Sea level rise update for Puget Sound

Bainbridge Island Environmental Conference
March 29, 2026

Sydney Fishman
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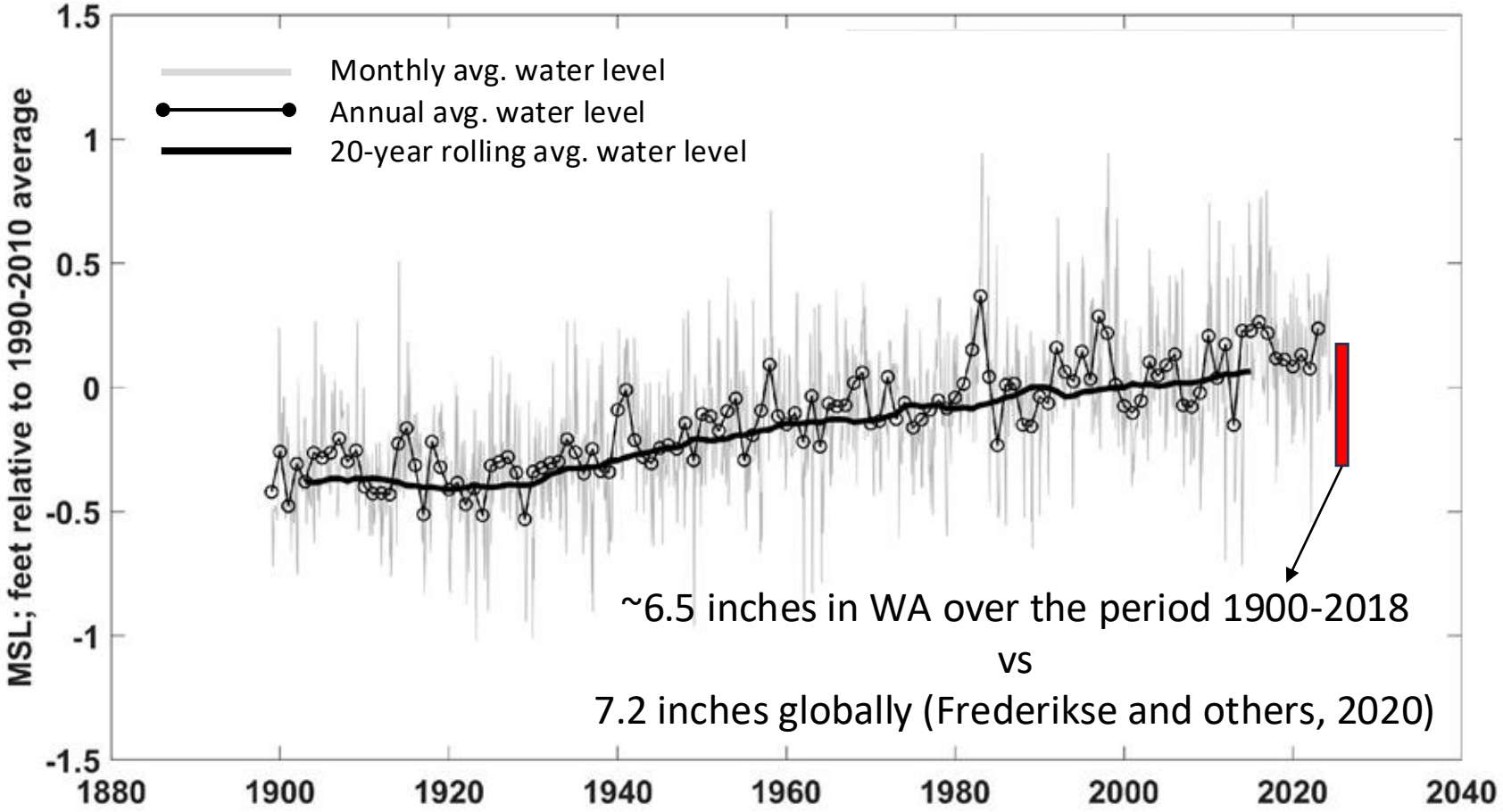
Sea Grant WASHINGTON

Outline and key takeaways

- Sea level is rising in Puget Sound
- Sea level rise is a hazard exacerbator
- Impacts are emerging
- New projections are available
- What do we do with this information?

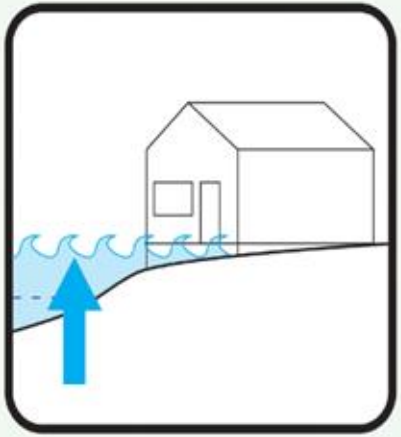
Sea level is rising here in Washington


Monthly avg. water level
Annual avg. water level
20-year rolling avg. water level
MSL; feet relative to 1990-2010 average
1.5
1
0.5
0
-0.5
-1
-1.5
1880
1900
1920
1940
1960
1980
2000
2020
2040
~6.5 inches in WA over the period 1900-2018
vs
7.2 inches globally (Frederikse and others, 2020)

Sea Level Rise is a hazard exacerbator

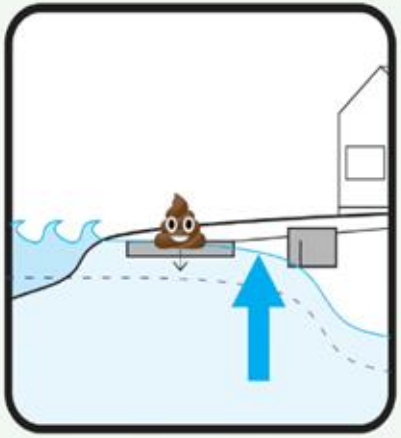
Gig Harbor, 27 December 2022

Sea Level Rise Impacts



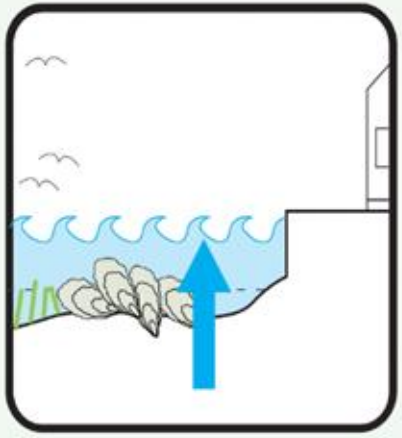
Coastal Flooding

Higher tides move storm surge higher and further inland. Extreme events will be more frequent; 100-year floods could become 10-year floods.



Salinity Change

Higher sea levels cause higher groundwater levels. This increase in salinity harms wells, septic systems and vegetation, which reduces soil stability and water quality.



Habitat Loss

Rising seas reduce the size of mudflats, marshes and intertidal habitats. If there is no upland area available for migration, these habitats will be lost as sea level rise.

Erosion and Deposition

Higher waters move shoreline materials and sediments. Depending on shoreline conditions, this causes land to erode or grow.

Impacts are already emerging

Gig Harbor, 27 December 2022

Relative Sea Level Trends

The sea level trends measured by tide gauges that are presented here are local relative sea level (RSL) trends as opposed to the global sea level trend. Tide gauge measurements are made with respect to a local fixed reference on land. RSL is a combination of the sea level rise and the local vertical land motion. The global sea level trend has been recorded by satellite altimeters since 1992 and the latest global trend can be obtained from NOAA's Laboratory for Satellite Altimetry, with maps of the regional variation in the trend. The University of Colorado's Sea Level Research Group compares global sea level rates calculated by different research organizations and discusses some of the issues involved.

