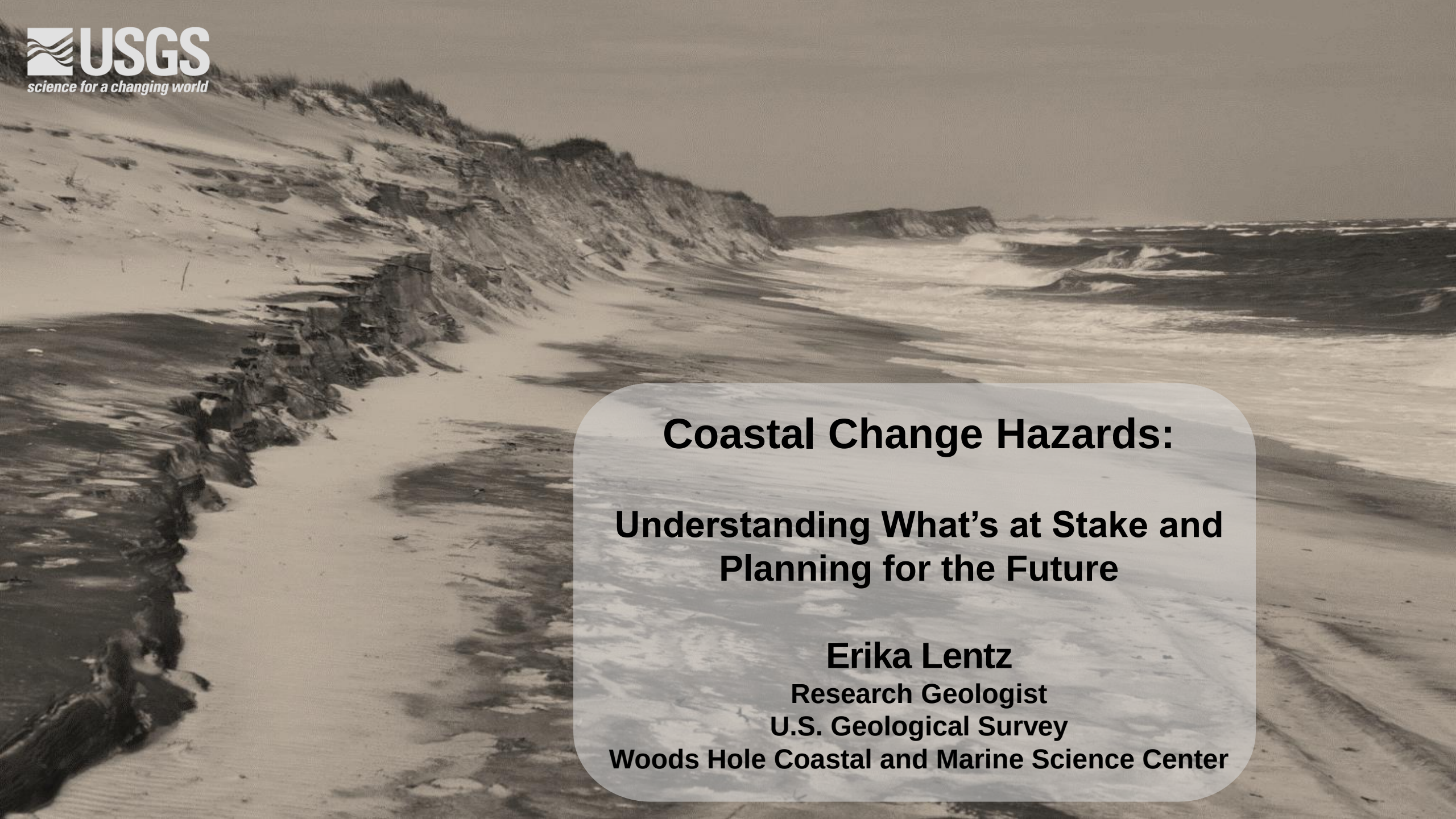

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Coastal Change Hazards:

Understanding What's at Stake and Planning for the Future

Erika Lentz
Research Geologist
U.S. Geological Survey
Woods Hole Coastal and Marine Science Center

Key Points

- By 2100, the Northeastern U.S. is most likely to see sea levels rise between **2 to 4.5 feet**. Worst case scenarios are much higher (**11 feet**). All projections mean sea-level rise rates will be higher and faster than the past 2000 years.

- The coastal landscape varies, and so does the response to climate drivers.

- Effective adaptation to future coastal change will require a variety of approaches to coastal management.

- Uncertainty doesn't mean we can't act.

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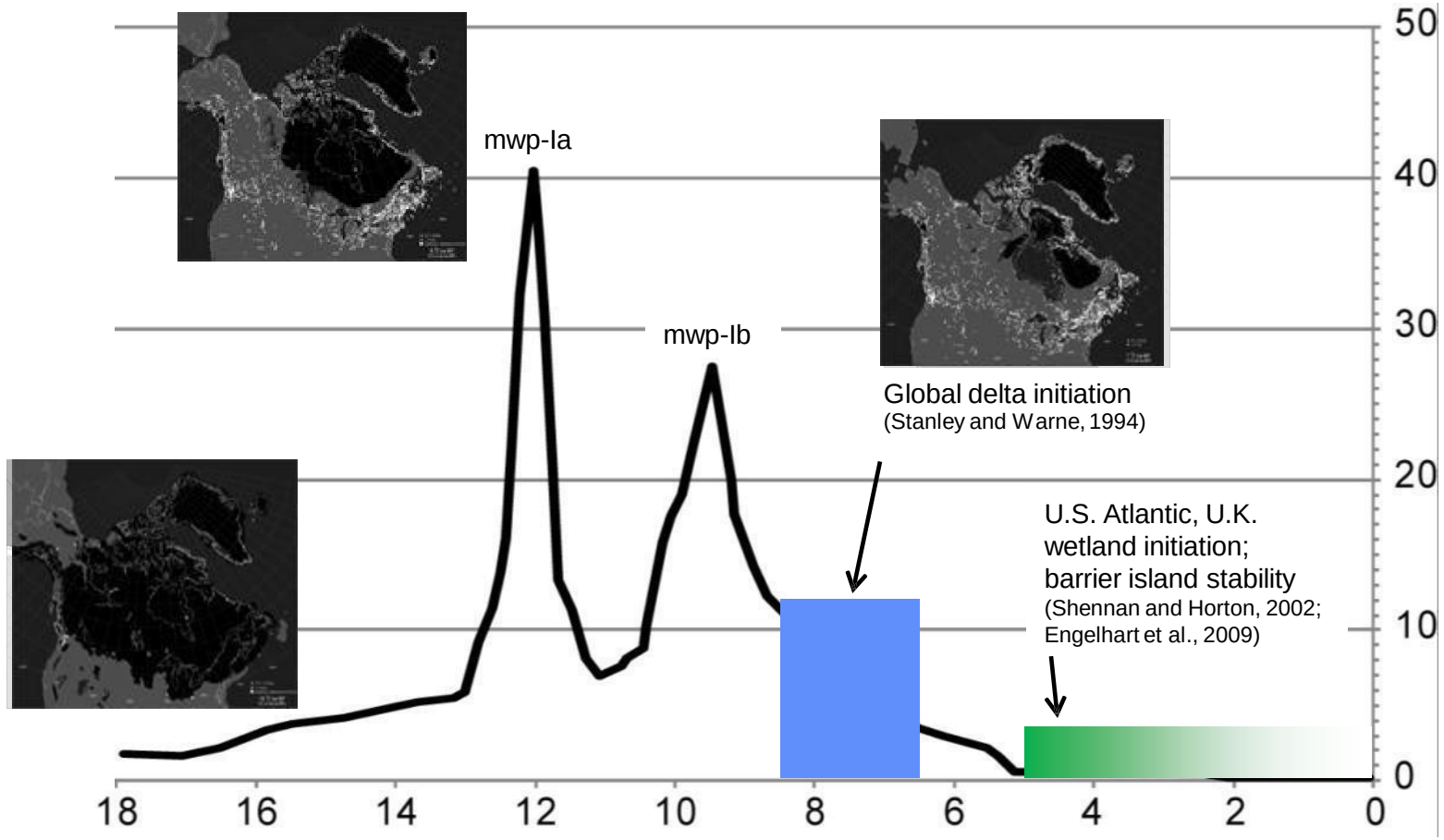
Sea-level rise rates have varied since the Last Glacial Maximum



