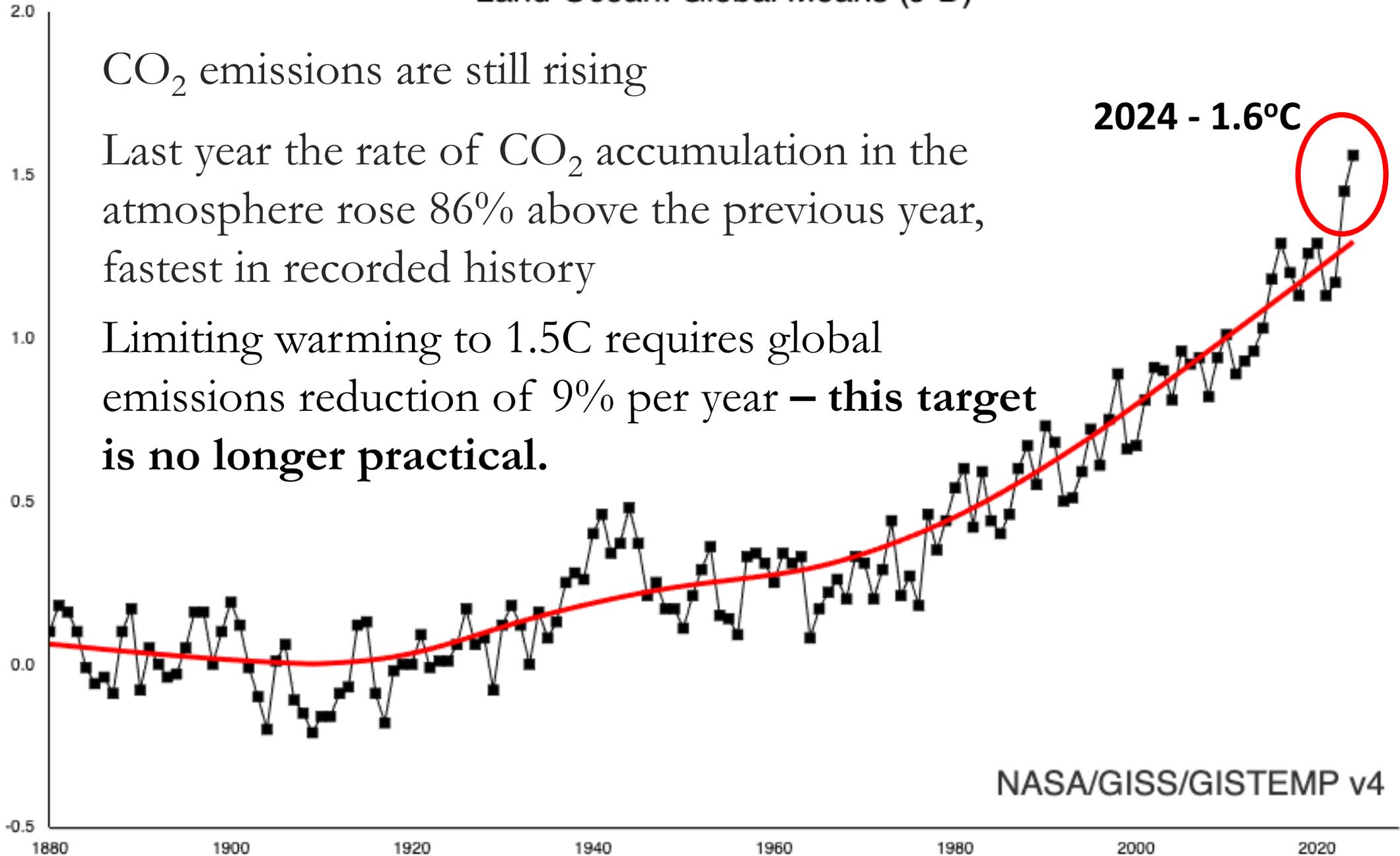
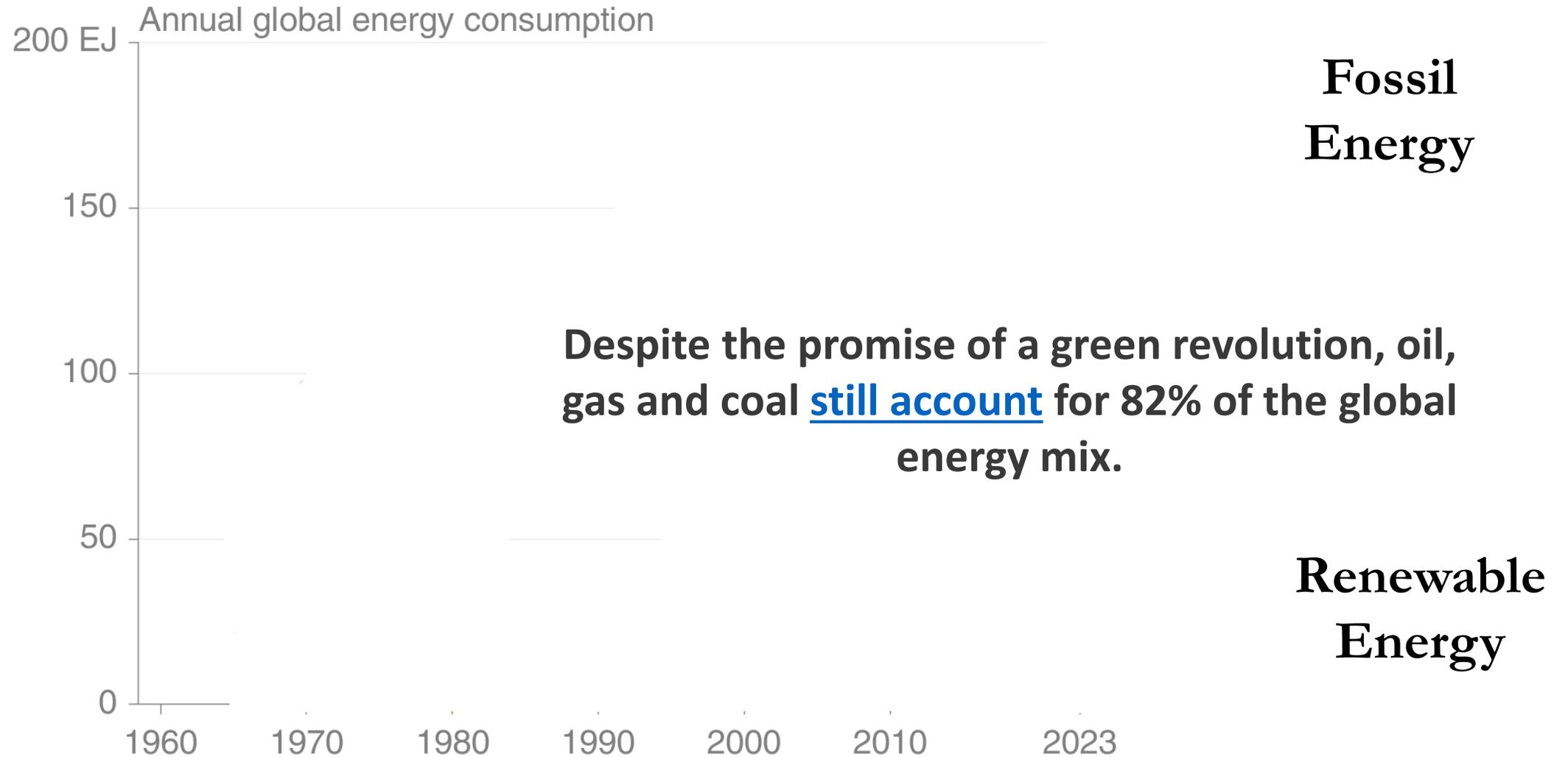


Land-Ocean: Global Means (J-D)

Temperature Anomaly w.r.t. 1880-1920 (°C)



Energy use by source



© ⓘ Global Carbon Project • Data: Energy Institute, IEA (bioenergy)

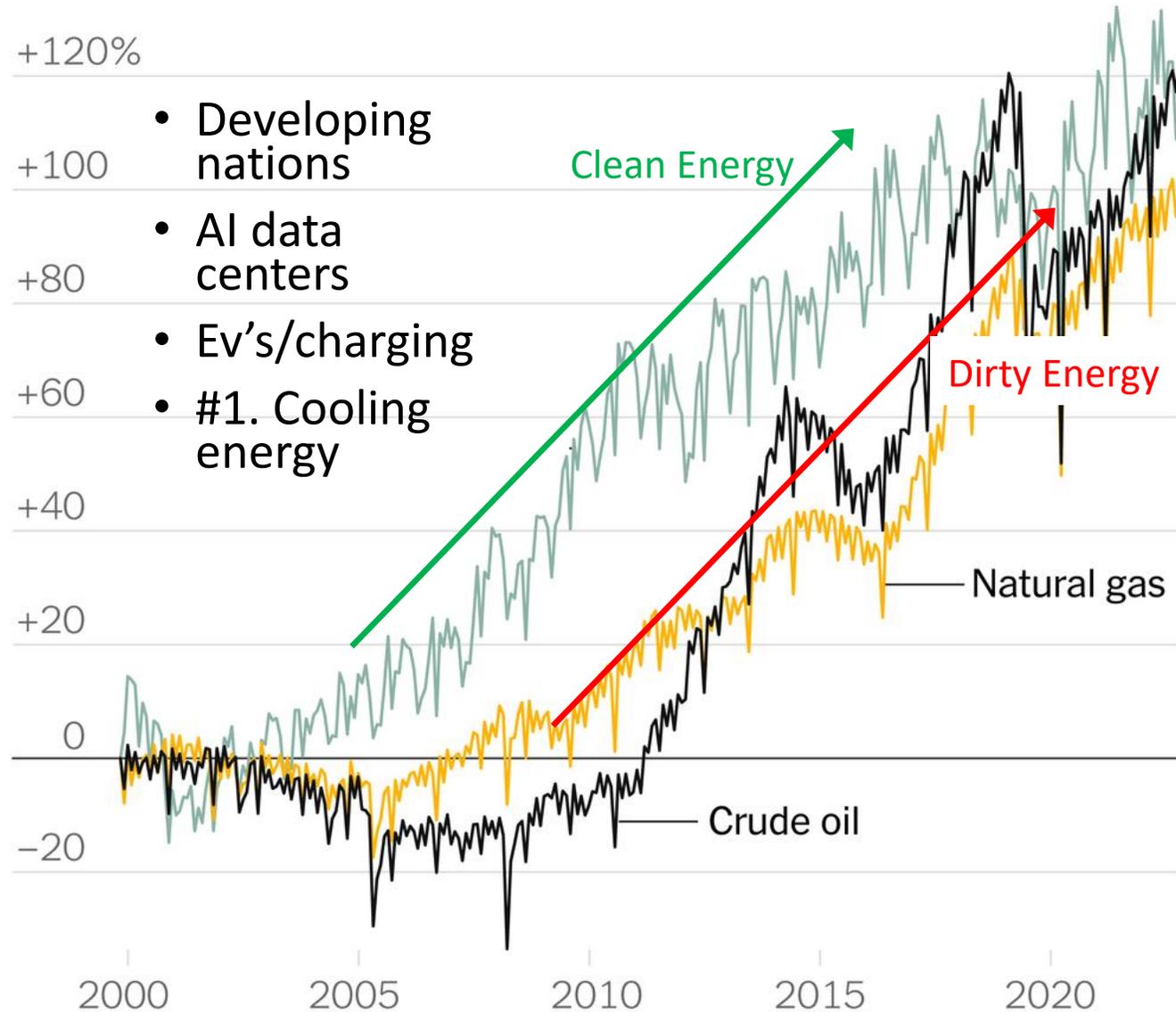
This figure shows “primary energy” using the substitution method (non-fossil sources are scaled up by an assumed fossil efficiency of approximately 0.38) Source: [Energy Institute 2024](#); [Global Carbon Project 2024](#)

