Coastal Sensitivity to Sea-Level Rise:
A Focus on the Mid-Atlantic Region

U.S. Climate Change Science Program
Synthesis and Assessment Product 4.1

IAC LOSC Brown Bag Presentation

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March 19, 2009

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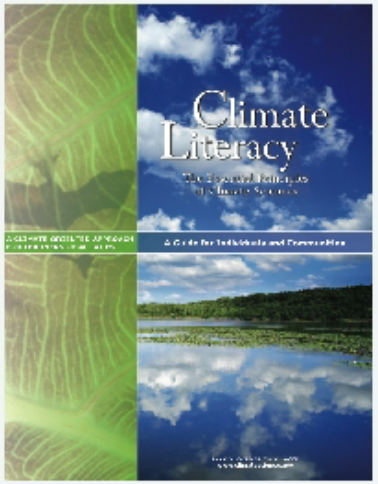
U.S. Climate Change Science Program (CCSP) | **CCSP Agencies**

Climate Literacy: "The Essential Principles of Climate Sciences" presents information that is deemed important for individuals and communities to know and understand about Earth climate, impacts of climate change, and approaches to adaptation or mitigation. See also the National Oceanic and Atmospheric Administration Climate Education website (posted 13 March 2009)

Final Report of Synthesis and Assessment Product 4.1 (Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region) is posted online. See also press release from the Environmental Protection Agency (EPA), and EPA web-page. (posted 16 Jan 2009)

Final Report of Synthesis and Assessment Product 4.2 (Thresholds of Climate Change in Ecosystems) is posted. See also press release from the U.S. Geological Survey (USGS). (posted 16 Jan 2009)

New Reports



Climate Literacy: "The Essential Principles of Climate Sciences" - A Guide for Individuals and Communities. See NOAA's Climate Education website

For other reports by the U.S. Climate Change Science

How was this report developed?

- EPA was the Convening Lead Agency, with NOAA and USGS as key authoring Agencies.
- Editors were: James G. Titus (EPA), Stephen K. Gill (NOAA), and the following USGS scientists: K. Eric Anderson, Donald R. Cahoon, Dean B. Gesch, Benjamin T. Gutierrez, E. Robert Thieler, and S. Jeffress Williams
- Information was obtained through synthesis and assessment of *current* scientific literature and expert panel assessments.
- Input was solicited during three stakeholder meetings, technical peer review, and a public review and comment period.
- A Federal Advisory Committee, chaired by Margaret Davidson, Director of NOAA's Coastal Services Center, provided review and guidance throughout report development.

NOAA Contributors

- Robb Wright: NOS/SPO – Population Analyses

- Doug Marcy: CSC – Coastal Flooding

- Rebecca Feldman: CPO –
  Report compilation and acceptance,
  Co-Author on Appendix I Section
  on North Carolina

How is the report organized?

Preface
Executive Summary

I. The Physical Environment
1. Sea-Level Rise and Its Effects on the Coast
2. Coastal Elevations
3. Ocean Coasts
4. Coastal Wetland Sustainability
5. Vulnerable Species

II. Societal Impacts and Implications
6. Shore Protection and Retreat
7. Population, Land Use, and Infrastructure
8. Public Access
9. Coastal Flooding, Floodplains and Coastal Zone Management Issues

III. Preparing for Sea-Level Rise
10. Implications for Decisions
11. Ongoing Adaptation
12. Institutional Barriers

IV. National Implications and a Science Strategy for Moving Forward
13. Implications of Sea-Level Rise to the Nation
14. Science Strategy

Appendix I: State and Local Information on Vulnerable Species and Coastal Policies
Appendix II: Basic Approaches for Shoreline Change Projections

PART I
The Physical Environment

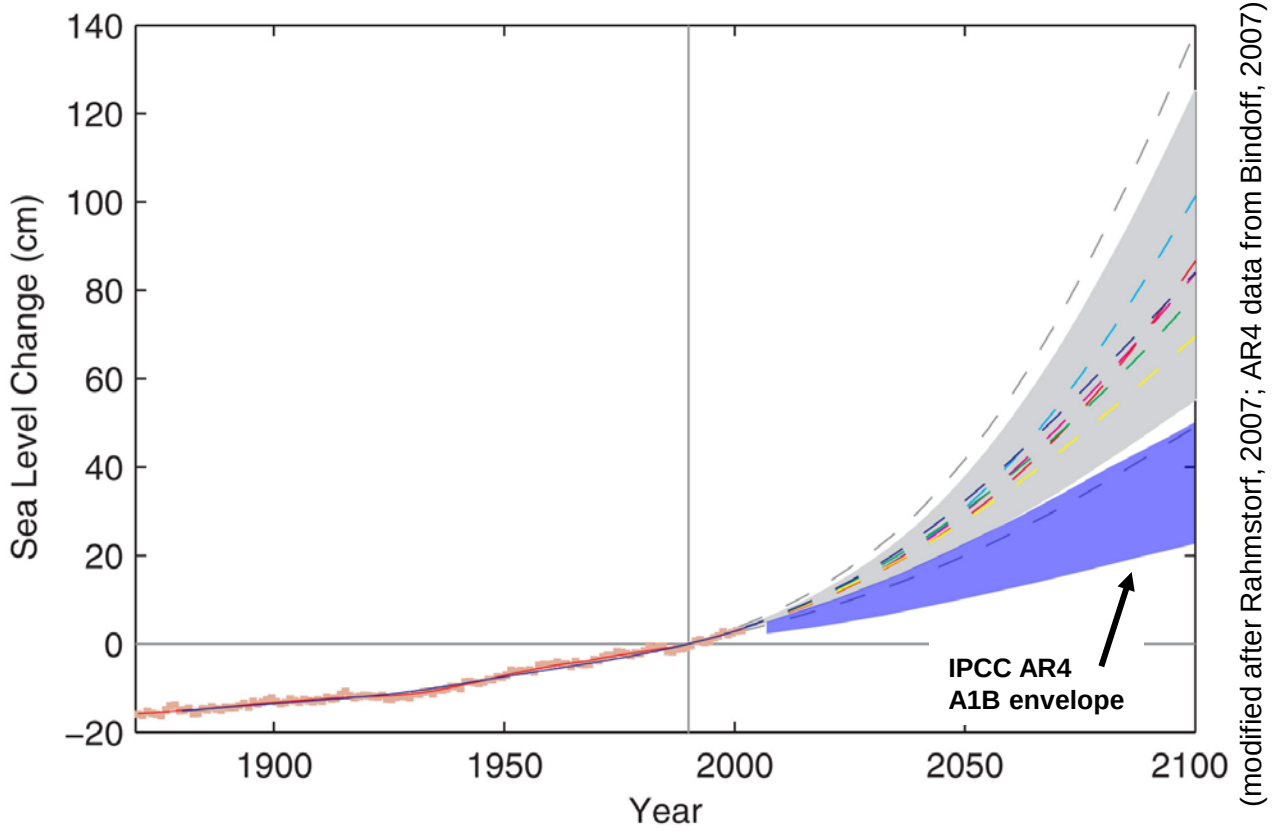
1. **Sea-Level Rise and Its Effects on the Coast**
2. **Coastal Elevations**
3. **Ocean Coasts**
4. **Coastal Wetland Sustainability**
5. **Vulnerable Species**

