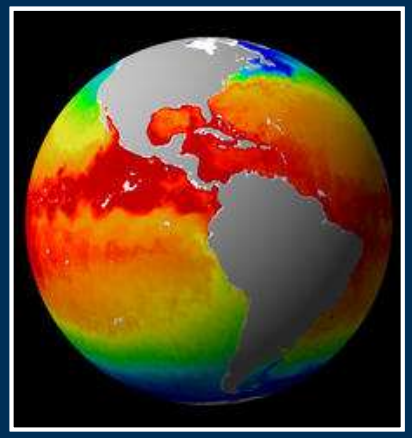
What can the past tell us about our current and future storm risks?




Neil K. Ganju
Woods Hole Coastal and Marine Science Center
U.S. Geological Survey
nganju@usgs.gov

USGS

Major points

- Sea-level rise is one of the most certain impacts of climate change, and adds to storm risks.
- Recent projections suggest that sea-level will rise between 1 foot and 8.2 feet by 2100.
- Every coastal issue that Falmouth faces today will very likely get worse, and increase in extent and magnitude.
- Effective adaptation to rising sea level and storms will require changing approaches to coastal management.

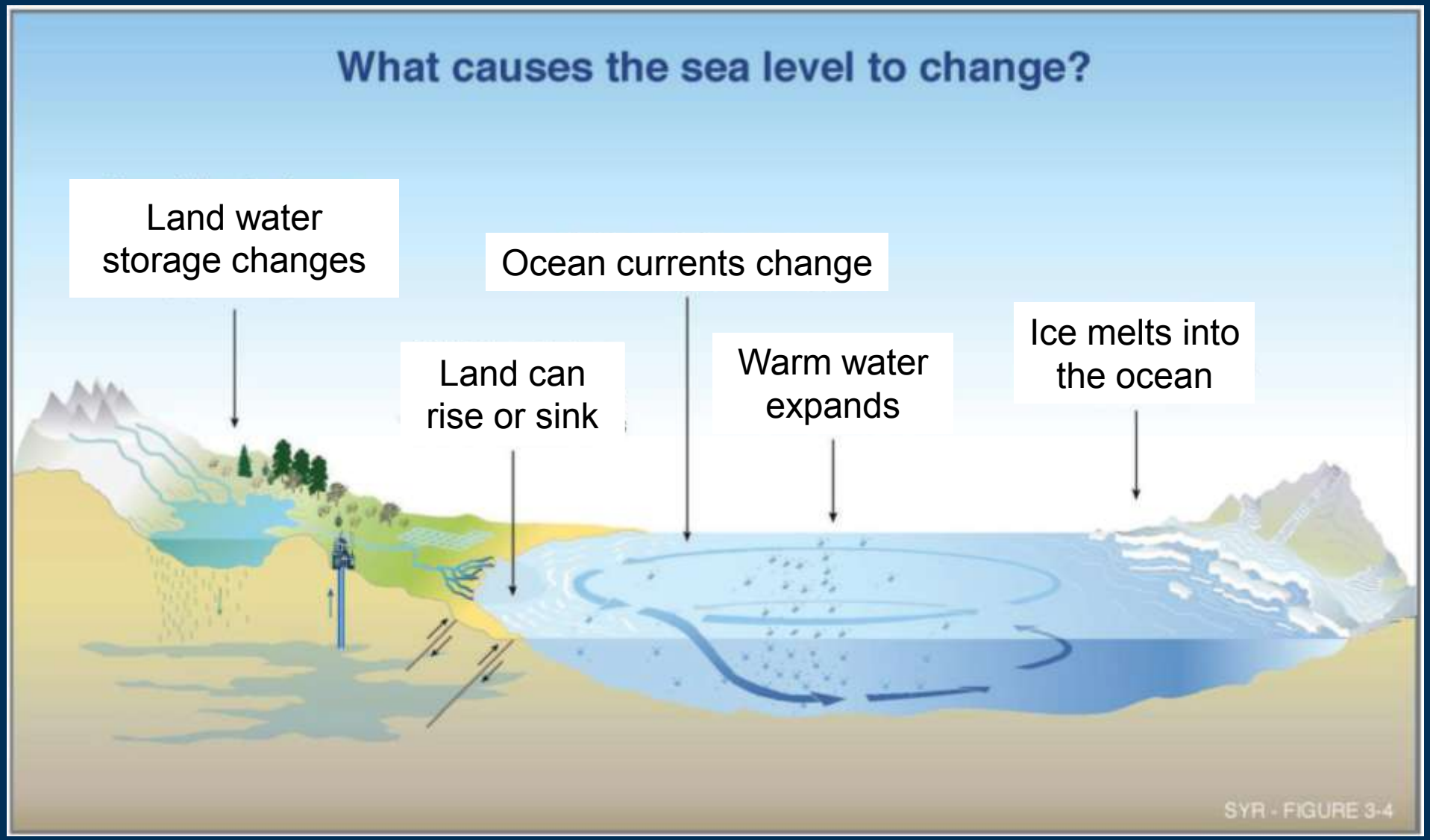
USGS

“We need better science* to prepare our local responses to climate change, especially in our coastal areas.”
(David Carter, Delaware Coastal Management)