- Global energy demand is rising 2-4% per year
- Clean energy deployment is increasing at only 1% per year
- Coal still accounts for 26% of the world's total energy consumption.
- Economists argue that energy "transitions" often add new sources rather than replace old ones, accelerating overall consumption.
- Experts suggest that true solutions require **drastically reducing energy and material use**, not relying on new energy sources.



Monthly change in energy produced in the United States

Compared with January 2000



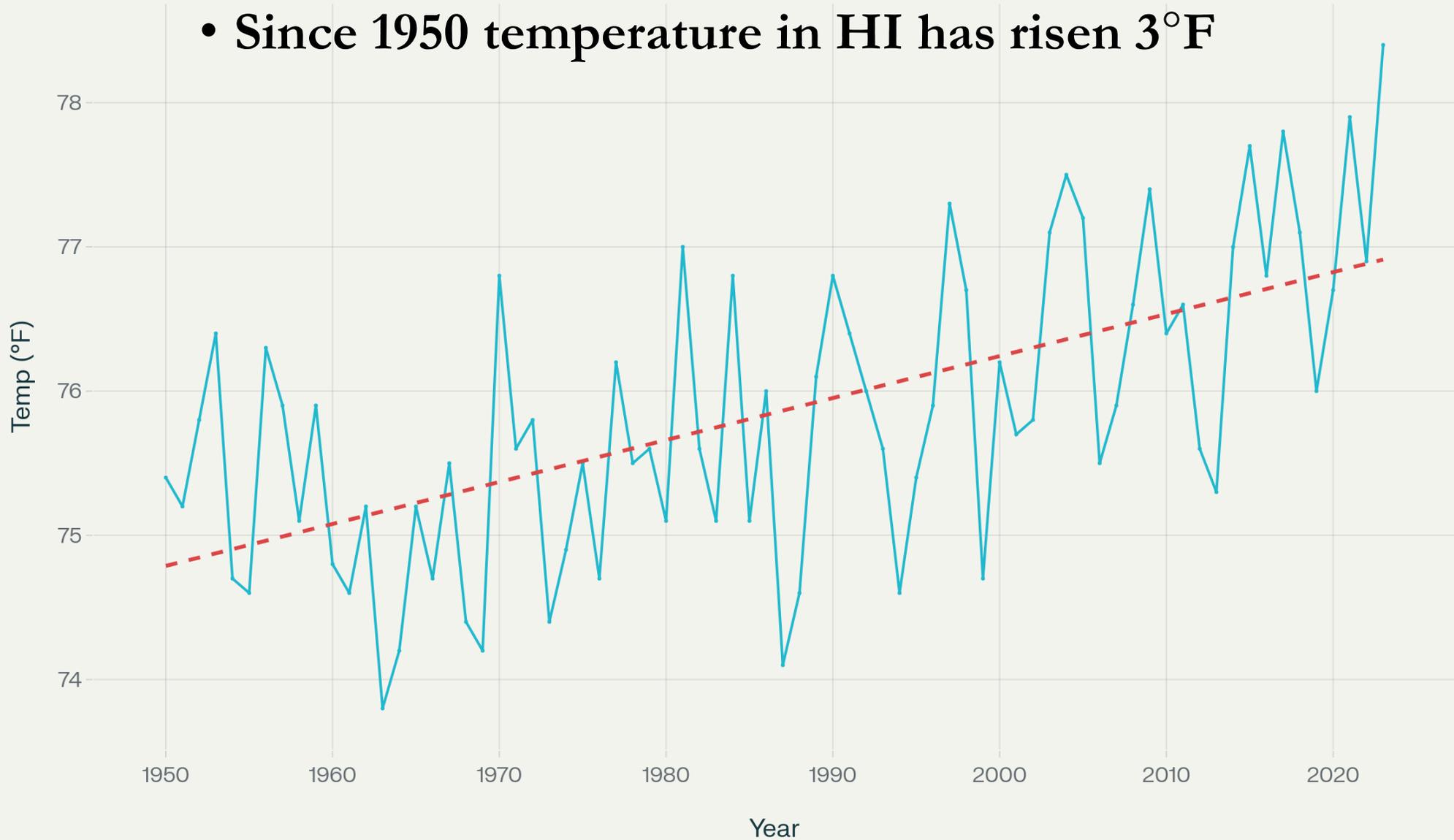
- Developing nations
- AI data centers
- Ev's/charging
- #1. Cooling energy

Even as renewables accelerate, so does the demand for new energy

Hawaii Temp 1950-2023 (+3.0°F)

— Annual Temp - - Trend Line

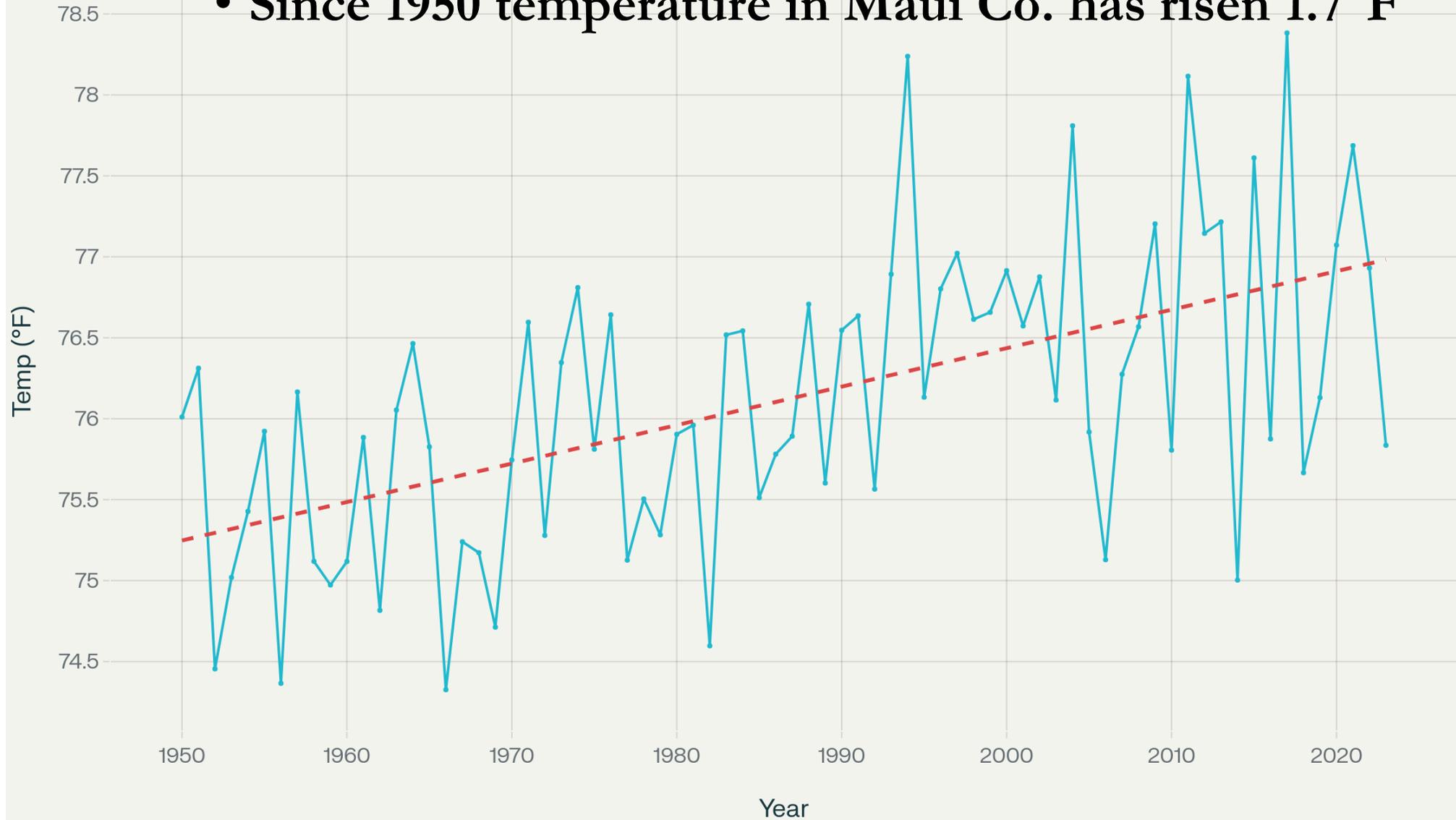
• Since 1950 temperature in HI has risen 3°F