East Coast | West Coast | Gulf Coast | Alaska | Hawaii | Global

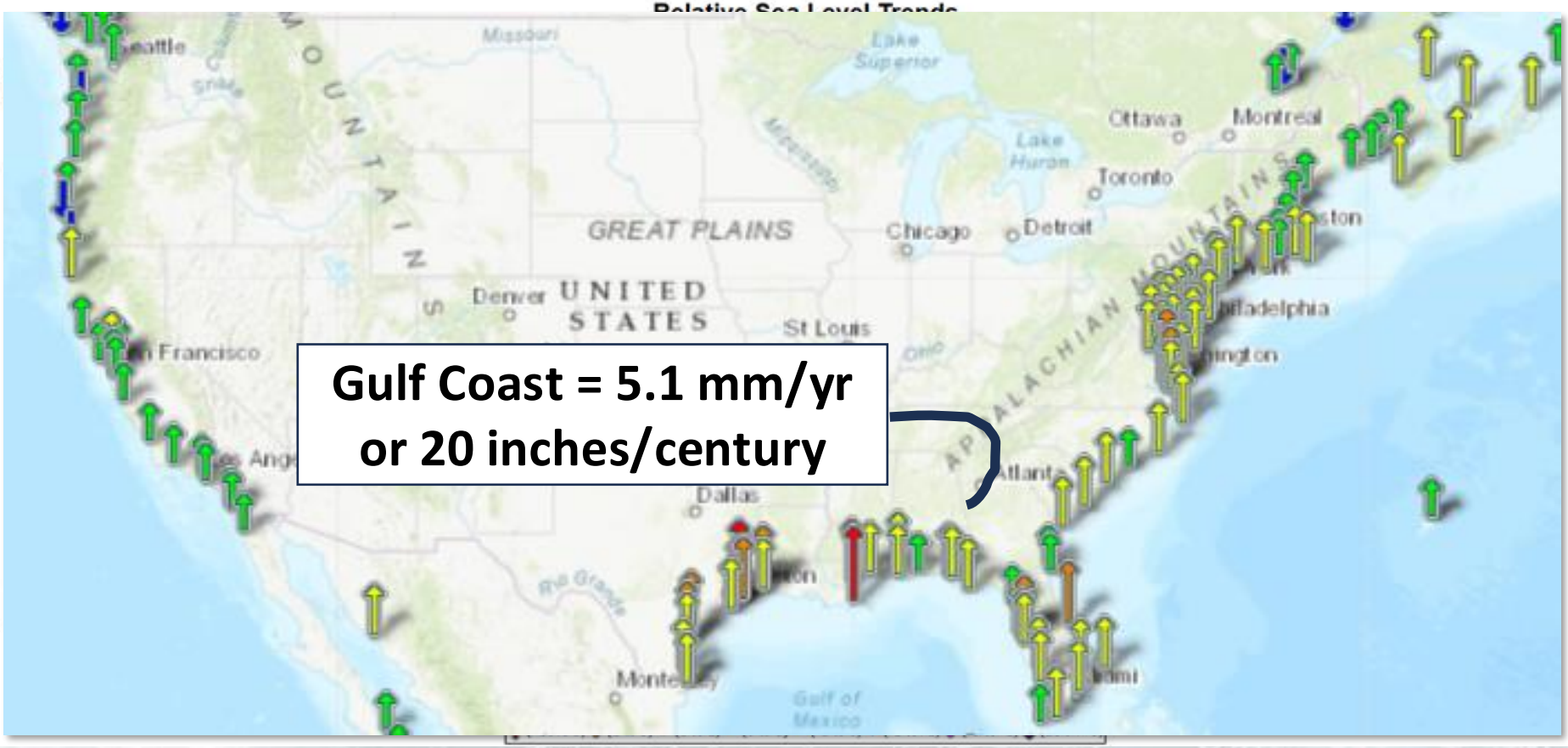
The map above illustrates relative sea level trends , with arrows representing the direction and magnitude of change. Click on an arrow to access additional information about that station.

Relative Sea Level Trends

mm/yr (feet/century)

Above 9 (Above 3)	6 to 9 (2 to 3)	3 to 6 (1 to 2)	>0 to 3 (0 to 1)	-3 to 0 (-1 to 0)	-6 to -3 (-2 to -1)	-9 to -6 (-3 to -2)	Below -9 (Below -3)

https://tidesandcurrents.noaa.gov/sltrends/



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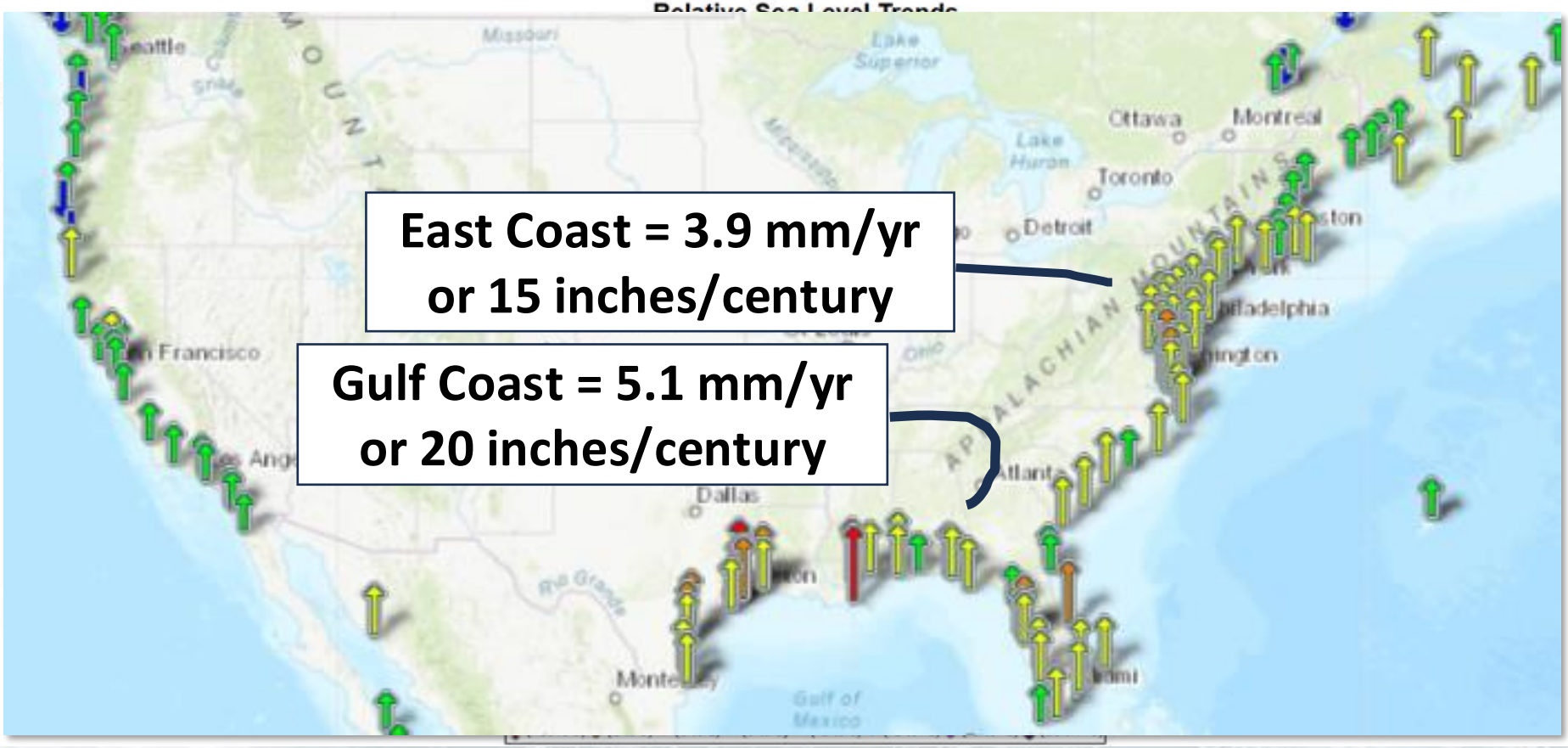