USGS

*science = better understanding of processes + better situation awareness



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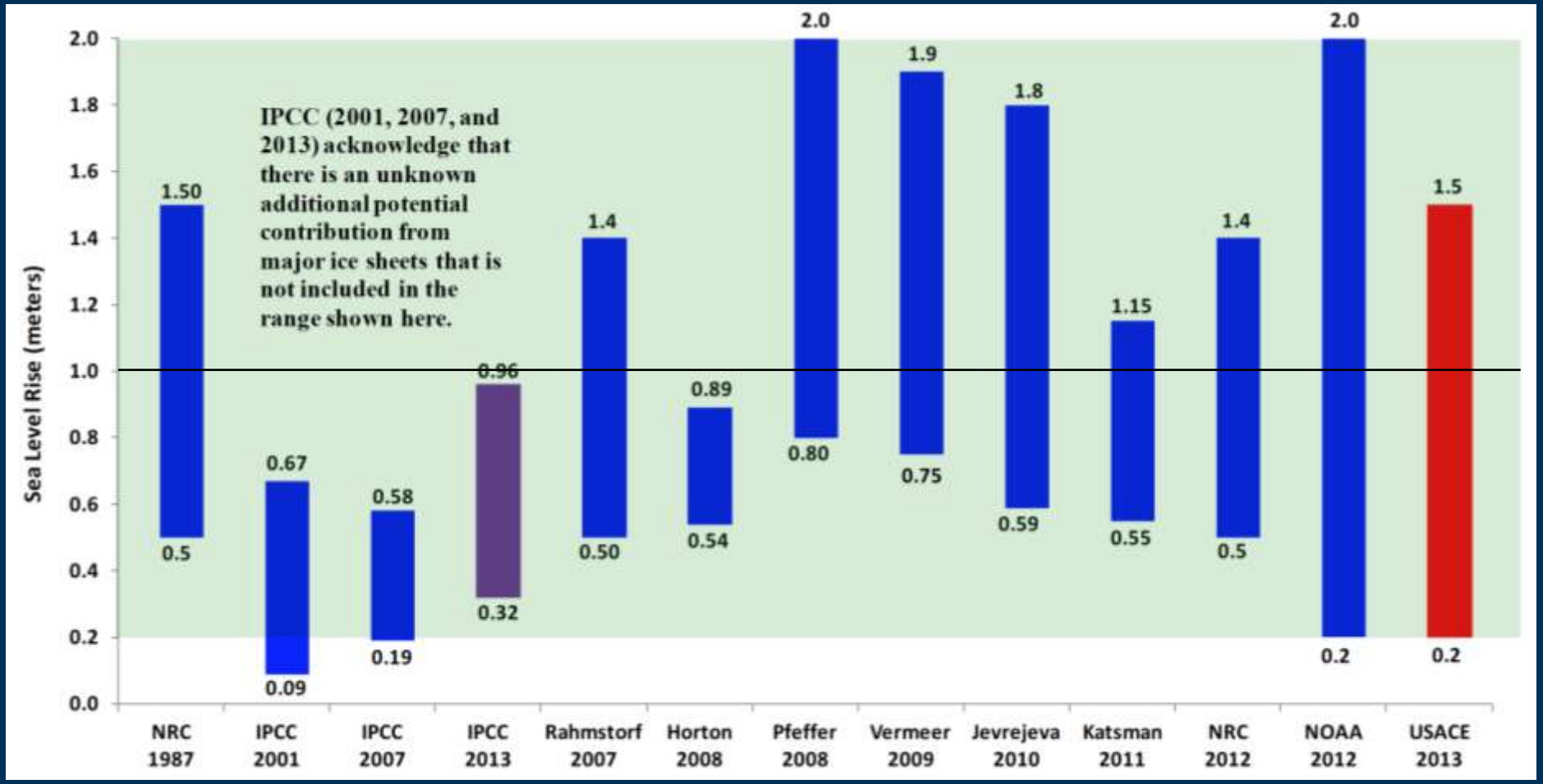
(IPCC, 2001)

Global Sea-level Rise Projections: 2100



(USACE, ETL 1100-2-1, 2014)

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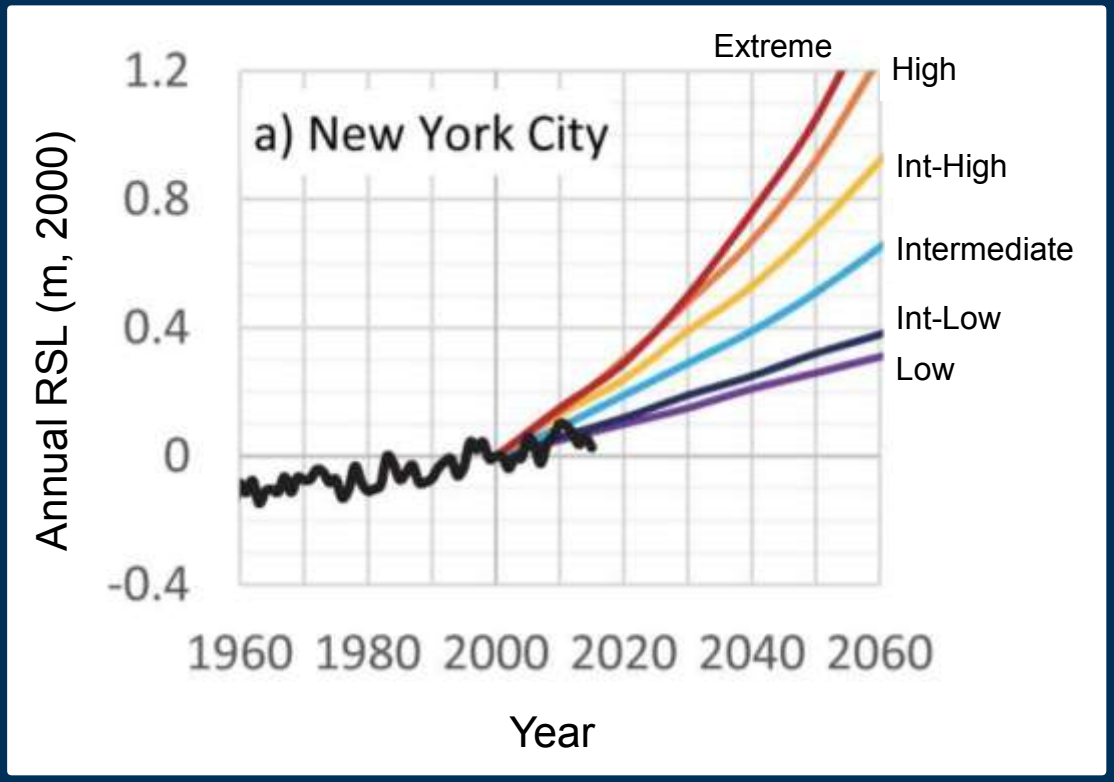
Local sea-level rise: NYC