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

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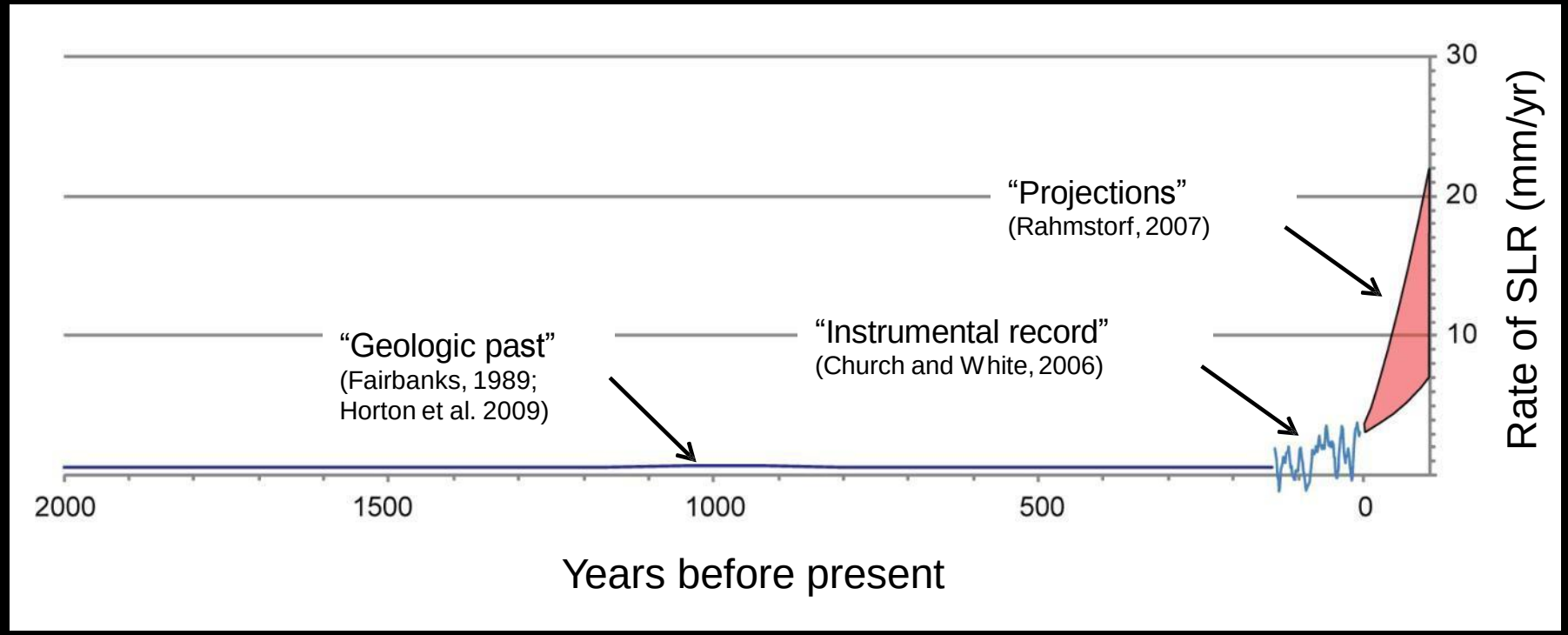
The future will not look like our recent past



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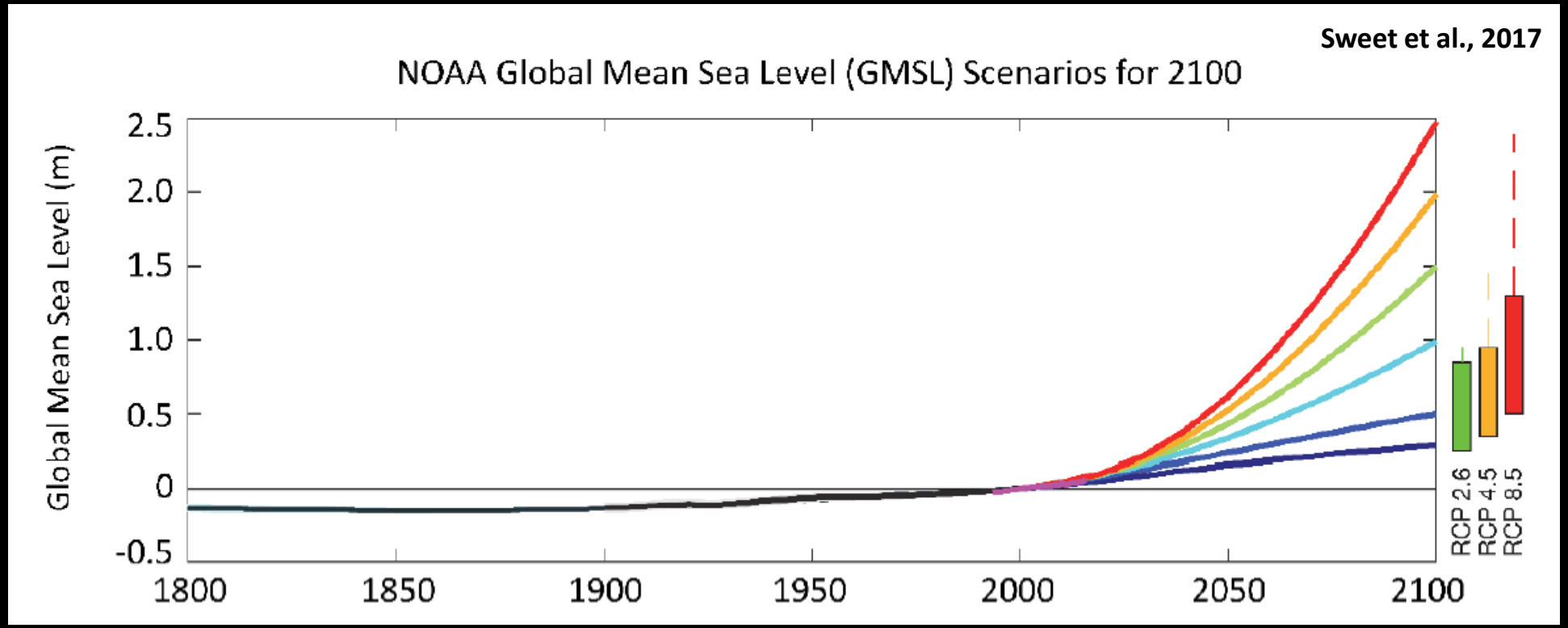

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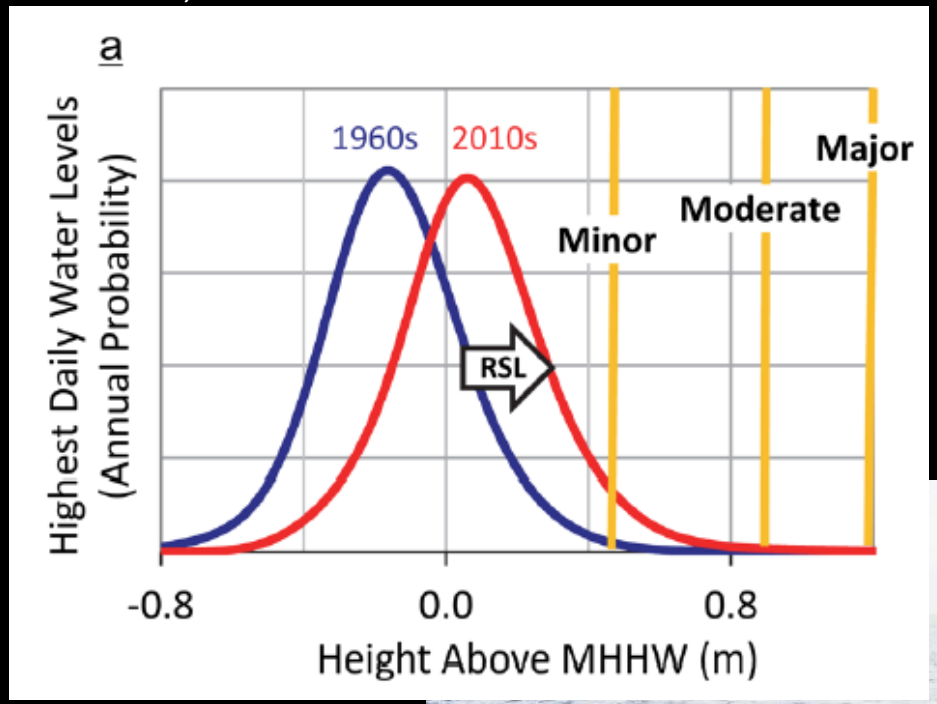
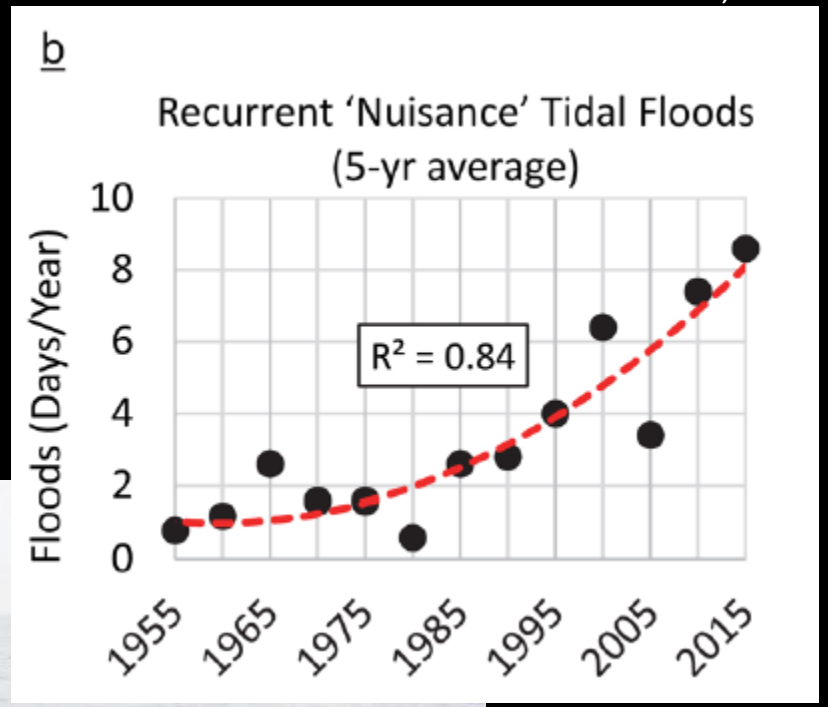
Sea-level rise is already affecting us

