CAPE COASTAL CONFERENCE

Linking Science with Local Solutions and Decision-Making

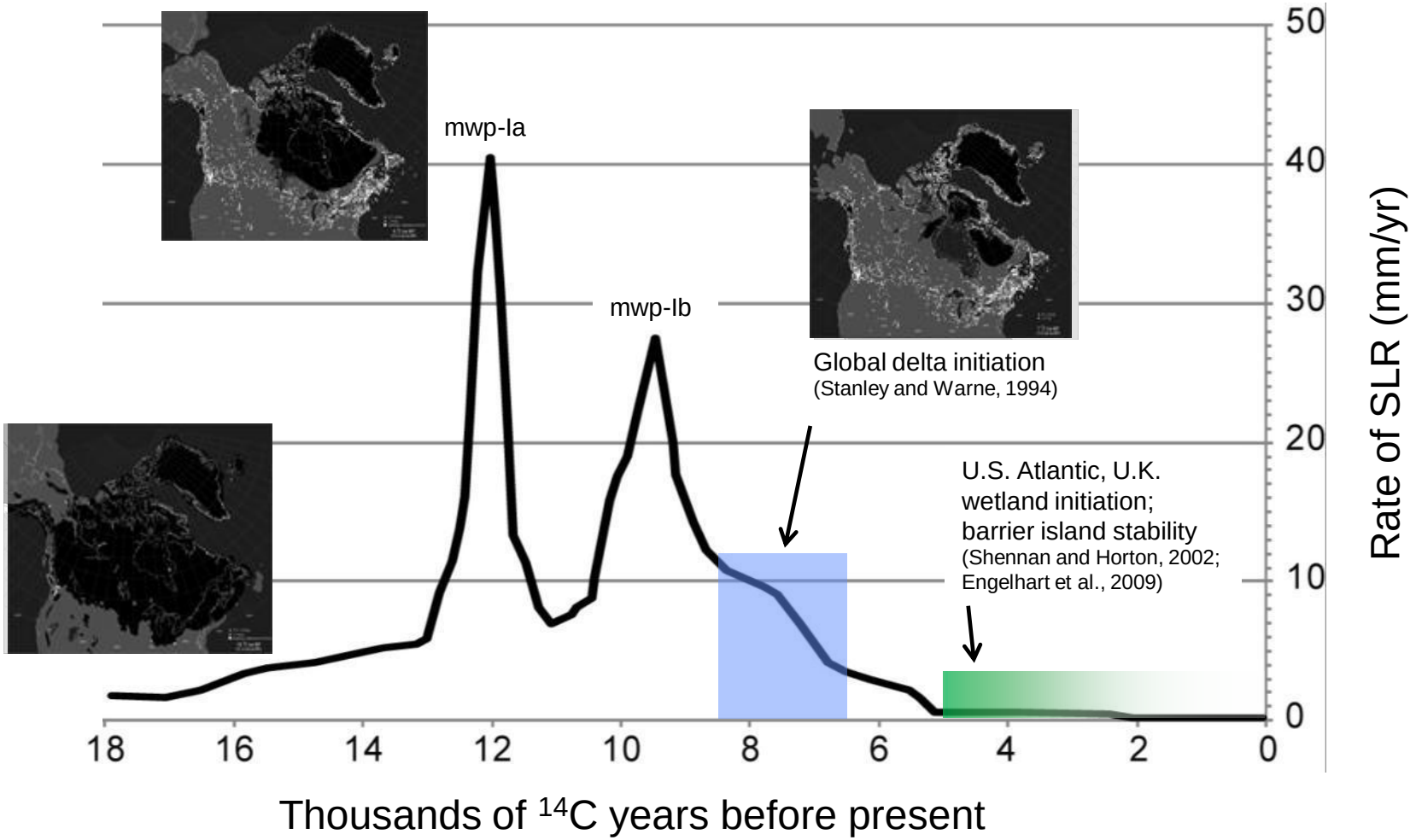
Will the Cape Fall Into The Sea? Future Sea Level Rise and Coastal Change on Cape Cod

Rob Thieler, USGS

Concepts

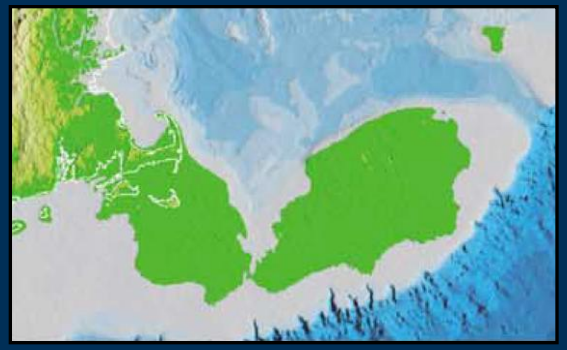
- There is very high confidence (>90% chance) that sea-level will rise between 8 inches and 6.6 feet by 2100. This is higher and will be faster than the past 2000 years.
- The coast does not flood like a bathtub. It's much more exciting.
- Effective adaptation to rising sea level will require changing approaches to coastal management.

Sea-level rise rates since the Last Glacial Maximum

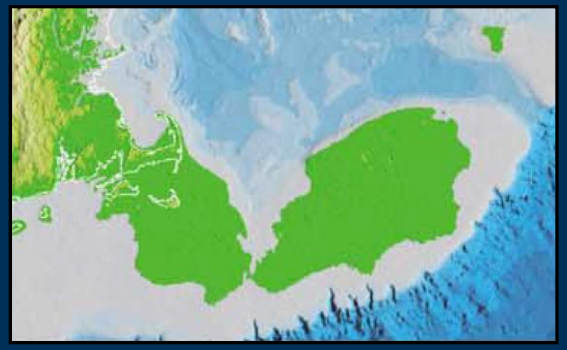


(SLR rate based on Fairbanks, 1989; ice extent from Dyke, 2004)

