Sea Level Rise from Global to Local:
The Decisive Decade for Coastal Communities

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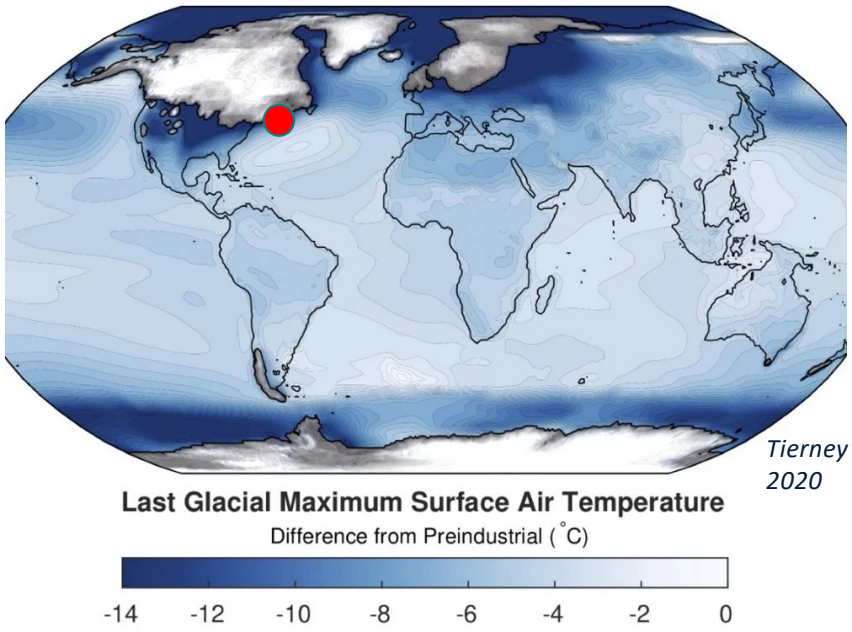
From Snow to Sea: Space vs Time

20,000 Years & A Few Degrees: Ice Age vs Beach Day

Last Glacial Maximum Δ5°C globally



Tierney et al., 2020

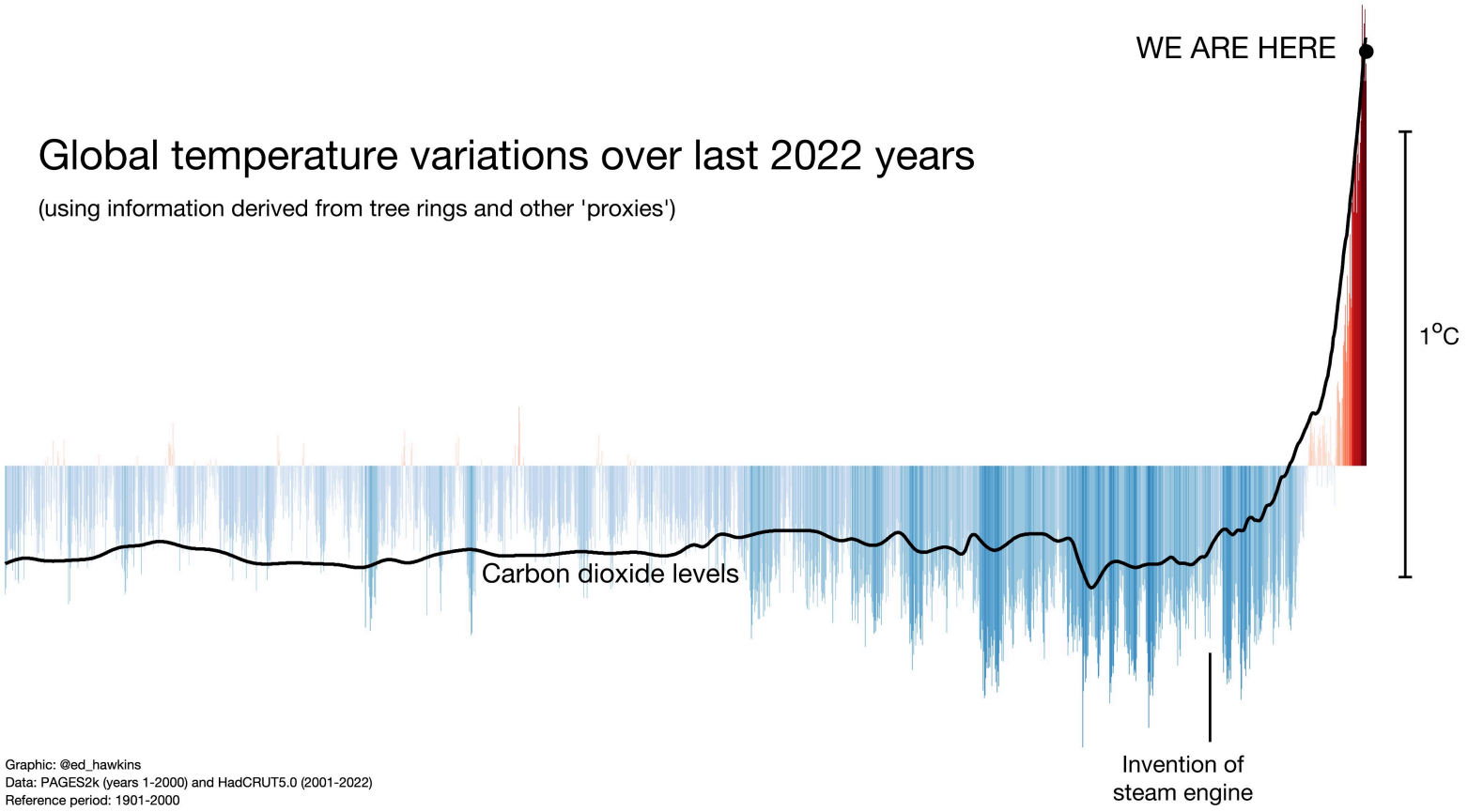
- After LGM, maximum warming rate was 1.5°C/1000 yrs
- Since 1850-present surface has warmed 1.1°C