Sweet et al., 2017



Sweet et al., 2017



King Tide in Boston, October 2016

Photo Credit: *Jean Nagy*

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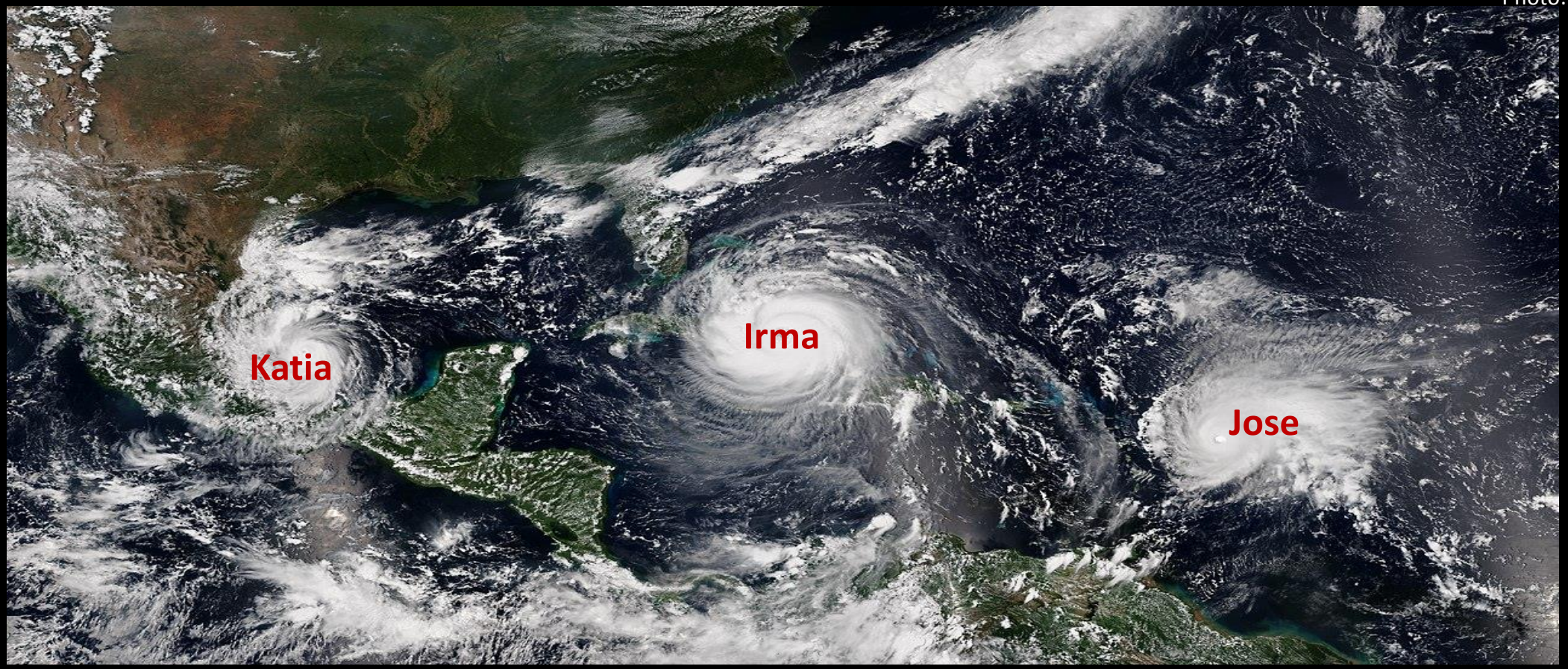
The strongest hurricanes are anticipated to become both more frequent and more intense in the future, with more precipitation.

Photo: Steven Senne



NOAA 2017

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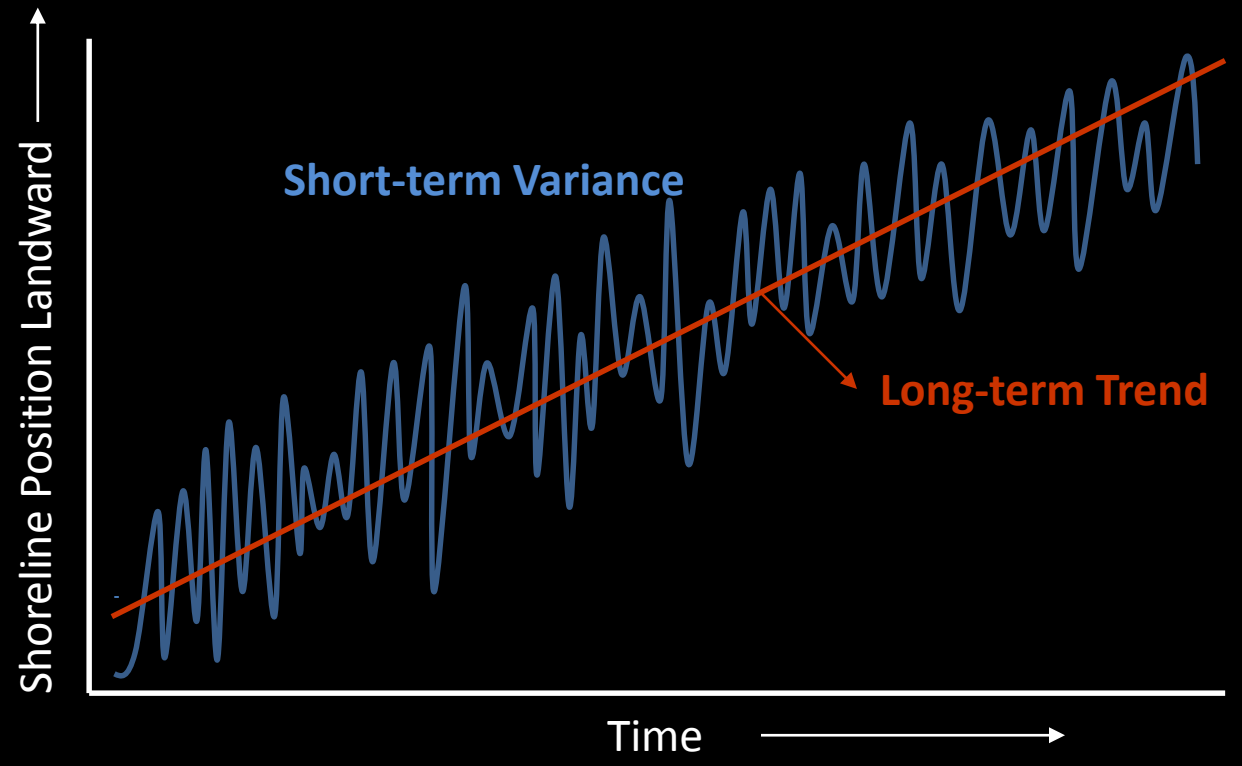
Timescales matter



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

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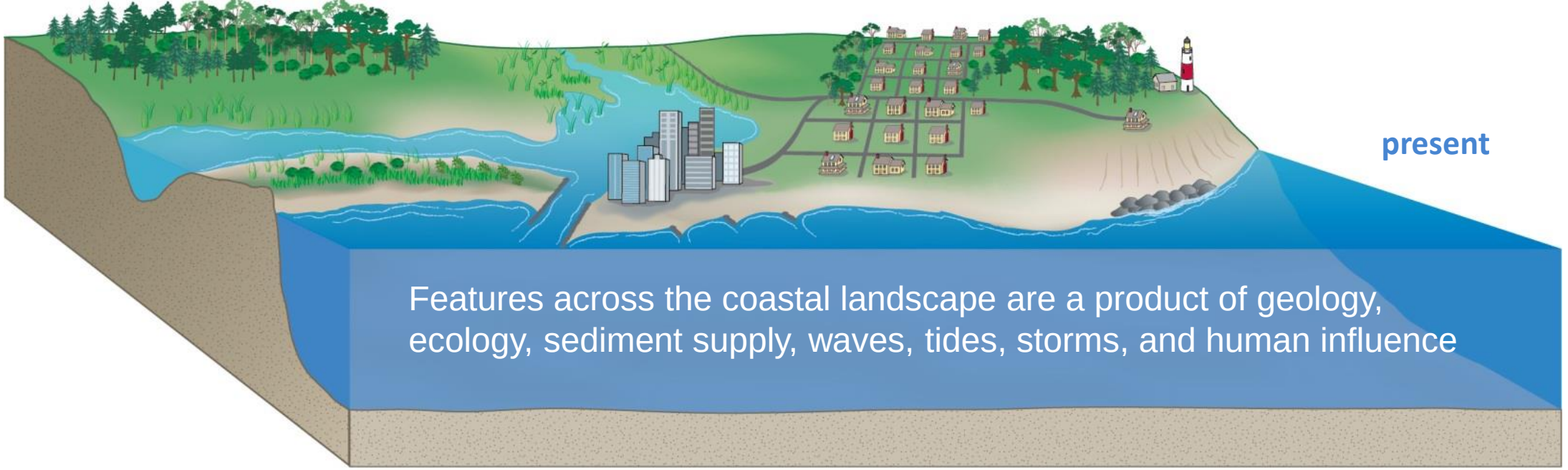