Sea-level Rise on Cape Cod
12,000 yr BP to Present



12,000 yr BP



11,000 yr BP

10,000 yr BP

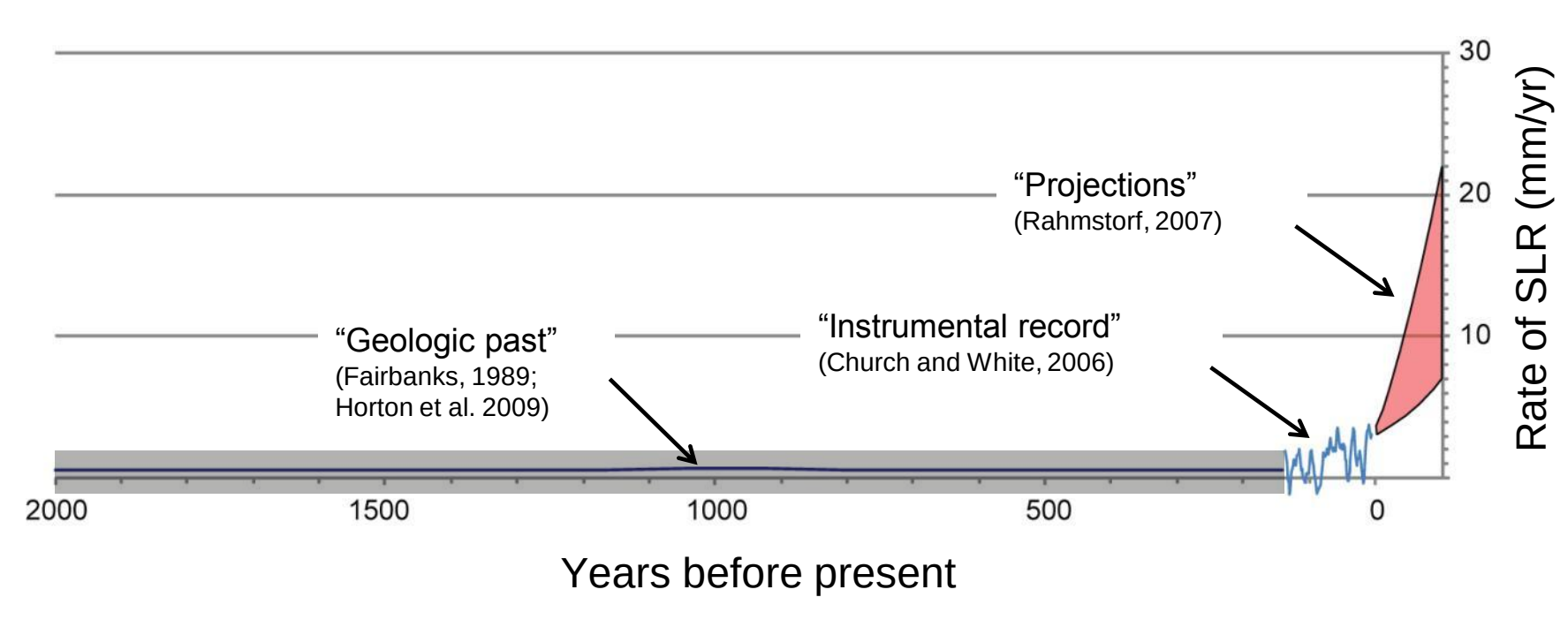
8,000 yr BP

6,000 yr BP

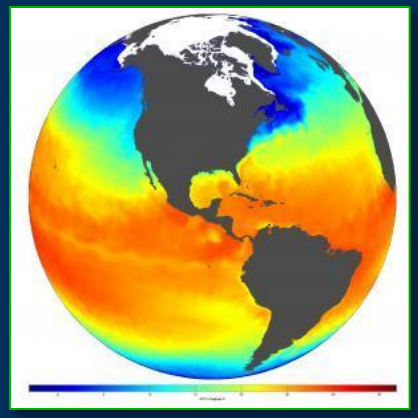
Present

(Shaw et al., 2002)

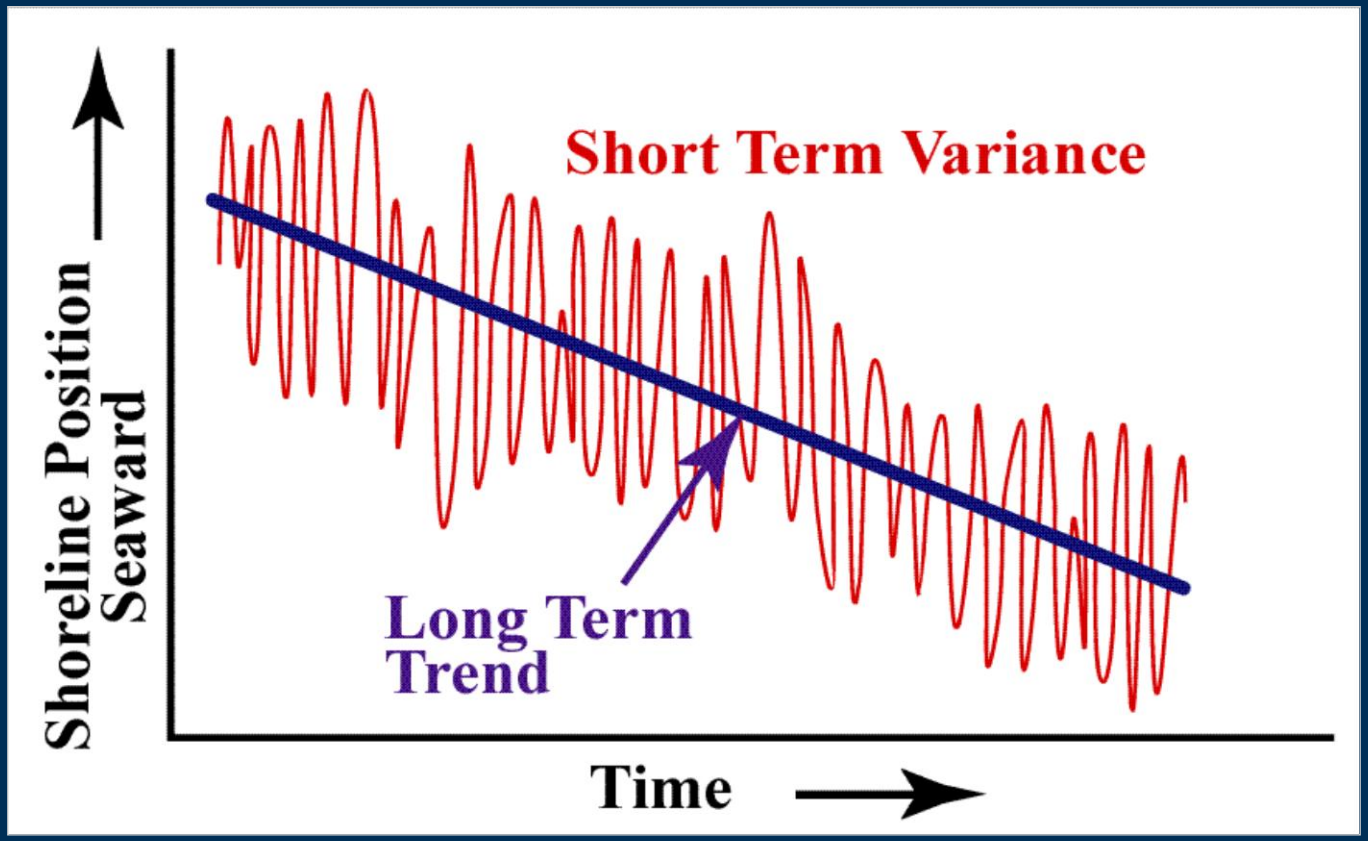
Past, present, and potential future rates of sea-level rise



Importance of Spatial Scale



Importance of Temporal Scale



Short-term Variance

(hours to decade)

Storm impact/recovery
Annual cycles
El Niño

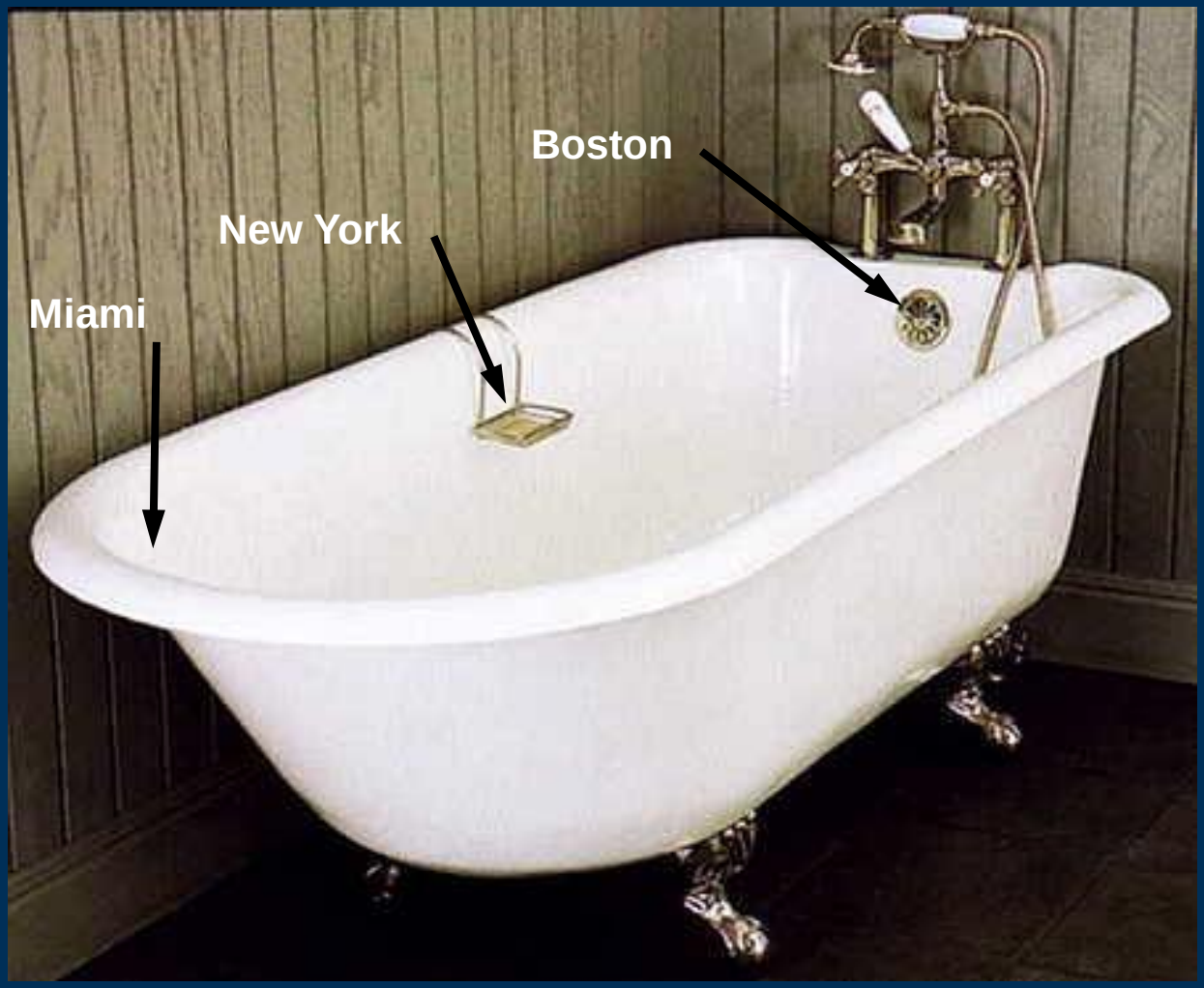
Long-term Trend

(decades to centuries)