Flooding potential in New York City

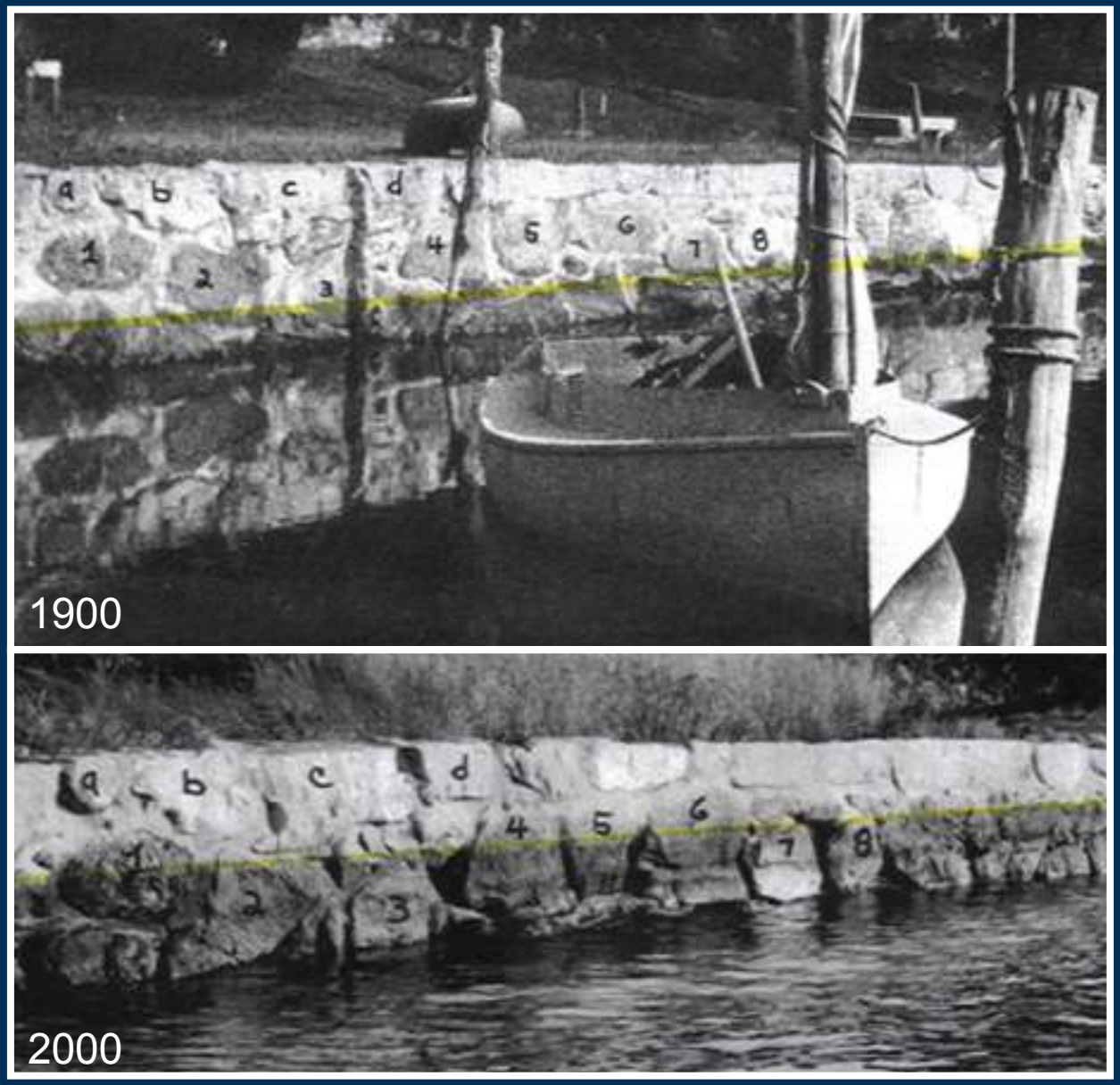
Time period	1-10 year events				1-100 year events			
Emissions	No SLR	low	int	high	No SLR	low	int	high
2001-2100	10	50	53	56	1	4	6	9

Rollingstone.com



Kopp and others 2014; Sweet and others 2017

Local sea-level rise: Woods Hole, Little Harbor



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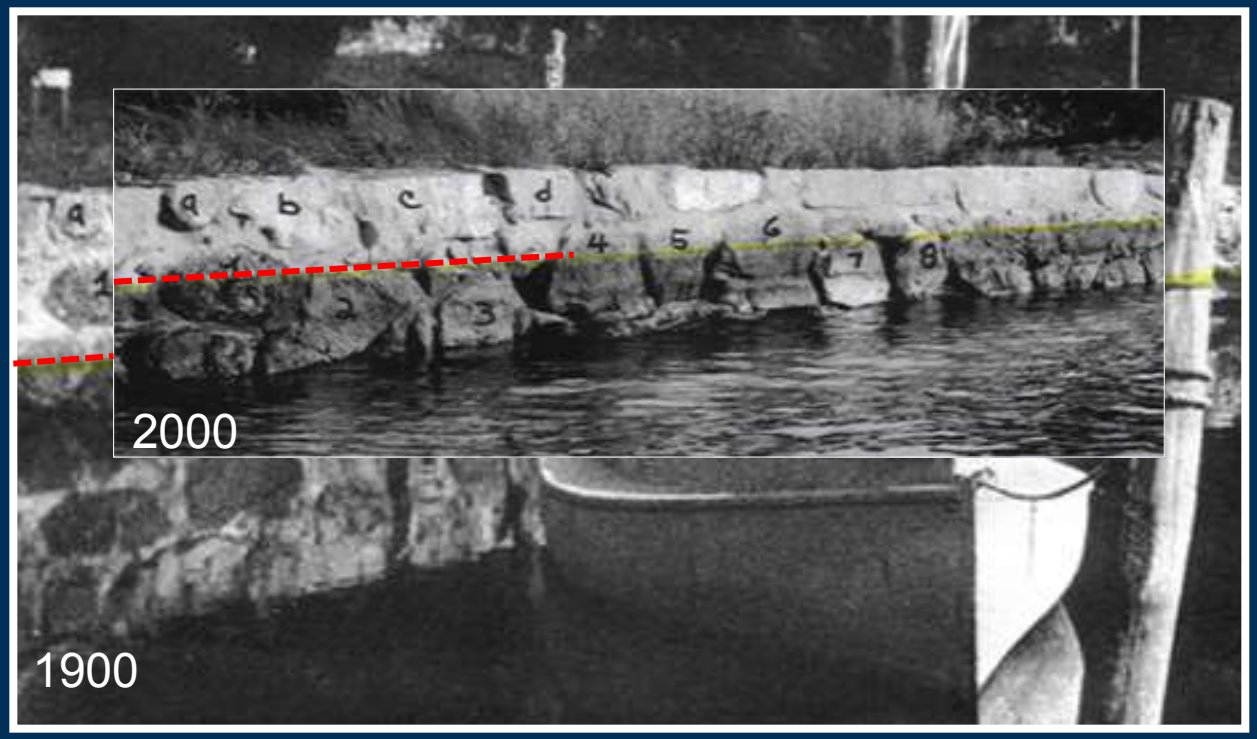
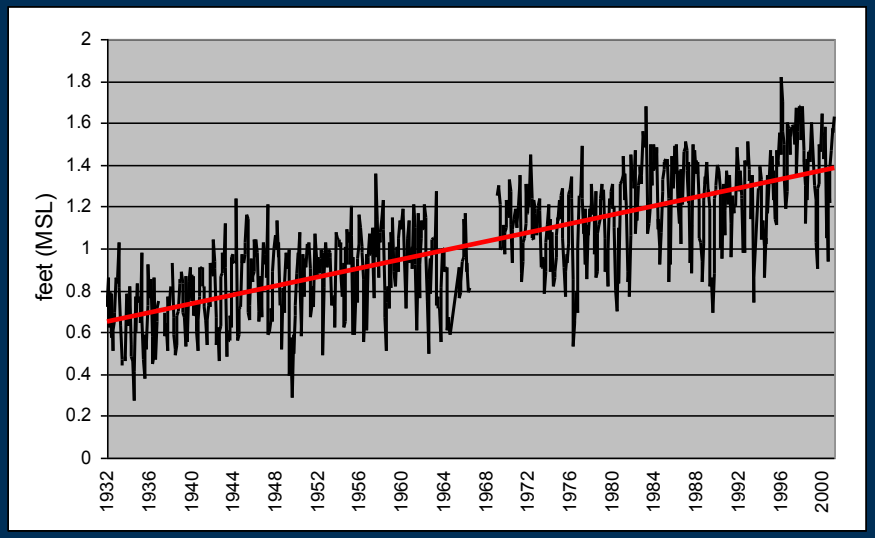
Local sea-level rise: Woods Hole, Little Harbor