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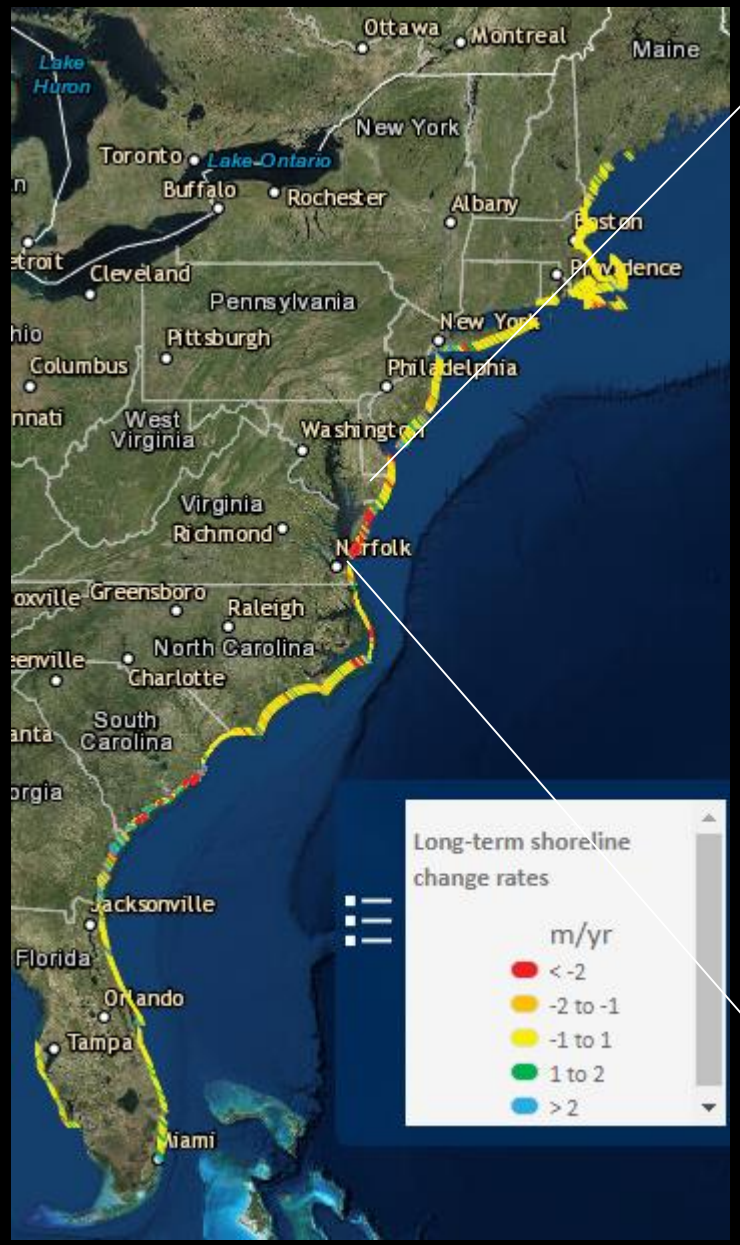
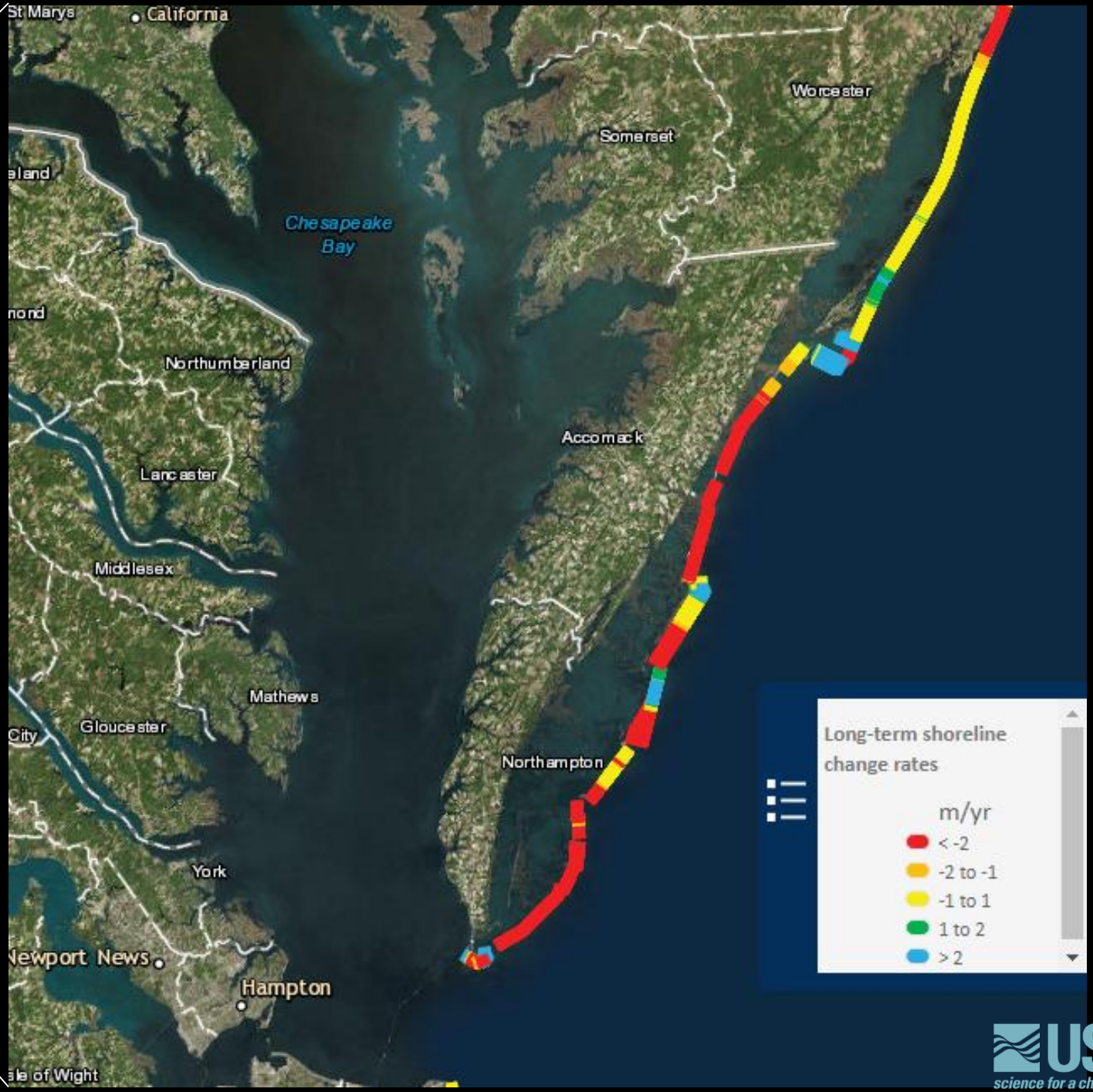
Shoreline change rate: 1800s to 2008