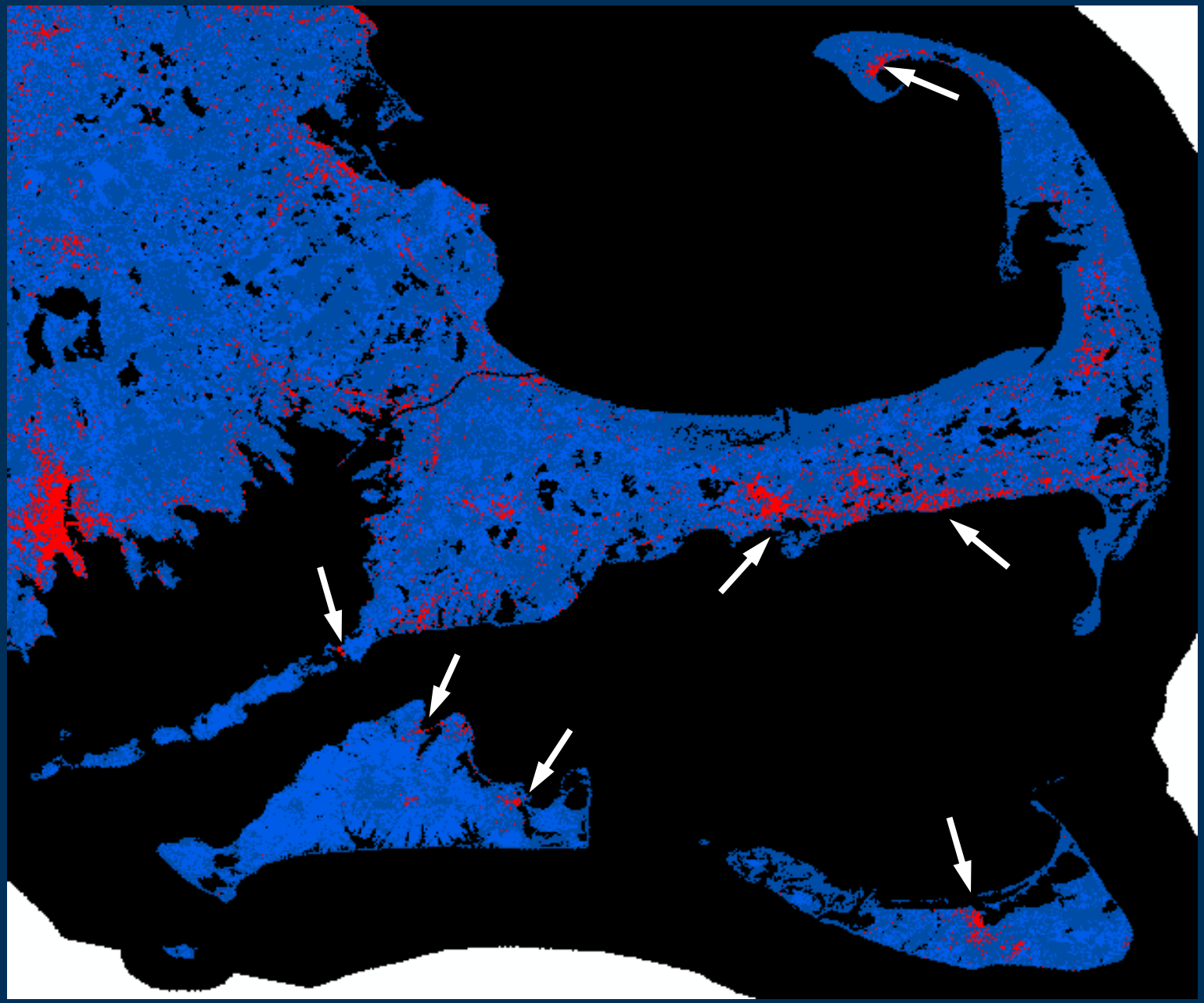
Sediment deficit or surplus
Sea-level rise

So, what can happen?

The coast is not like a bathtub…



Especially the Cape and Islands…



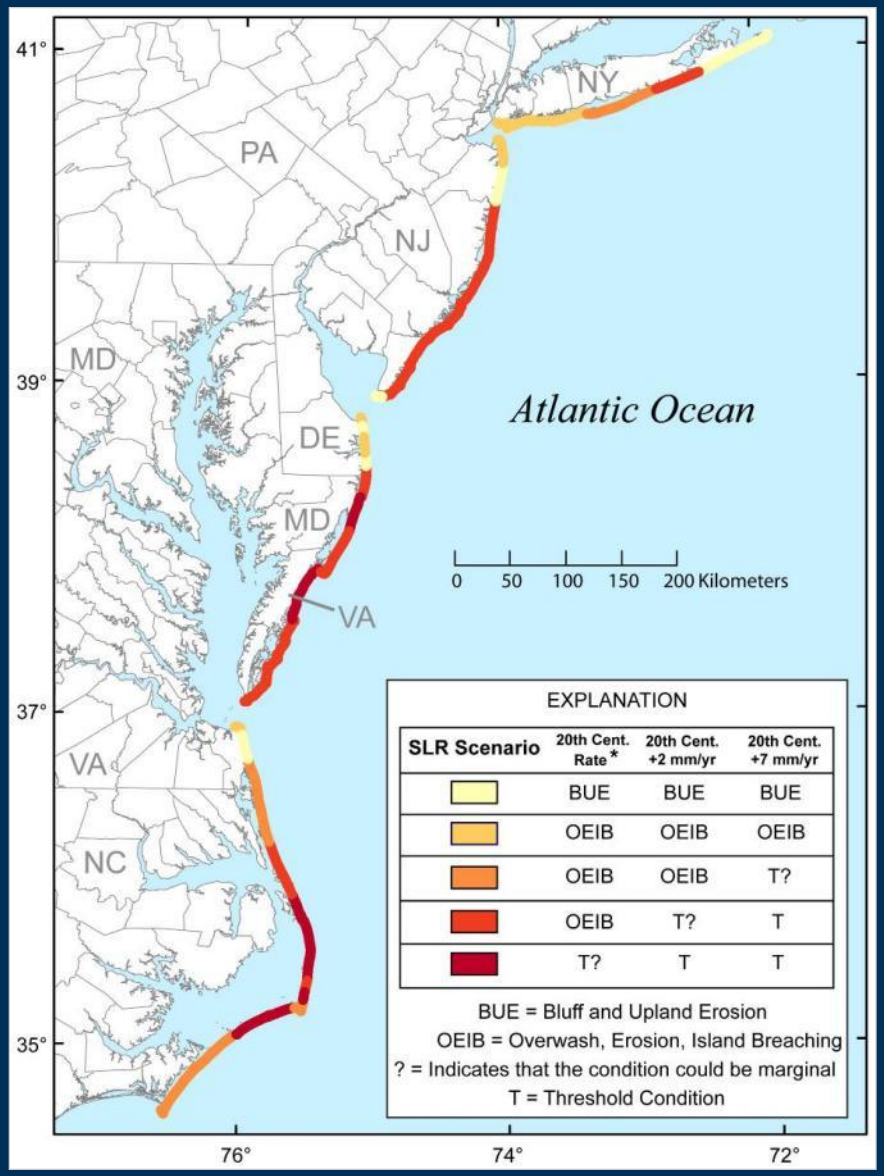
With a few exceptions, most of our coast is a dynamic, not static system.