Maui County Mean Annual Temp

Annual Temp Trend Line

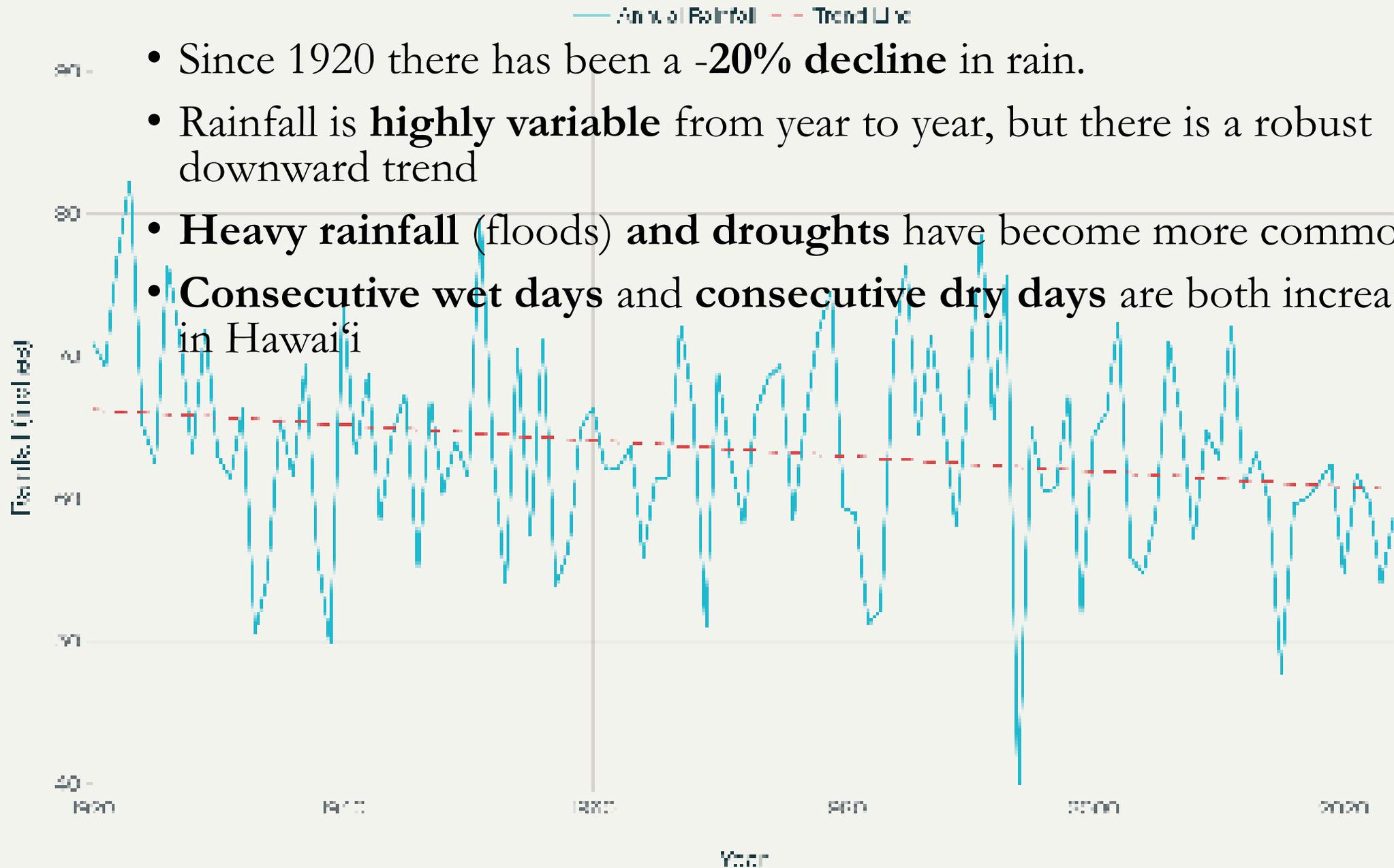
• Since 1950 temperature in Maui Co. has risen 1.7°F



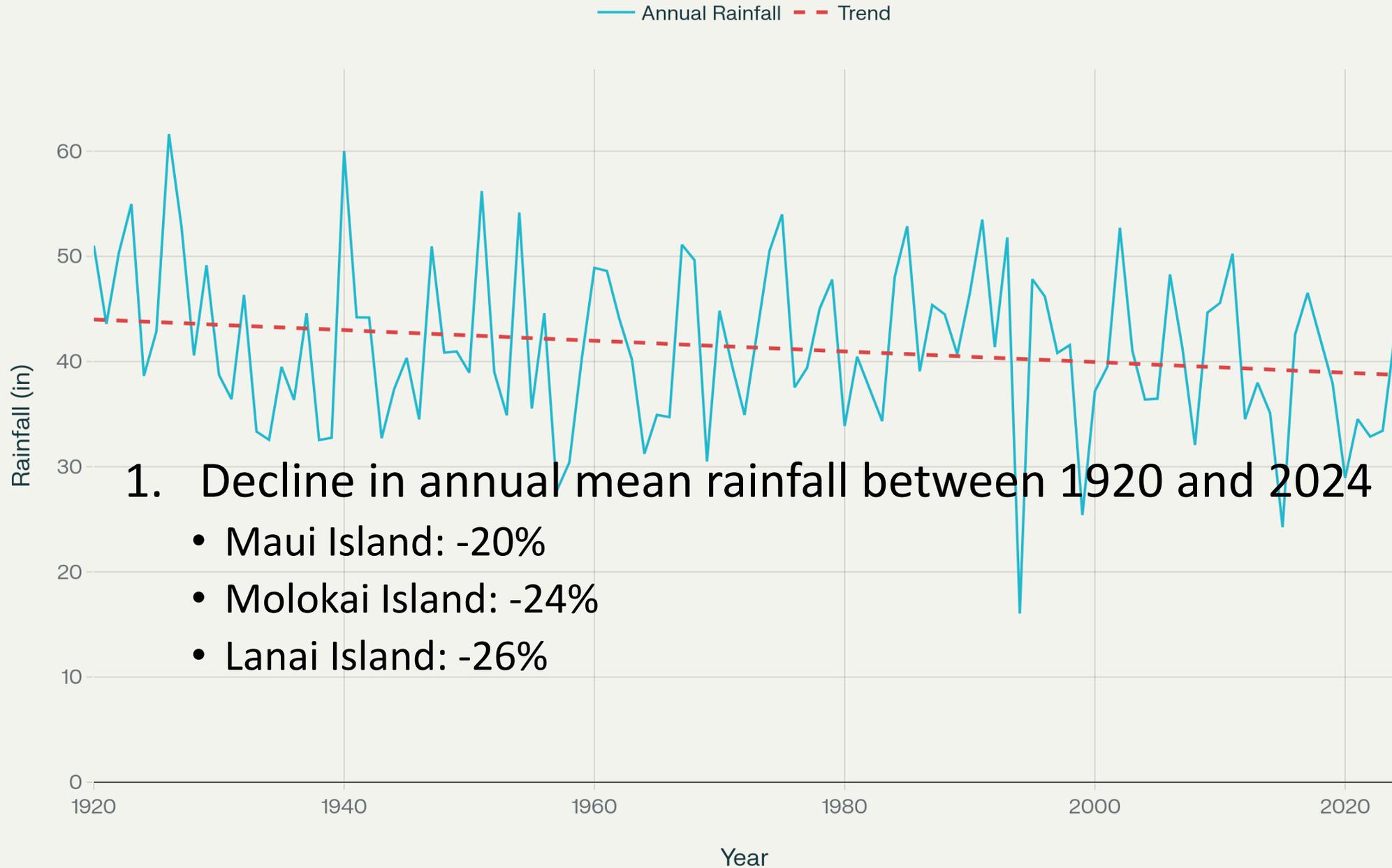
Average daily wind speeds are declining The number of trade wind days is declining