https://marine.usgs.gov/coastalchangehazardsportal/

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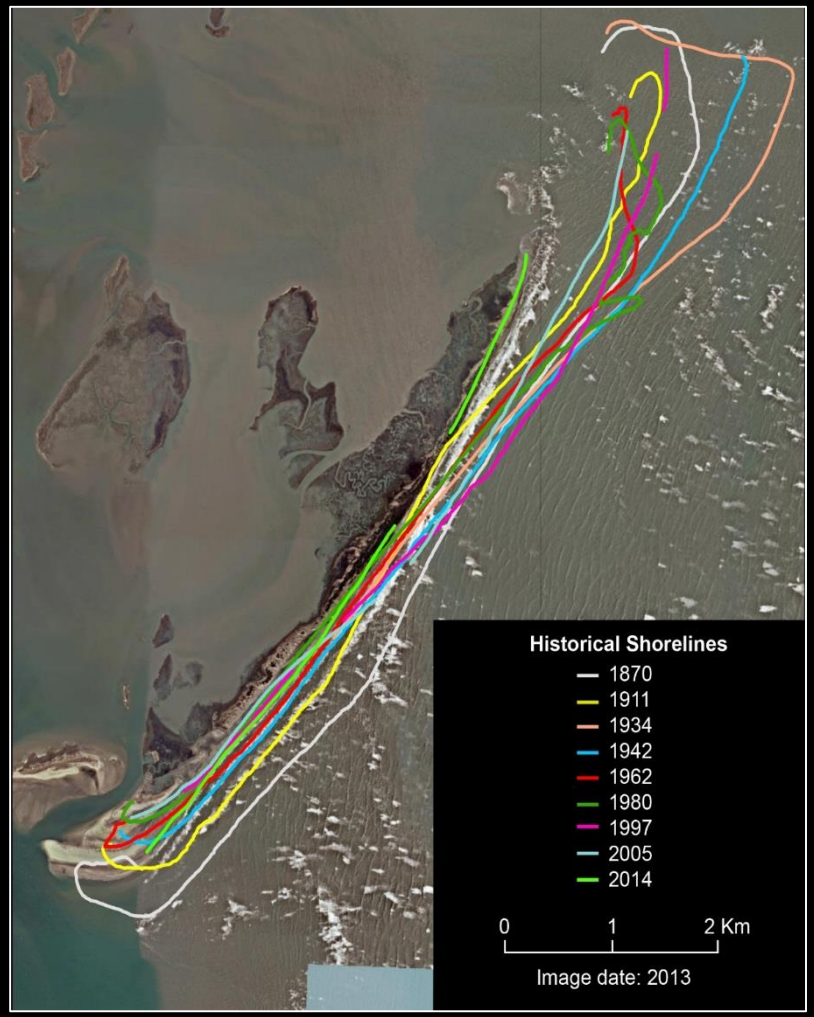
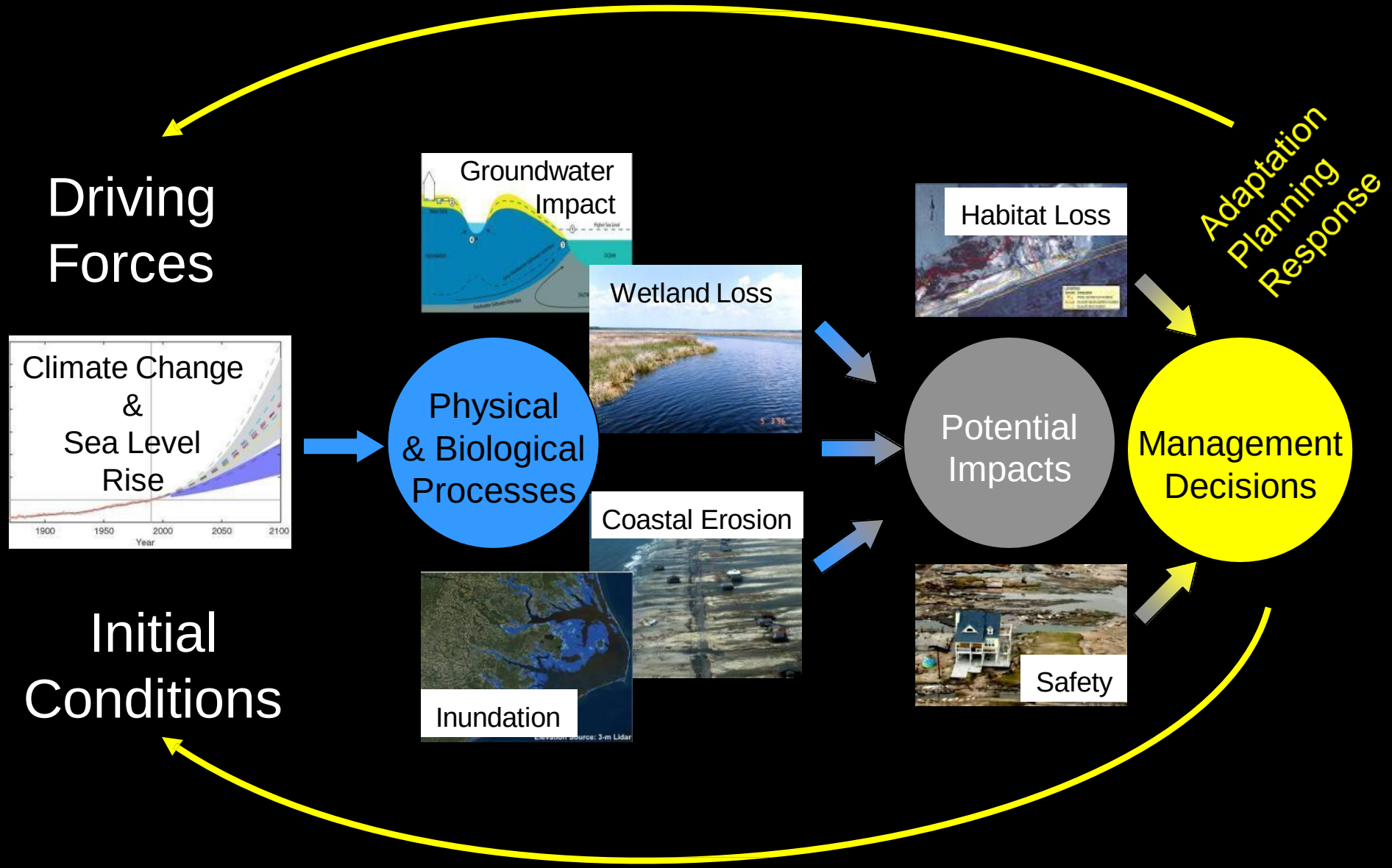
Rapid Changes Occurring on Cobb Island

Source: Landsat



Coastal change impacts:
A multivariate problem with uncertainties everywhere



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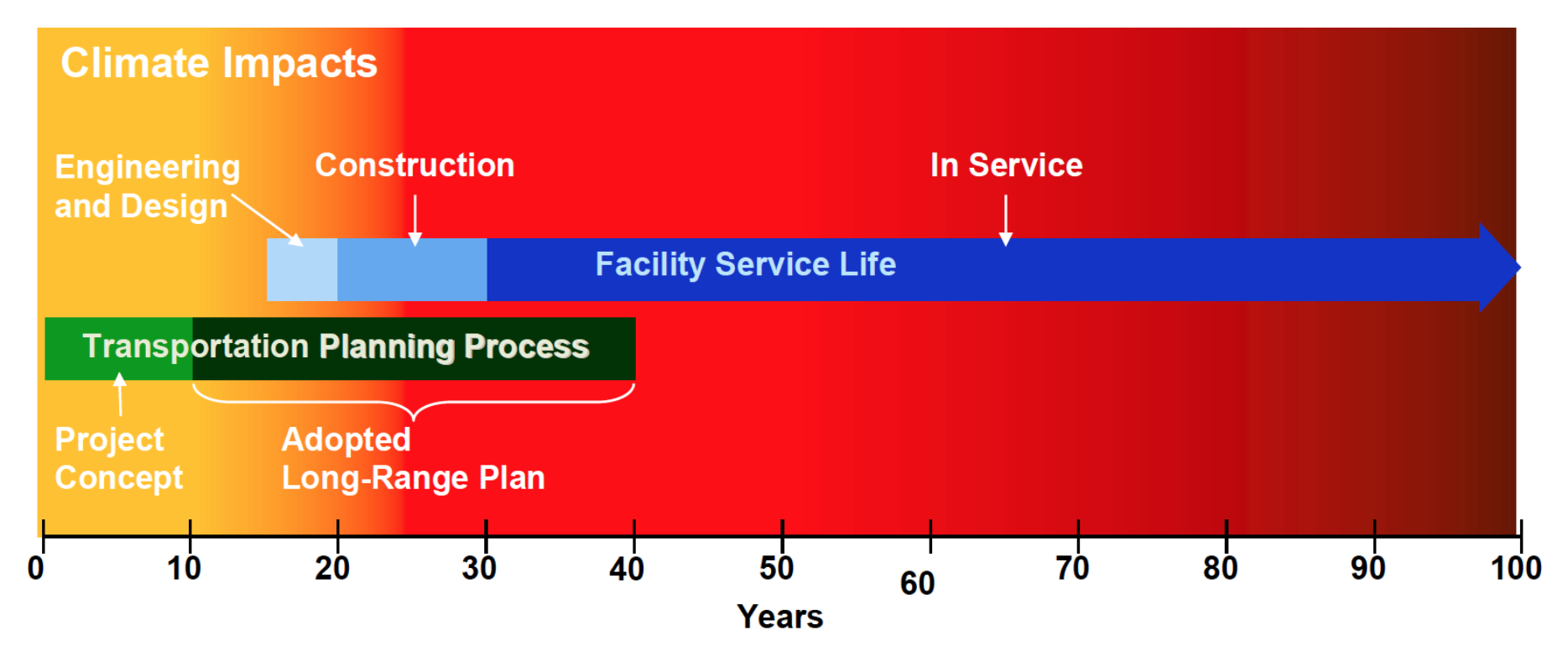
Timing matters

Decisions are being made…

- Now (both short- and long-term)
- Regardless of whether information and understanding is adequate



(Savonis, 2011)

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U.S. Geological Survey Coastal Change Hazards Program

Extreme erosion from Hurricane Irene
Rodanthe, NC

Long-term cliff erosion
Pacifica, CA

Mission: to **develop** and **apply** hazard **science** to help protect the safety, security, and economic well-being of the Nation.