Heavily Developed

Other

(NOAA C-CAP, 2006)

Mid-Atlantic Assessment of Potential Dynamic Coastal Responses to Sea-level Rise



(Gutierrez et al., 2009)

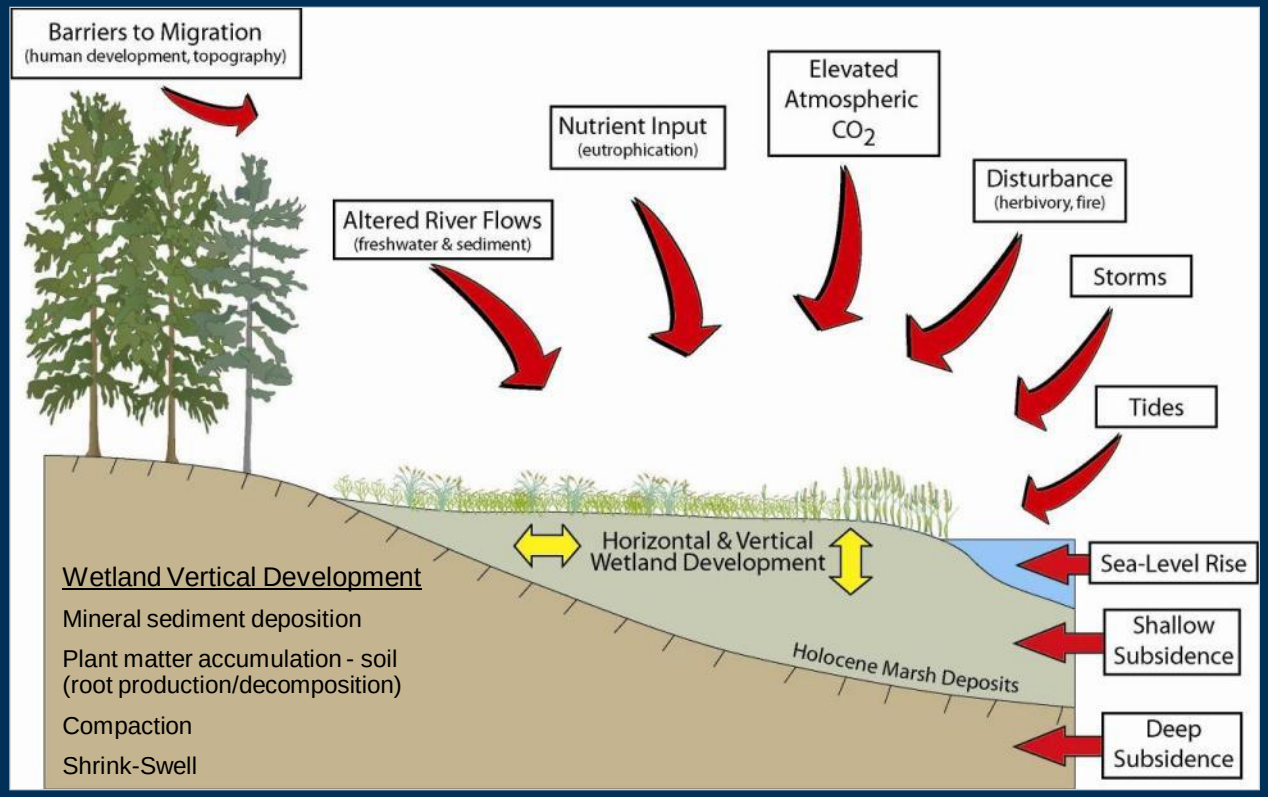
Bluff erosion

Overwash

Island Breaching

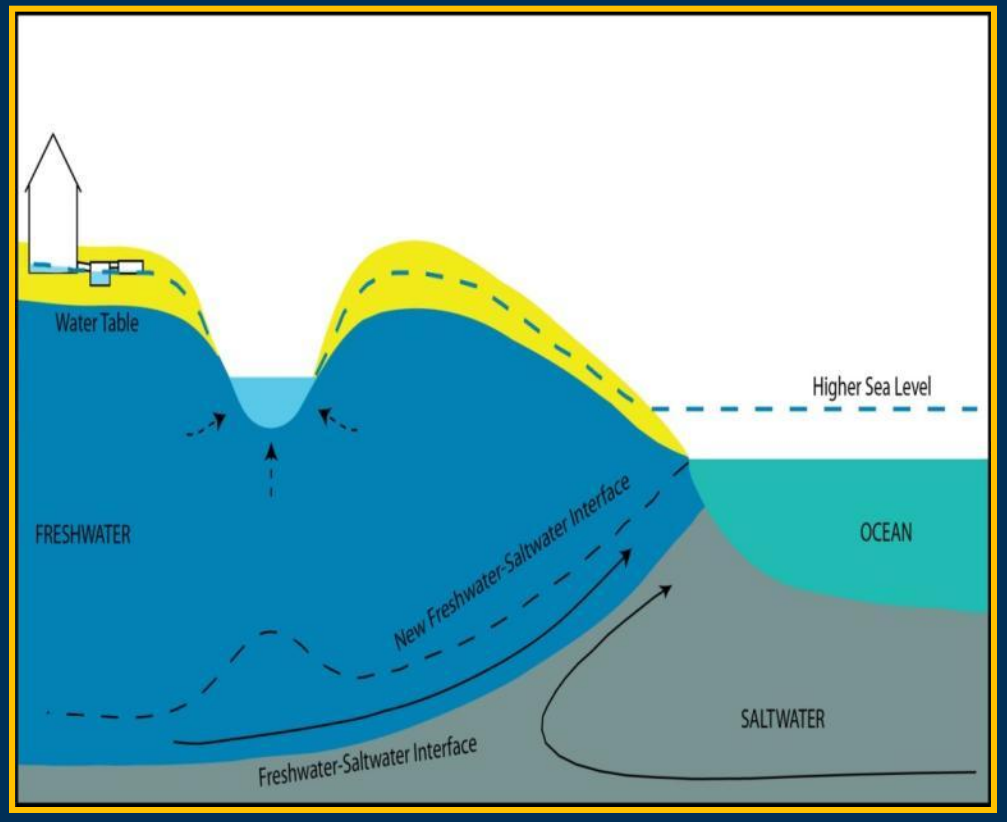
Threshold Crossing

Coastal Wetlands Respond Dynamically to Environmental Change

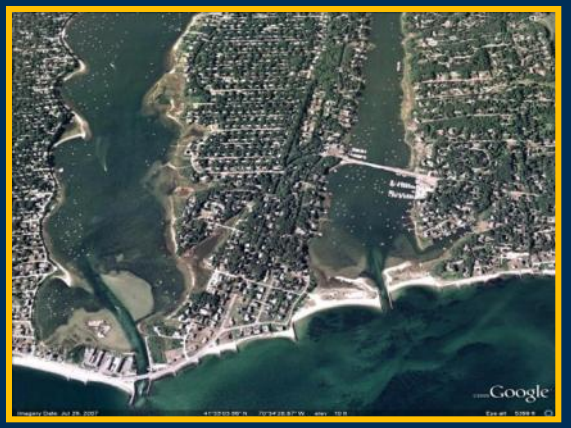


(Cahoon et al., 2009)

Sea-Level Rise Impacts on Groundwater Systems



Water quality reduction



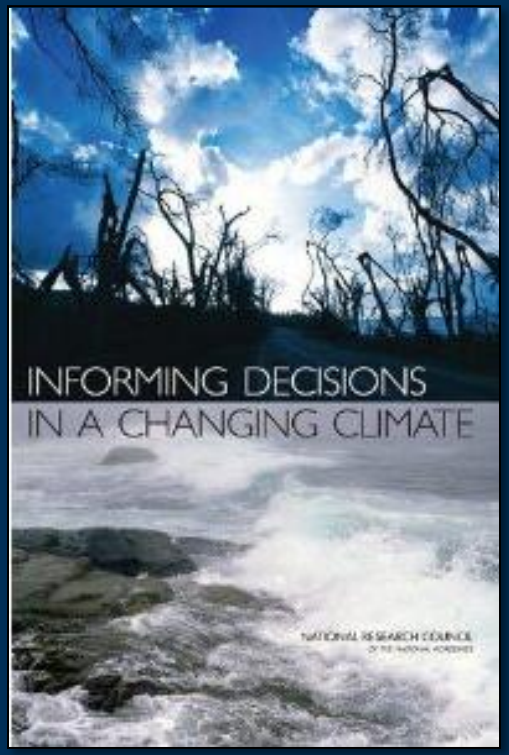
Infrastructure failure

Ecosystem change

Informing Decisions in a Changing Climate

National Research Council (2009)

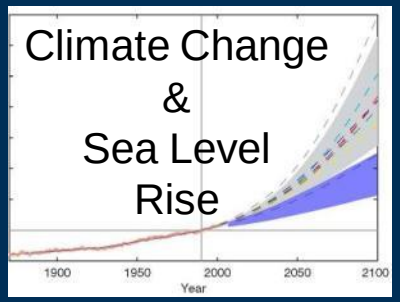
The end of “Climate Stationarity” requires that organizations and individuals alter their standard practices and decision routines to take climate change into account. Scientific priorities and practices need to change so that the scientific community can provide better support to decision makers in managing emerging climate risks.