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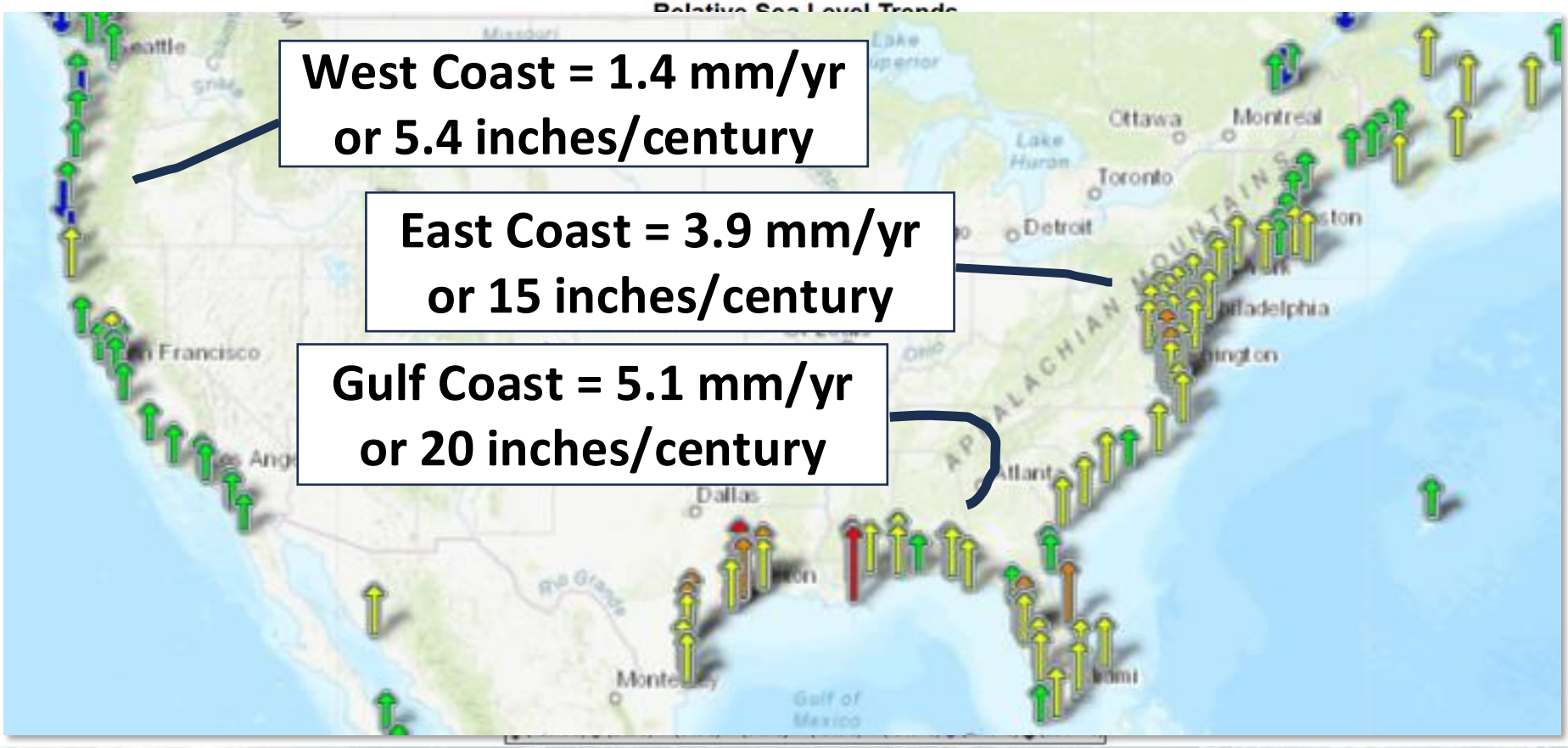

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But SLR impacts are not created equally

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Sea-level rise exponentially increases coastal flood frequency

Mohsen Taherkhani[1], Sean Vitousek[1,2*], Patrick L. Barnard[2], Neil Frazer[3], Tiffany R. Anderson[3] & Charles H. Fletcher[3]

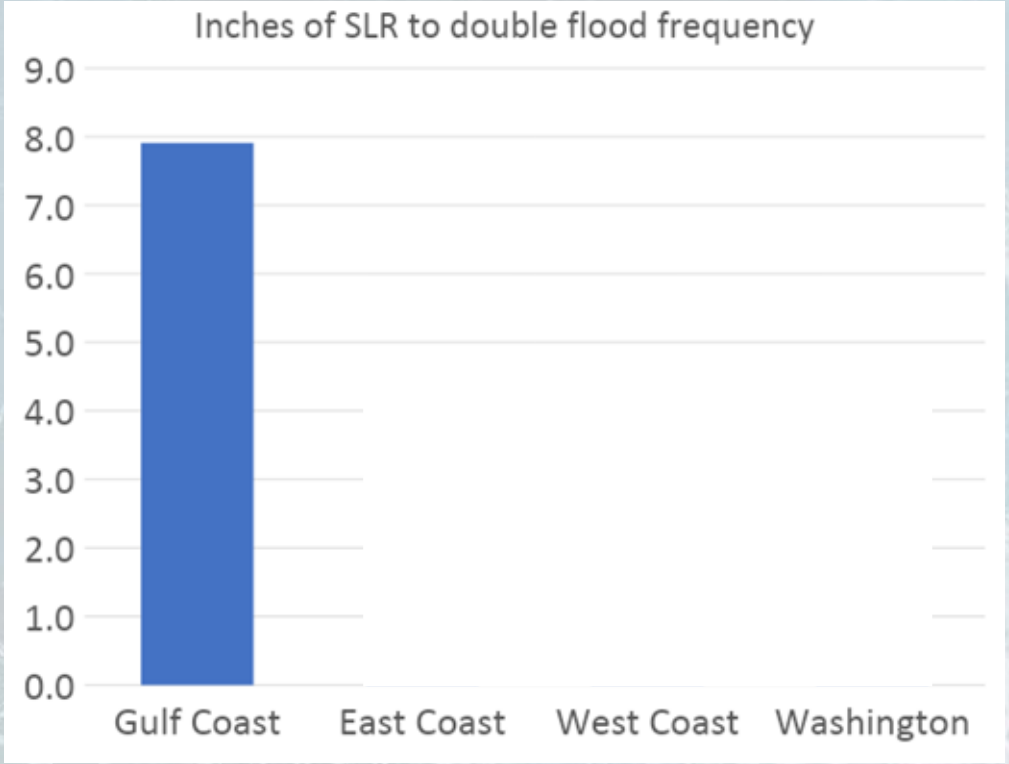
Sea-level rise will radically redefine the coastline of the 21st century. For many coastal regions, projections of global sea-level rise by the year 2100 (e.g., 0.5–2 meters) are comparable in magnitude to today's extreme but short-lived increases in water level due to storms. Thus, the 21st century will see significant changes to coastal flooding regimes (where present-day, extreme-but-rare events become common), which poses a major risk to the safety and sustainability of coastal communities worldwide. So far, estimates of future coastal flooding frequency focus on endpoint scenarios, such as the increase in flooding by 2050 or 2100. Here, we investigate the continuous shift in coastal flooding regimes by quantifying continuous rates of increase in the occurrence of extreme water-level events due to sea-level rise. We find that the odds of exceeding critical water-level thresholds increases exponentially with sea-level rise, meaning that fixed amounts of sea-level rise of only ~1–10 cm in areas with a narrow range of present-day extreme water levels can double the odds of flooding. Combining these growth rates with established sea-level rise projections, we find that the odds of extreme flooding double approximately every 5 years into the future. Further, we find that the present-day 50-year extreme water level (i.e., 2% annual chance of exceedance, based on historical records) will be exceeded annually before 2050 for most (i.e., 70%) of the coastal regions in the United States. Looking even farther into the future, the present-day 50-year extreme water level will be exceeded almost every day during peak tide (i.e., daily mean higher high water) before the end of the 21st century for 90% of the U.S. coast. Our findings underscore the need for immediate planning and adaptation to mitigate the societal impacts of future flooding.