Sea-level rise (SLR)

- **Primary climate change impacts on coasts would be SLR and increased major storm intensity**
- **In the past 400,000 years, sea level has been 120 m lower and 5 m higher than present, but rising at variable rates for the past 20,000 years**
- **Data over the past 15 years show SLR appears to be accelerating**
- **Relative SLR for some coastal regions in the U.S. such as the mid-Atlantic and Gulf of Mexico is greater than the global average due to land subsidence**
- **Climate model studies suggest SLR rates in the 21st century will exceed rates over the past century; rates could be much greater if ice losses in Greenland and Antarctica increase**

In this Report, no new SLR projections were developed. Three scenarios broadly representing the range in the literature were used: continuation of 20th century rate, +2 mm/yr, +7 mm/yr

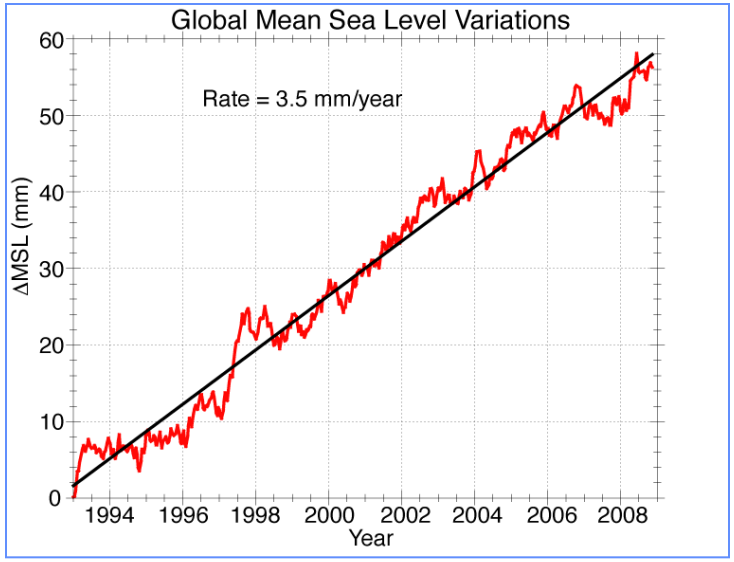
Sea-Level Rise Will Affect U.S. Coastal Regions



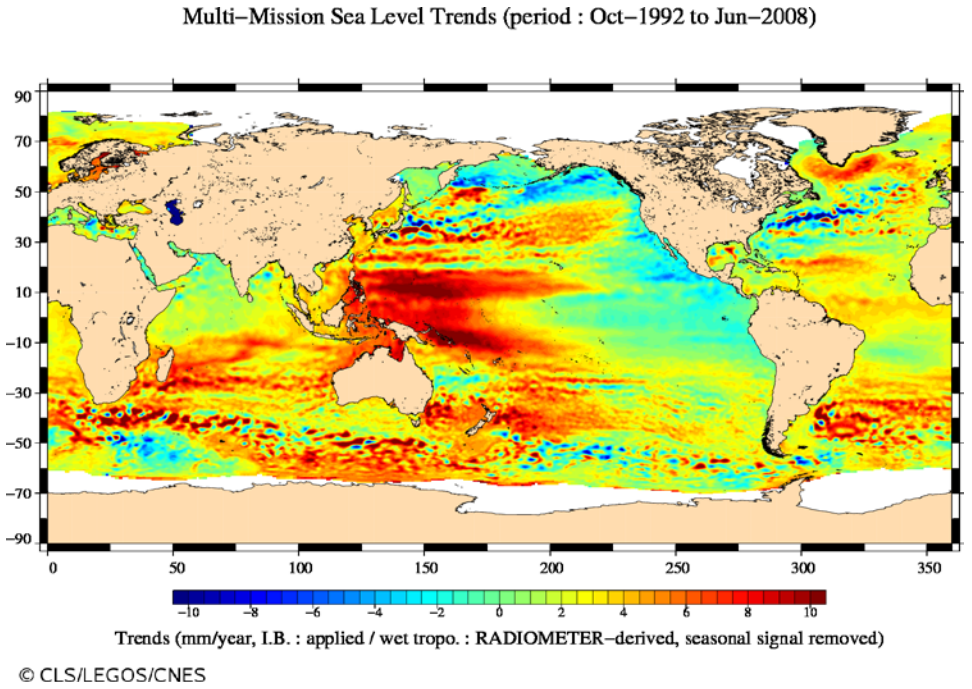
- Future sea-level rise is very likely to be faster than the last ~40 years; published projections have substantial uncertainty regarding the possible upper bound
- Sea level rise will inundate low-lying coastal areas and lead to increased flood frequency
- U.S. coastal populations have doubled over the past 50 years, greatly increasing vulnerability to rising sea level and storms