Ongoing Tasks

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

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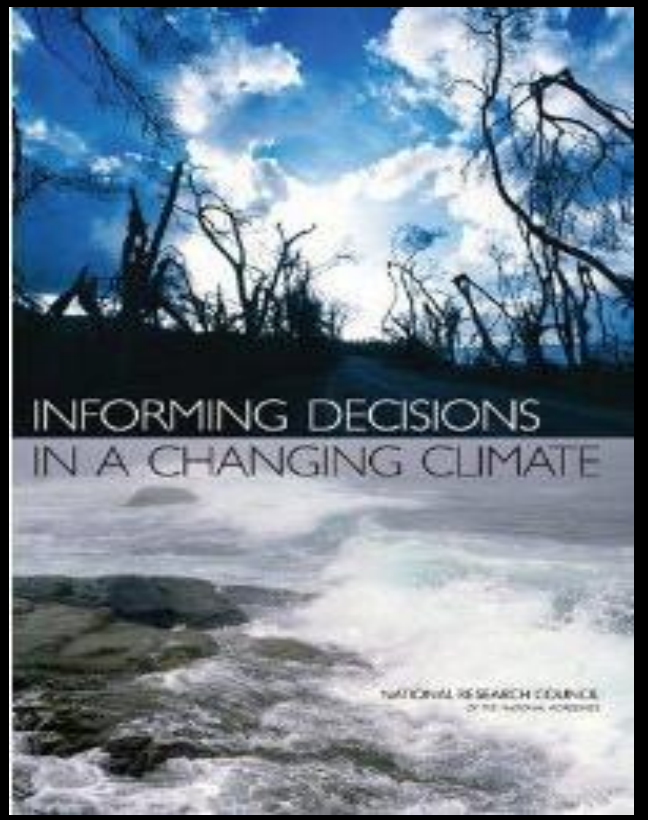
Informing Decisions in a Changing Climate

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.



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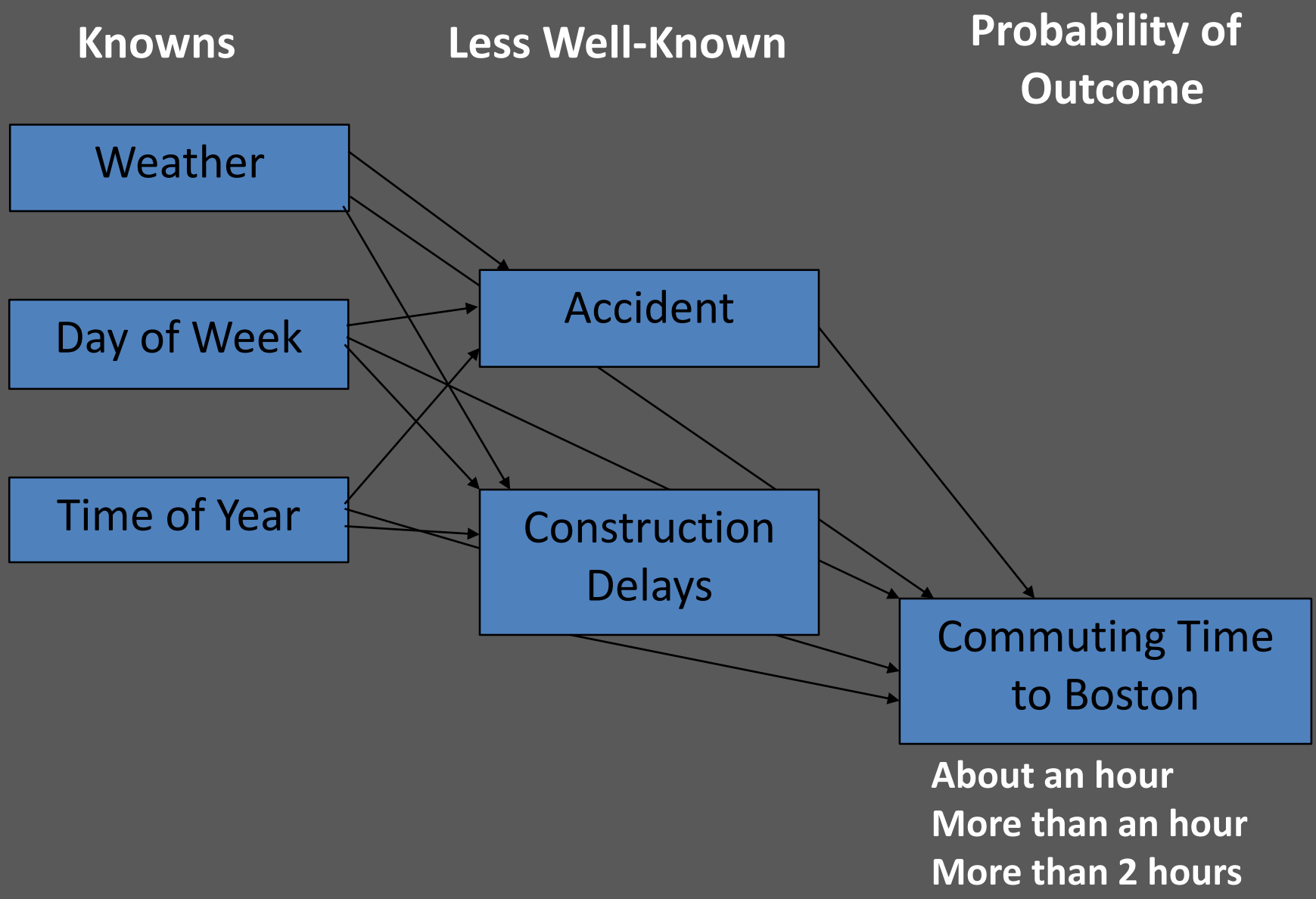
Bayesian Networks: An Example



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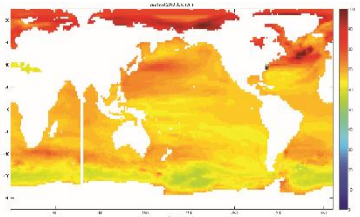
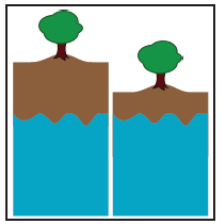
Modeling Coastal Response to Sea-Level Rise



Sea-Level Projections

Probability of Outcome

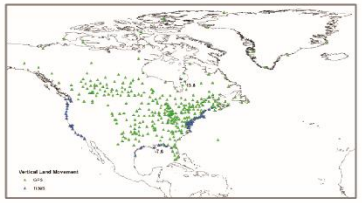


Adjusted Land Elevation

Knowns

+

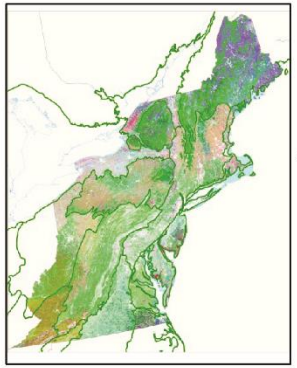
Less Well Known



Vertical Land Movement

Elevation

Coastal Response Type:
Dynamic vs. Inundation



Land Cover

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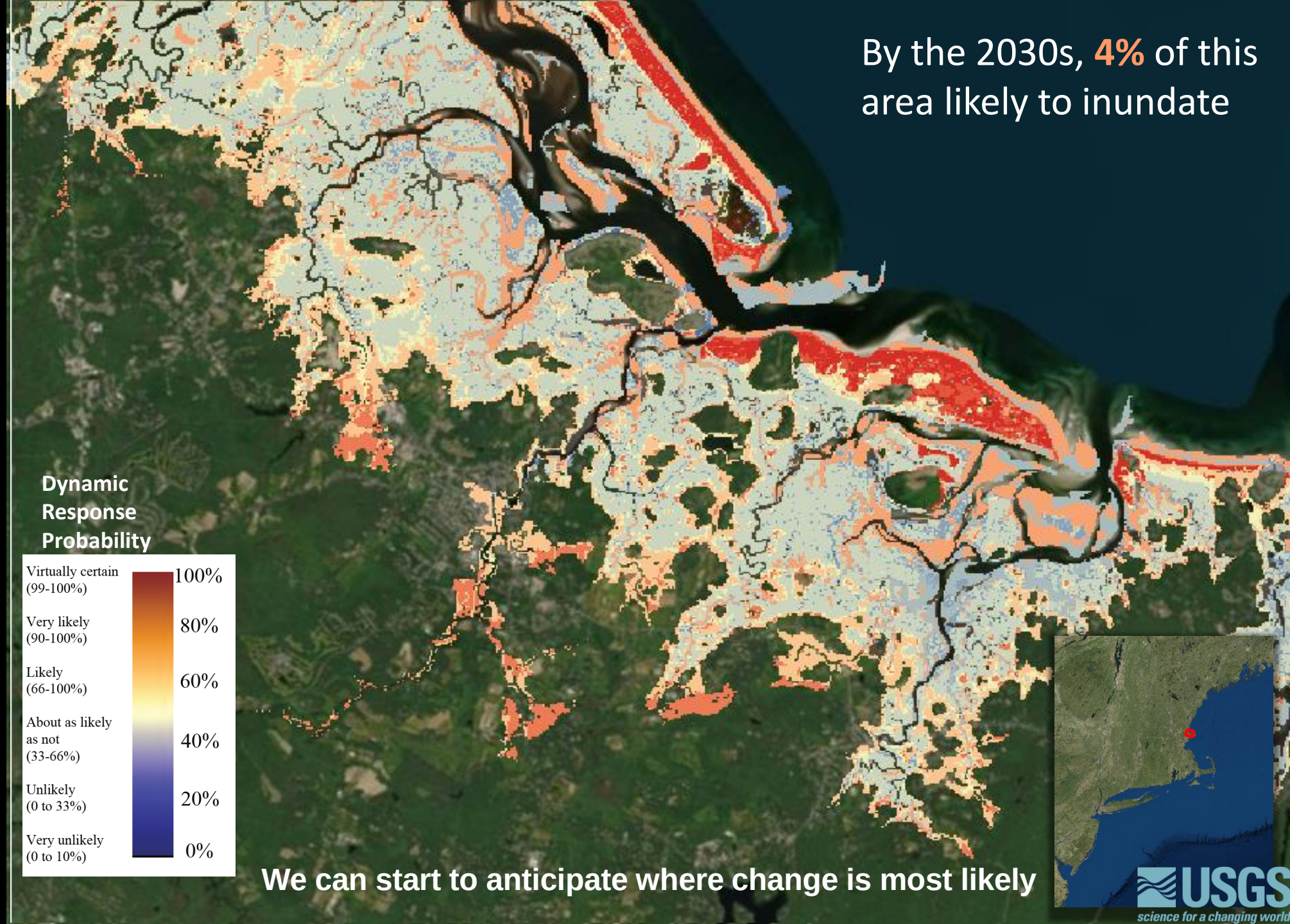
- Uncertainty maps can be used to identify where better information is needed
- Areas of low confidence require
  - better input data
  - better understanding of processes
- Can use this map to focus research resources