- Decision makers must expect to be surprised because of the nature of climate change and the incompleteness of scientific understanding of its consequences.
- An uncertainty management framework should be used because of the inadequacies of predictive capability.

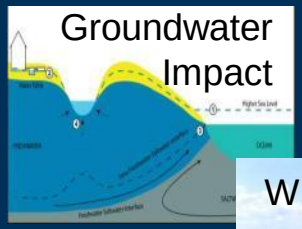
Sea-level rise impacts: A multivariate problem with uncertainties everywhere

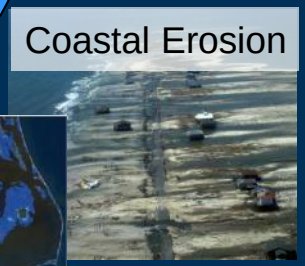
Driving Forces

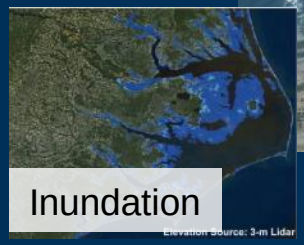


Initial Conditions

Physical & Biological Processes





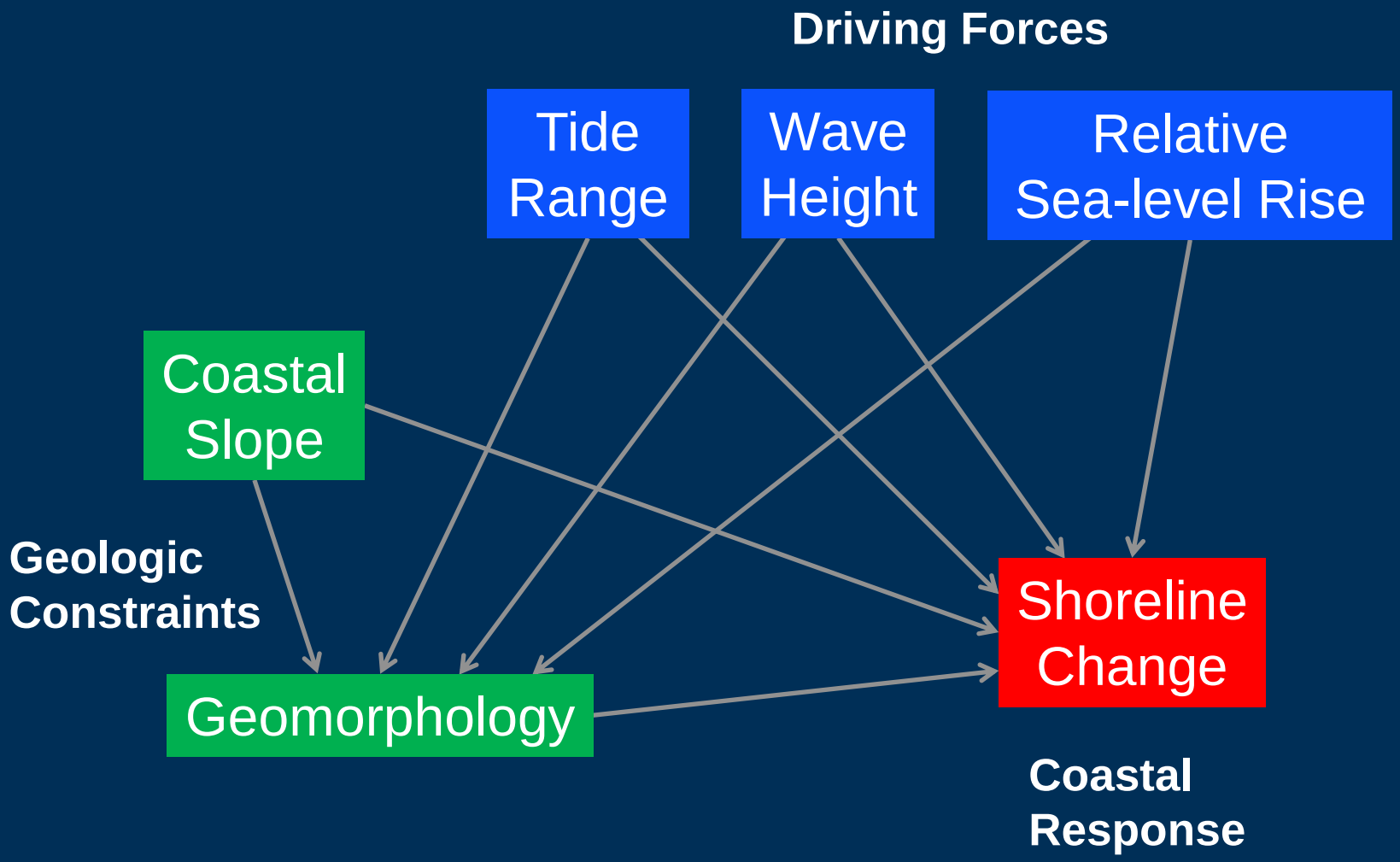


Potential Impacts

Management Decisions

Adaptation Planning Response

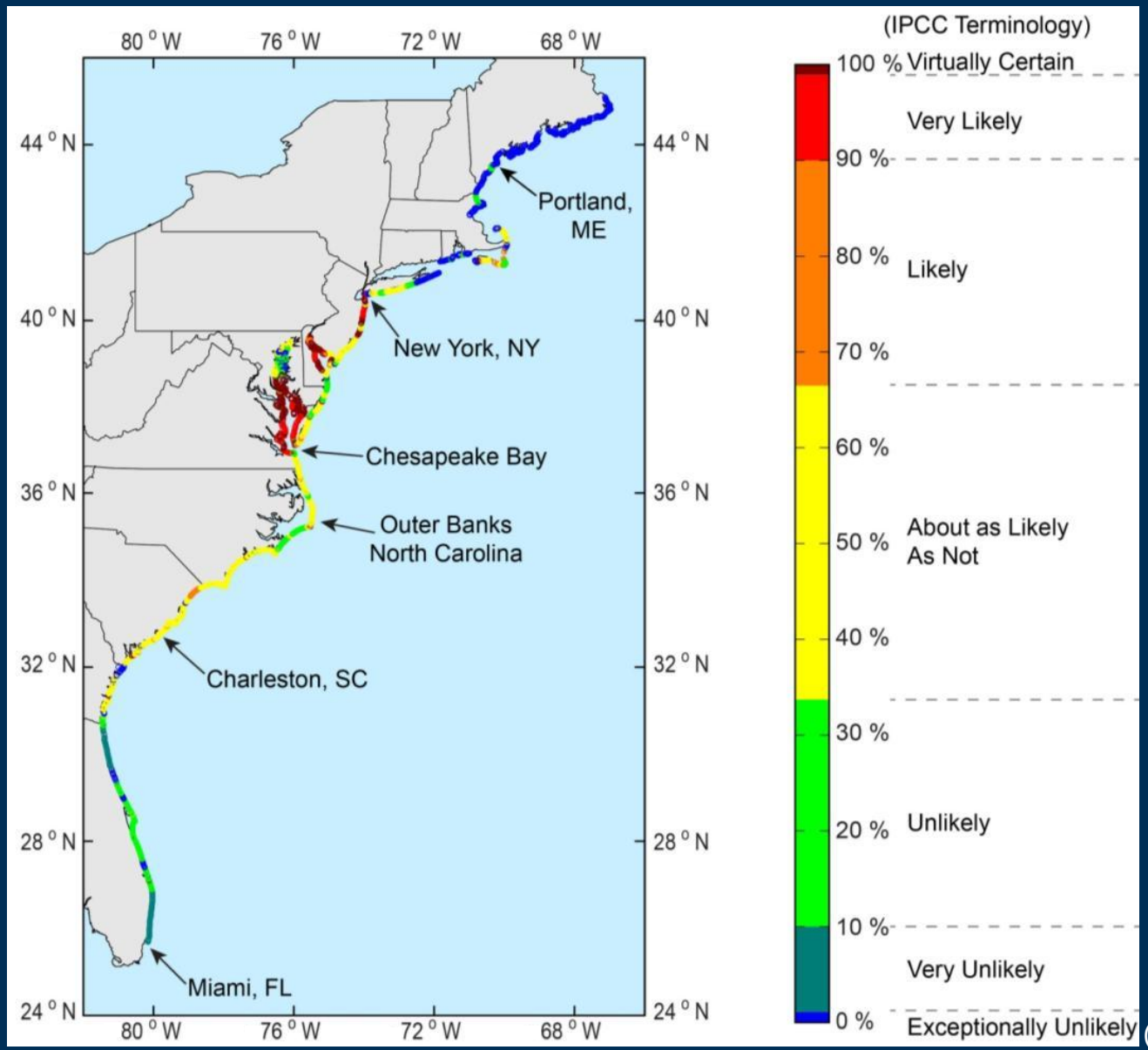
Bayesian Network for Predicting Coastal Vulnerability to Sea-level Rise