Sea-level rise is slow, yet consequential[1] and accelerating[2]. Upper-end sea-level rise scenarios could displace hundreds of millions of people by the end of the 21st century[3]. However, even small amounts of sea-level rise can disproportionately increase coastal flood frequency[4,5]. A multitude of oceanic processes affect both mean and extreme water levels, such as the tide, tropical and extratropical storms, climatic cycles (e.g., El Niño/Southern Oscillation), oceanic eddies, and circulation patterns[6–11]. Hence, the frequency and severity of coastal flooding varies on a multitude of time scales. Yet, the persistent trend and acceleration of sea-level rise have a profound interaction with transient extreme events[12]. In theory, sea-level rise progressively increases the frequency and severity of flooding[2]. In practice, the monotonic increase in flooding, driven by elevating long-term mean sea level, is often overshadowed by interannual variability in extreme events[13], which will likely continue through the middle of the 21st century[14].

Many have quantified future increases in potential coastal flood frequency by deriving 'multiplying factors'[15], 'amplification factors'[16], or 'factors of increase'[5] in exceedance probability or, equivalently, reductions in return period of extreme water-level events due to sea-level rise by 2050 or 2100[4,5,17,18]. Large-scale studies of future 'flooding' typically investigate potential increases in the water-level hazard in the absence of site-specific exposure (as is the case in the current paper as discussed below in Application). The reported factors of increase in flood hazard potential are often exceedingly large, ranging from 10 to 1000 for even modest sea-level rise scenarios of 0.5 m or less. Yet, focusing on SLR scenarios and their impacts by 2050 or 2100 is perhaps inappropriate, given that significant changes in coastal flooding have been observed in recent years[19,20] and are expected to change dramatically in the coming decades[5,21–23], and planning horizons rarely exceed thirty years. While the incremental (e.g., 'stair-cased') factors of increase are staggering, they do not effectively illuminate the continuous,

https://www.nature.com/articles/s41598-020-62188-4

"How much sea level rise will double the odds of a "50-year" extreme coastal water level?"



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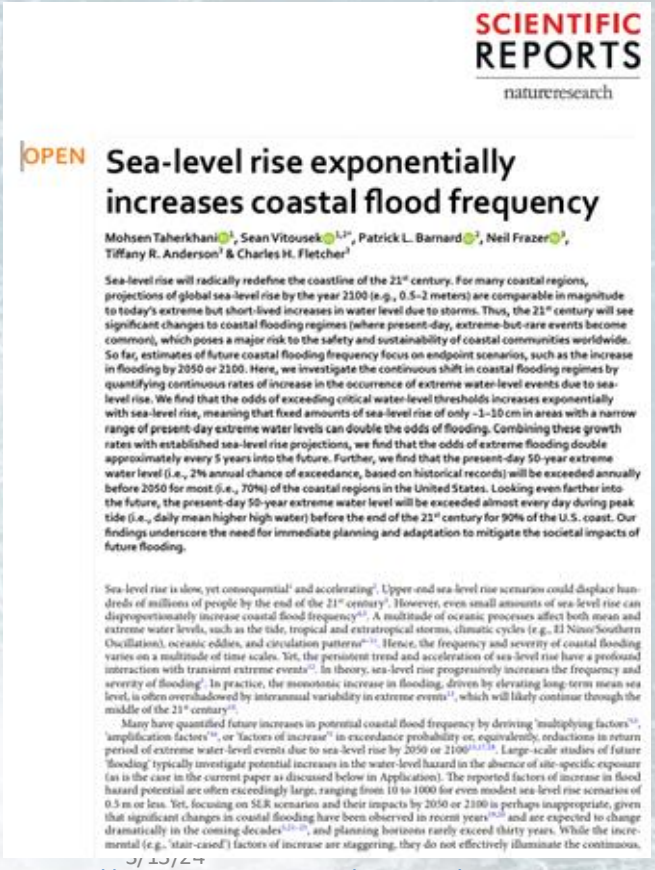

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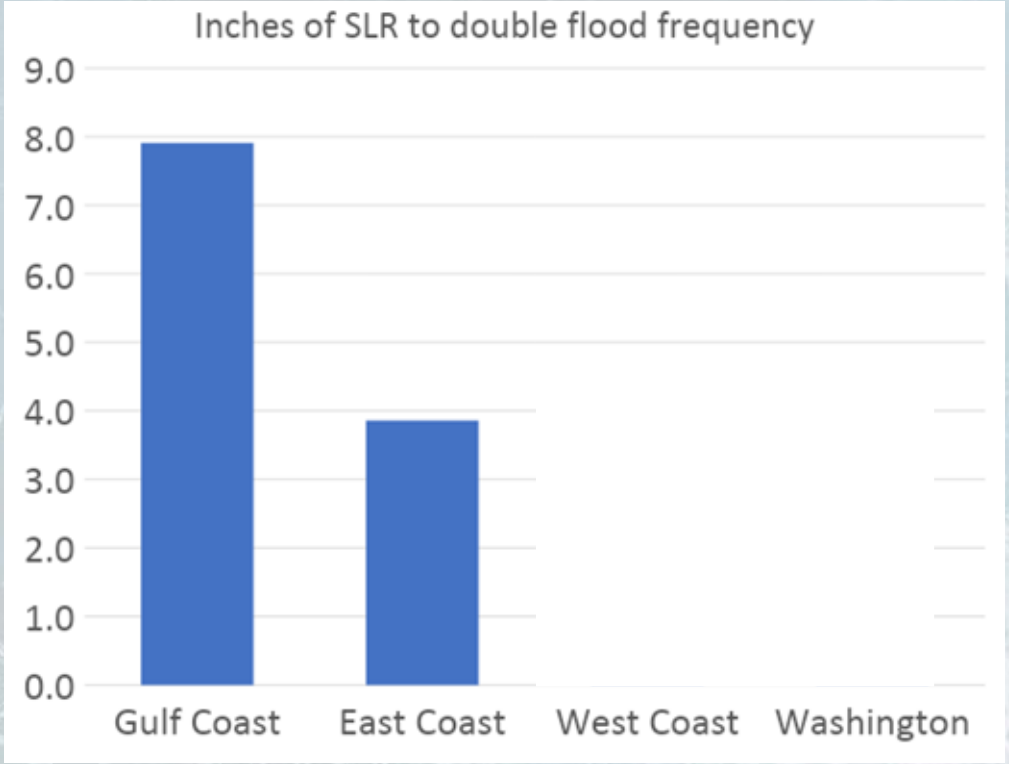