20,000 years ago
GLACIER ICE

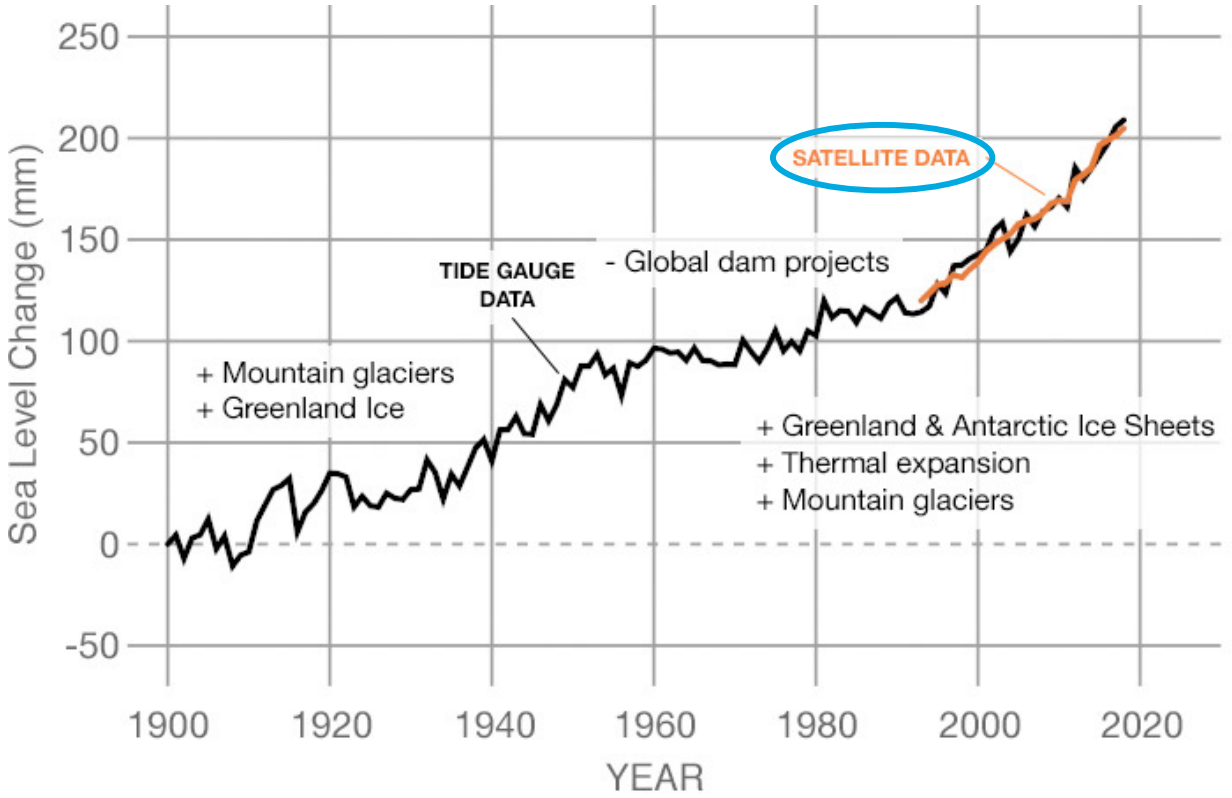
10,000 years ago
BOREAL FOREST
WETLANDS

Today
BEACH
COASTLINE

2,000 Years of Global Temperature Change



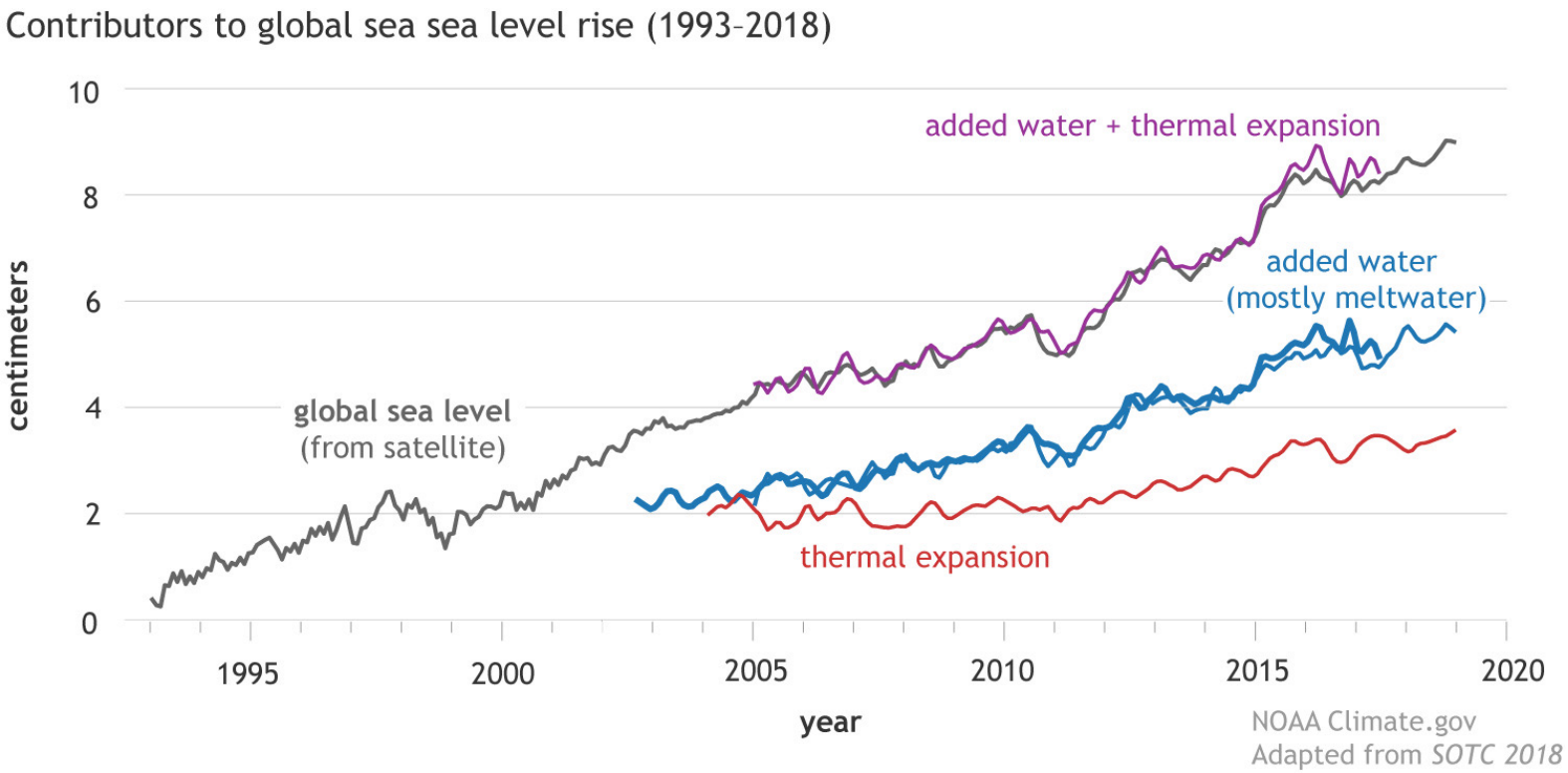
100 Years of Global Sea Level Rise



~ 8” globally

Climate.nasa.gov

25 Years: Contributions to Global SLR during the Satellite Era



Global vs Local Sea Level Rise

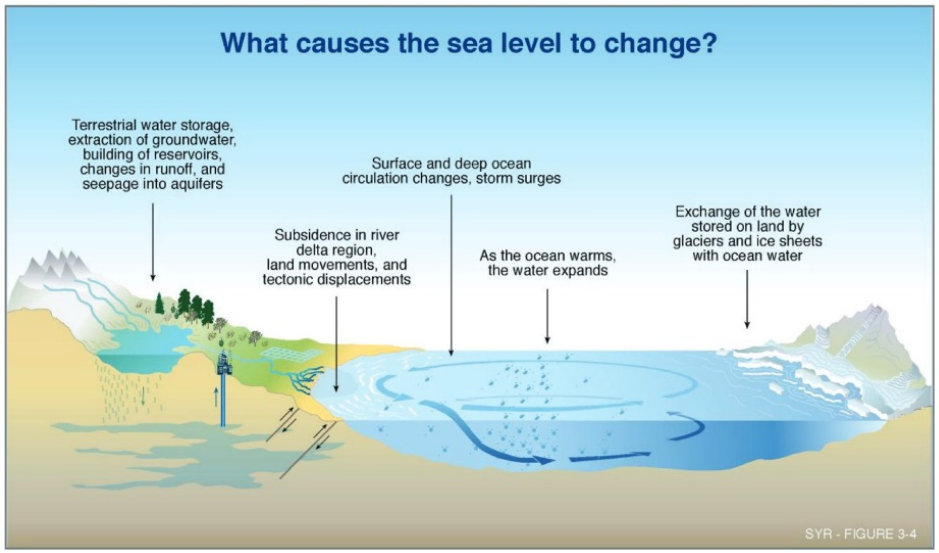
Process Scale and Effect

These processes affect different components of sea-level change, and act on different geographic scales.

	Rise/Fall	Acceleration	Variability
Steric	Global		
Eustatic (Greenland/Antarctic Melting)		Global	
Glacial Isostatic Adjustment	Regional		
Atmospheric Processes		Unknown	Regional
Ocean Dynamics			Global-Regional
Groundwater/Oil Pumping		Local	

VIMS.edu

IPCC



Climate change is global but effects are LOCAL

Top climate concerns for coastal MA

Sea-level rise →
flooding, erosion, infrastructure damage, saltmarsh degradation

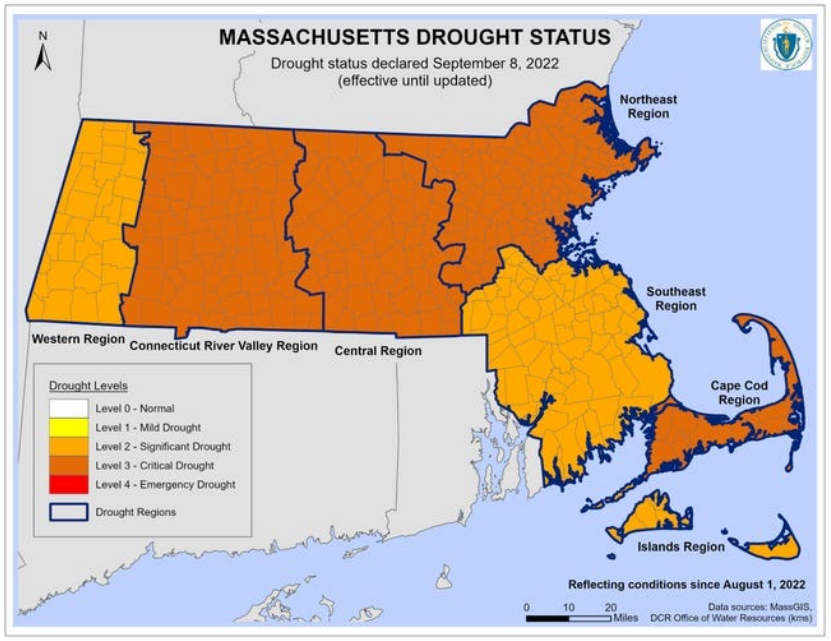
Rising ocean temperatures →
Impact fisheries, toxic algae blooms, stronger storms