(Gutierrez et al., 2011)

Mapping Erosion Risk Using Bayesian Networks

Probability of coastal erosion >2 m/yr

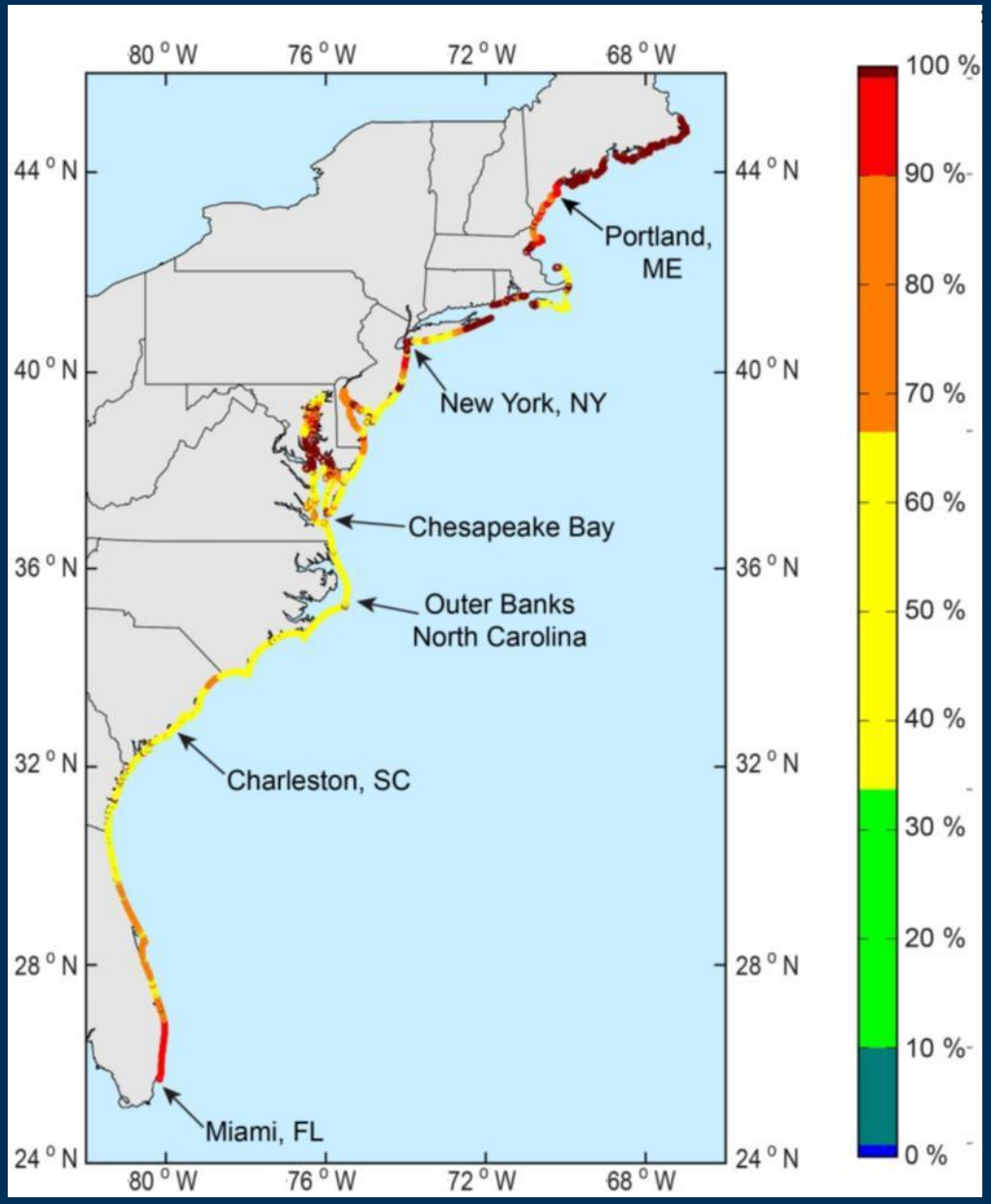


(Gutierrez et al., 2011)

Mapping Prediction Uncertainty

Higher probability = higher certainty of outcome

- Uncertainty map can be used to identify where better information is needed
- Areas of low confidence require
  - better input data
  - better understanding of processes
- Can use this map to focus research resources

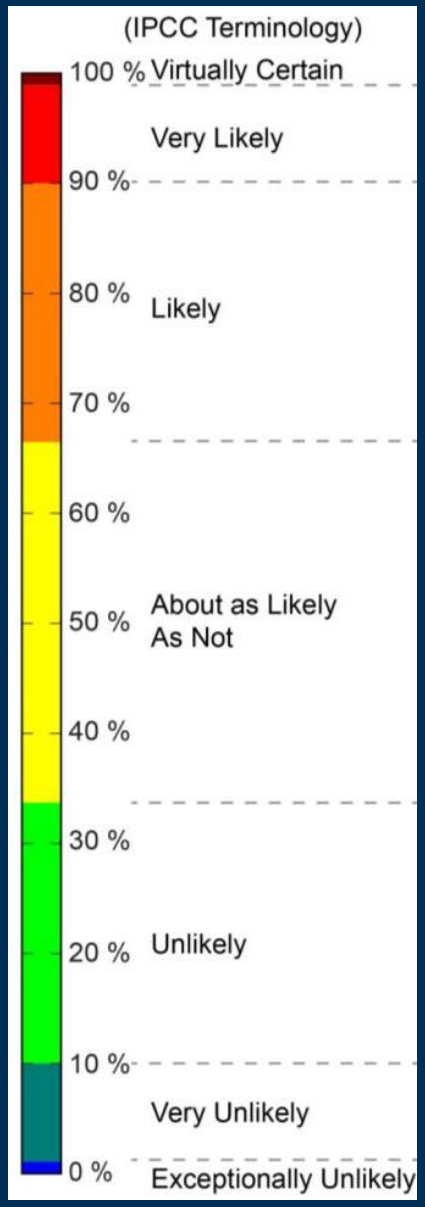


(Gutierrez et al., 2011)

Cape and Islands (a very preliminary 1st attempt)

Probability of coastal erosion >1 m/yr

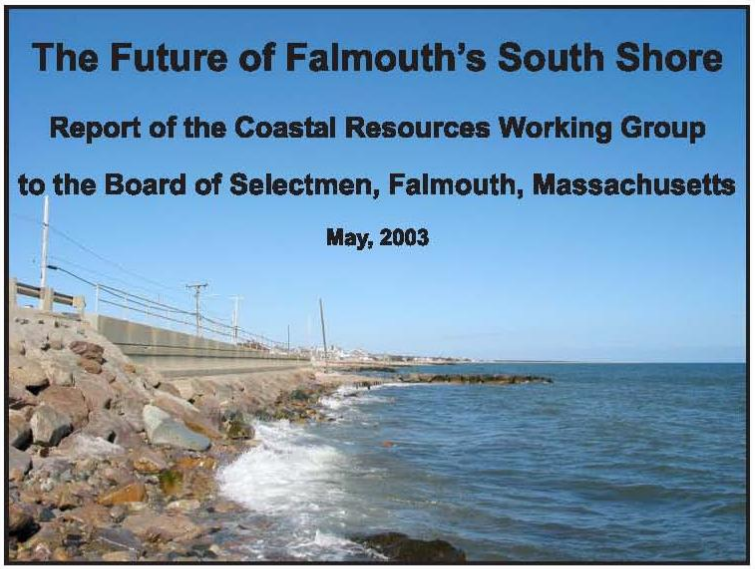
Probability



Max. Probability ("confidence")