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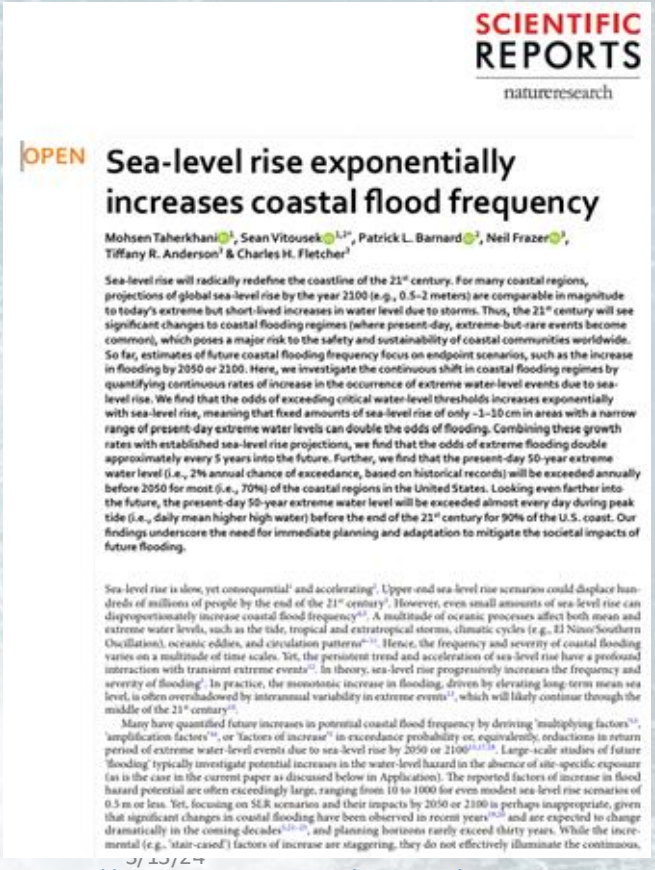

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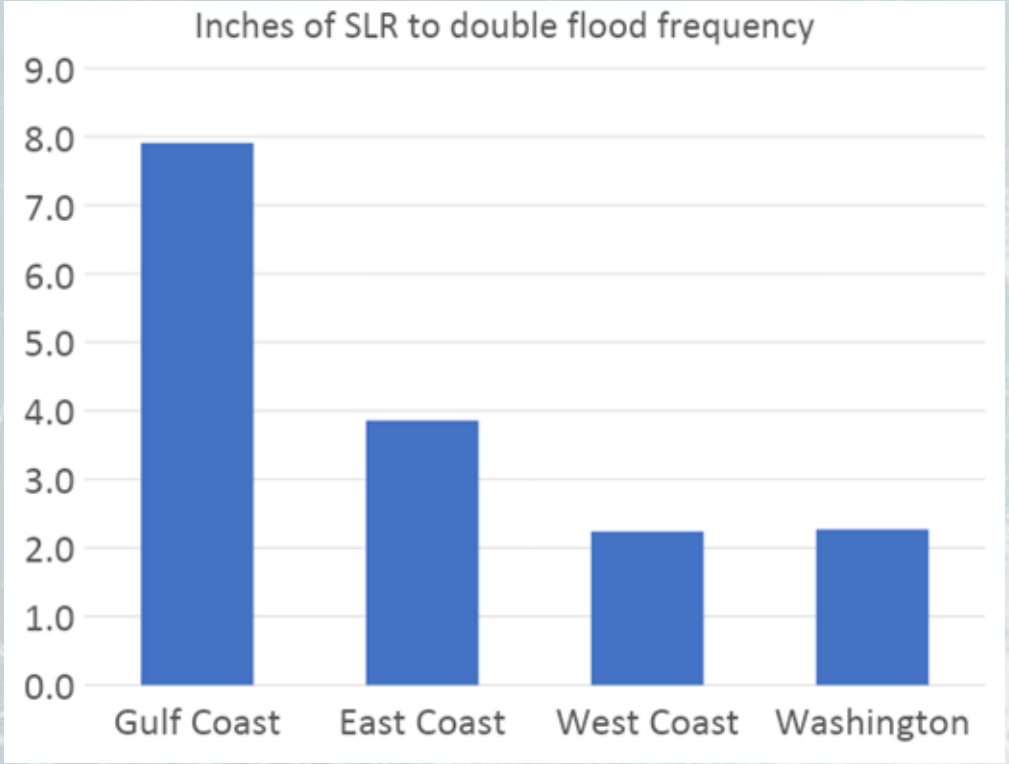
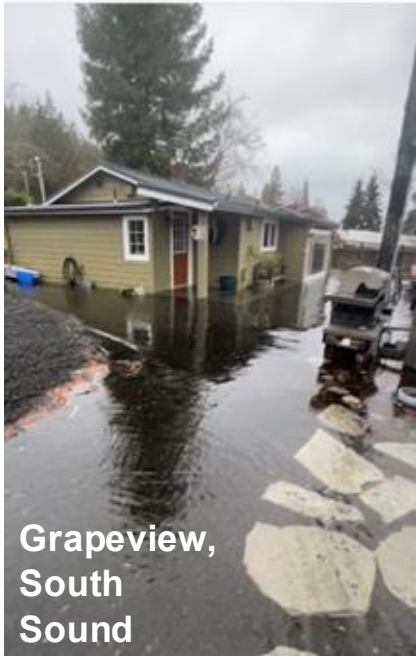
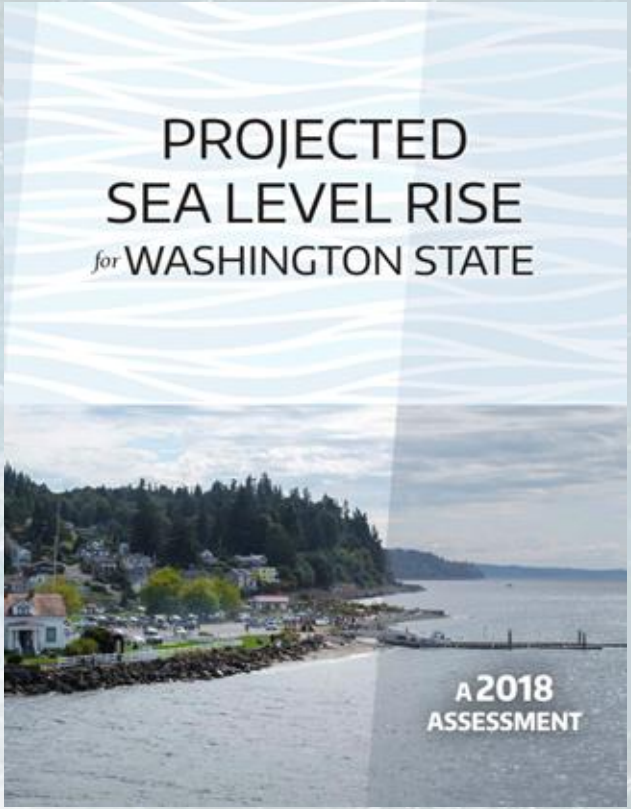


A few inches of sea level rise…

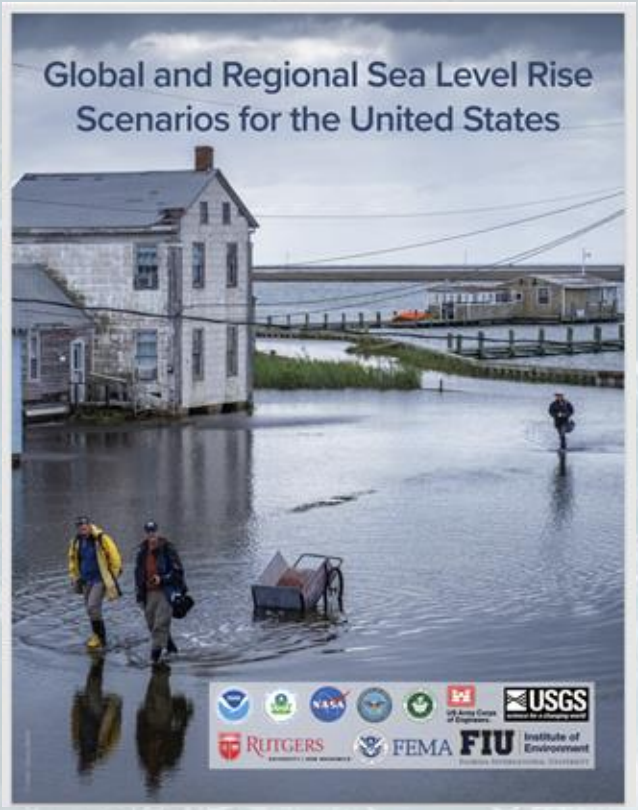


https://coastnerd.blogspot.com/2023/12/december-27th-2022-did-sea-level-rise.html