Increased heavy precipitation events →
flooding, heavy snows, erosion, runoff

More intense droughts →
agriculture, freshwater supplies, wildfires

Tropical storms →
Track farther north, longer TS season, more erratic paths

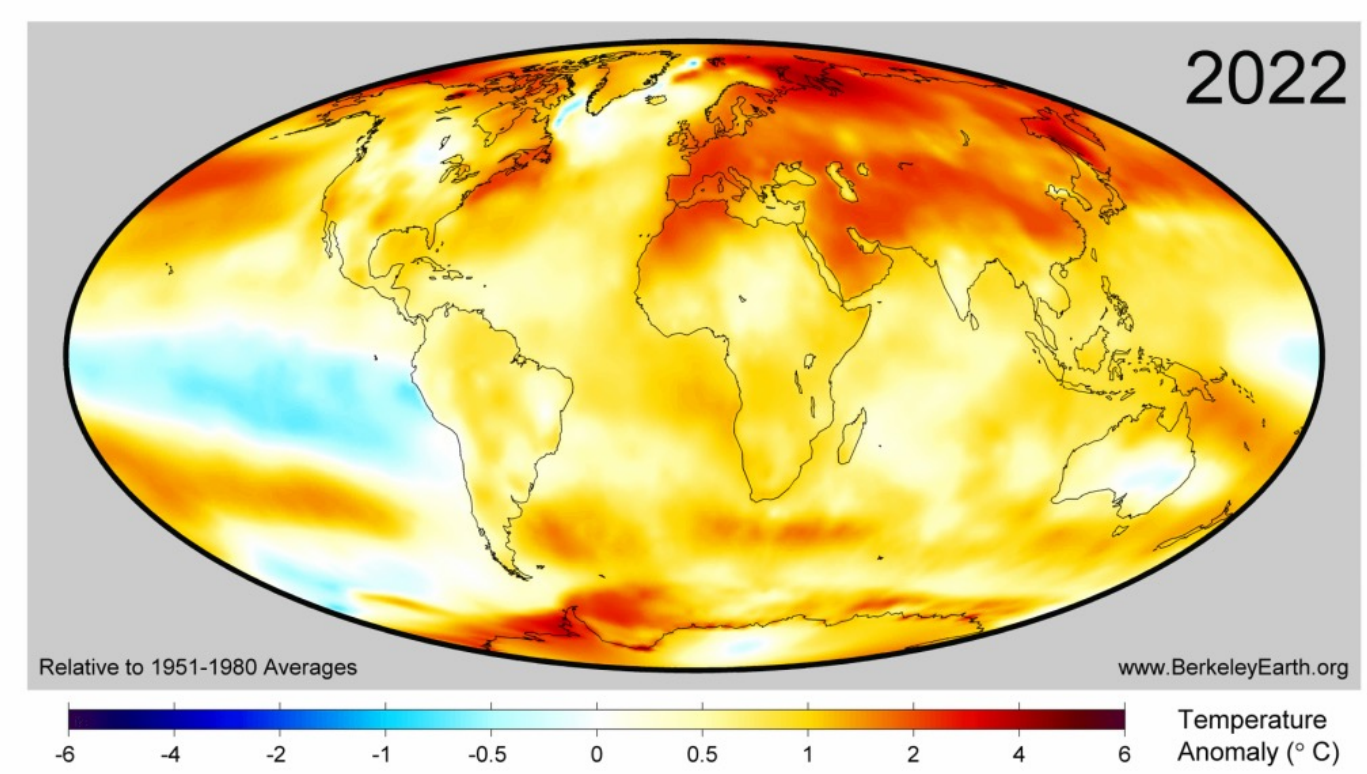
Precipitation Extremes: More droughts, More heavy rain



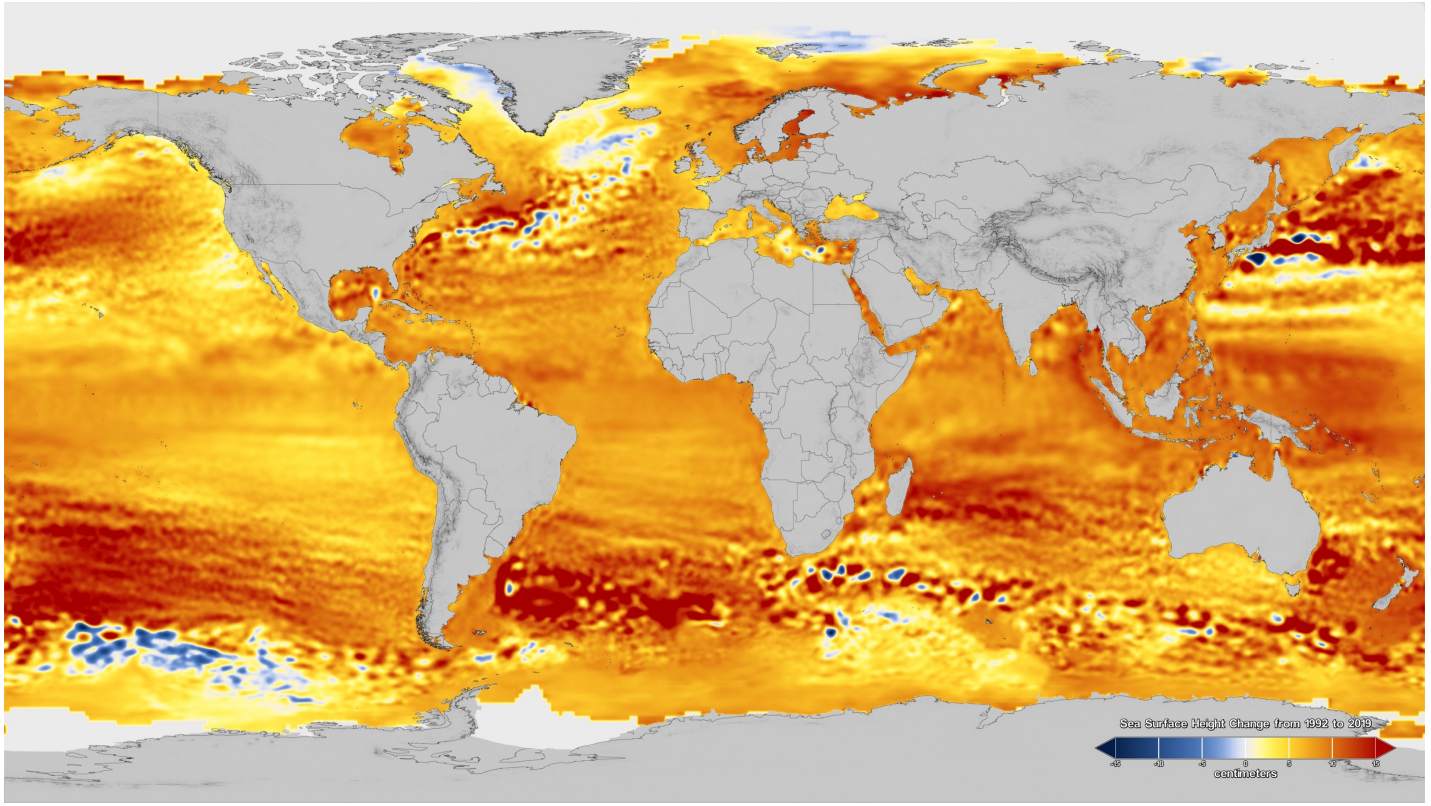
Sept 2022

October 2022

Temperatures: It's Hot and getting Hotter (2022)



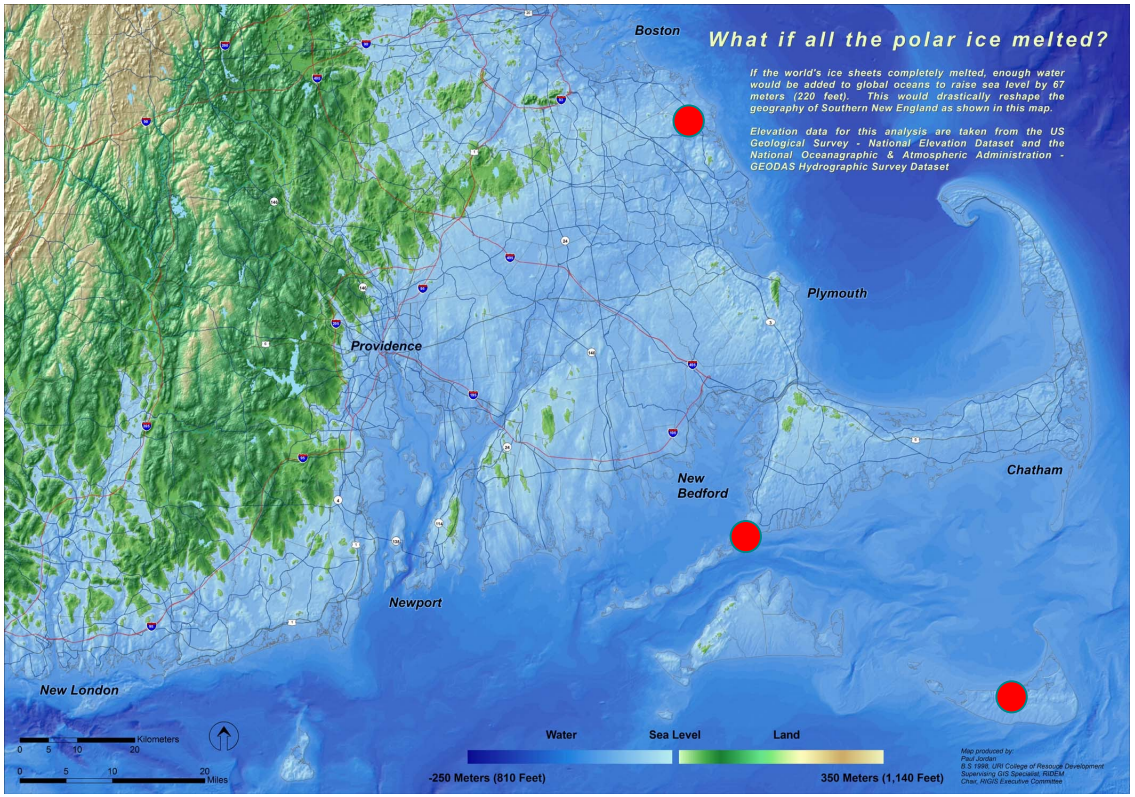
Sea Surface Height (1992-2019)