Understanding Where We Are, and Where We Could Go

www.falmouthmass.us/depart.php?depkey=coastal



Coastal Resources Working Group

Rob Thieler, Chairman
Dorothy Aspinwall
Bob Barker
Rocky Geyer
Jo Ann Muramoto
Beth Schwarzman
Charles Swain
Jane Tucker
Chris Weidman

George Calise, Town Engineer, *ex officio*
Jude Wilber, *ex officio*

The Future of Falmouth's Buzzards Bay Shore

Report of the Coastal Resources Working Group
to the Board of Selectmen, Falmouth, Massachusetts

22 October 2010

Coastal Resources Working Group

Jane Tucker, Chair
Bob Barker
Rocky Geyer
Jo Ann Muramoto
Beth Schwarzman
Doc Taylor
Rob Thieler
Chris Weidman

George Calise, Town Engineer (retired), *ex officio*
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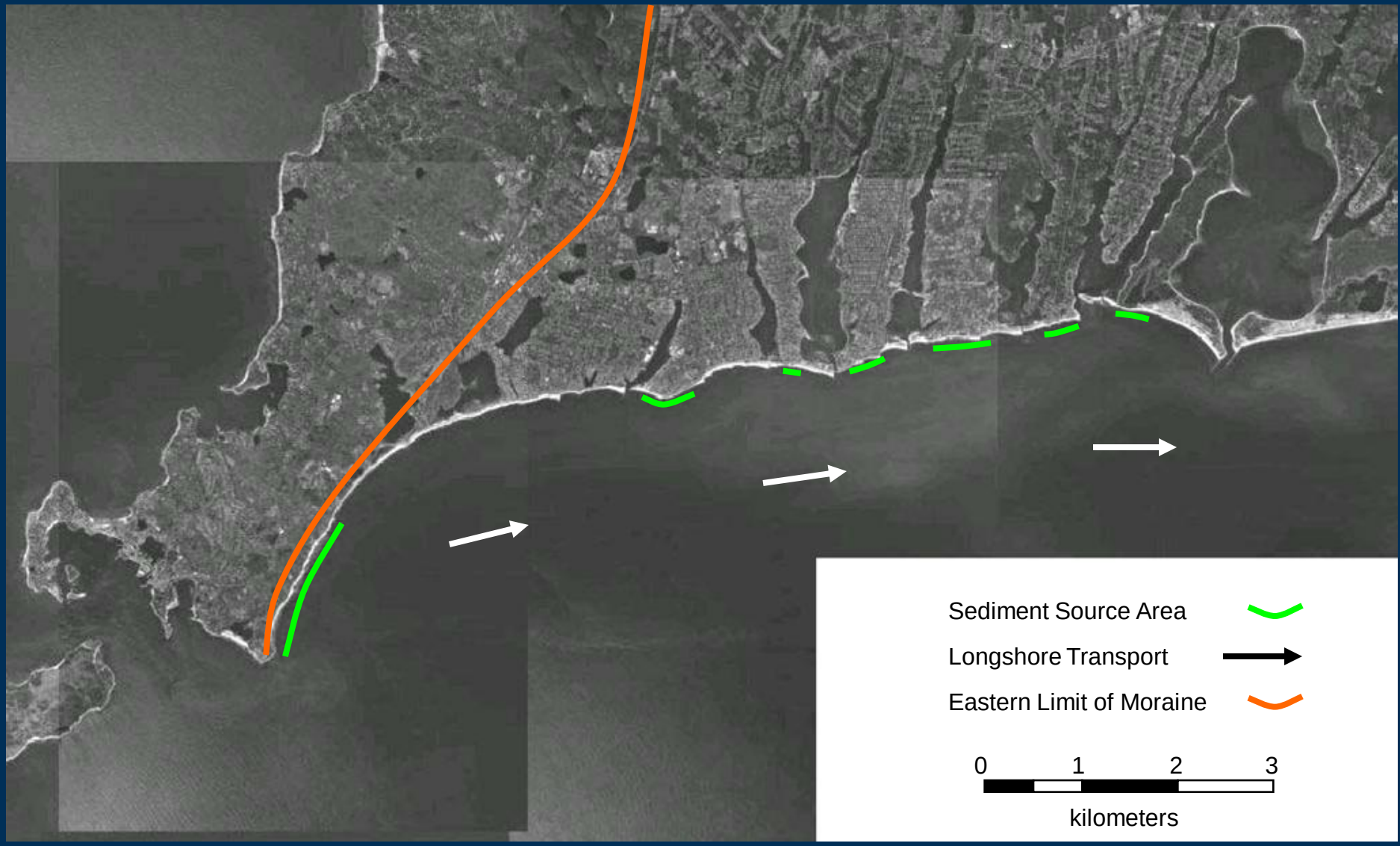
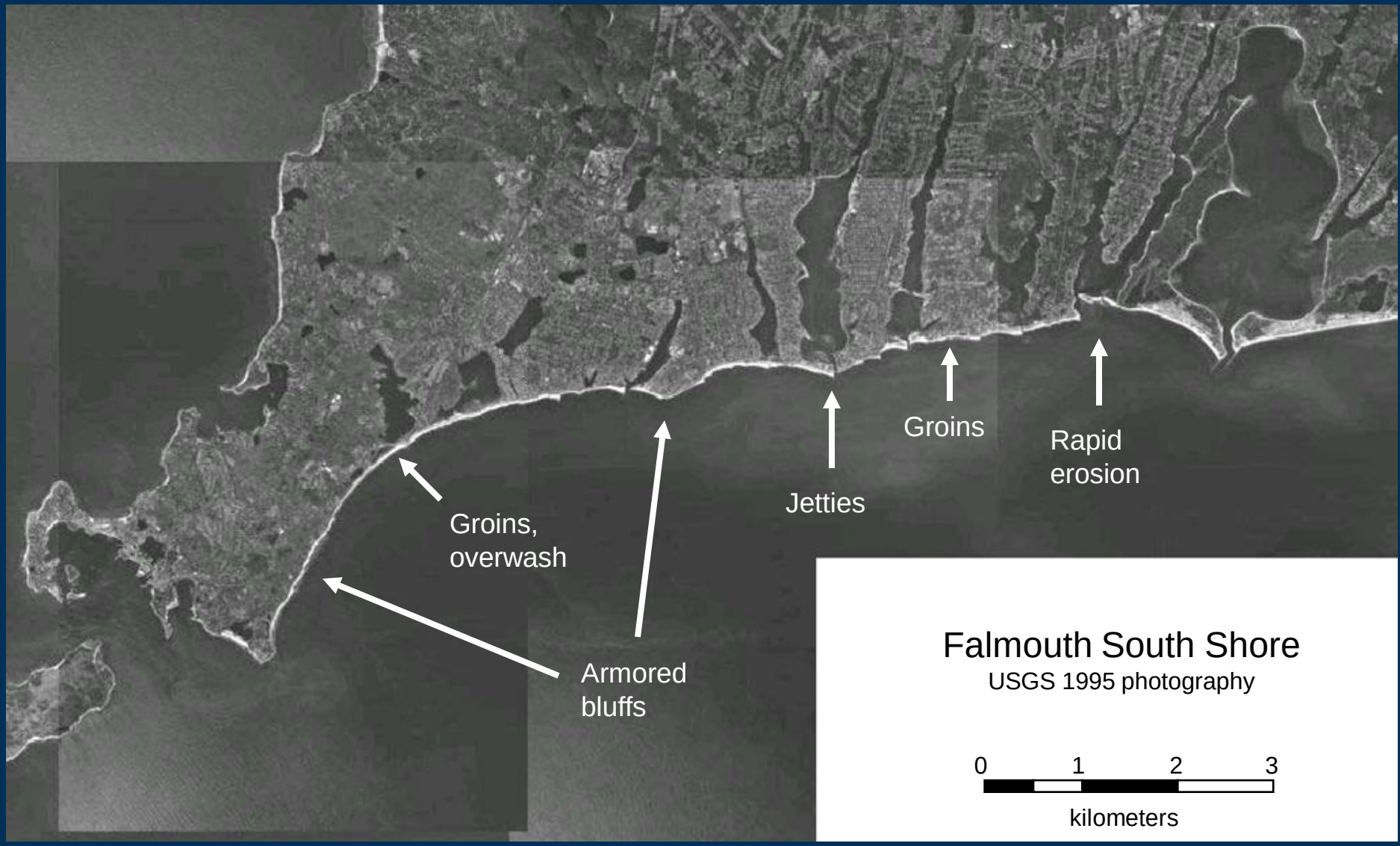