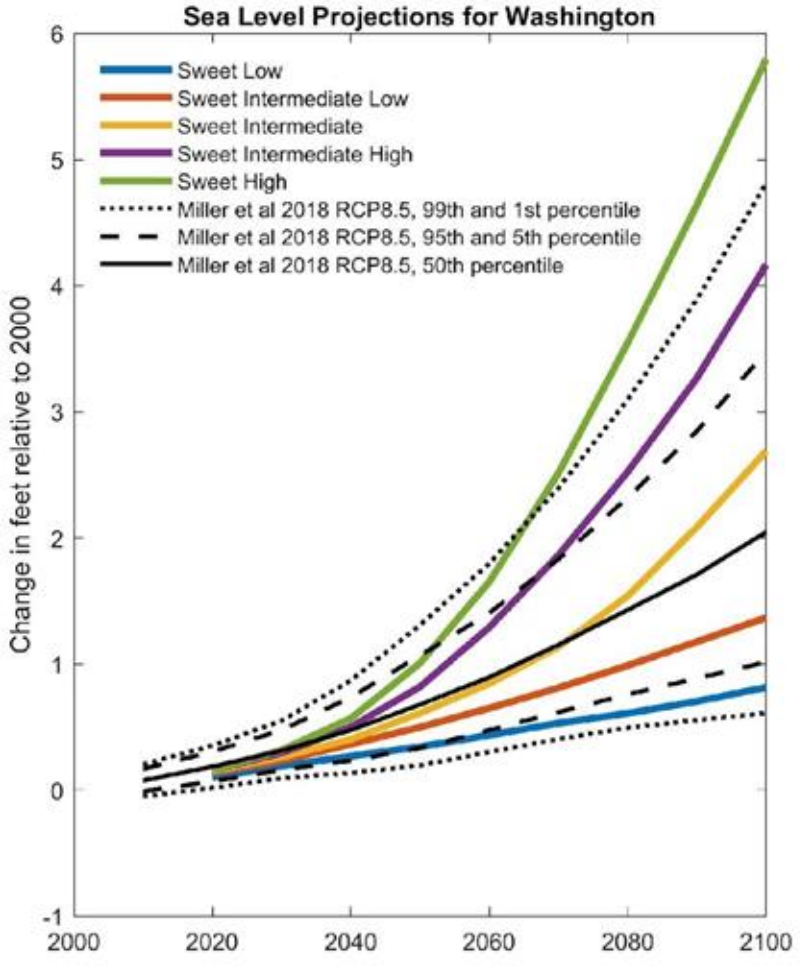
New projections are available



2018

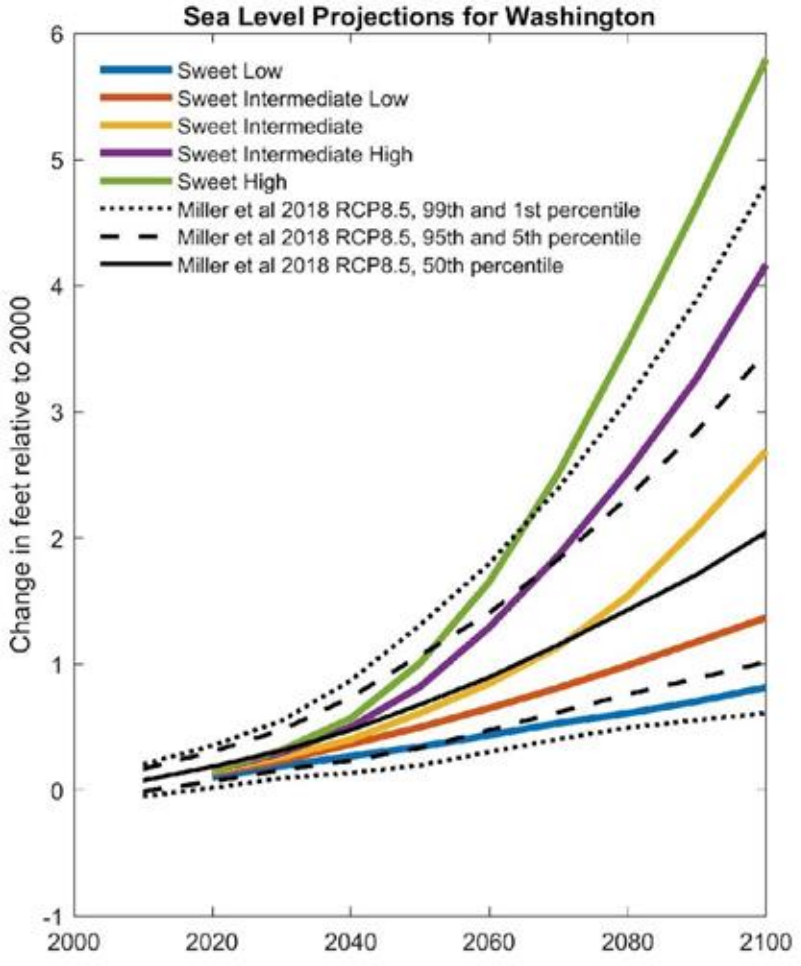


2022



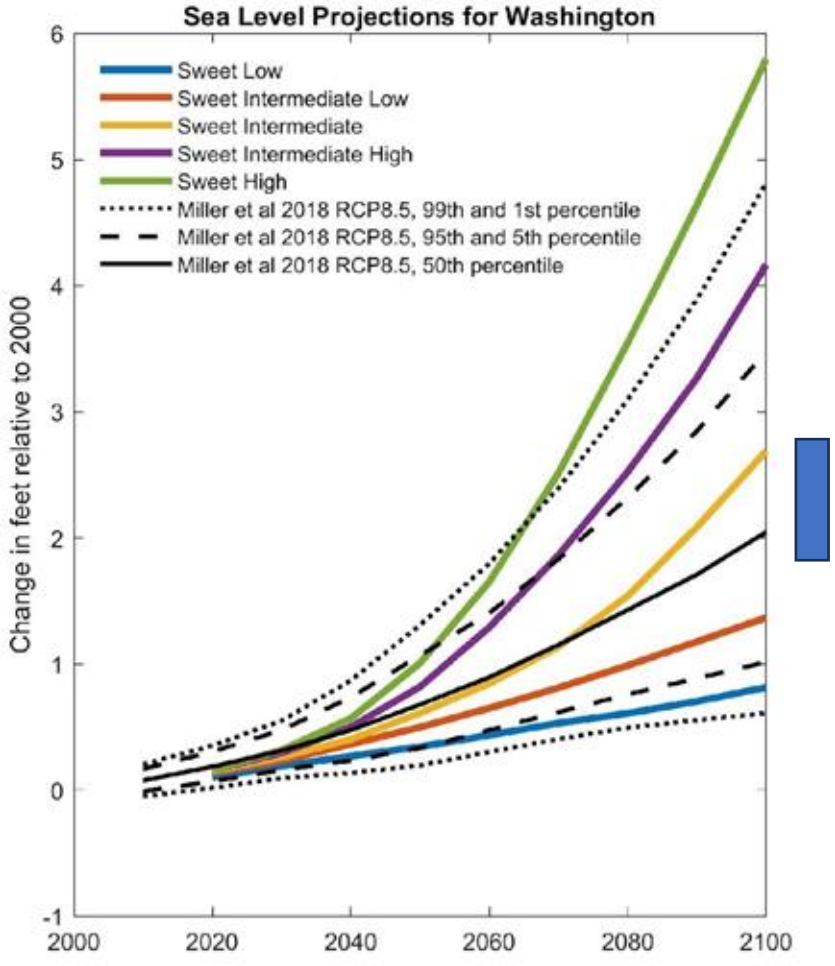
There are some important differences

1. Scenarios vs. probabilistic framing
2. Acceleration in sea level rise pushed towards the end of the century
3. Reduced mid-century uncertainty