sealevel.nasa.gov

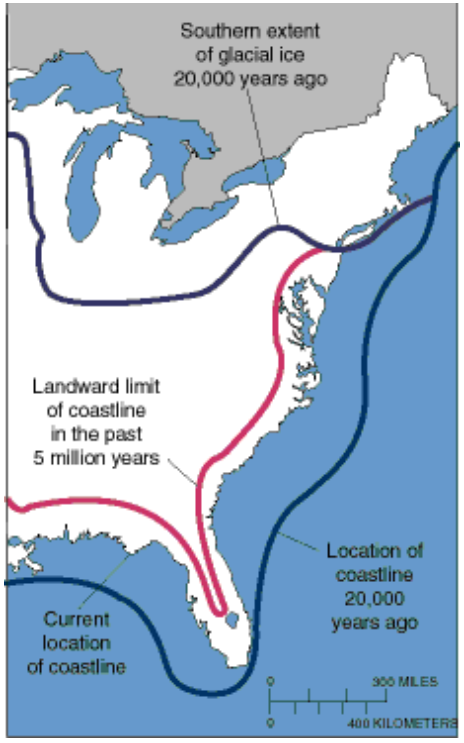
Our Coastline in a World Without Ice Sheets

http://www.riclimatechange.org/changes_sea_level.php

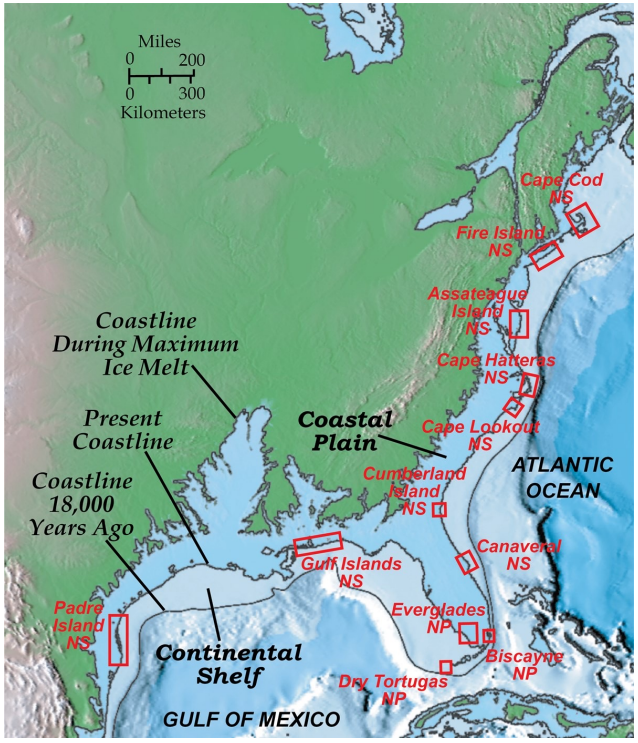


Earth's Past @ 400 ppmv CO_2: Glimpse of the (Far) Future?