Falmouth South Shore

USGS 1995 photography



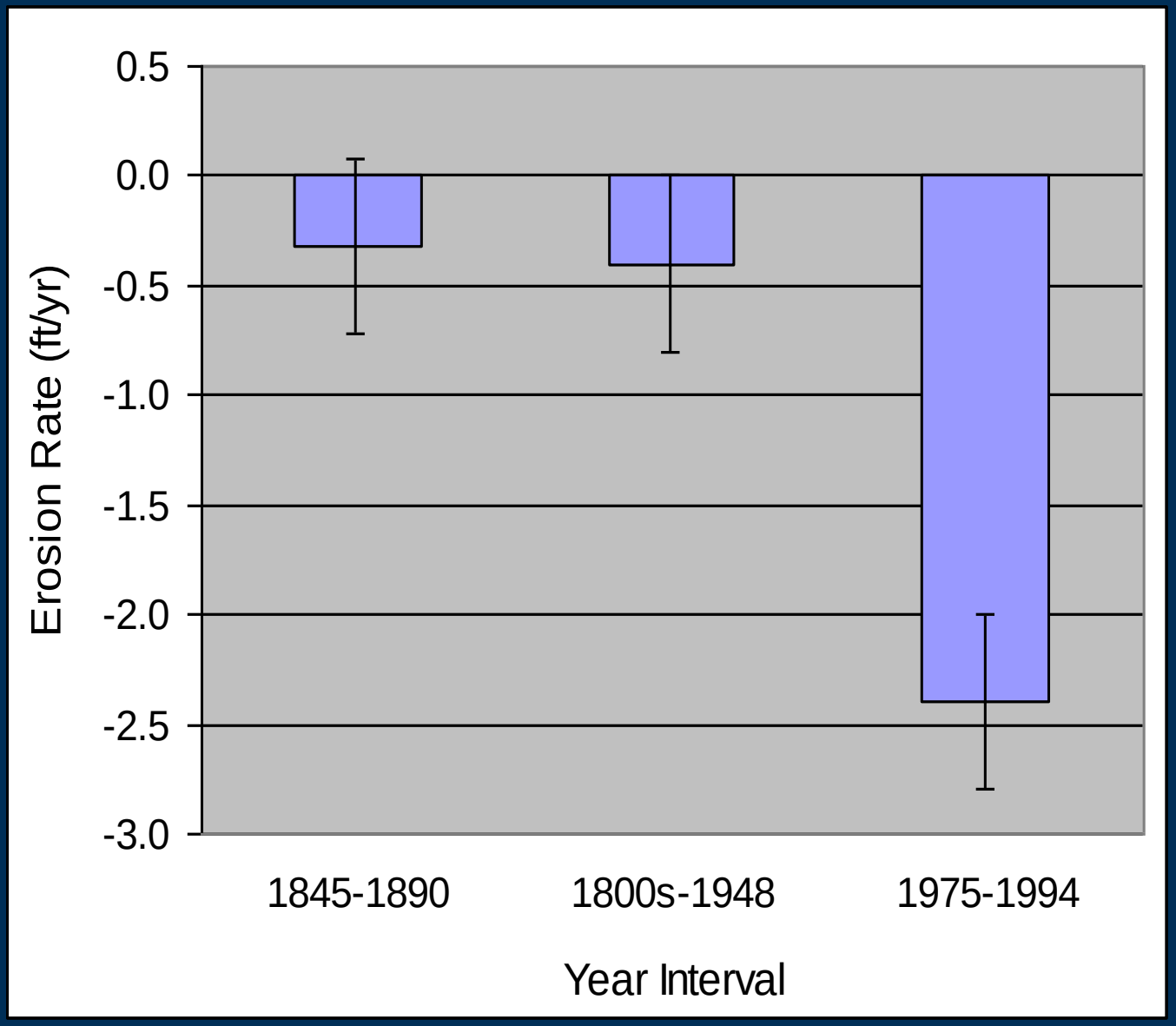
About 50% of south coast parcels are armored. Half are Town parcels. There are 70 groins, 10 jetties, and 94 revetments on the south coast.

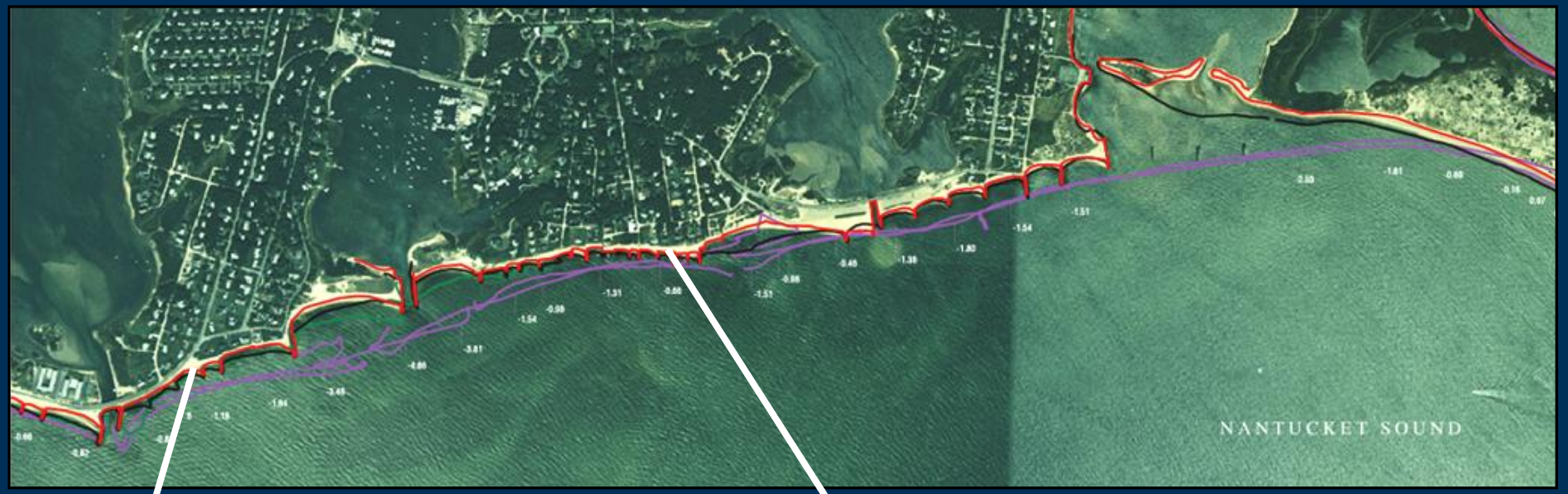
Nobska Point

Falmouth Heights, 1897

Falmouth Heights, 2000

Falmouth South Shore Erosion Rates





Green Pond Shoreline Change Since 1845

- Sediment supply decreased
- Uplands armored, beaches narrowed
- Barrier has migrated into the pond

Vision for Falmouth's Coast
(for the next 50-100 years)

- Beaches and dunes wide enough for protection from storms and public access and use.
- Sufficient sand in the coastal system.
- Sustained and enhanced water quality, habitat and fisheries resources.
- A minimum of hard structures (groins, seawalls, etc.).
- Public infrastructure will be relocated from the immediate coast.
- A proactive approach to shoreline management to prevent problems and provide a response protocol when shoreline damage occurs.

Achieving the Vision for Falmouth's Coast

- Acquire coastal land for open space.
- Move or change vulnerable public infrastructure. Plan future infrastructure (e.g., roads, sewers) wisely.
- Conduct beach nourishment experiments at key "source" locations.
- Remove unnecessary, hazardous, or damaging coastal armoring structures.
- Create effective sand management systems.
- Improve regulations to protect coastal systems and beaches.
- Encourage landowners to obtain conservation easements that protect valuable coastal assets such as unarmored bluffs.

Summary

- Will the Cape fall into the sea?
  - No. But there will be major changes to the coast, ecosystems, and resources
  - Informed preparation is important
- Sea-level has been rising (at varying rates) for the past several thousand years and is an important component of coastal evolution.
  - The coast as we know it today is a product of sea-level rise
- Future sea-level rise is a **certain** impact
  - We have already made a commitment to several centuries of rise
- Future sea-level rise is an **uncertain** impact
  - Rates and magnitudes poorly constrained
  - Societal response unknown