Sea-level rise
in Woods Hole
~13” in 100 years



NOAA tide-gauge
1932-2001

USGS

Coastal Flooding in Charleston, SC

Built environment impacts

(NOAA CSC)

- NOAA Charleston issues shallow coastal flooding advisories for 7 ft tides
- 7 ft tides typically predicted to occur twice a year
- With 1.6 ft of relative sea-level rise, this advisory could be issued 355 times

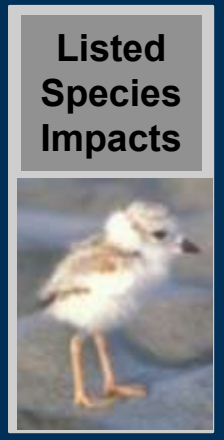
But… the coast is not like a bathtub

Nantucket, MA
~2.6 mm/y;
500 m shoreline retreat

Pacifica, CA
~2.0 mm/y;
cliff erosion and retreat

USGS

So, what can happen?



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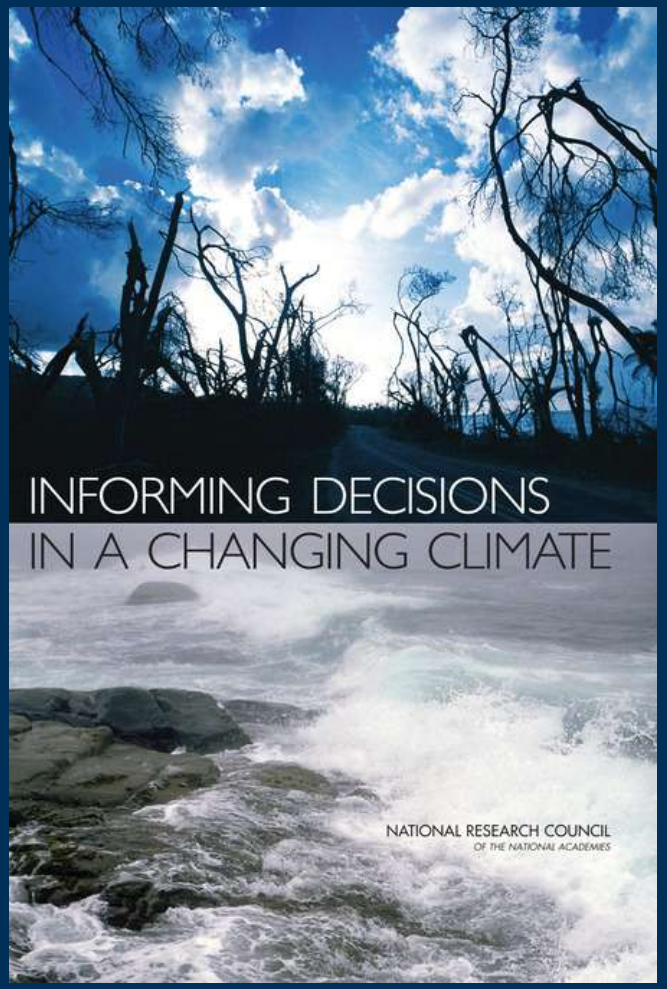
Informing Decisions in a Changing Climate

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.

- Decision makers must expect to be surprised.
- An uncertainty management framework should be used.



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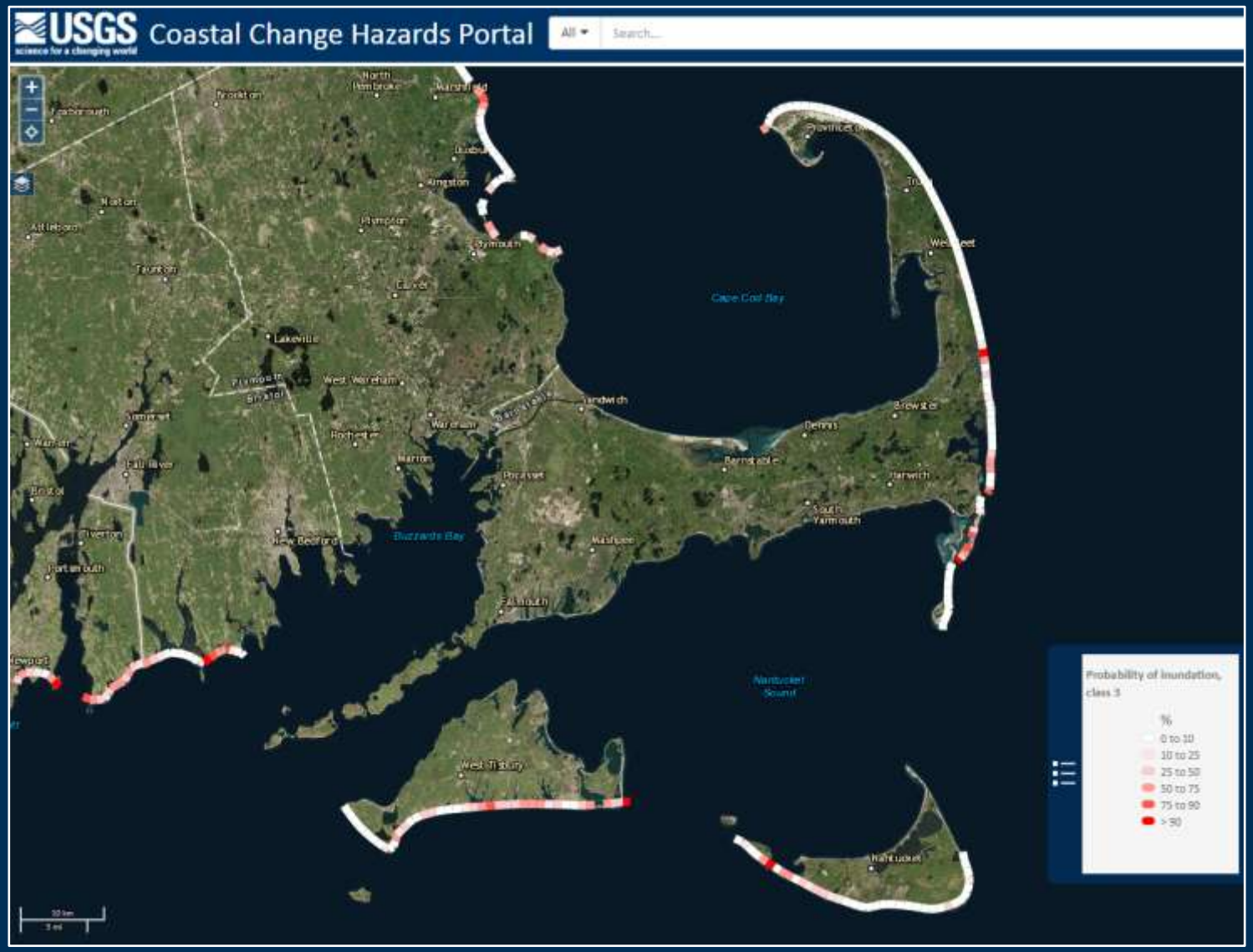
Storm and coastal impact forecasting