Hawaii Annual Rainfall 1920-2024



Maui County Annual Rainfall 1920-2024

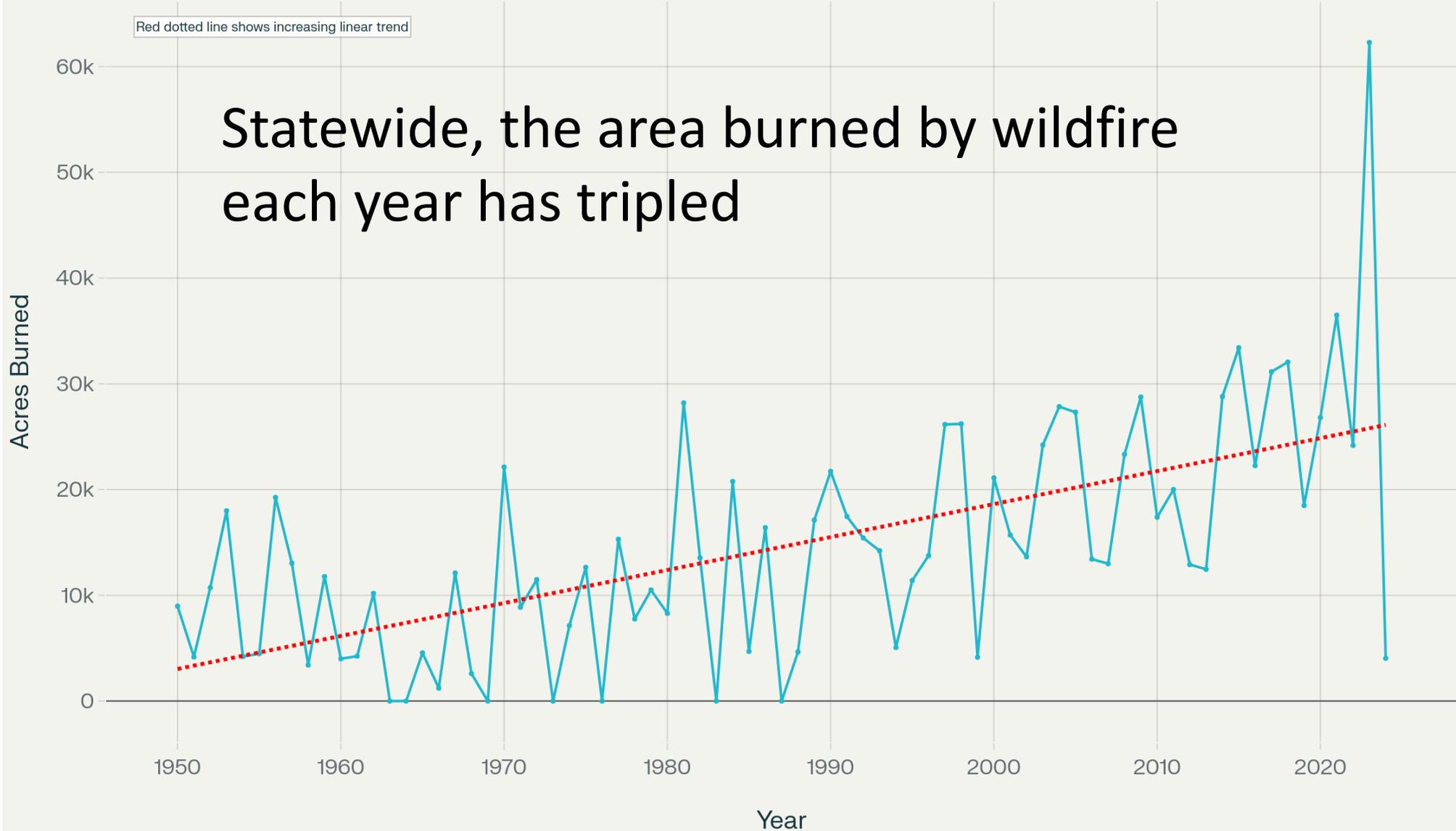


Hawaii Wildfire Area Burned 1950-2024

Annual Acres Linear Trend

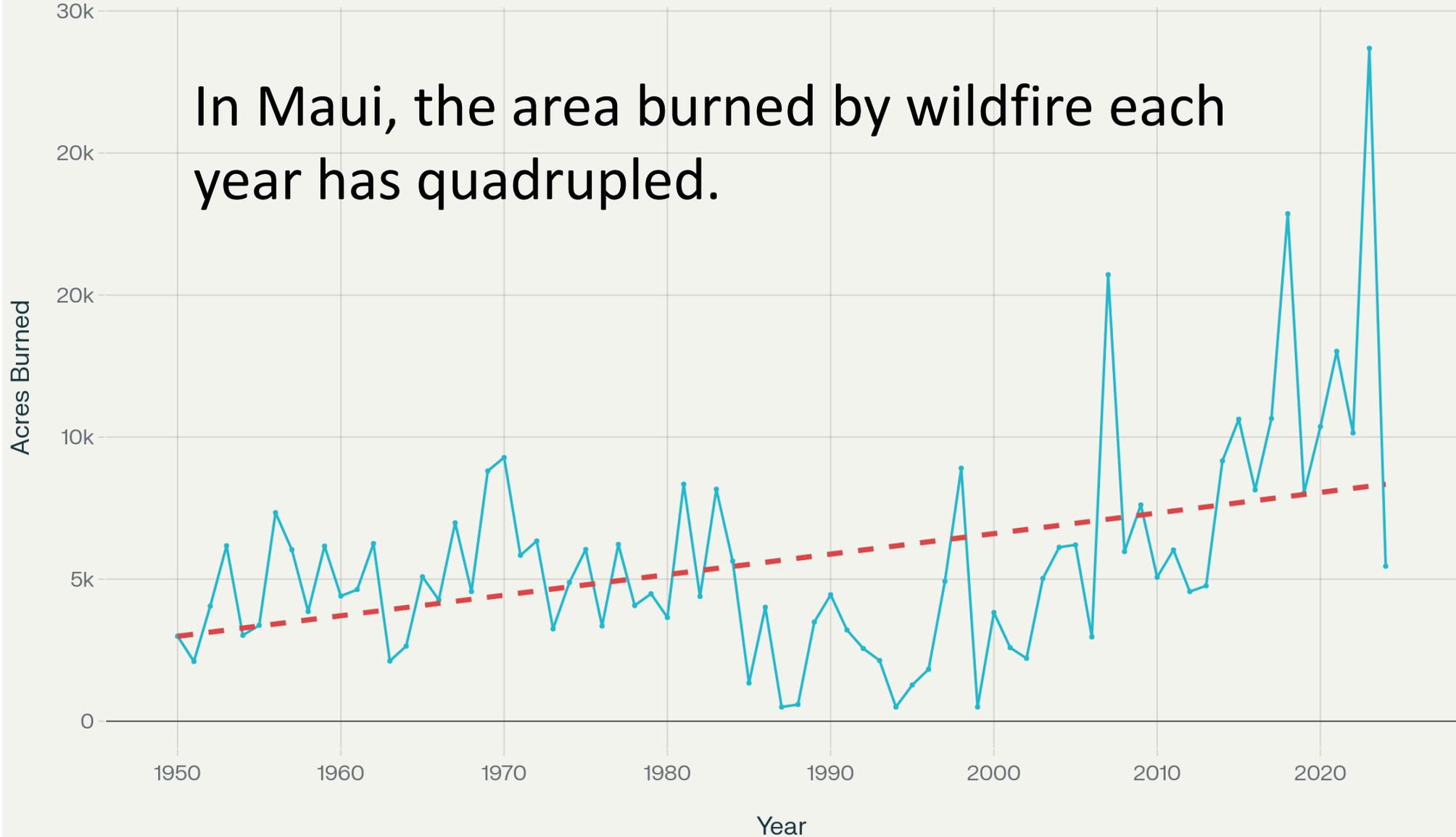
Red dotted line shows increasing linear trend