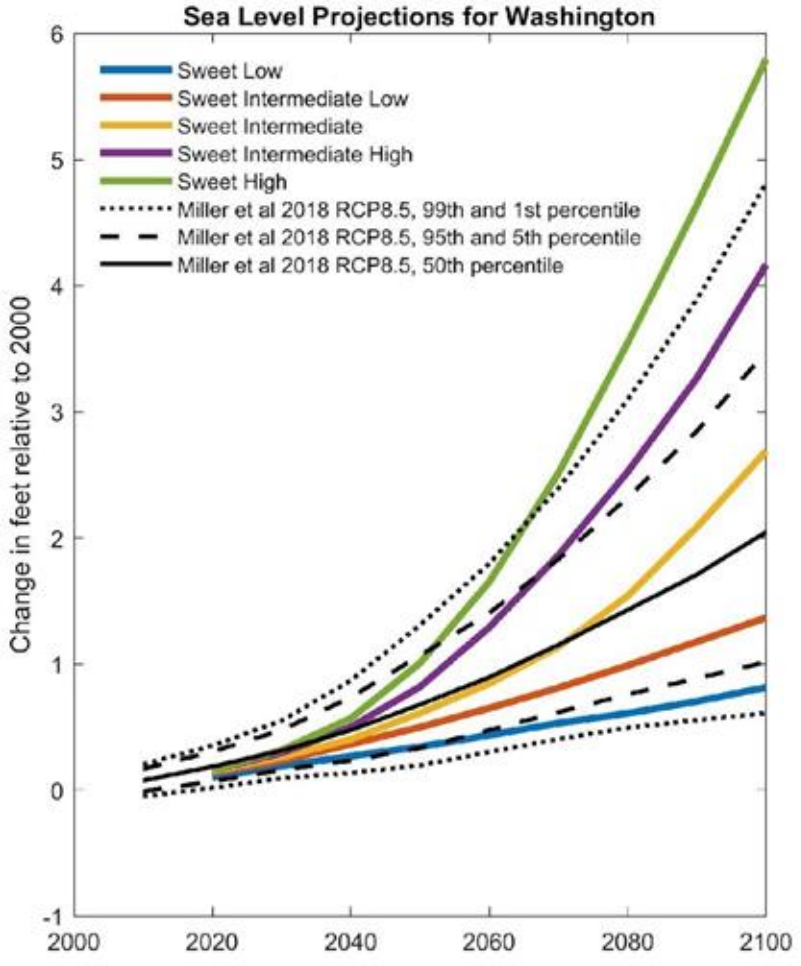
Minor variations on a theme

1. Sea level is almost certain to continue to rise, and very likely will accelerate



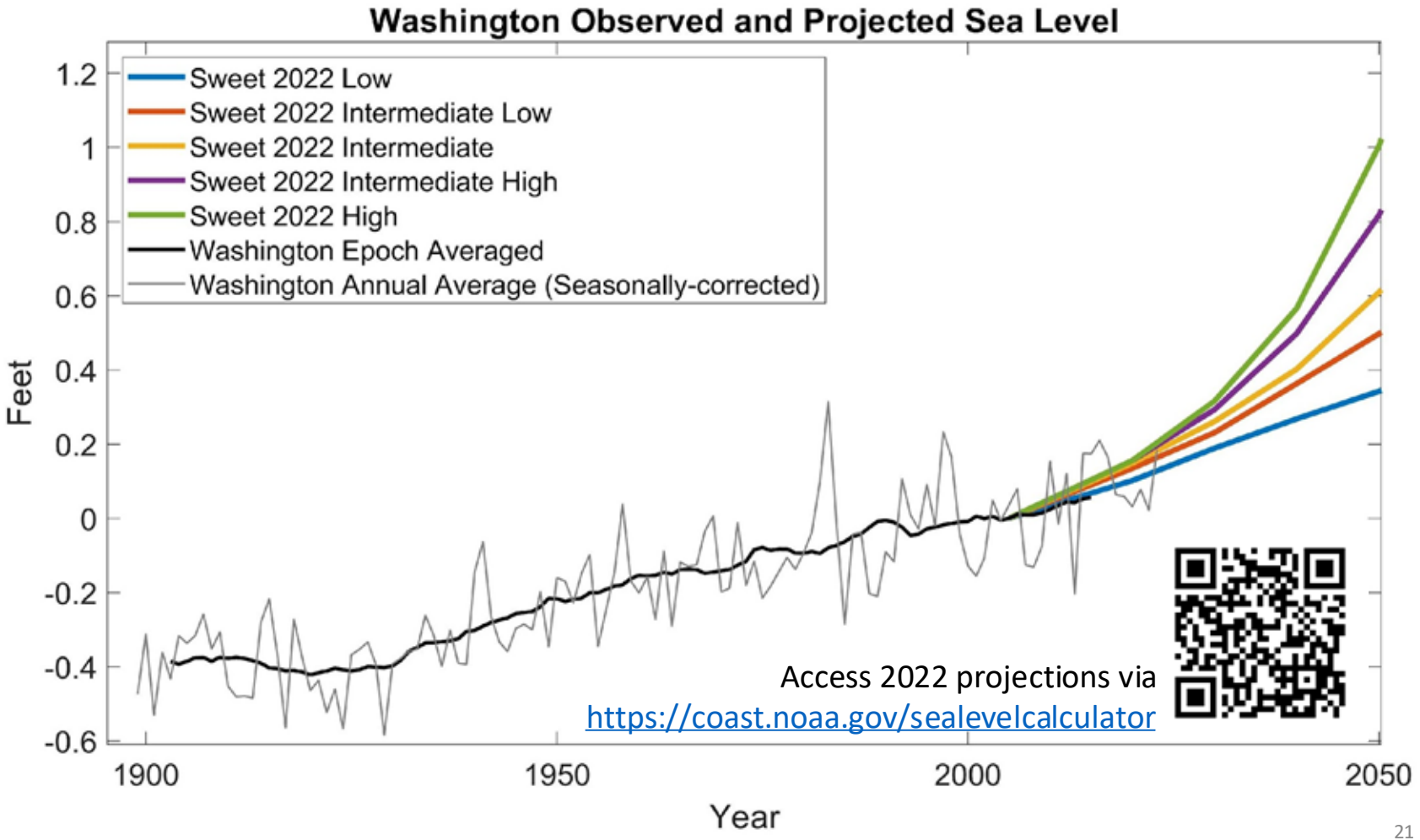
Minor variations on a theme

1. Sea level is almost certain to continue to rise, and very likely will accelerate
2. Most likely assessed outcomes continue to be in the 2ish feet by 2100 zone



Minor variations on a theme

1. Sea level is almost certain to continue to rise, and very likely will accelerate
2. Most likely assessed outcomes continue to be in the 2ish feet by 2100 zone
3. Emissions reduction dramatically reduces the likelihood of high magnitude outcomes