Aside comment – the information in this slide is not from CCSP4.1

The altimeter record

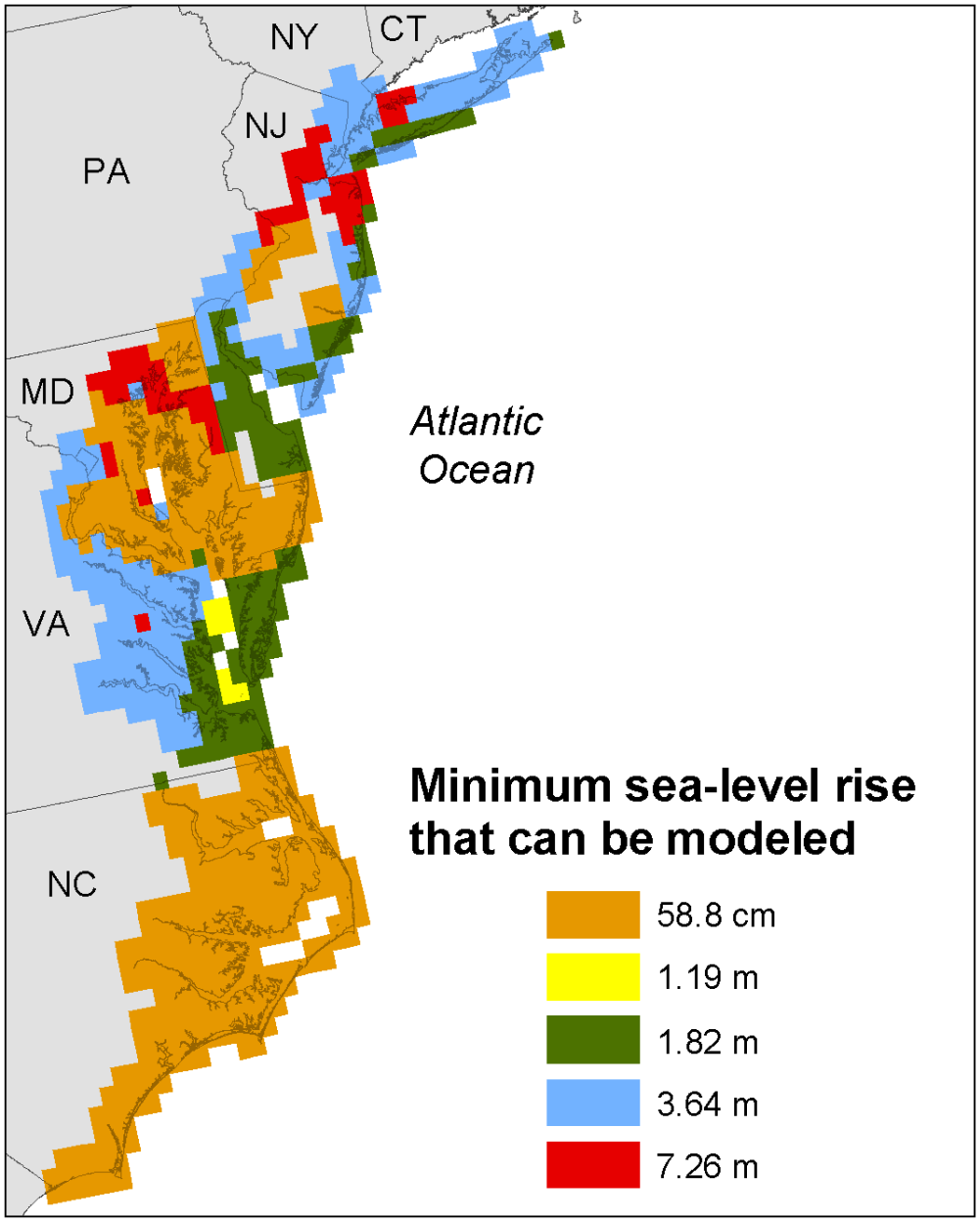


Source – S. Nerem, 2009



Coastal Elevations

- Elevation is a critical factor in assessing potential impacts (specifically, inundation)
- Current elevation data do not provide the degree of confidence needed for quantitative assessments for local decision making
- Collection of high-quality elevation data (lidar) would be valuable