Statewide, the area burned by wildfire each year has tripled



Maui County Wildfire Area Burned 1950-2024

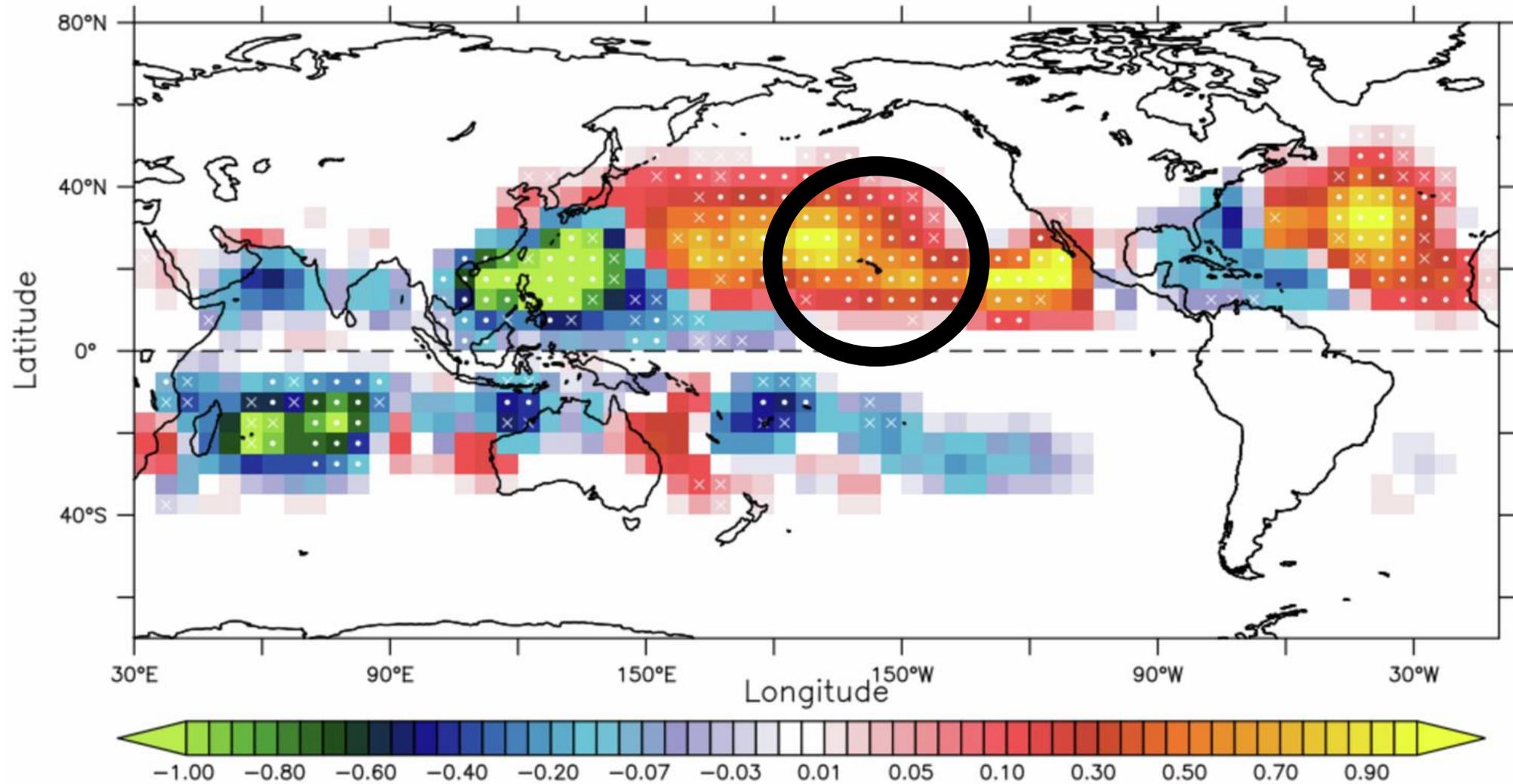
Annual Burned Trend Line



2018 Hurricane season
Olivia, Lane



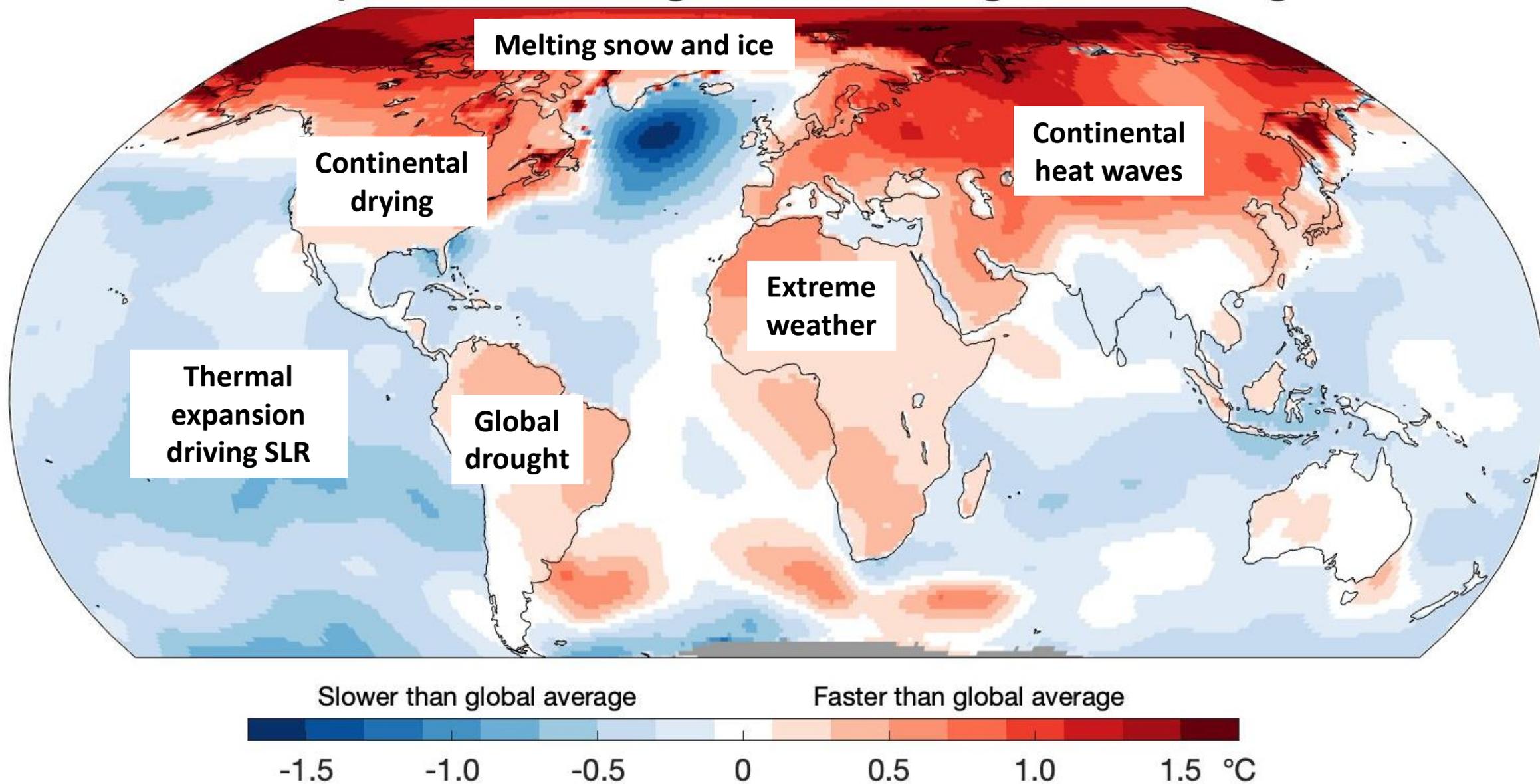
Tropical Cyclone Occurrence is Projected to strongly increase



Murakami, H., *et al.* Robust future projections of major tropical cyclones and sea level pressure gradients. *Commun Earth Environ* 5, 479 (2024).

<https://doi.org/10.1038/s43247-024-01644-9>

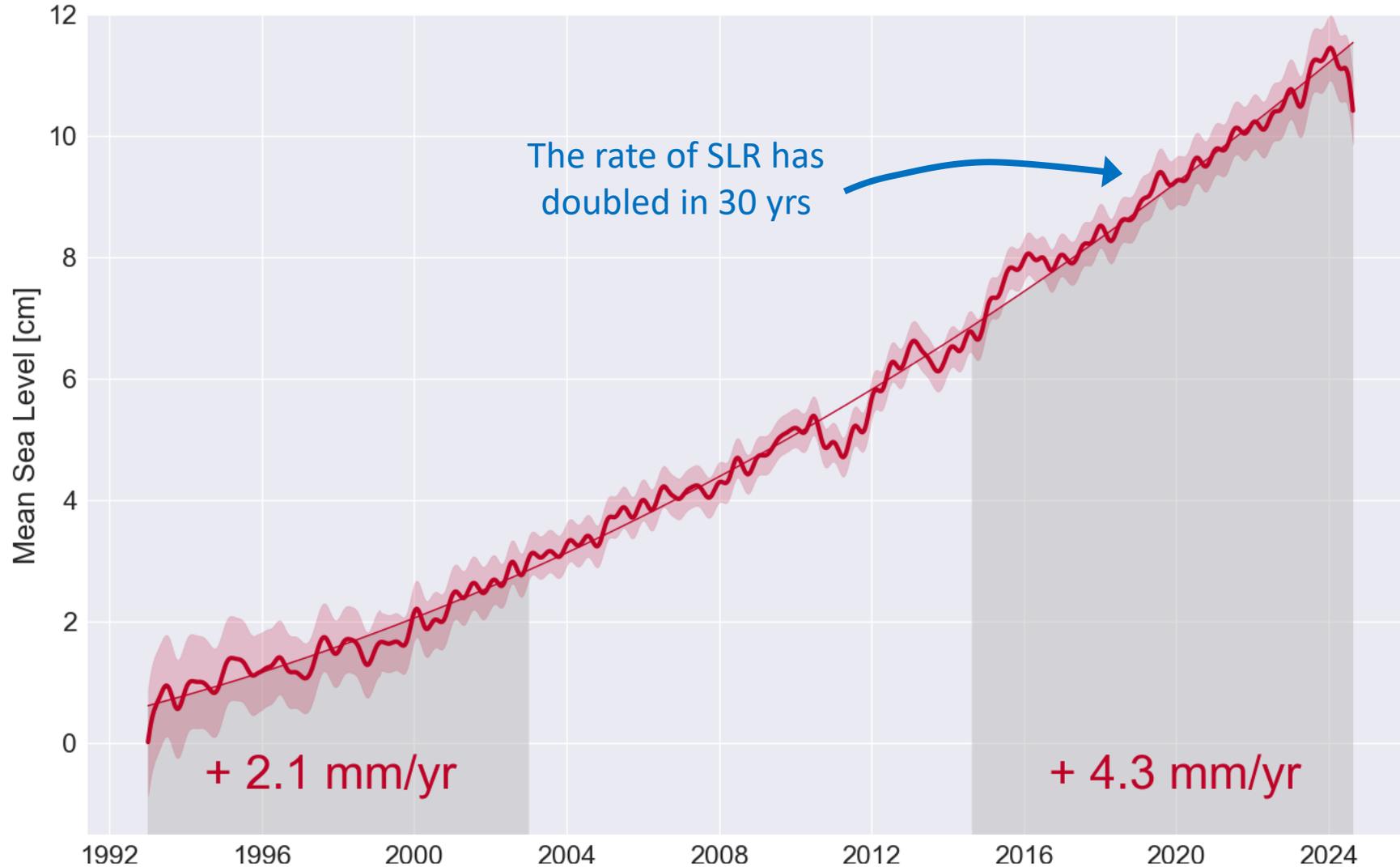
Temperature change relative to global average



Global Mean Sea Level Rise

Latest MSL Measurement
2024-08-21

Acceleration: $0.11 \pm 0.05 \text{ mm/yr}^2$

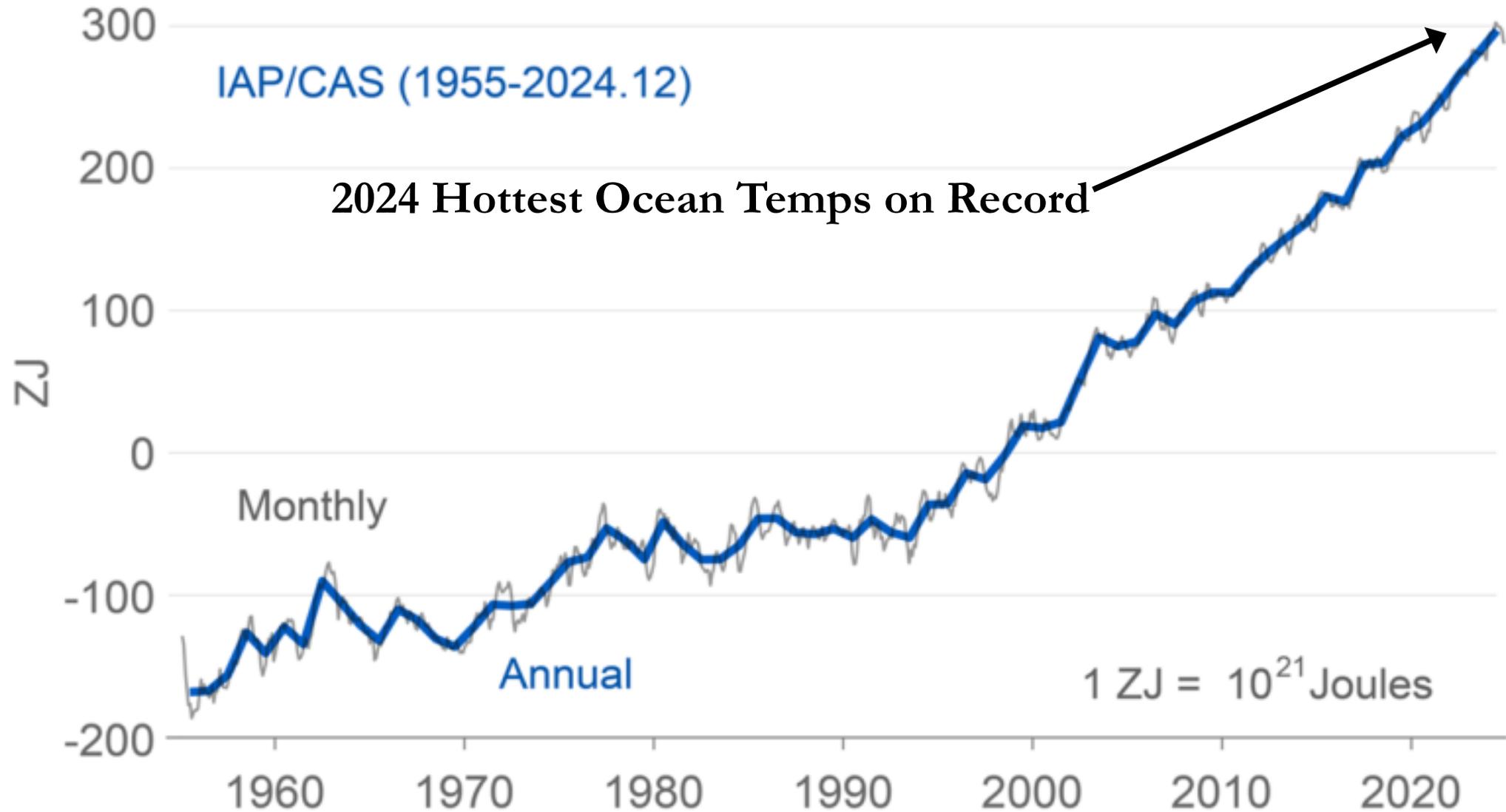


<https://www.aviso.altimetry.fr/en/data/products/ocean-indicators-products/mean-sea-level.html>

