question 2, page 5 of SAP 4.1)

To address this question, a small panel of experts in coastal geology and marine processes was convened to discuss the best approaches to describing, ranking, and visualizing how future sea-level rise (SLR) might affect coastal regions. The focus is on the Mid-Atlantic region from Long Island, New York to Cape Lookout, North Carolina.

USGS
science for a changing world

Meeting Goal

- Develop a consensus-based assessment of the potential for sea-level rise driven shoreline changes and related impacts to the open coast of the Mid-Atlantic Bight over the next century.

Objectives

- Assess current status of our understanding of how shoreline change occurs in response to sea-level rise, focusing on the Mid-Atlantic region of the United States.
  - Define key geomorphic settings
  - Define important processes in each setting and how SLR will affect them
  - Develop a synthesis for each setting within the study area for given SLR scenarios: 0.25, 0.5, 1, and 2 m
- Identify what type of information products (maps, etc.) will be most useful to coastal scientists, policy makers, and coastal managers

SAP 4.1 Q2 WORKSHOP ATTENDEES and PARTICIPANTS*

1) Fred Anders* – New York Department of State
2) Eric Anderson – U.S. Geological Survey, CSC
3) Mark Byrnes - Applied Coastal Research and Engineering
4) Stewart Farrell - Coastal Research Center, Richard Stockton College
5) Paul Gayes – Center for Marine and Wetland Studies, Coastal Carolina University
6) Duncan FitzGerald* – Boston University
7) Benjamin Gutierrez - U.S. Geological Survey
8) Carl Hobbs - Virginia Institute of Marine Science
9) Randy McBride - Geology & Earth Science Program, George Mason University
10) Jesse McNinch - Virginia Institute of Marine Science
11) Stan Riggs* – East Carolina State University
12) Antonio Rodriguez - Institute of Marine Sciences, University of North Carolina
13) Jay Tanski – New York Sea Grant
14) E. Robert Thieler - U.S. Geological Survey
15) Art Trembanis - College of Marine and Earth Studies, University of DL
16) S. Jeffress Williams - U.S. Geological Survey

Panel classification of primary coastal landforms along the mid-Atlantic Bight

- Coastal spits
- Coastal headlands
- Wave-dominated barriers
- Mixed-energy barriers

Expert panel assessment:

- five potential SLR effects
- SLR scenarios of 25 cm, 50 cm and 1 m

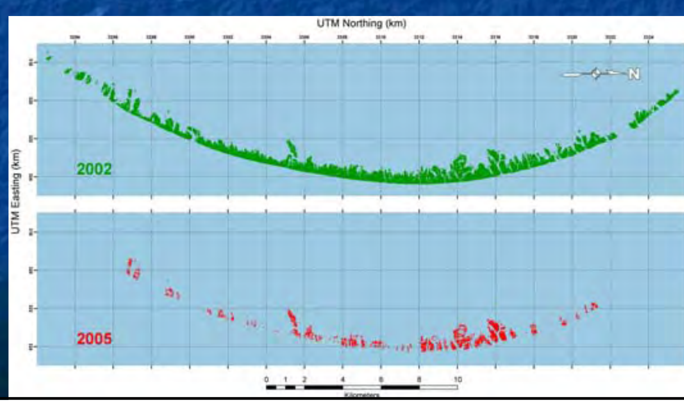
Output products:

- Soundwaves article, July ’07
- USGS/OFR Gutierrez, et al., draft in peer review

Concern: non-linear behavior, “thresholds” of stability of coastal landforms may be crossed due to SLR, storms

- Increasing evidence that SLR from 2000-100 yr BP was near zero
- Acceleration began at end of 19th century
- Consequences may be dire for U.S. barrier islands and spits
- Barriers are ~50% of U.S. coast; ~90% of SAP focus area

Chandeleur Islands extreme coastal change… 85% land loss, erosion continues, minimal recovery to date



Northern Assateague Island: a barrier at risk of threshold collapse?