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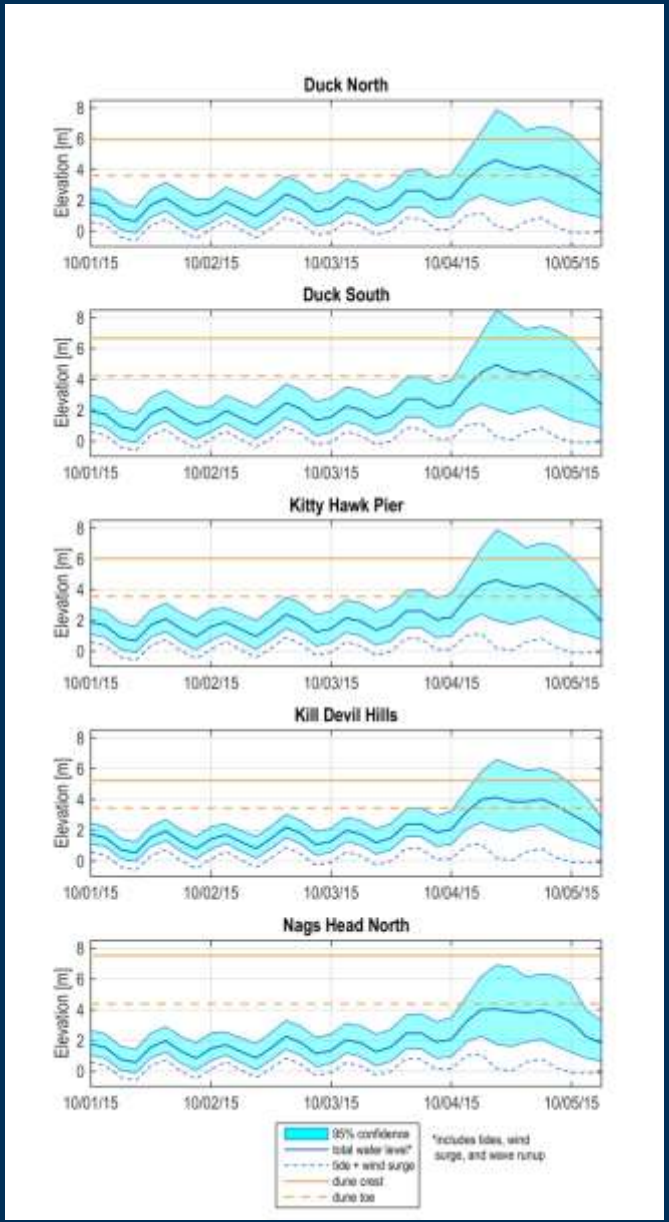
Storm impact forecasting (Hurricane Joaquin, 2015)

Photo credit: Dare County Emergency Management



Operational forecasts of total water levels can warn local officials of potential overwash, such as that observed along Hwy 12 in Kitty Hawk, NC.
(USGS collaboration with NOAA, NWS)

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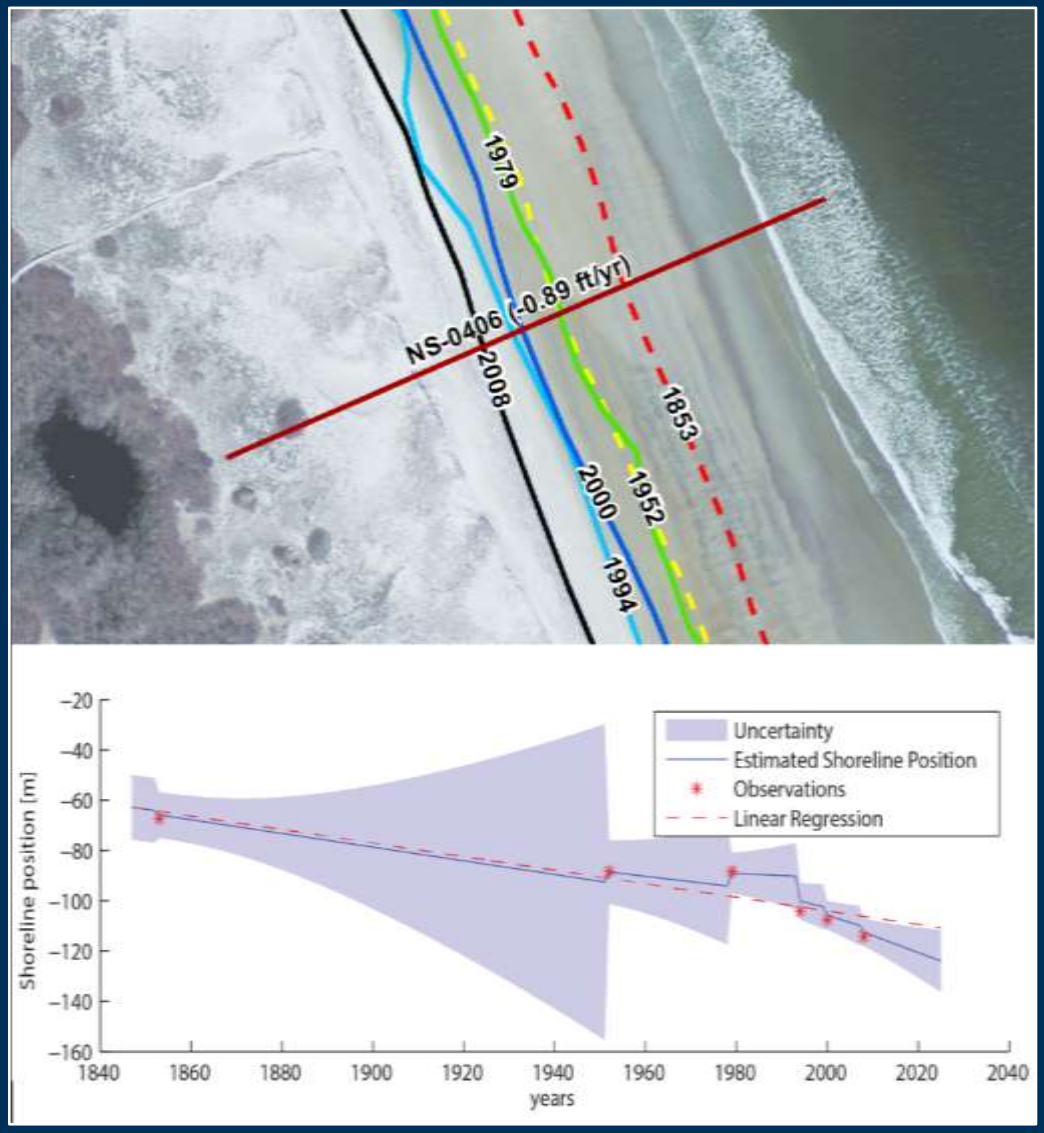
Decadal-scale shoreline change forecasting