Mid-Pliocene ~ 3 Ma (+2.5°-4°C) Sea Level ~ 25 m higher



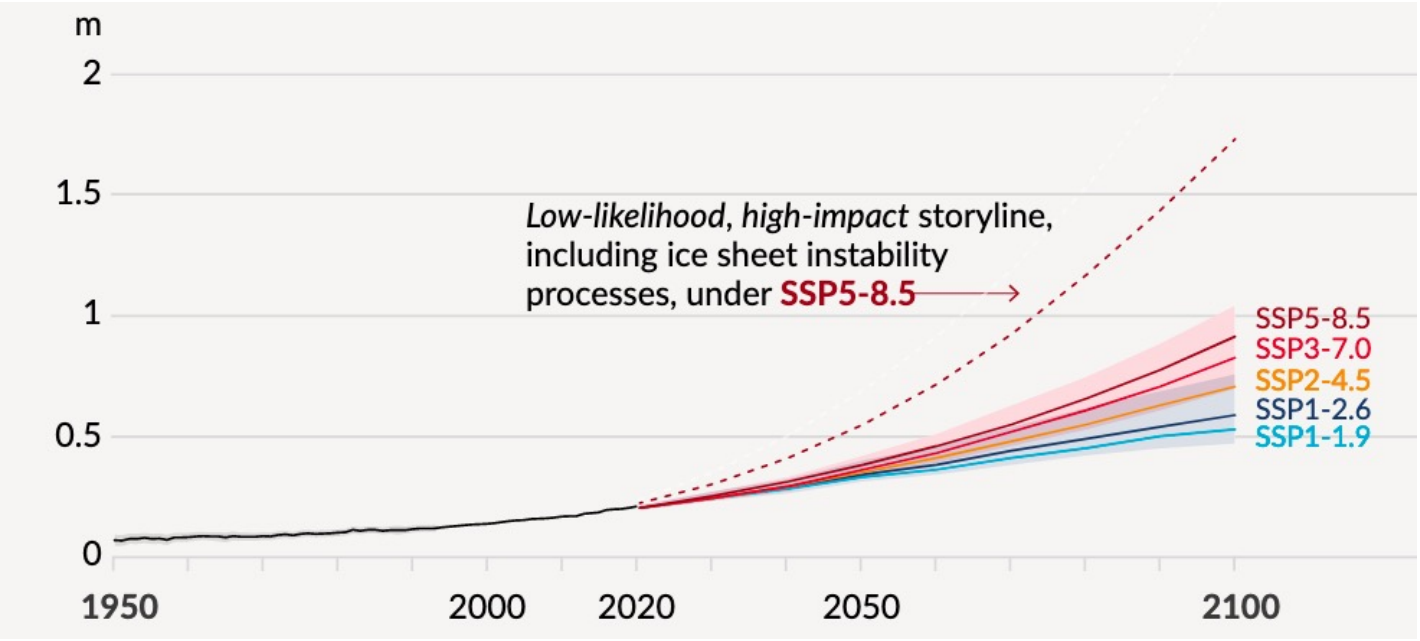
USGS



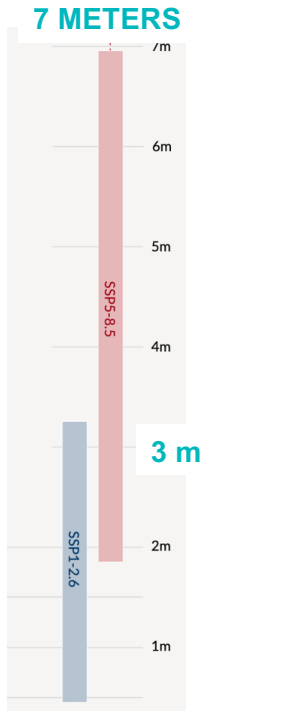
Rovere et al, 2015

Near Future Sea Level: Global

Global mean sea level change relative to 1900: IPCC Projections



2021 AR6 WR1 SPM

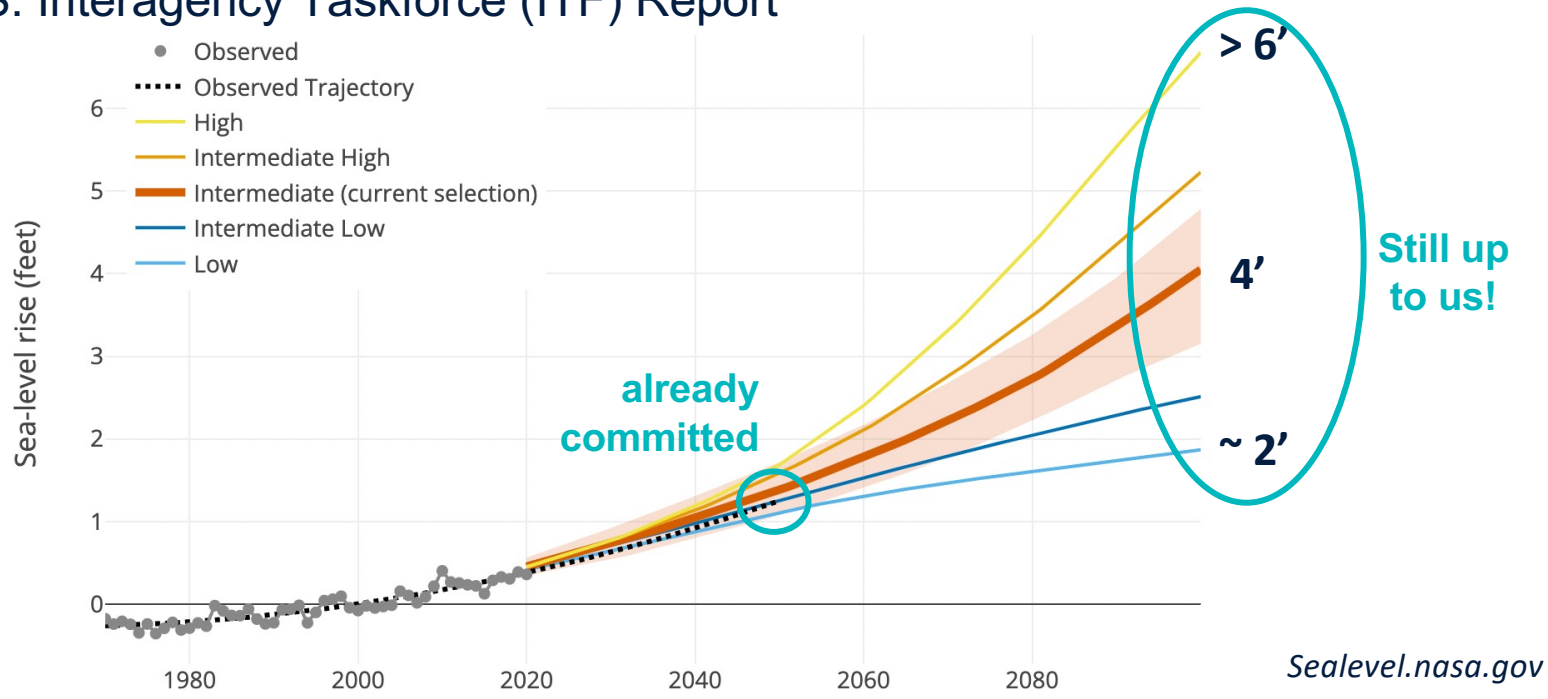


by 2300

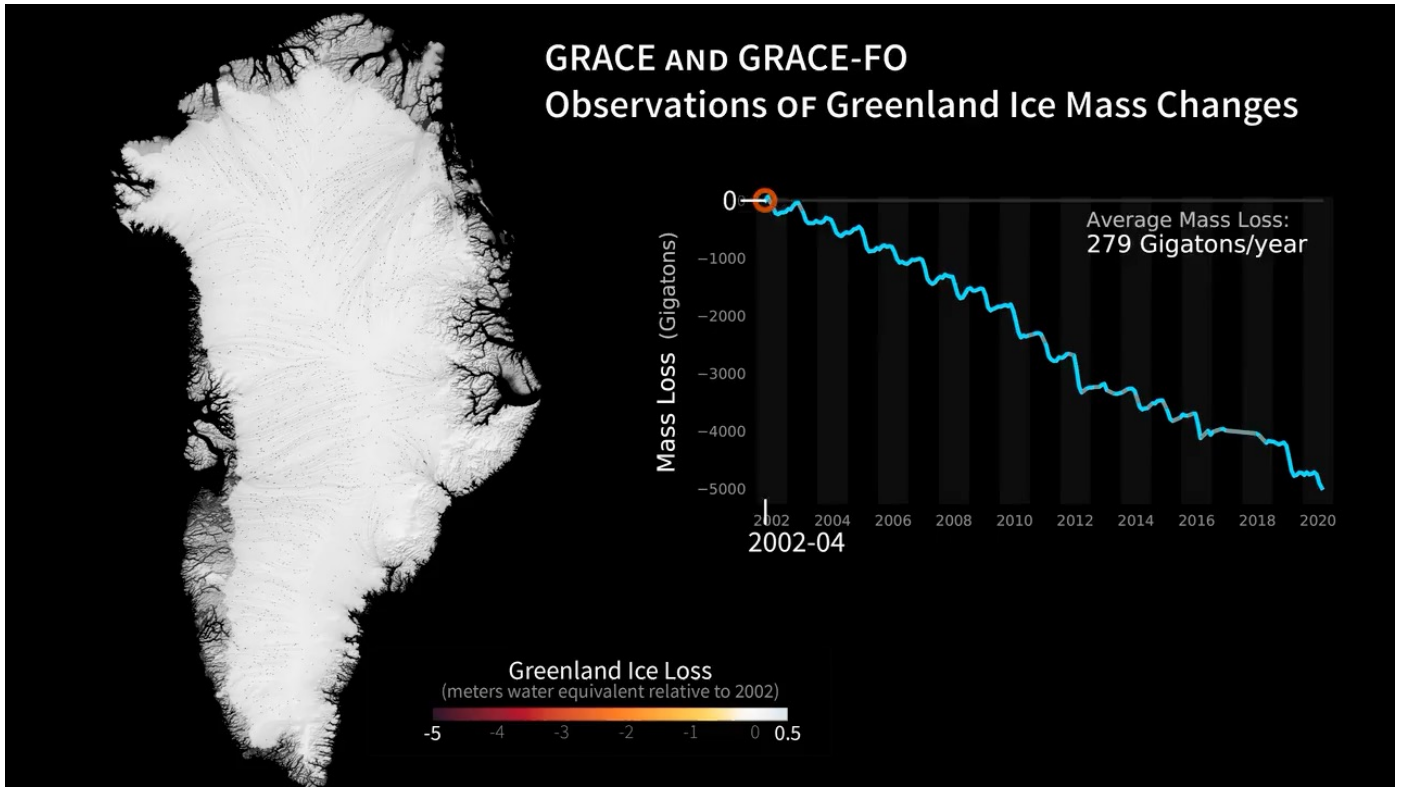
2021 AR6 WR1 SPM

Near Future Sea Level: Local (Nantucket)

Global mean sea level change relative to 2000:
2022 U.S. Interagency Taskforce (ITF) Report



Why such a spread?
Emissions, Temperature & those pesky ice sheets



NASA

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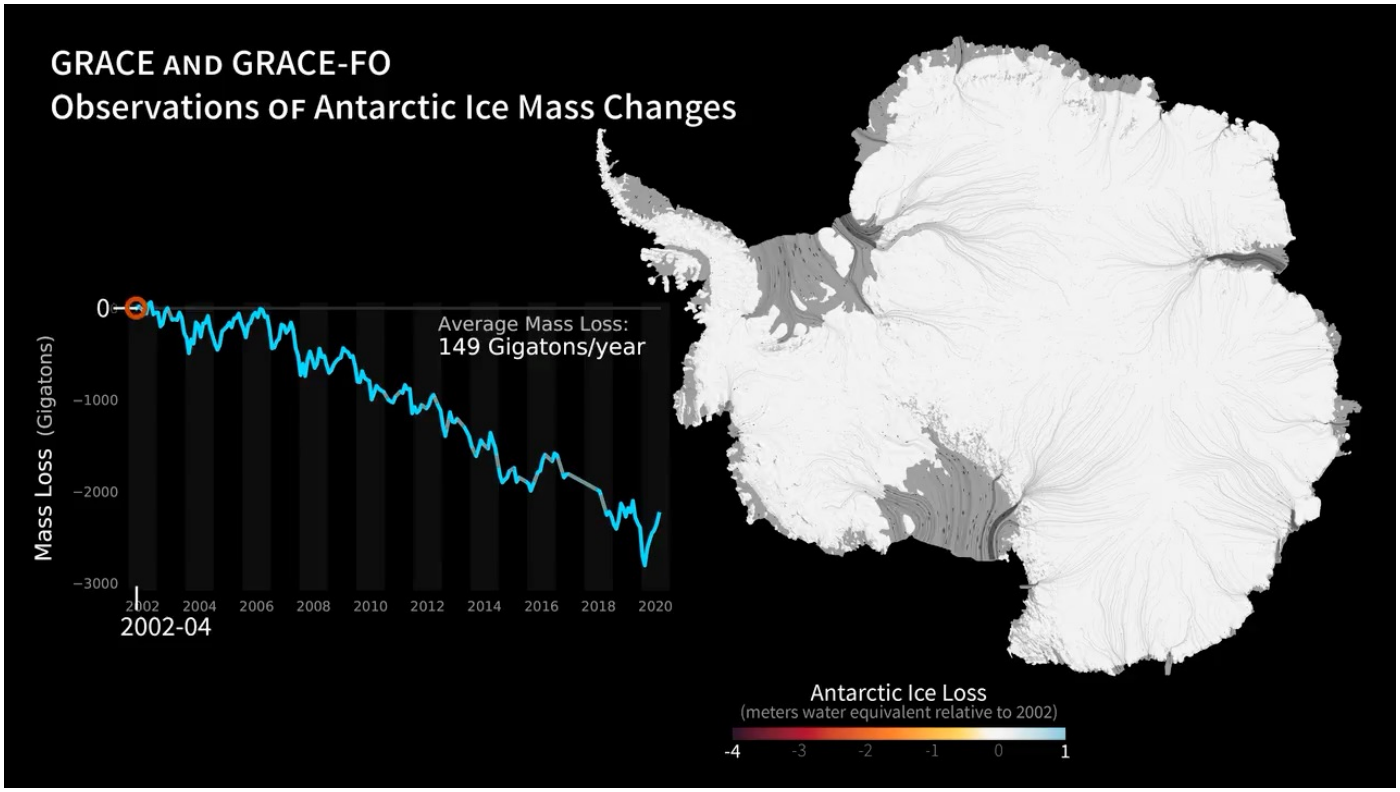