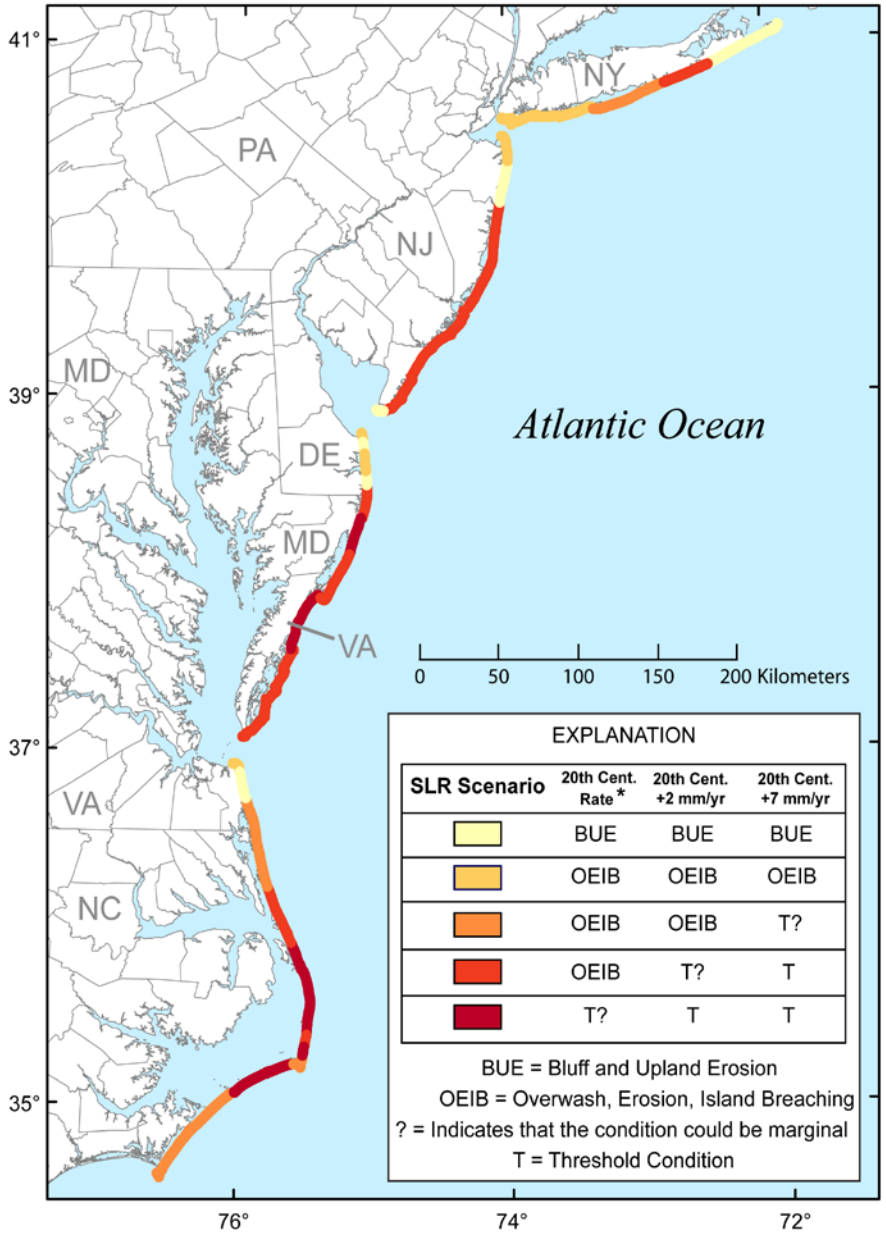


Ocean Coasts

- It is *virtually certain* that erosion will dominate changes in shoreline position along the mid-Atlantic ocean coasts in response to sea-level rise and storms

- For higher sea-level rise scenarios, it is *very likely* that some portions of the mid-Atlantic coast will undergo large changes which will depend in part on local geologic and oceanographic conditions

- Specifically, some barrier island coasts will likely cross a threshold and become prone to more rapid landward migration or segmentation

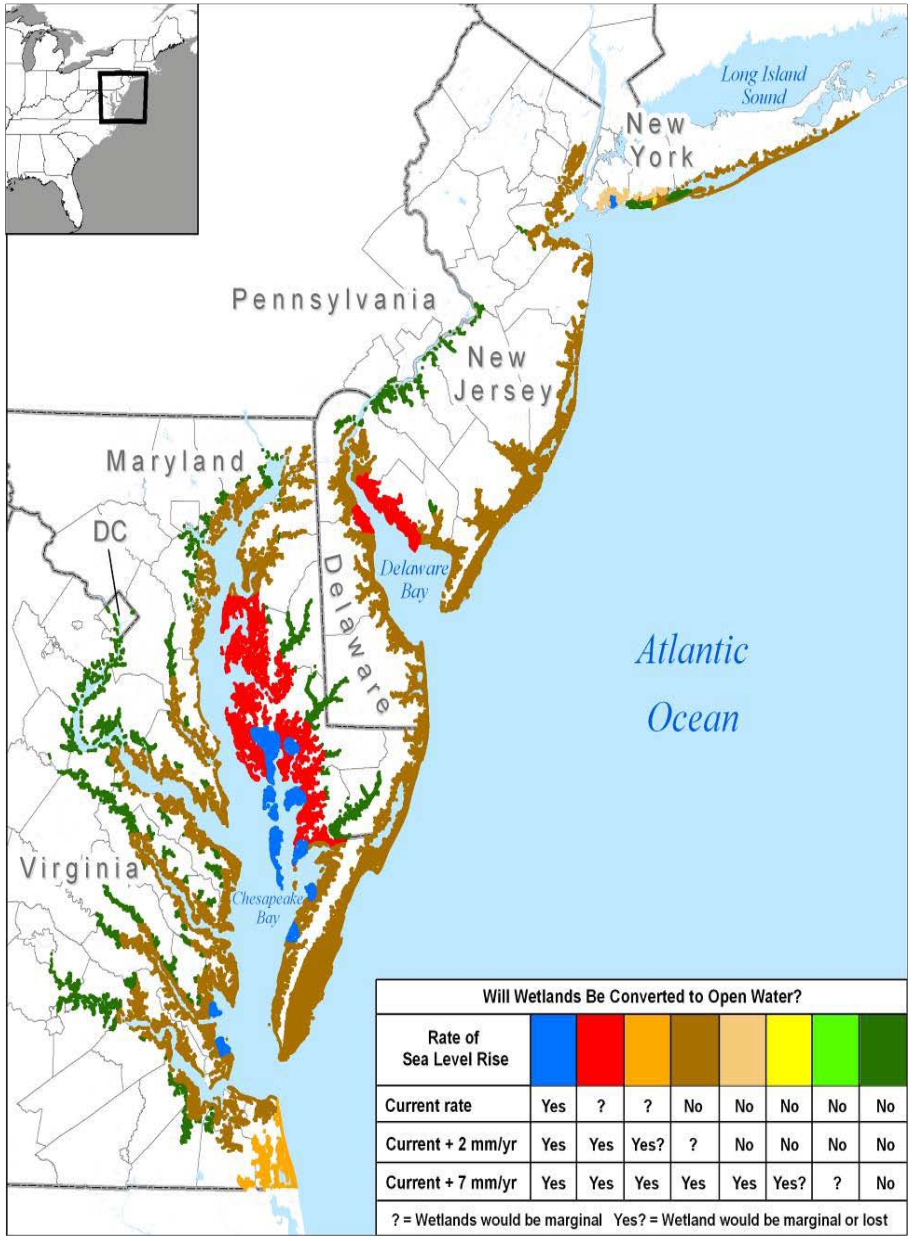


Wetlands

- Wetlands currently keeping pace with sea-level rise would likely survive 2 mm per year acceleration in sea-level rise only under optimum conditions, and would not survive 7 mm per year acceleration