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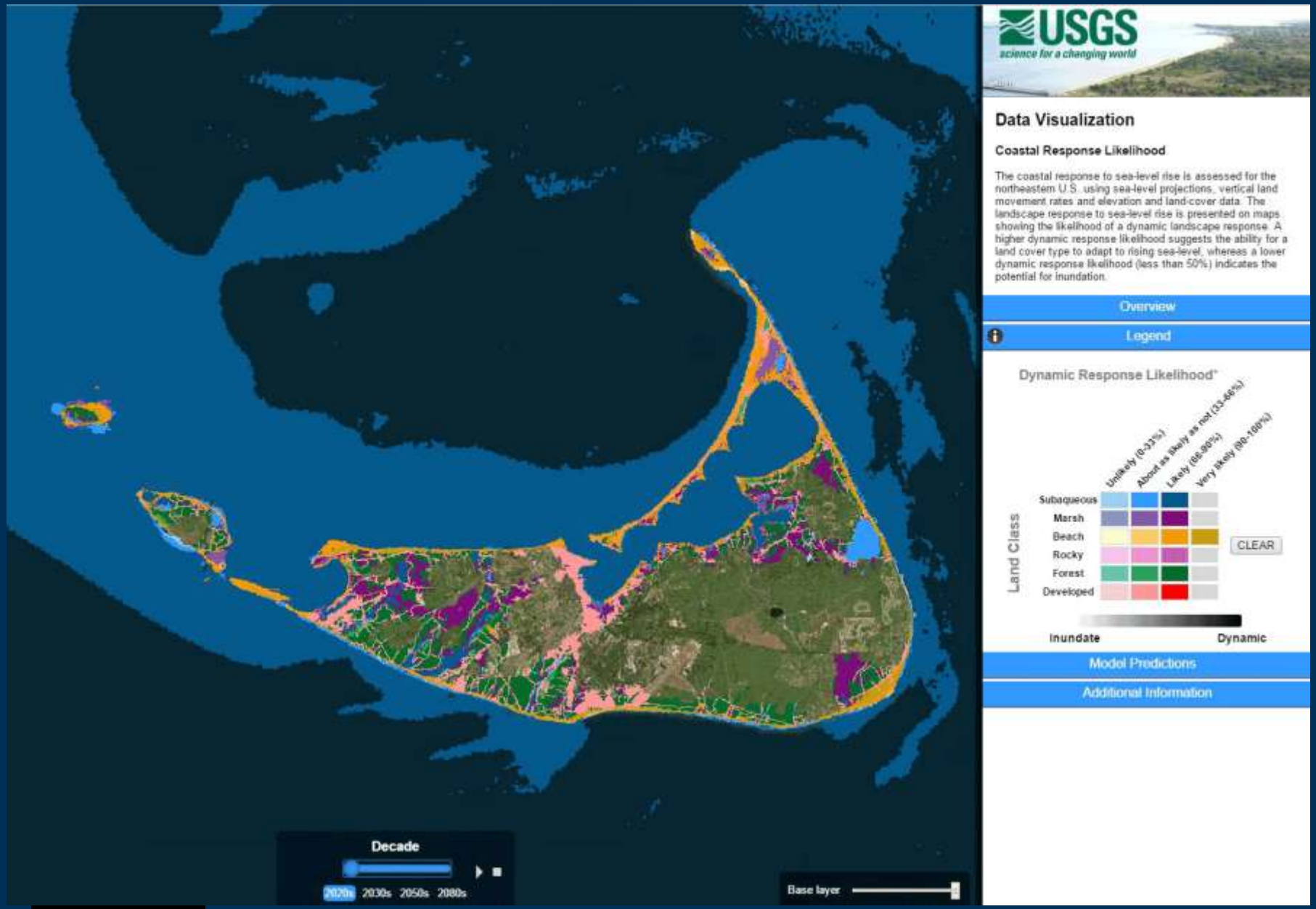
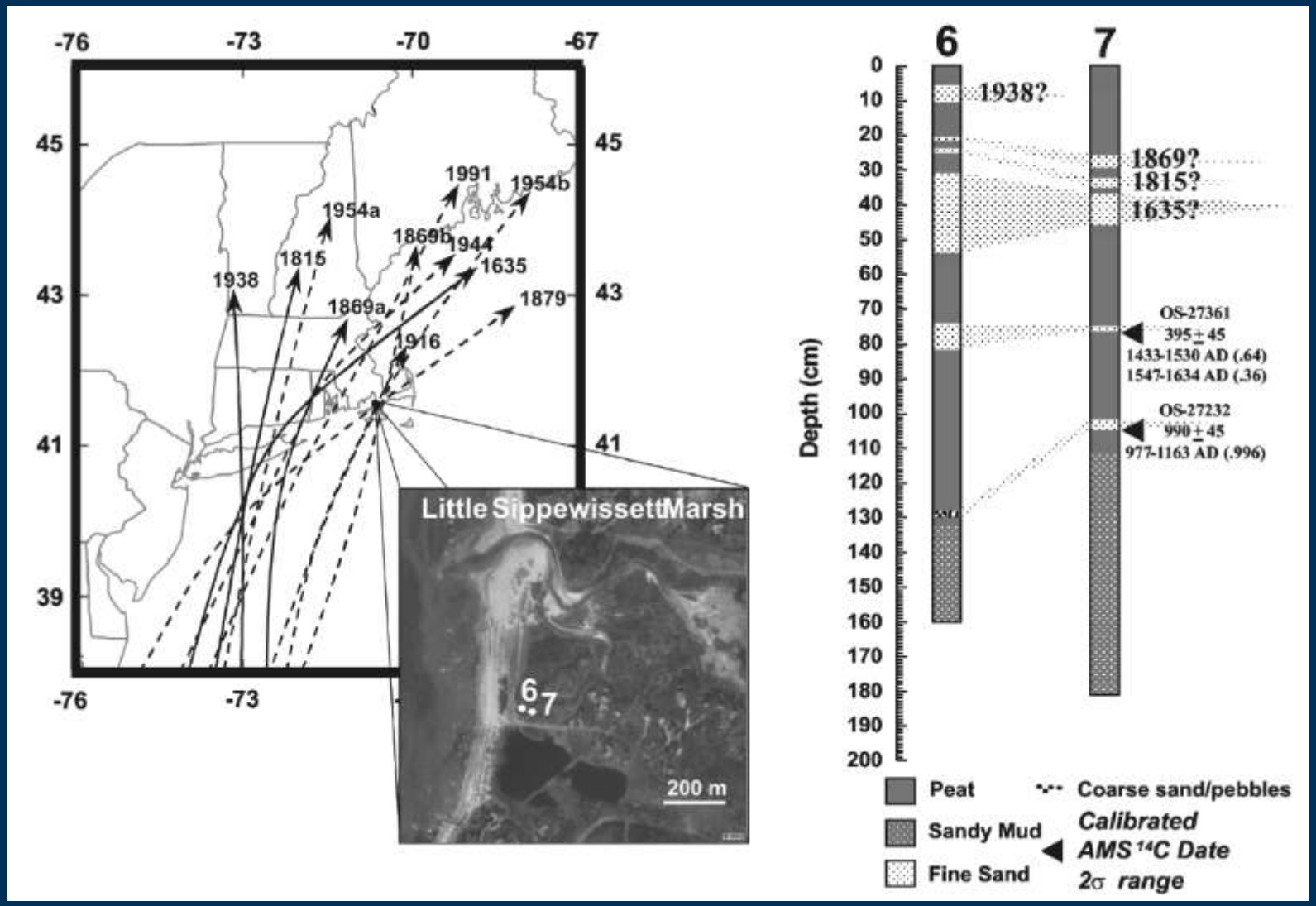
(Massachusetts Coastal Erosion Commission, 2015)