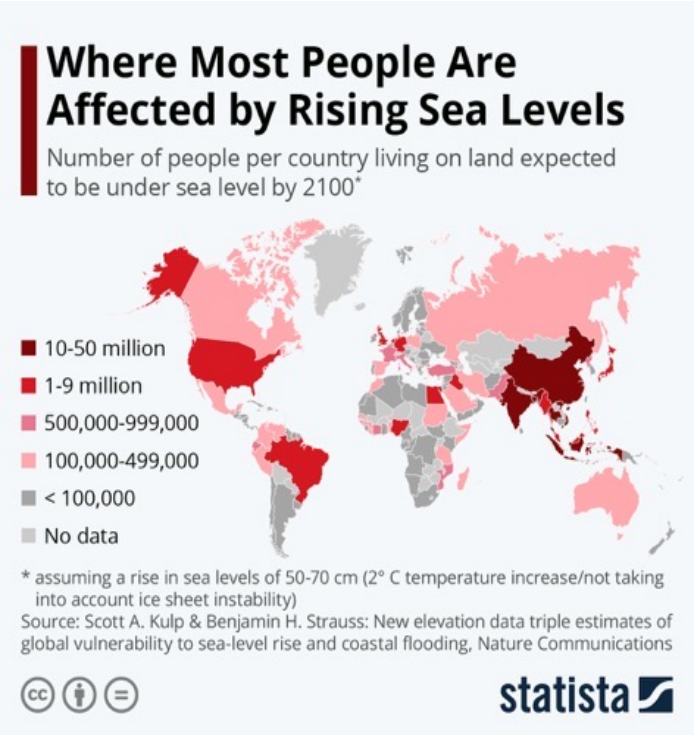
NASA

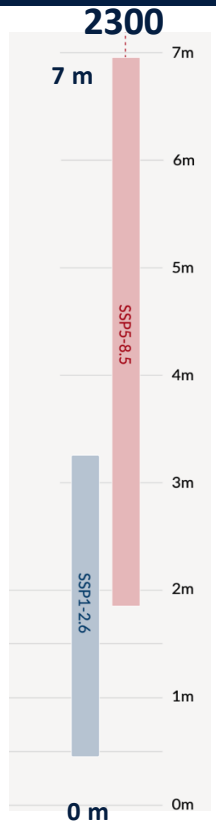
Coastal Inundation: A Looming Global Crisis

- **230 M people** live less than **1 m below current high tide lines**
- **190 M people** live below projected high tide lines for **2100 under low carbon emissions**
- **630 M people** live below projected high tide lines for **2100 under high carbon emissions**

Kulp & Strauss, 2019

2°C IN 2100 SCENARIO





2021 AR6 WR1 SPM

Coastal communities flood vulnerabilty: Extreme events

Golovin, Alaska,
Typhoon Merbok
Sept 2022
(NYT)

Boston, MA
Winter Storm Grayson,
January 2018
(Boston Globe)

Imperial Beach, CA
Winter Storm
Jan 2019
(LAT)

Pine Island, Florida
Hurricane Ian,
September, 2022
(Sky News)

Historic flood events in New England

The Great New England Hurricane (1938)

www.masshist.org

Bourne Bridge

Perfect Storm (1991)

coastalengineeringcompany.com

Easy Street Park, Nantucket

An increasing concern: recurring events

Annapolis, MD,
High-Tide Flooding
(Chesapeake Bay
Program)

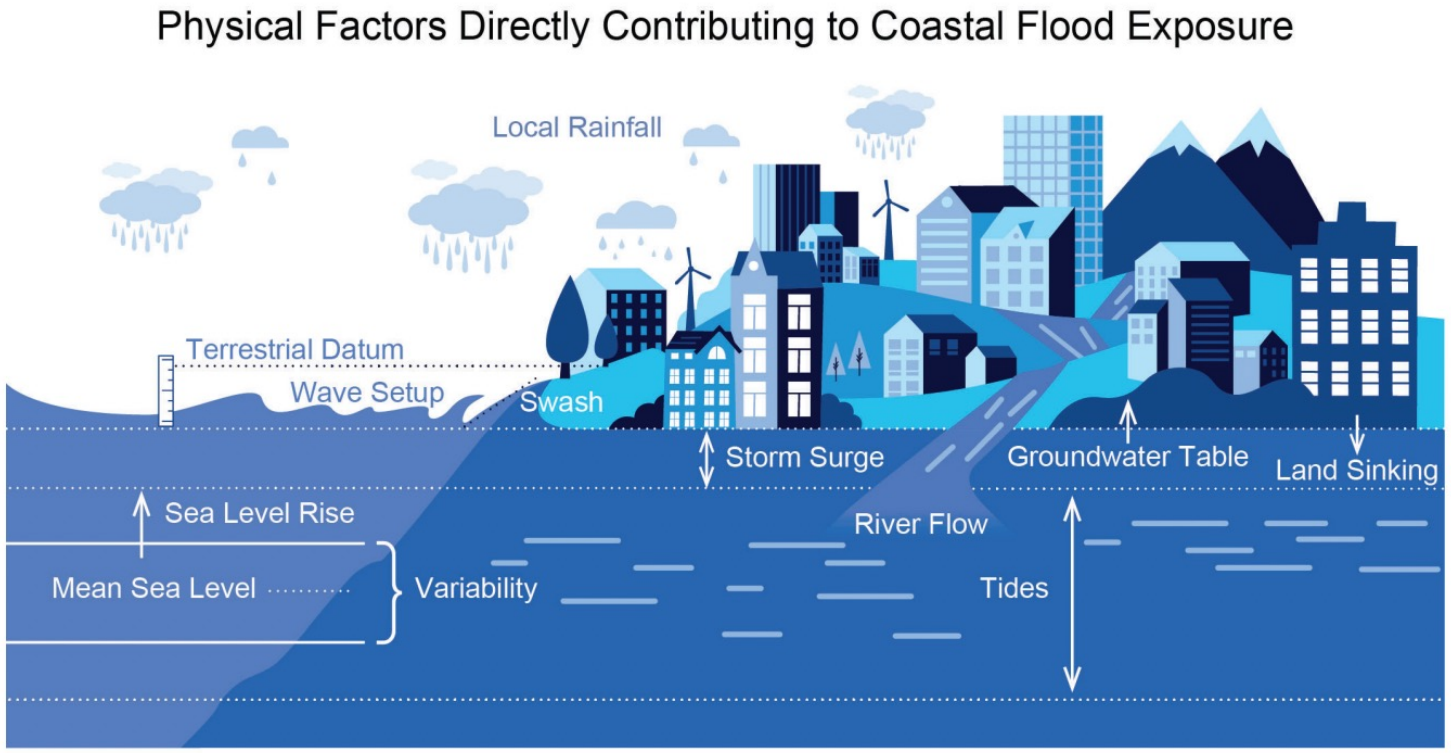
Morrisset Blvd, Boston,
High-Tide Flooding
(Streetsblog.org)

Newport Beach, CA
High-Tide Flooding
(NPR)

Miami Beach, Florida
High-Tide Flooding
(Getty)

High-Tide Flooding aka ‘nuisance’, ’sunny day’, or ‘king tide’ flooding

Contributions to Coastal Flood Exposure: Physical factors



https://oceanservice.noaa.gov/

Contributions to Coastal Flood Exposure: Human factors

ARTICLES
https://doi.org/10.1038/s41558-021-01265-6
nature climate change
Check for updates

OPEN

Inequitable patterns of US flood risk in the Anthropocene

Oliver E. J. Wing[1,2]✉, William Lehman[3], Paul D. Bates[1,2], Christopher C. Sampson[1], Niall Quinn[1], Andrew M. Smith[1], Jeffrey C. Neal[1,2], Jeremy R. Porter[4,5,6] and Carolyn Kousky[7]