- Future wetland area determined by (1) the ability of a wetland to keep pace with sea-level rise, (2) the area available for those wetlands keeping pace with sea-level rise to migrate inland, and (3) the rate of lateral erosion of the marsh edge

- Regional or national scale assessments of wetland vulnerability should not be used to develop local management plans in the absence of local data due to model uncertainty and variability



Habitats and Species

•The quality, quantity, and spatial distribution of coastal habitats will change as a result of erosion, salinity changes, and wetland loss. This will have adverse impacts on a range of plant and animal species.

•As coastal development continues, the ability for habitats to change and migrate inland along the rest of the coast will not only be a function of the attributes of the natural system, but also of the coastal management policies and practices for both developed and undeveloped areas.

Roanoke River, NC

Potomac River, MD

Peconic Bay, NY

PART II
Societal Impacts and Implications

6. **Shore Protection and Retreat**

7. **Population, Land Use, and Infrastructure**

8. **Public Access**

9. **Coastal Flooding, Floodplains and Coastal Zone Management Issues**

Shore Protection and Retreat

- **Tradeoffs between different approaches**
  - Shore protection maintains existing land use
  - Retreat allows natural processes
  - Costs and social implications vary
  - Accelerated sea-level rise may shift the balance toward retreat

Population and Infrastructure

- Increasing sea level will put additional stress on the ability to effectively manage competing interests of increasing population and development, and trying to maintain the benefits of natural ecosystems.
- Map resolution and accuracy are often too limited for local scale planning

Public Access

- Publicly funded beach nourishment promotes public access to and along the shore
- Shoreline armoring usually eliminates intertidal zone

Coastal Flooding and Floodplains

- Sea level rise increases flood hazard by providing a higher base for storm surges to build upon, slowing natural drainage, and eroding natural protective features such as beaches, dunes, and wetlands.
- Floodplain maps, which are used to guide development and building practices in areas at risk to coastal hazards, do not take into account accelerated sea-level rise

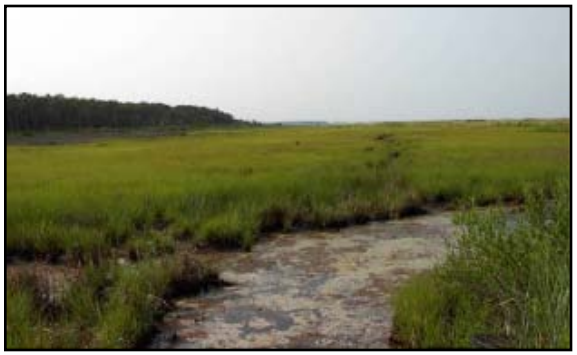
PART III
Preparing for Sea-Level Rise

10. **Implications for Decisions**

11. **Ongoing Adaptation**

12. **Institutional Barriers**

Potential Preparation



Coastal Habitat

Anticipating sea-level rise (examples):

- "Living shorelines" could often replace "hard" shoreline armoring
- Possibilities to engineer preservation of existing wetlands
- Identifying land for migration

Institutional barriers (examples):

- Nationwide permit for and industry practices favoring hard structures
- Statutes do not consider habitat migration

Structures with Long Lifetimes

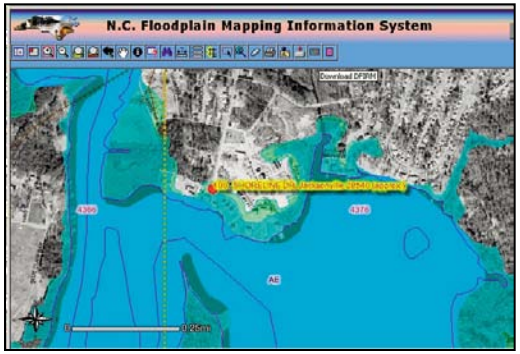
Anticipating sea-level rise (examples):

- Designing for the future is less expensive than retrofitting, rebuilding or moving infrastructure (e.g., highways or sewer systems)

Institutional barriers (examples):

- Lack of clear plan as to which areas will be protected or abandoned.

Potential Preparation



Flood Insurance

Anticipating sea-level rise (examples):

- Incorporate risk in cost of coastal habitation
- Key tool for ensuring safe construction

Institutional barriers (examples):

- Grandfathering risk removes incentives to prepare or respond
- Sea level rise not included in flood mapping

Development, Shore Protection

Anticipating sea-level rise (examples):

- Sea level rise can alter merits of:
  - Home elevation
  - Shore Protection
  - Coastal development

Institutional barriers (examples):

- Flood Insurance
- Local gov’ts encourage growth
- Federal subsidies & safety nets
- Subsidized shore protection
- Emergency programs pay for rebuilding beaches, home elevation, relocation

PART IV
National Implications and a Science Strategy for Moving Forward

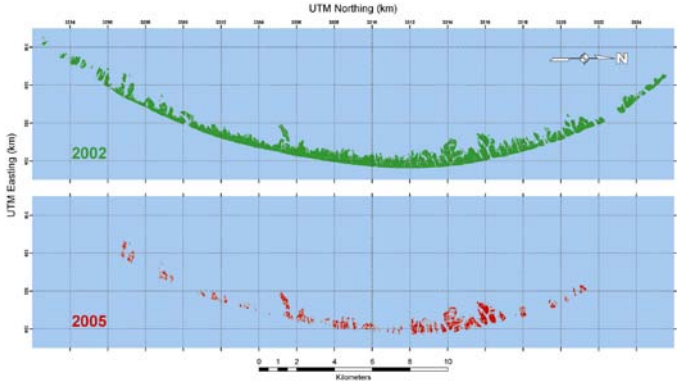
13. **Implications of Sea-Level Rise to the Nation**