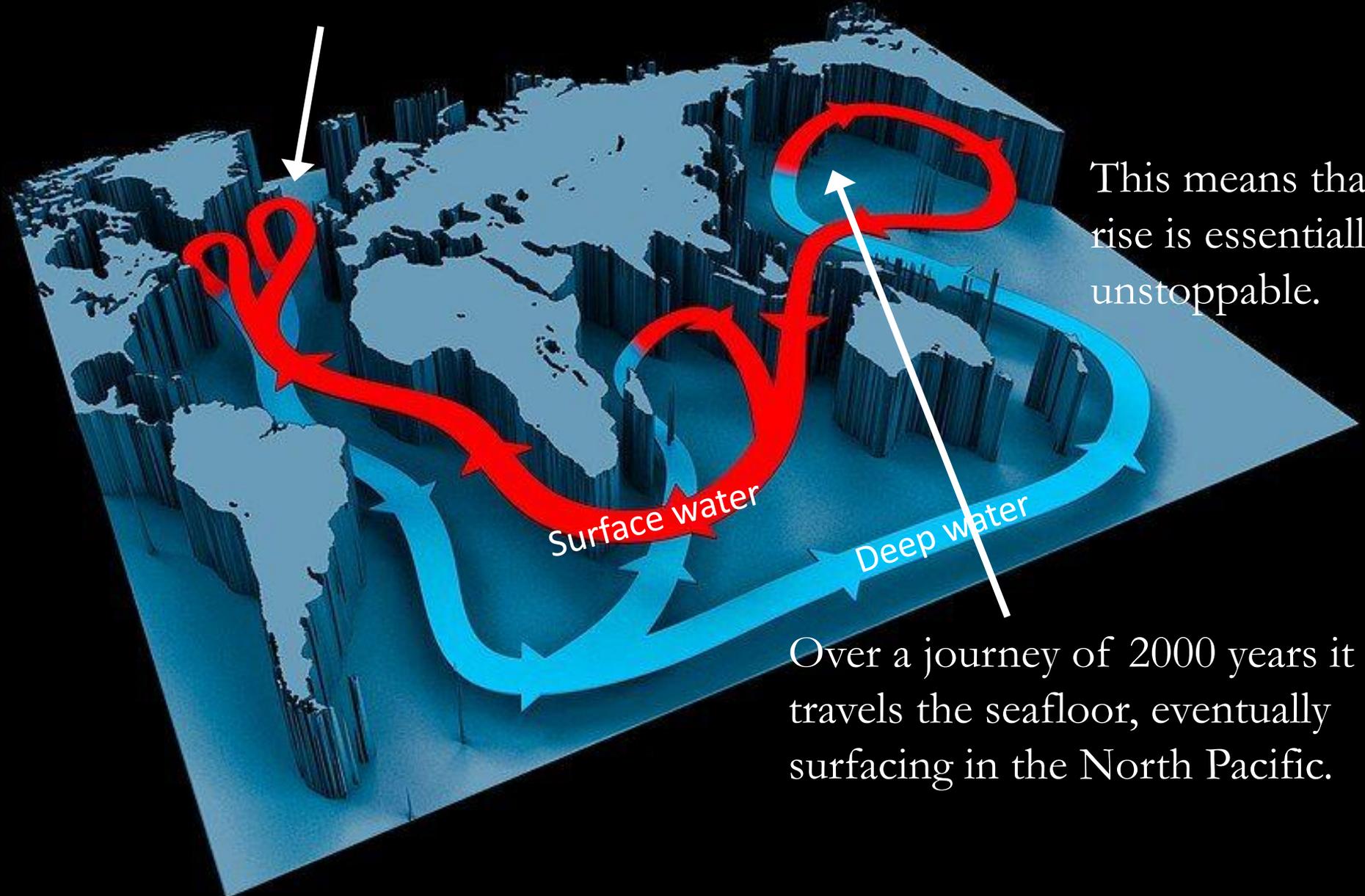
Hamlington, B.D., *et al.* The rate of global sea level rise doubled during the past three decades. *Commun Earth Environ* 5, 601 (2024). <https://doi.org/10.1038/s43247-024-01761-5>

Global upper 2000 m ocean heat content (OHC) change

Difference from 1981-2010 average



Warm surface water circulates into the deep sea causing thermal expansion wherever it goes.



This means that sea level rise is essentially unstoppable.

Over a journey of 2000 years it travels the seafloor, eventually surfacing in the North Pacific.

IPCC, 2021 Assessment Report 6

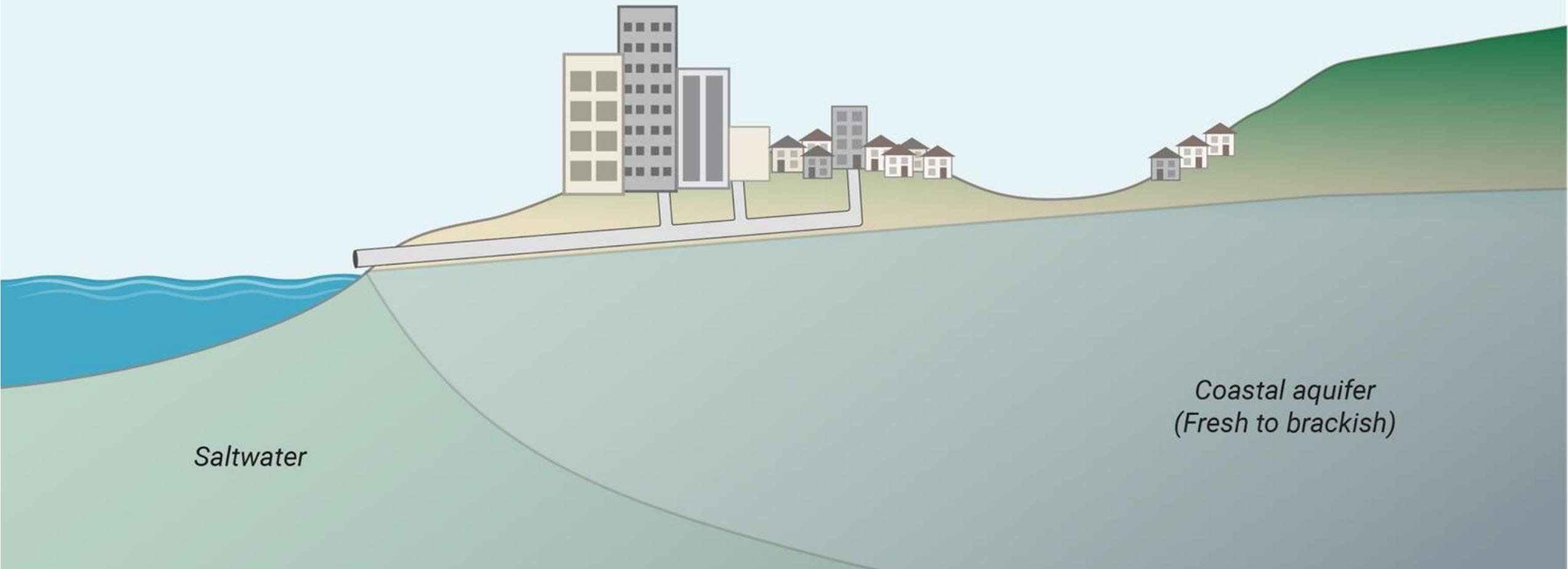
Sea level is **committed to rise for centuries to millennia** due to continuing deep-ocean warming and ice-sheet melt and will remain elevated for thousands of years (high confidence). *[AR6 WGI SPM p.21 B.5.4]*