NJ, Hurricane Sandy, 2012

- **26.4% increase in US flood risk by 2050** due to climate change alone under RCP4.5 (<2°)
- US estimates indicate current average **annual losses of US $32.1 billion**
- **Population change** could cause **flood risk increases** that **outweigh climate impact** **x4**
- Impacts borne **disproportionately by poorer communities**

Coastal Communities through Time: Nantucket

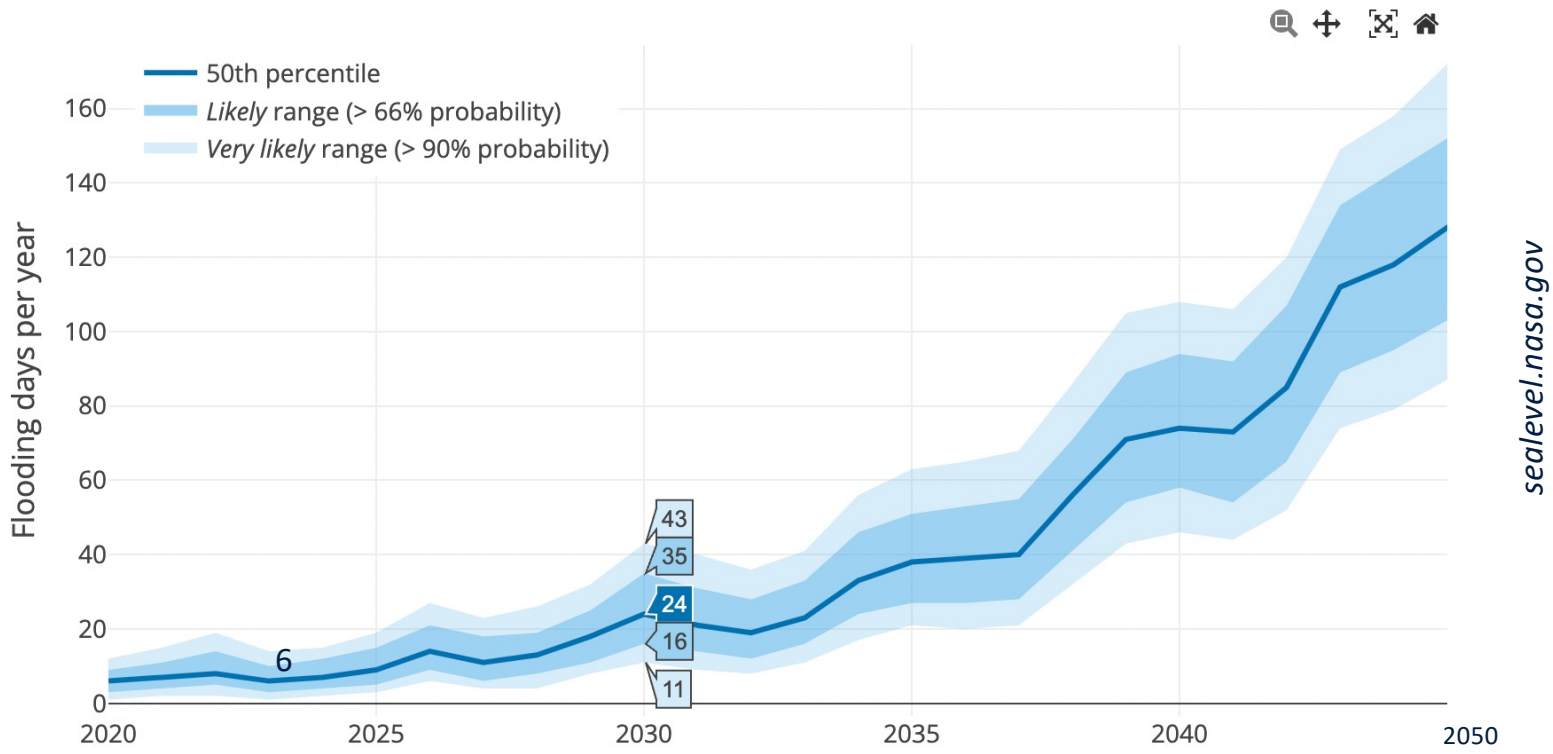
nha.org

www.gsd.harvard.edu

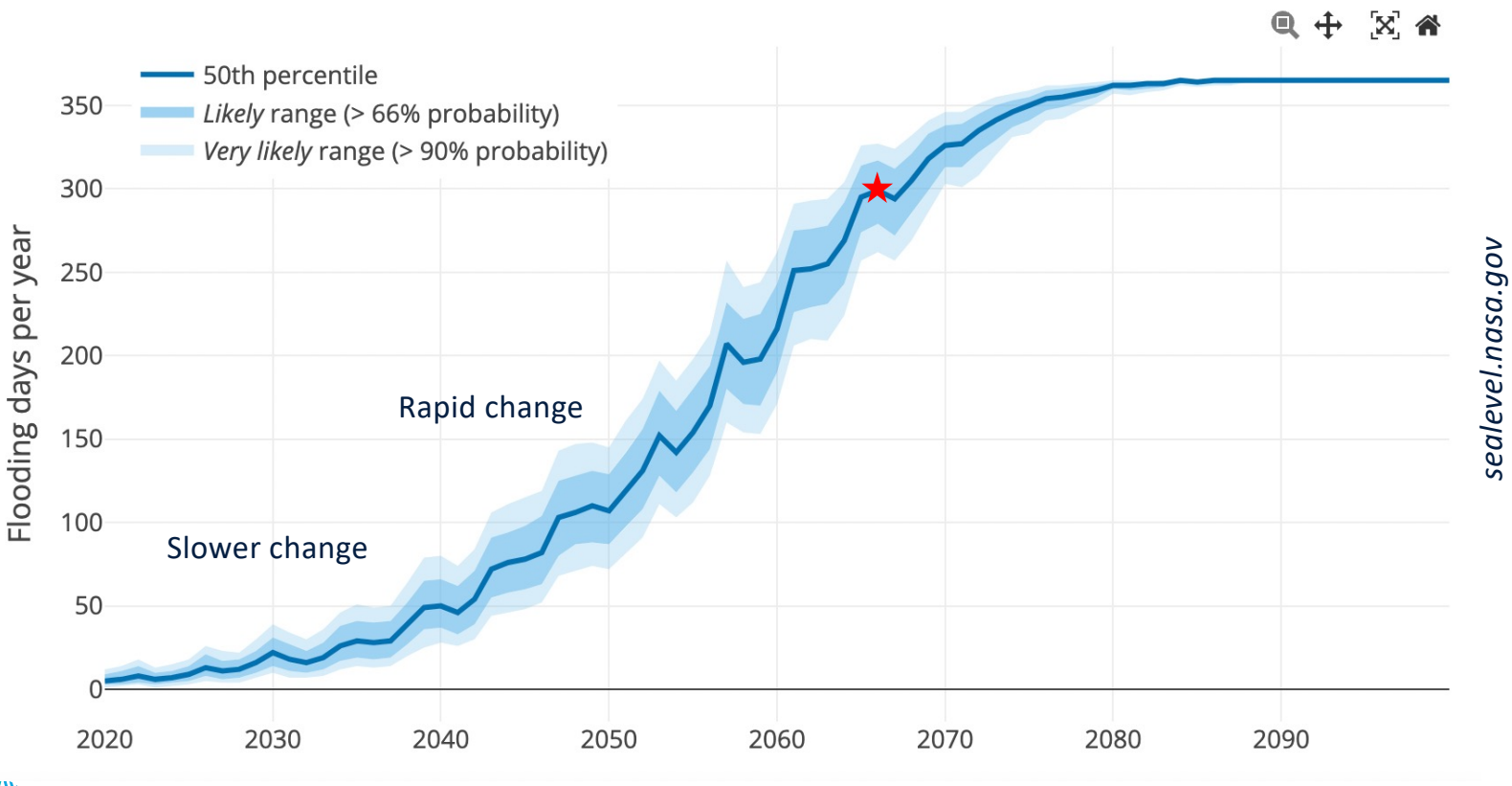
?