Sea-level rise impact forecasting



(Lentz et al., 2015; 2016)

What did the past look like?



Buynevich and Donnelly, 2006

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Past storm impacts – history repeats itself

1938: Great New England Hurricane

Category 5, landfall as Category 3

Estimated $40 BN damage if landfall in 2005 (NOAA HRD)

1991: Hurricane Bob

Category 3, landfall as Category 2

$3 BN damage in 2017 $

USGS

Mike Crew, Pinterest;
Joanne Rathe, Boston Globe

History repeats itself again…

1954: Hurricane Carol

Category 1-2

Costliest U.S. hurricane at the time

1991: Hurricane Bob

Category 3, landfall as Category 2

$3 BN damage in 2017 $

(Mike Crew; Cape Cod Times)

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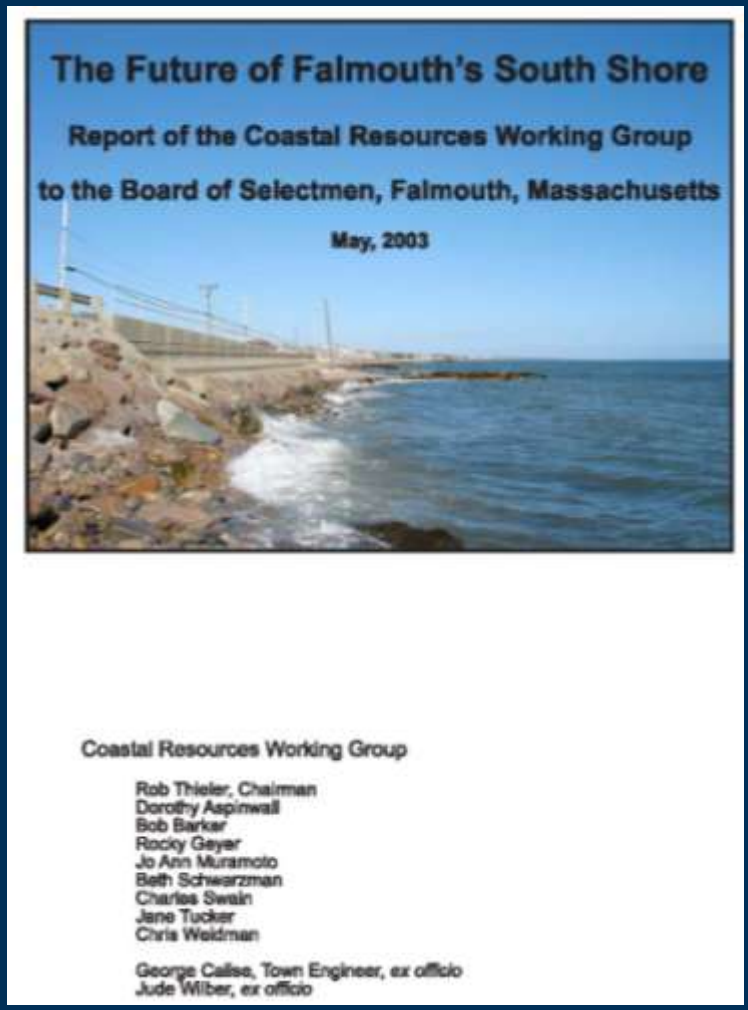
Have we learned from Bob, Andrew, Katrina, Sandy, Harvey, Irma, Jose, Maria…..?

Trunk River, Falmouth as a microcosm…

What's a community to do?