Sea level rise, an unstoppable reality

Photo, S. Habel

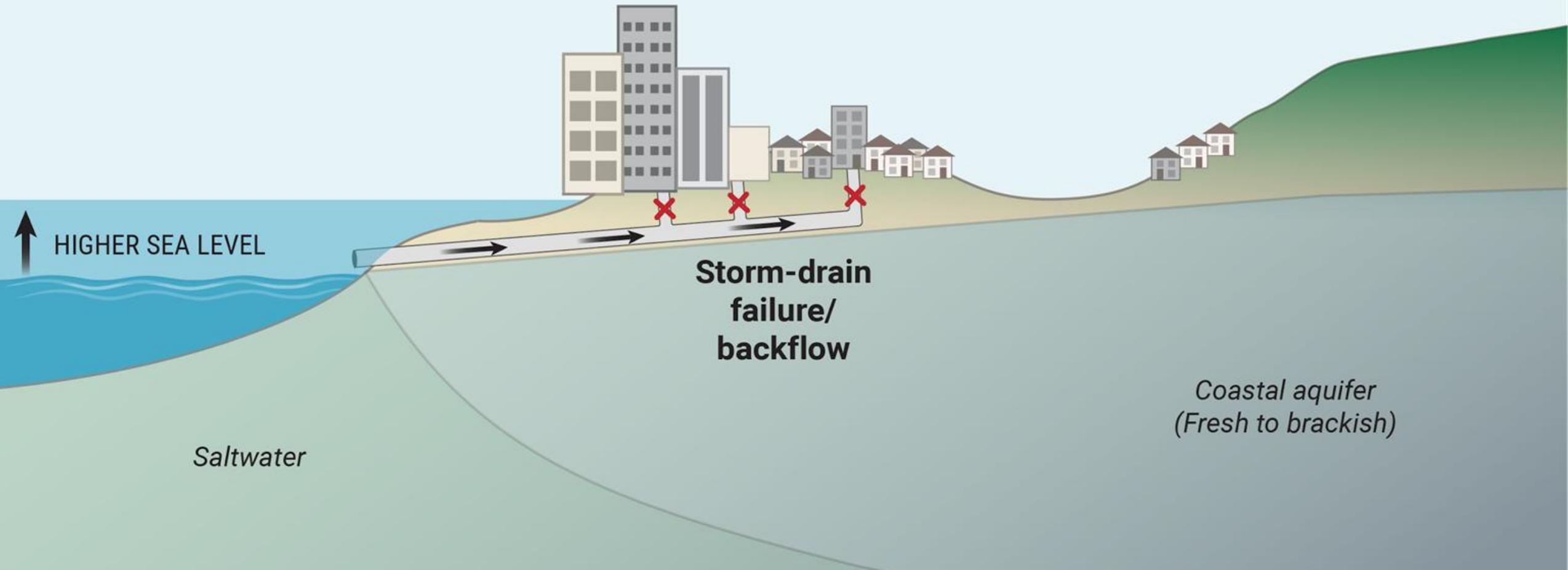
Multiple Impacts from Sea Level Rise



Saltwater

*Coastal aquifer
(Fresh to brackish)*

Stormwater Drainage Failure

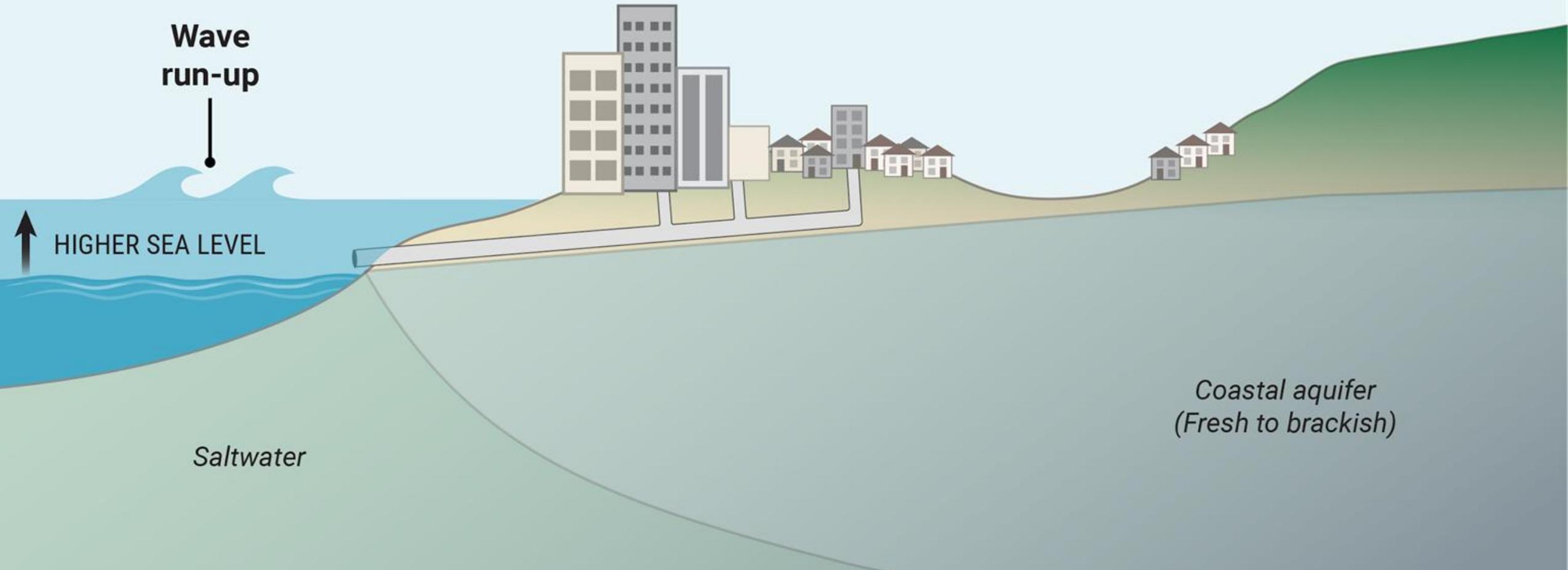


Storm
drain
backflow



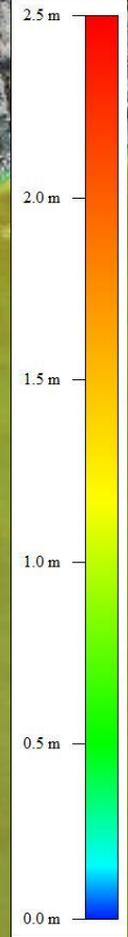
- 
- 71% of storm drain outfalls in Waikīkī are submerged below water at present MHHW
 - 100% of outfalls will be submerged by MHHW + 2 ft of SLR

Seasonal Wave Flooding



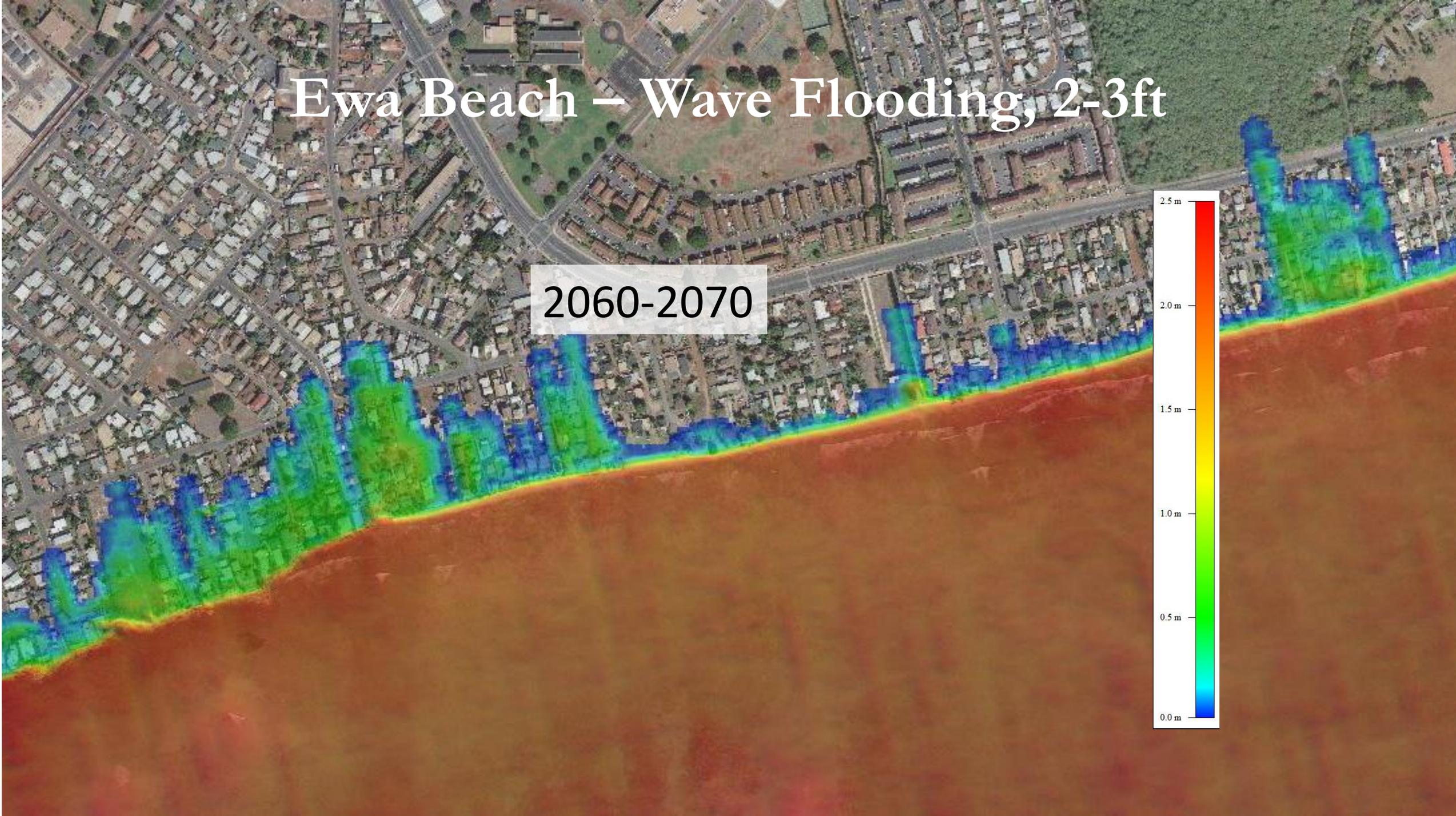
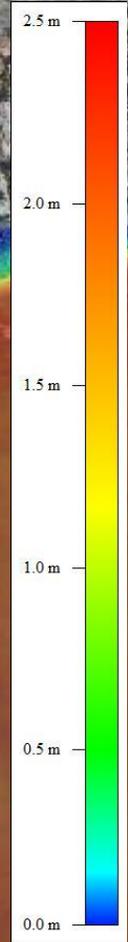
Ewa Beach – Wave Flooding, 1ft