Washington Observed and Projected Sea Level
Sweet 2022 Low
Sweet 2022 Intermediate Low
Sweet 2022 Intermediate
Sweet 2022 Intermediate High
Sweet 2022 High
Washington Epoch Averaged
Washington Annual Average (Seasonally-corrected)
Feet
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
1900
1950
2000
2050
Year
Access 2022 projections via
https://coast.noaa.gov/sealevelcalculator

Planning for sea level rise

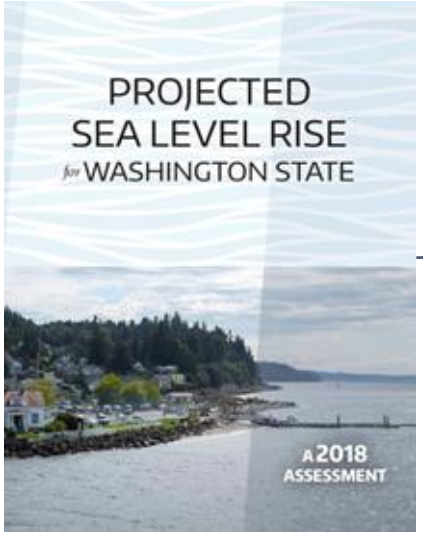
Local and state examples

The adaptation planning cycle

SLR projections used here

Source: California Governor's Office of Emergency Services 2020.

Bainbridge Island vulnerability assessment (2024)



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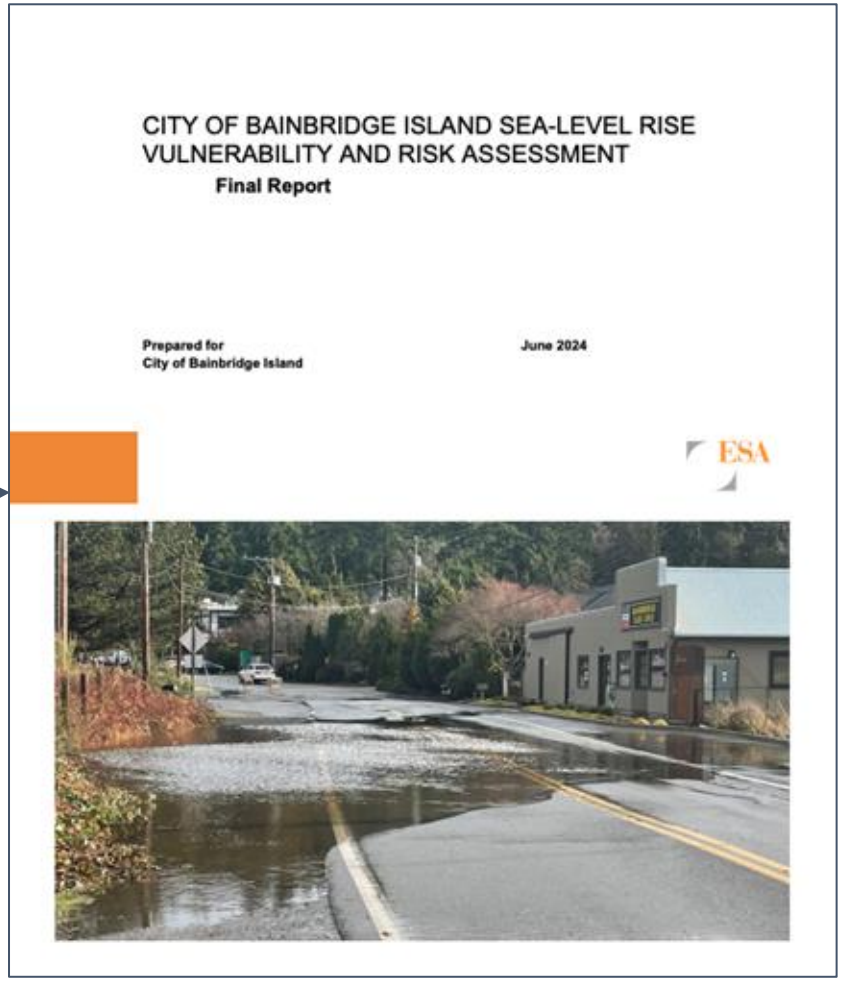

CITY OF BAINBRIDGE ISLAND SEA-LEVEL RISE
VULNERABILITY AND RISK ASSESSMENT

Final Report

Prepared for
City of Bainbridge Island

June 2024

ESA

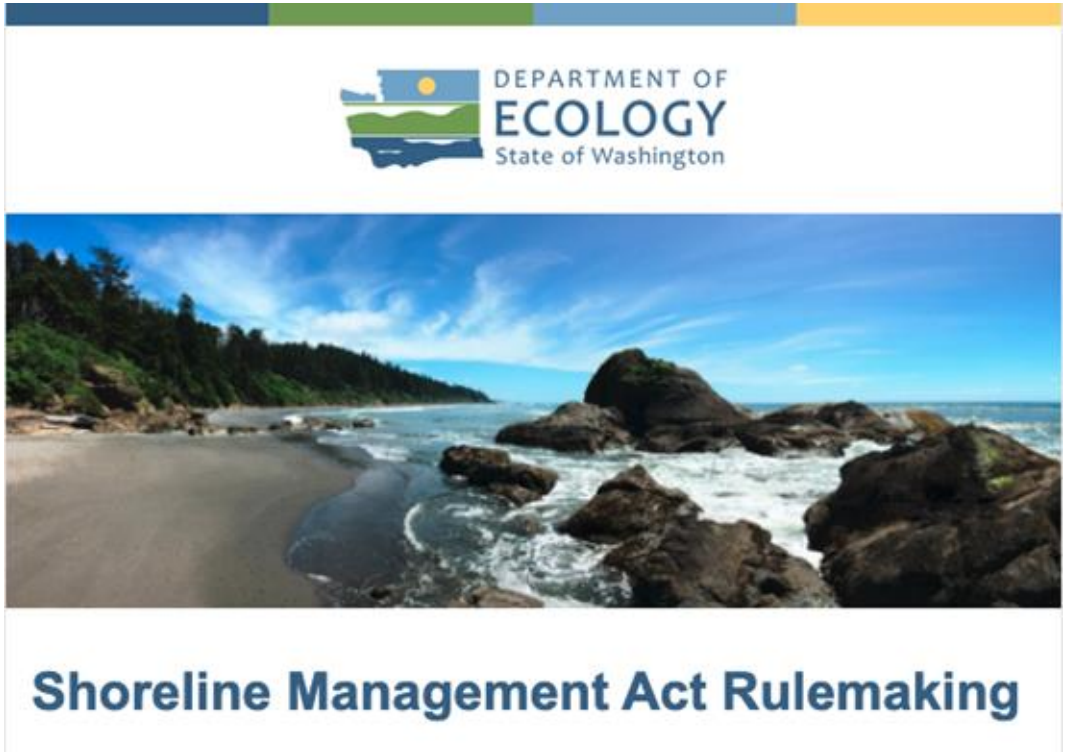
https://www.bainbridgewa.gov/DocumentCenter/View/18709/COBI_SLR_Vulnerability_Assessment_2024-07-01

Local education and engagement action

Bainbridge Island ferry

Photos: Ian Miller

On your radar: Shoreline Management rulemaking and Shoreline Master Program (SMP) updates



- Public comment period Fall 2026
- Rules adopted Spring 2027
- 2027-2029: Bainbridge Island SMP updates

https://ecology.wa.gov/regulations-permits/laws-rules-rulemaking/rulemaking/wac-173-26-27-shoreline-management-act

- Sea level is rising in Washington
- SLR is a hazard exacerbator, and impacts may already be shaping the coast
- Different projections have some similar themes
- Planning is underway, with much more coming soon

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Coastal Hazards Resilience Network
https://wacoastalnetwork.com/

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