~ 10,000 years | 1600s | Today | Future

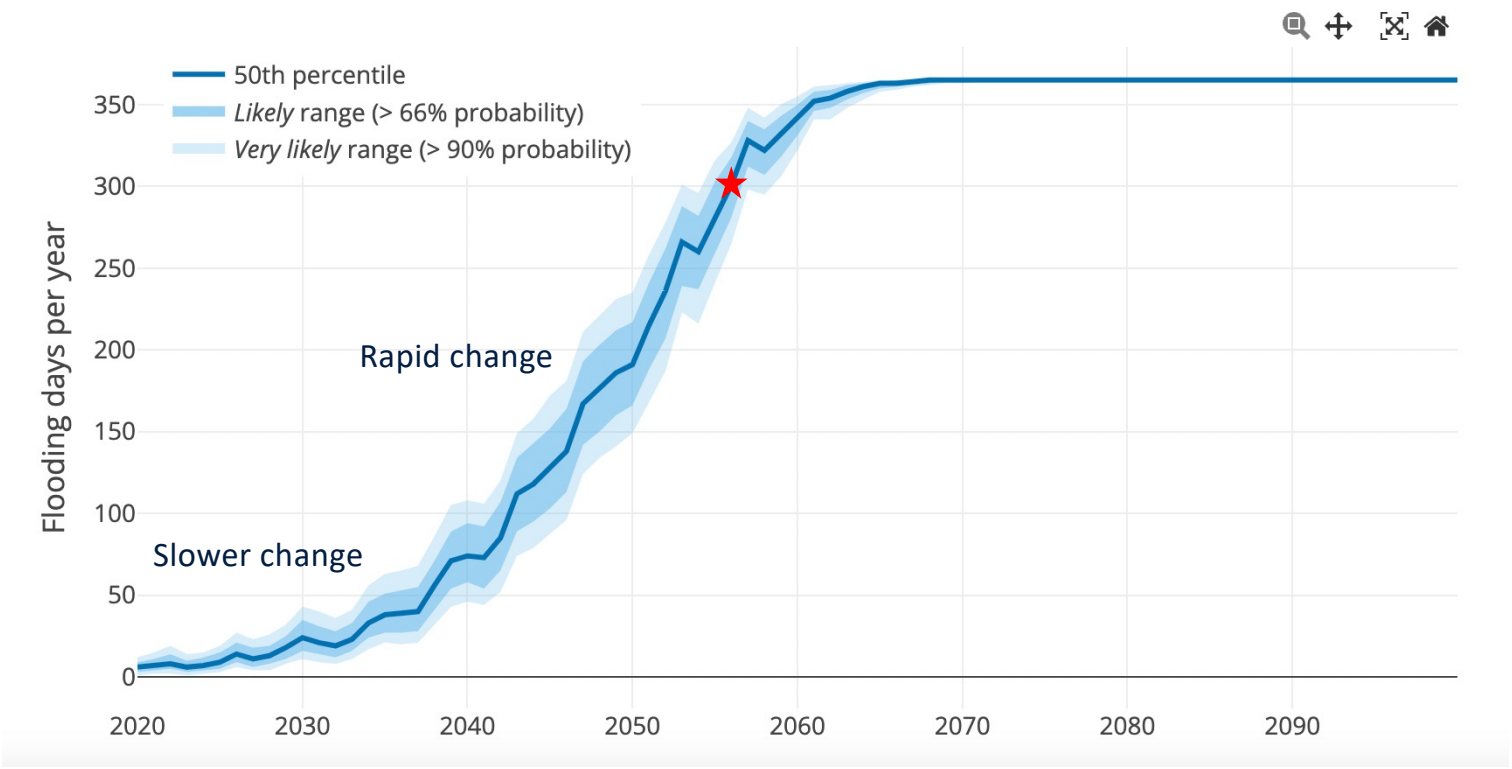
Nantucket Flooding Days Now (2023) vs 2030: Quadruple



Nantucket Flooding: ~2033 Inflection point (intermediate T scenario)

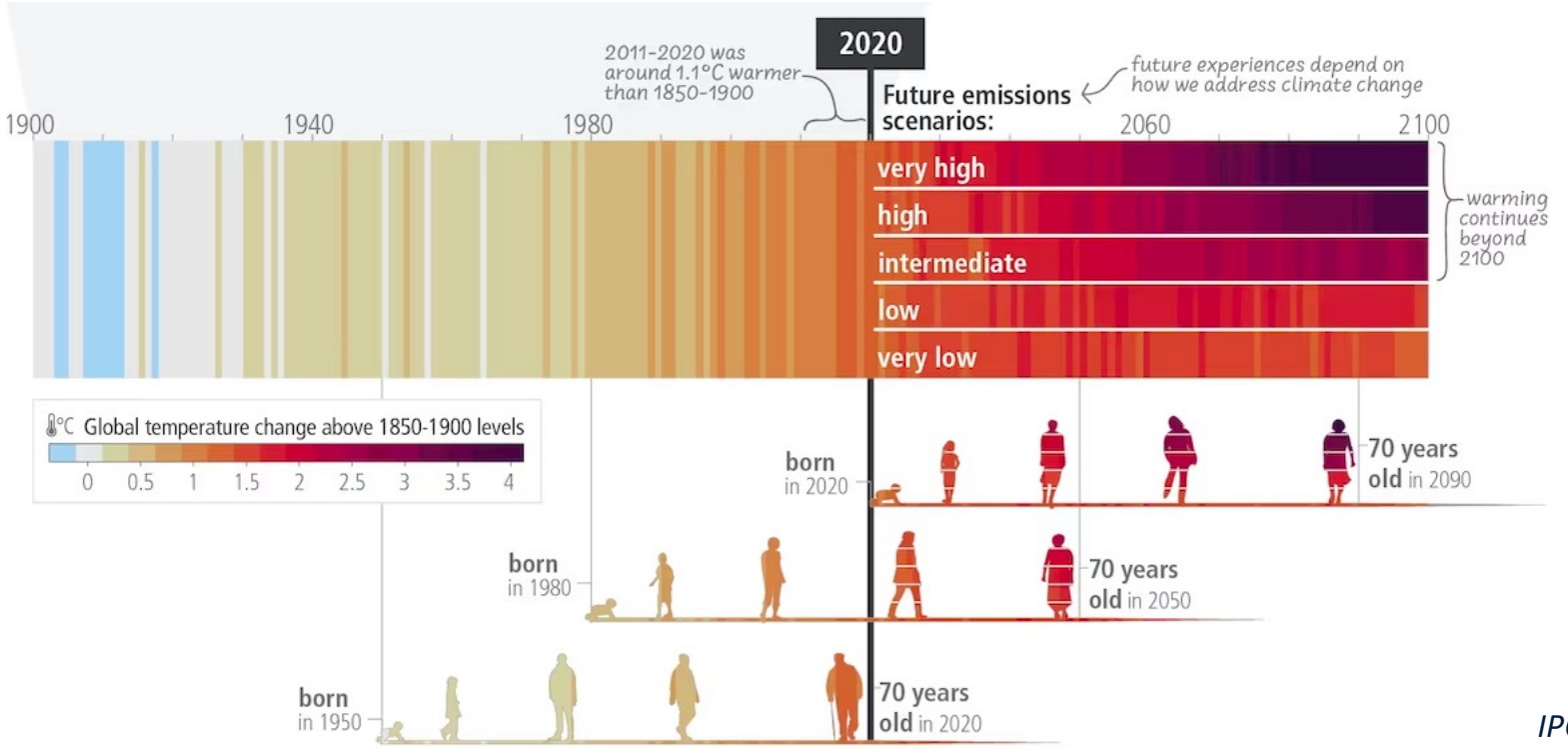


Nantucket Flooding: ~2033 Inflection point (high T scenario)



sealevel.nasa.gov

What's in a Decade?



IPCC

The Decisive Decade for Coastal Communities

• Sea level **is rising at accelerated rates as the ocean warms and ice sheets melt**. Relative sea level along the U.S. coast is expected to rise on average as much over the next 30 years (0.25–0.30 m over 2020–2050) as over the last 100 years (NOAA).

• Accelerating sea level rise is also creating **abrupt increases in flood risk** (frequency and magnitude), from both storms and increasingly tides alone, with an inflection point projected in the early 2030s.

• Up until now, many coastal communities could get by with 'business as usual' planning, and/or reactive (vs proactive) response to disasters. This will become increasingly untenable and/or unaffordable through each decade of the 21st century.

• Many infrastructure decisions and land use regulations last for decades or longer, thus decisions made this decade are the landscape upon which the coming century of sea level rise and increased flood risk will fall.

• Sea level trajectories through ~2050 (~ 1') are relatively well constrained, as this shorter timeframe is less sensitive to future GHG emissions pathways. About 2' of SLR along U.S. coastline through 2100 is also 'baked in' from emissions to date

• **Post-2050** sea level rise scenarios (i.e. will Nantucket be on the path towards 2' or 6' of SLR by 2100?) are **highly sensitive to emissions decisions and actions** at the national and international level this decade.

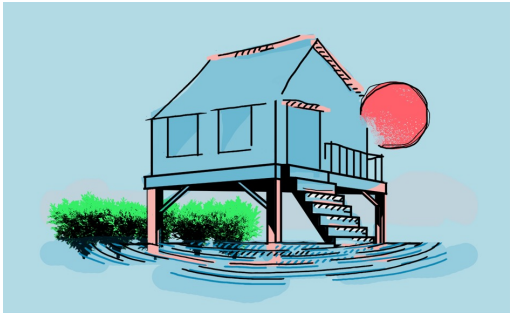
WE are the solution to coastal resiliency

www.rutgers.edu

coastalengineeringcompany.com

Individual

CityLab



Community

www.hsph.harvard.edu

National & Global