NCA 2018 scenarios:

GMSL rise Scenario
Low (0.3 m)
Intermediate-Low (0.5 m)
Intermediate (1.0 m)
Intermediate-High (1.5 m)
High (2.0 m)
Extreme (2.5 m)

By the 2030s, **4%** of this area likely to inundate



We can start to anticipate where change is most likely

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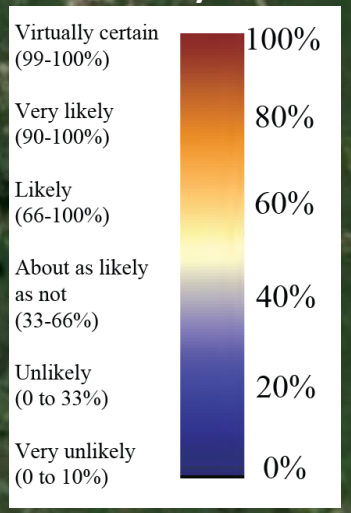
High (2.0 m)
Extreme (2.5 m)

By the 2080s, **35%** of this area likely to inundate

Dynamic Response Probability



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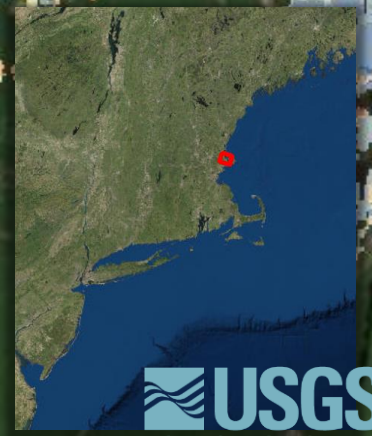

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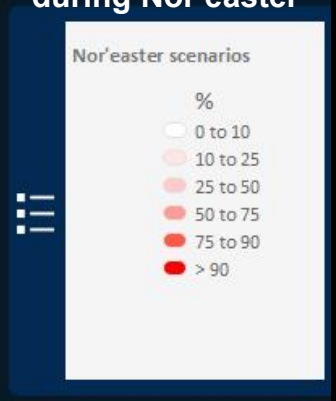
Likelihood of Storm Impacts

Collision	Overwash	Inundation
		
Waves/surge higher than base of dune lead to erosion	Waves/surge overtop dune crest, moving sand landward	Mean water levels are higher than dune crest, submerging beach system

Probability of Collision, Overwash, and Inundation (landward-seaward bands) during Nor'easter



https://marine.usgs.gov/coastalchangehazardsportal/

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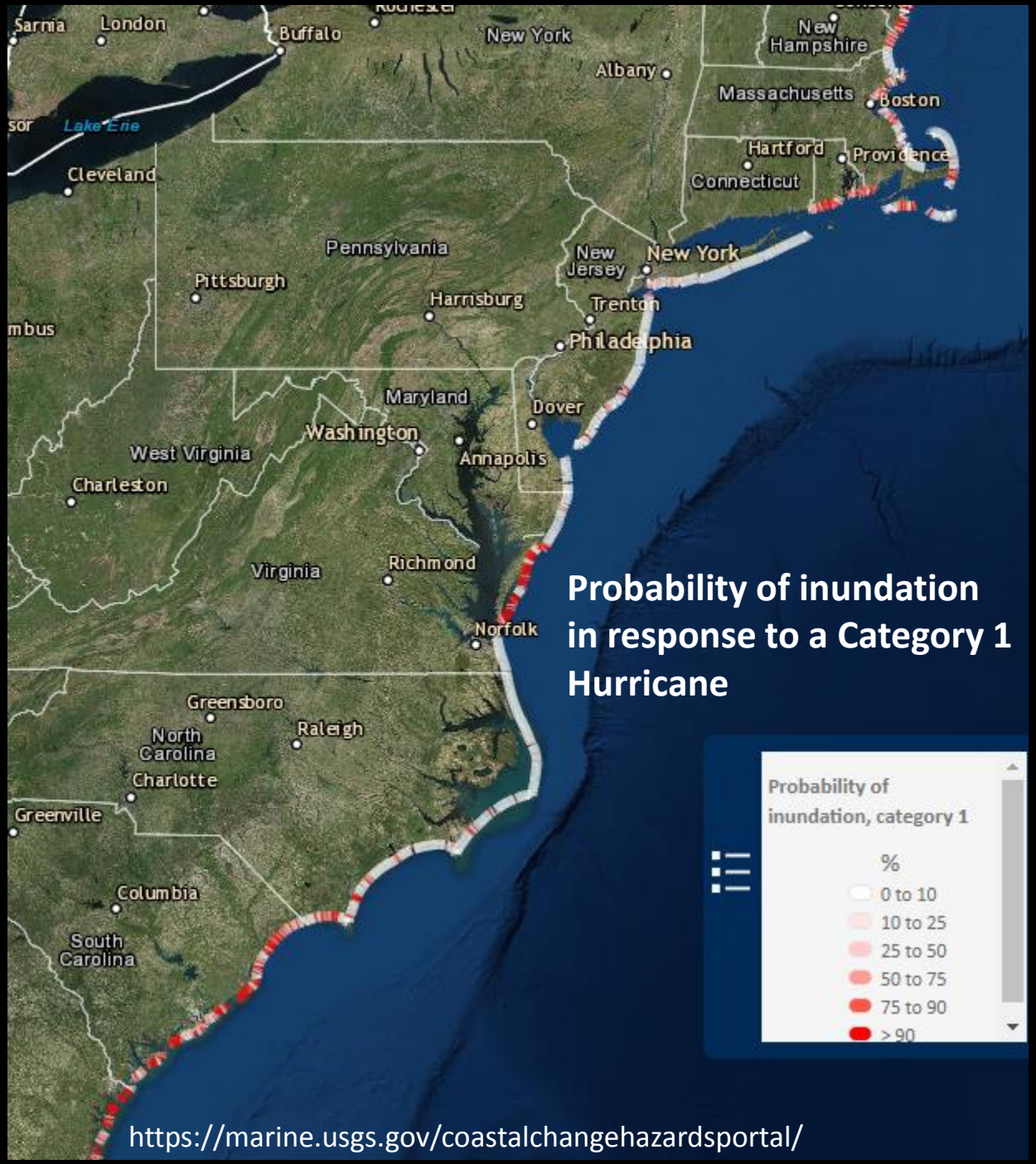