14. **A Science Strategy for Improving the Understanding of Sea-Level Rise and Its Impacts on U.S. Coasts**

National Implications

- **Increased risk and economic costs for all people and development at the coast**
- **Erosion processes at highly variable rates will dominate where there are barrier islands, dunes, spits, and bluffs (over the next century and beyond)**
- **Some coastal landforms may undergo large changes in shape and location if the rate of SLR increases as predicted**
- **Tidal wetlands already being submerged by sea-level rise, land loss, and other factors, and this will continue**

Vulnerable ports & industries in Oakland, CA

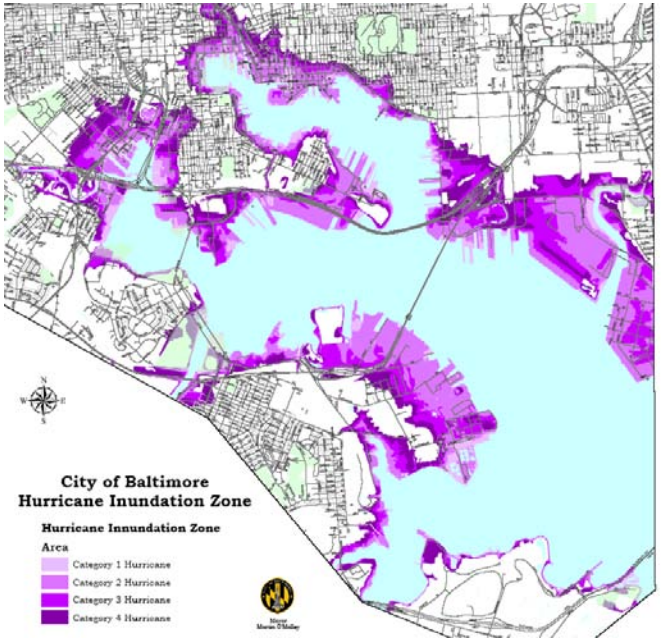


Ecologically and economically important areas at risk from sea-level rise and storms (Chandeleur Islands, LA)

Appendix I: State and Local Information on Vulnerable Species and Coastal Policies

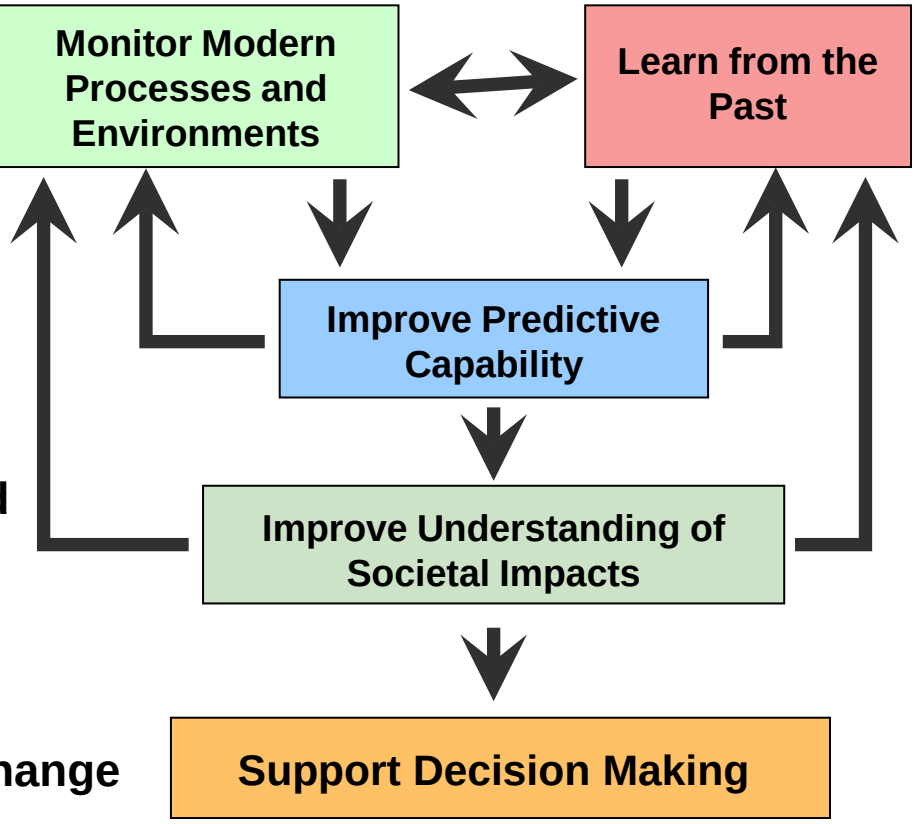
- State-specific policies on:
  - coastal land use
  - public access
  - shore protection

- Vulnerable habitat and species



Science Strategy

- Integrated multidisciplinary research
- Expanded coastal observations, time series data
- Use historic and geologic records and integrate them into predictive models
- Improved quantitative assessments
- Improved models, including of past change
- Ability to identify thresholds/tipping points
- Research on adaptation and mitigation
- Easy access to data, resources, and information on factors affecting decisions
- Better public education and decision support