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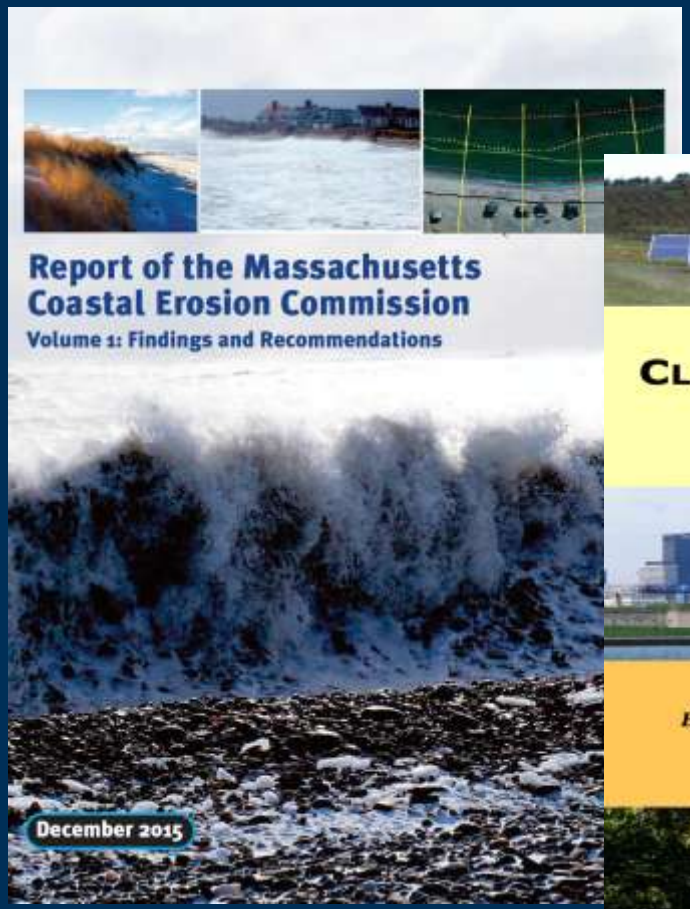
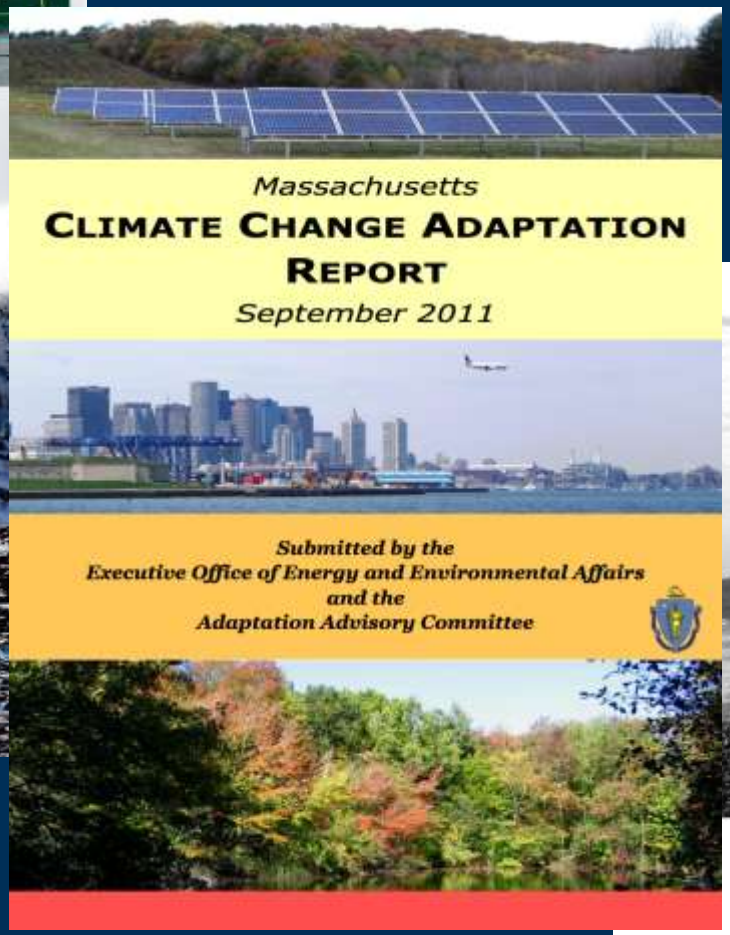
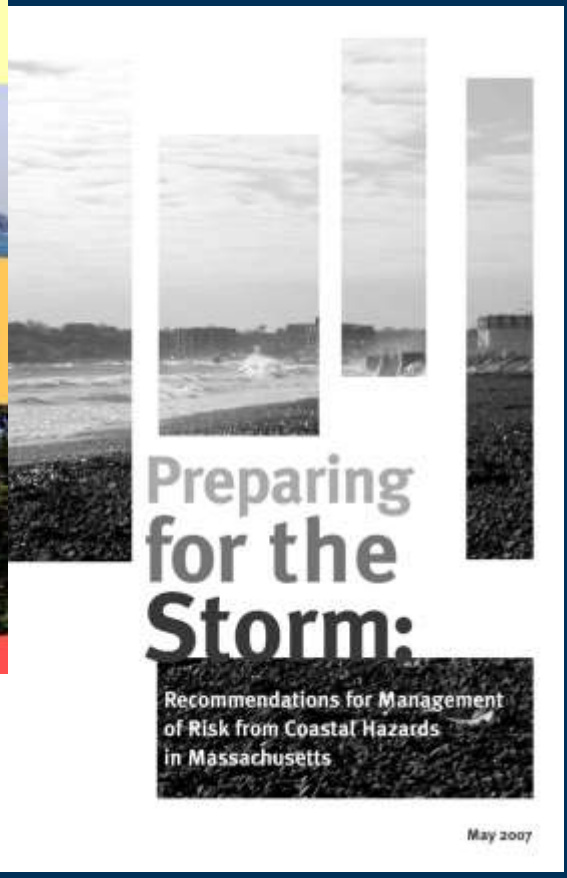
State resources are abundant and actionable

Here are just a few…







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Summary

- The coast as we know it today is a product of sea-level rise; coastal erosion is an expected response
- 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
- Major changes are occurring on the coast, as a result of human activity and changing climate
- Informed preparation is important

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Some things to consider…

Options that maintain future flexibility

- Magnitude and timing of future climate change and our responses to it are uncertain
- "No regrets" options

Holistic examination of potential impacts

- Geologic, biologic, economic, social...
- Expectations of your coastal zone (resources, tourism, aesthetics, navigation, etc.)

Time horizon

- How long should something last? Until you have a better plan to address the problem? The next big storm? Two feet of sea-level rise? Forever?

Risk tolerance

- Scale with size, value, time
- Implications of failure, or over-planning/building

Protocols for what happens after large events

- Because there will be a "next time"

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