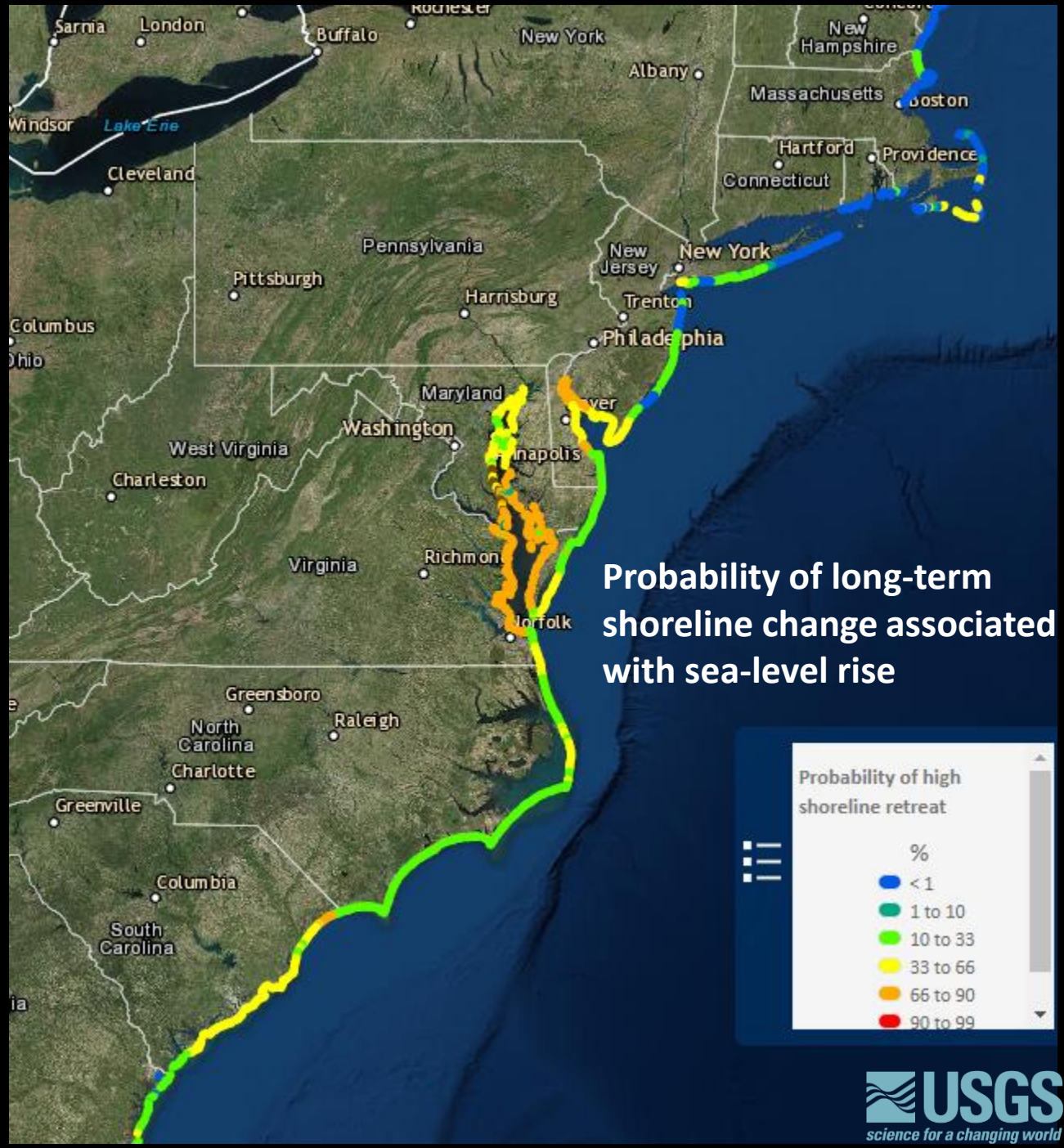

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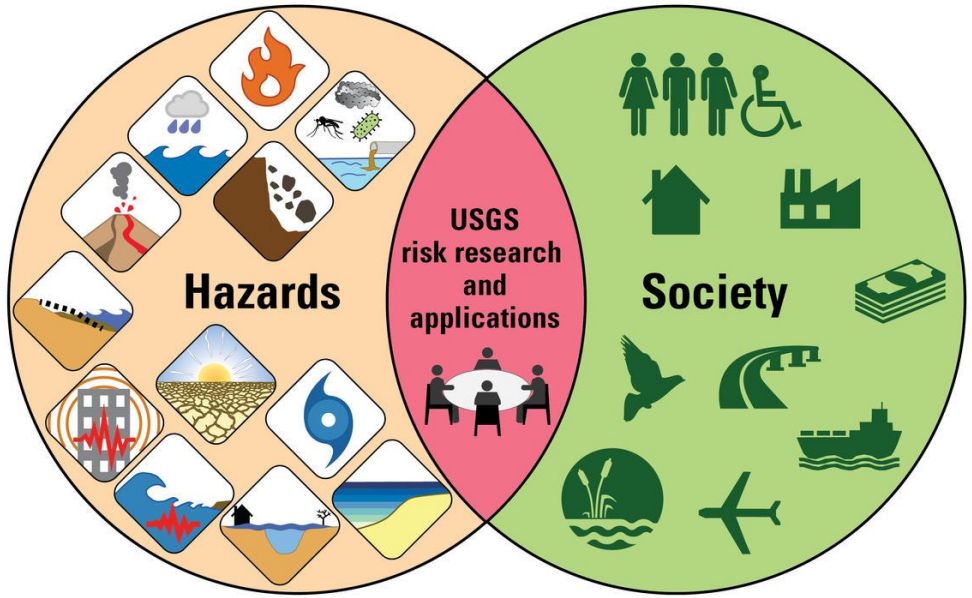
Risk-based framing for decision-making

"What is most likely to happen?" (e.g., with future climate)

AND

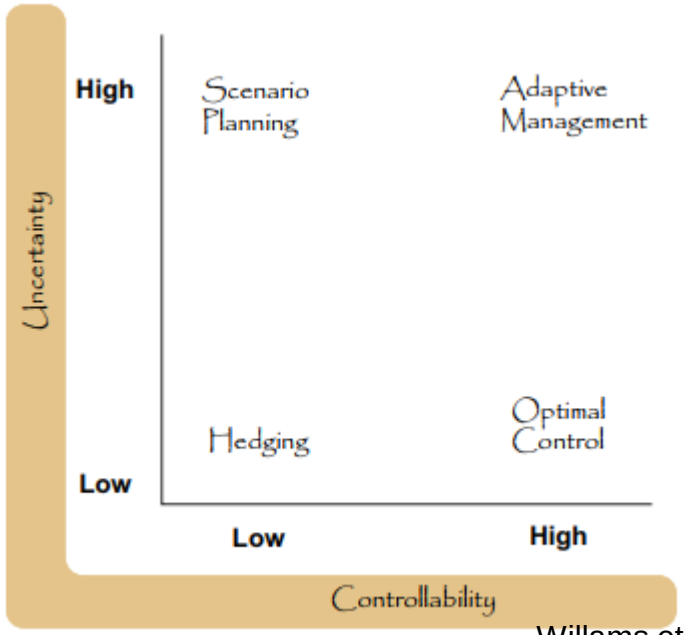
"How bad could things get?" (e.g., as a result of uncertainty in climate sensitivity and the climate system response).

Risk Community of Practice



Ludwig et al., 2018

Approaches to Decision Making



Willams et al., 2009

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Structured decision making:

Defining shared goals and a common vision

Sustain services and infrastructure

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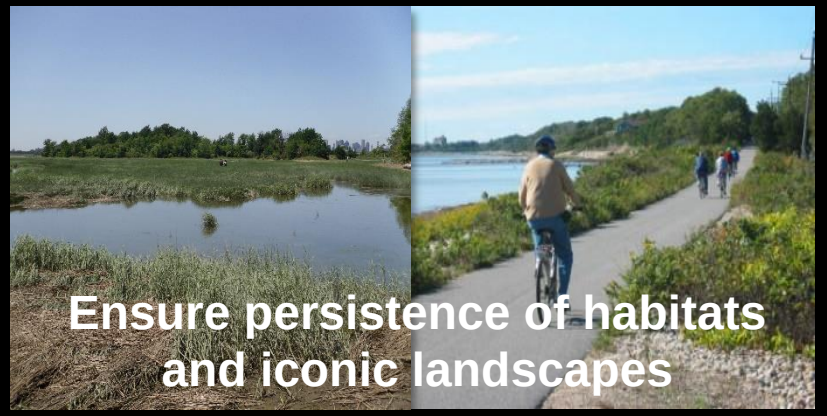
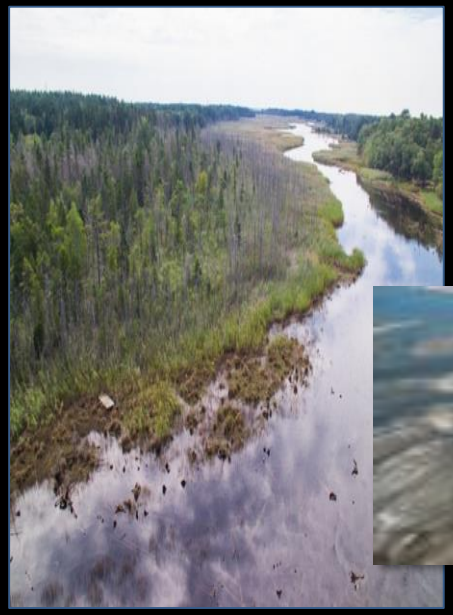


Ensure persistence of habitats and iconic landscapes



Ted Blanco

Coastal land availability vs. land loss

Charlie Flagg

Actions: Manage differently, adapt existing structures, acquire new or existing land

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Summary

- The coastal landscape is variable in both configuration and response to change

- We know a lot about where and when the coast will change, and we need to know more
  - Rates of sea-level rise and magnitudes poorly constrained
  - Uncertain where and when storms will hit
  - Human action is difficult to predict
  - There will be major changes to the coast, ecosystems, and resources

- We can prepare using both uncertainty and knowledge
  - Adaptive management and scenario planning will allow for planning flexibility and vision
  - Understanding your risk tolerance can help frame decision-making
  - User engagement is key to producing actionable research and tools

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