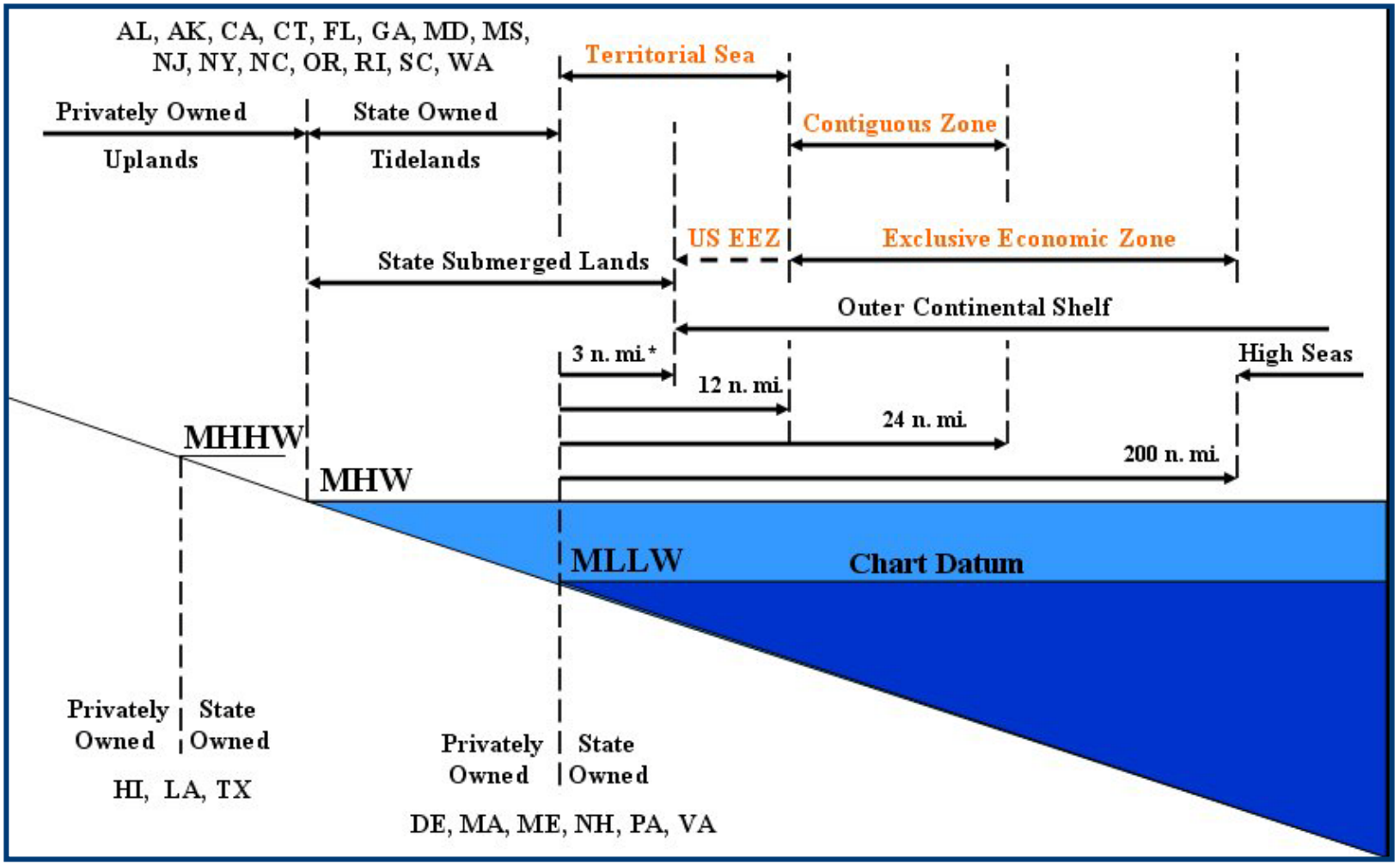


Appendix I: Regions Included

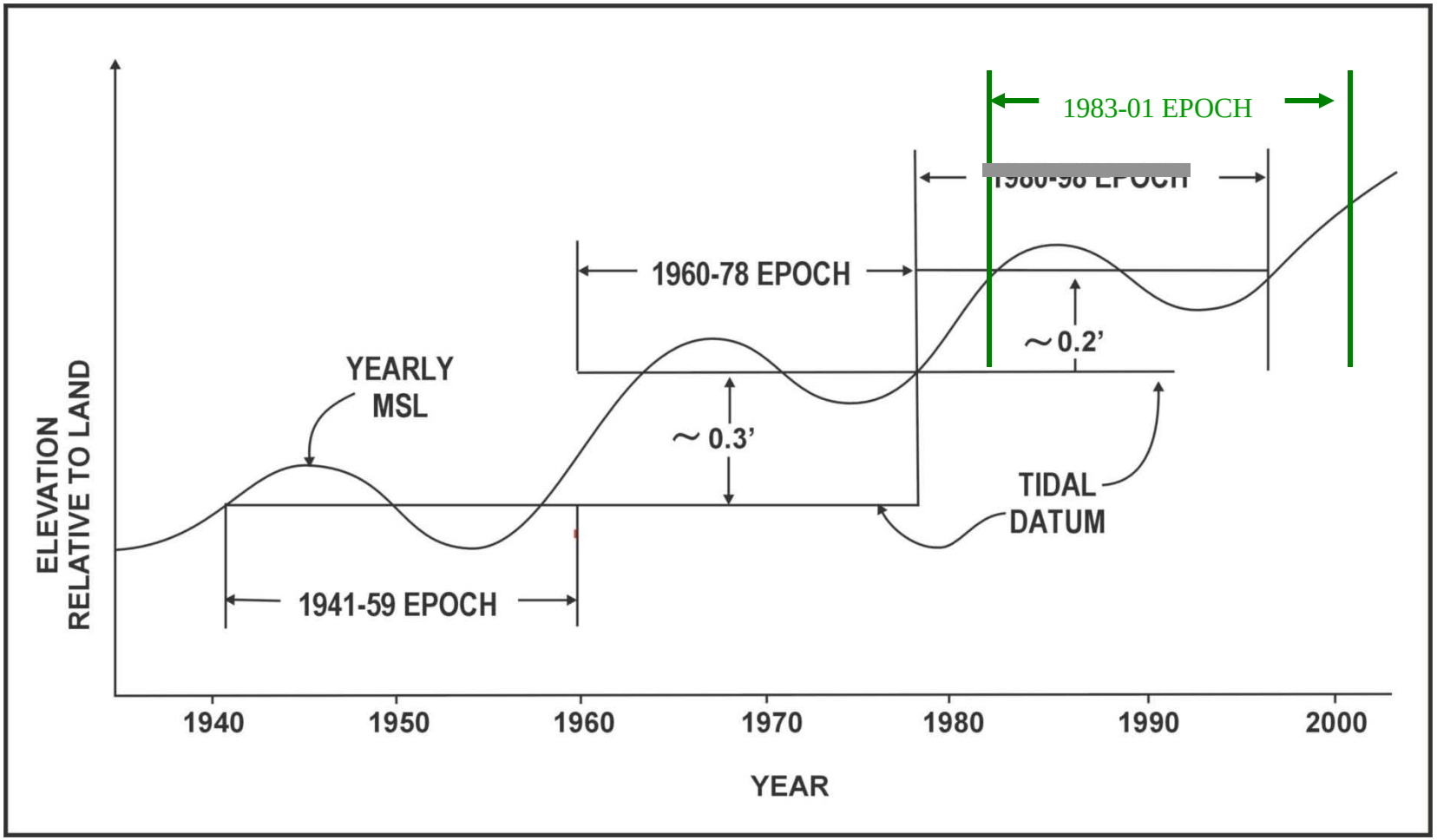
- **A. Long Island**
- **B. New York Metropolitan Area**
- **C. New Jersey Shore**
- **D. Delaware Estuary**
- **E. The Atlantic Coast of Virginia, Maryland, and Delaware (including coastal bays)**
- **F. Chesapeake Bay**
- **G. North Carolina**

Additional Discussion – not form CCSP 4.1

Datums and Maritime Boundaries



ACTUAL
~~IDEALIZED~~ CHANGE OF TIDAL EPOCH



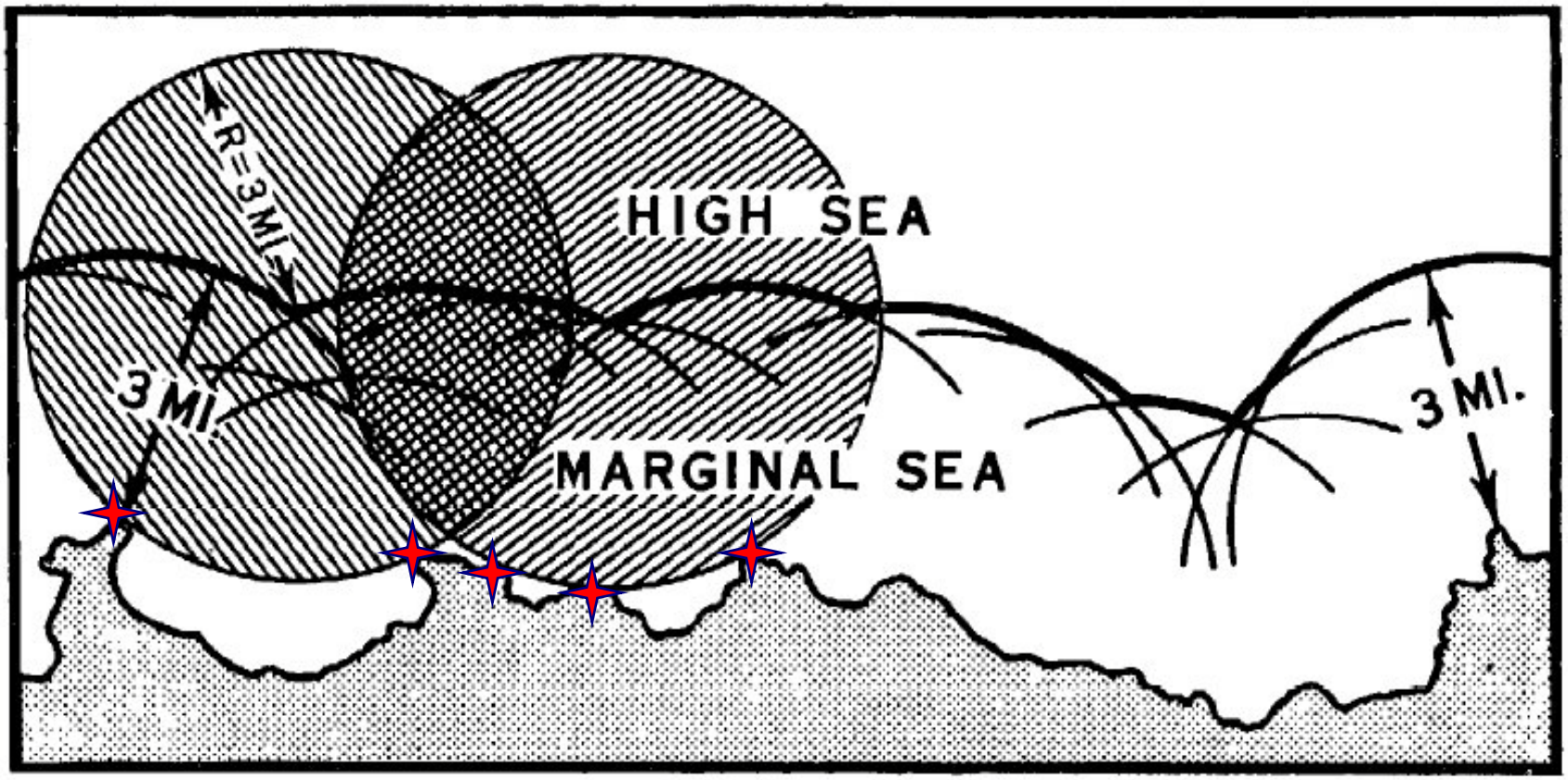


FIGURE 27.—The envelope line is the locus of the center of a circle rolled along the coastline with circumference always in contact with it.

For more information

http://www.climatescience.gov/Library/sap/sap4-1/

See also:

http://www.sealevelreport.com

Thank You

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