2050



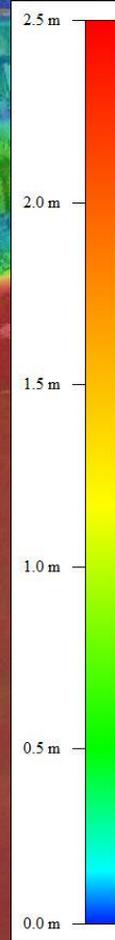
Ewa Beach – Wave Flooding, 2-3ft

2060-2070

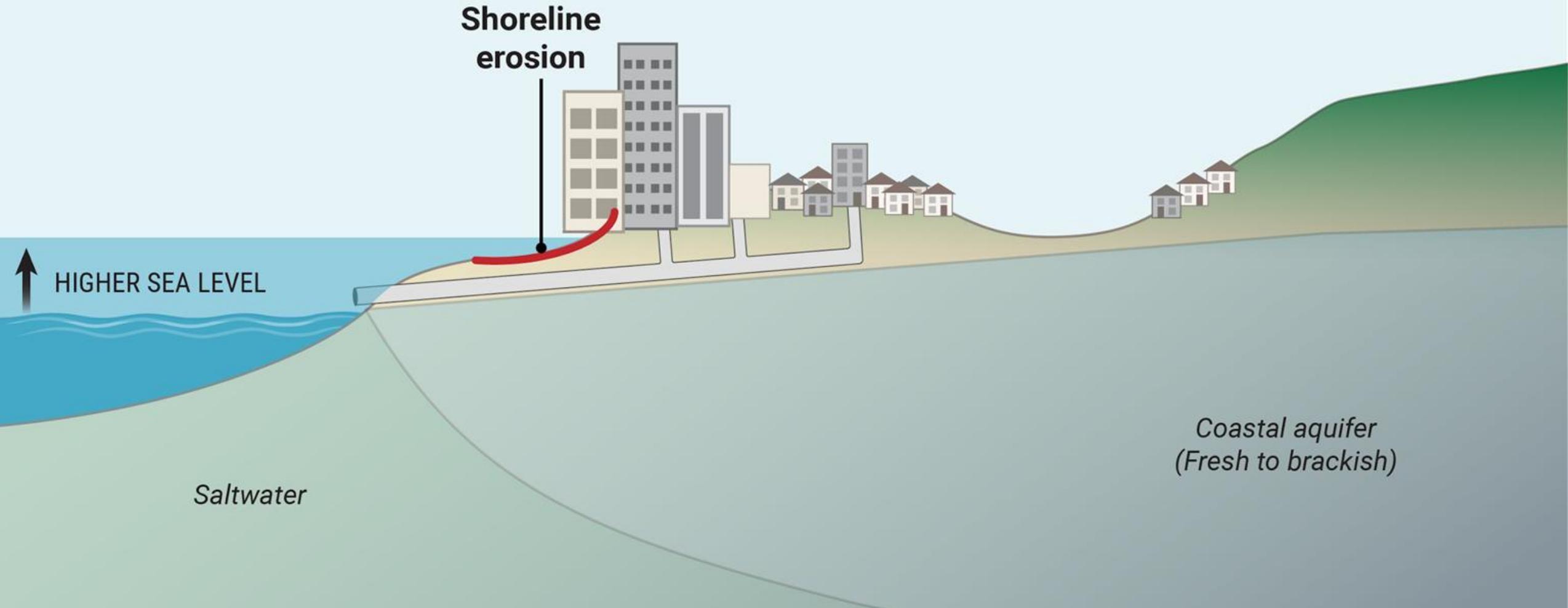


Ewa Beach – Wave Flooding, 4ft

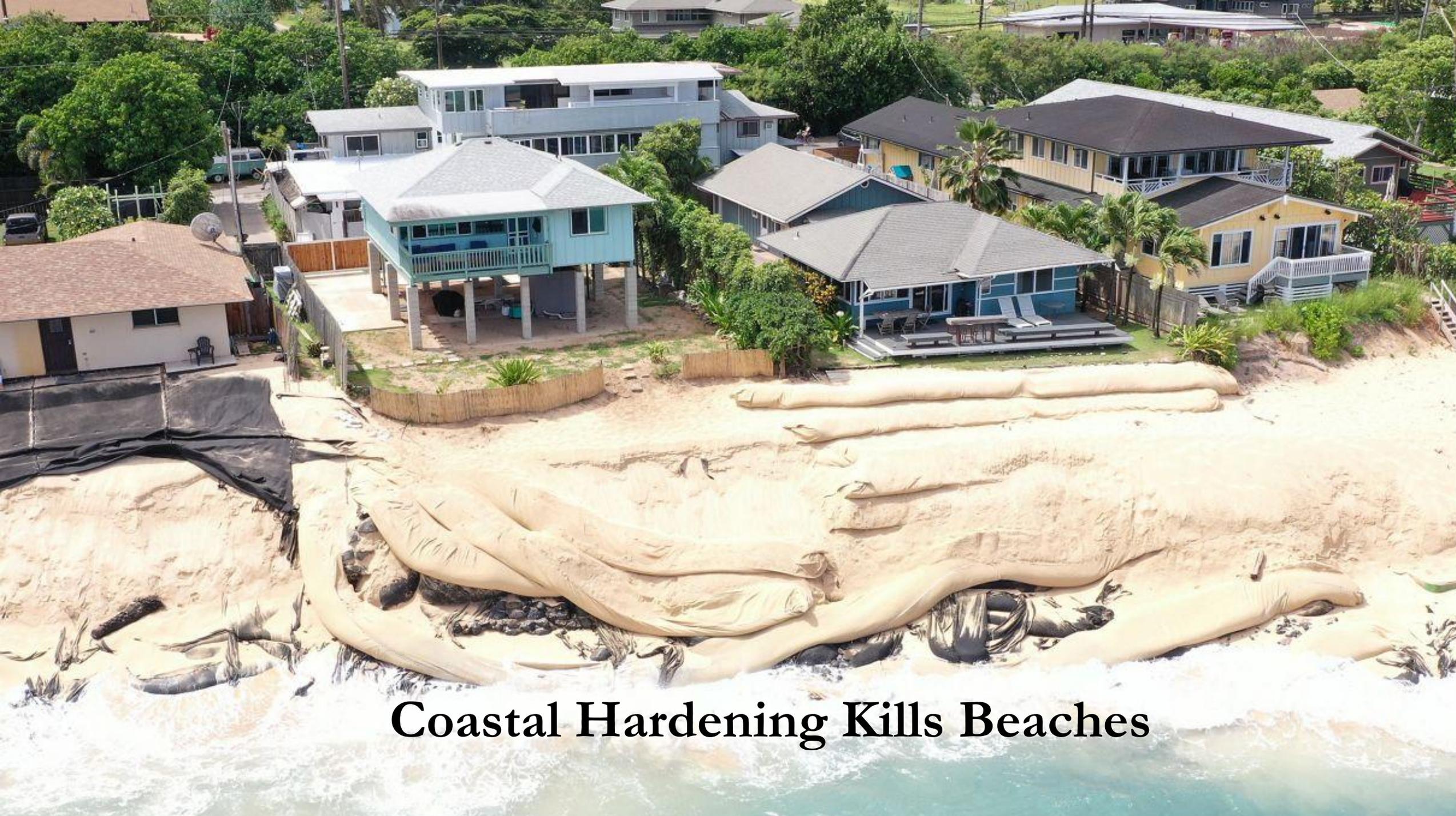
2080-2100



Shoreline Erosion

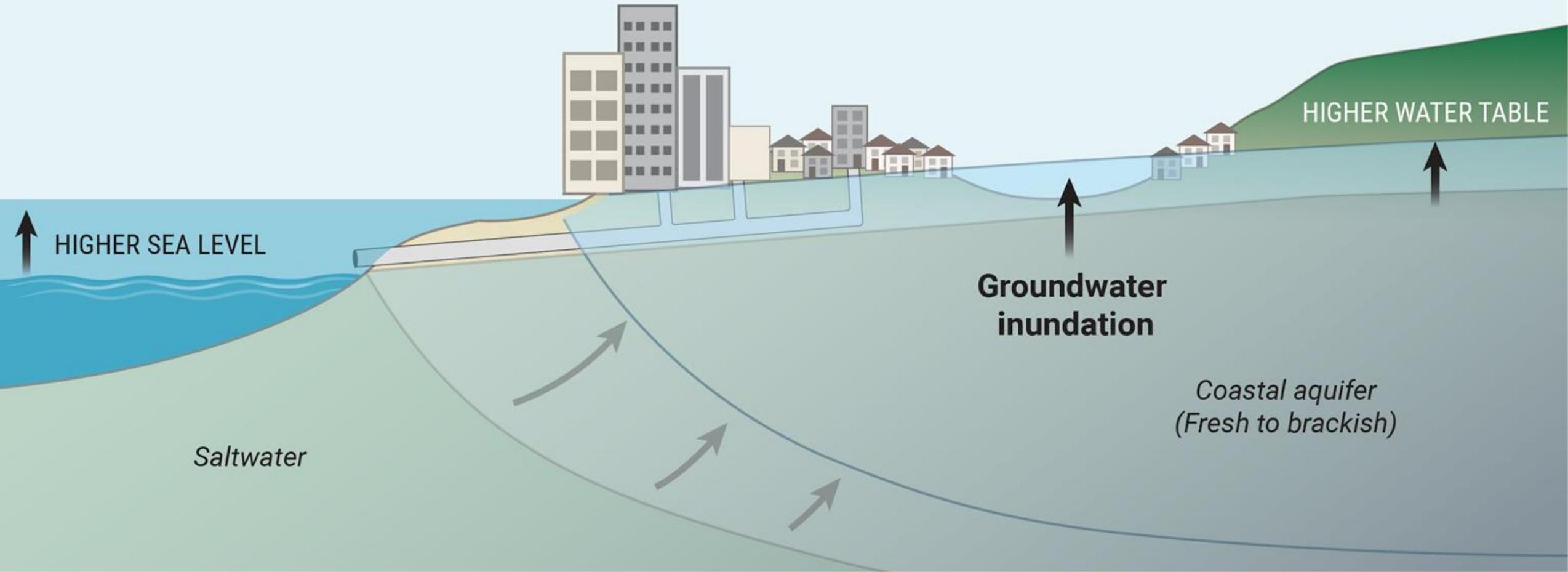






Coastal Hardening Kills Beaches

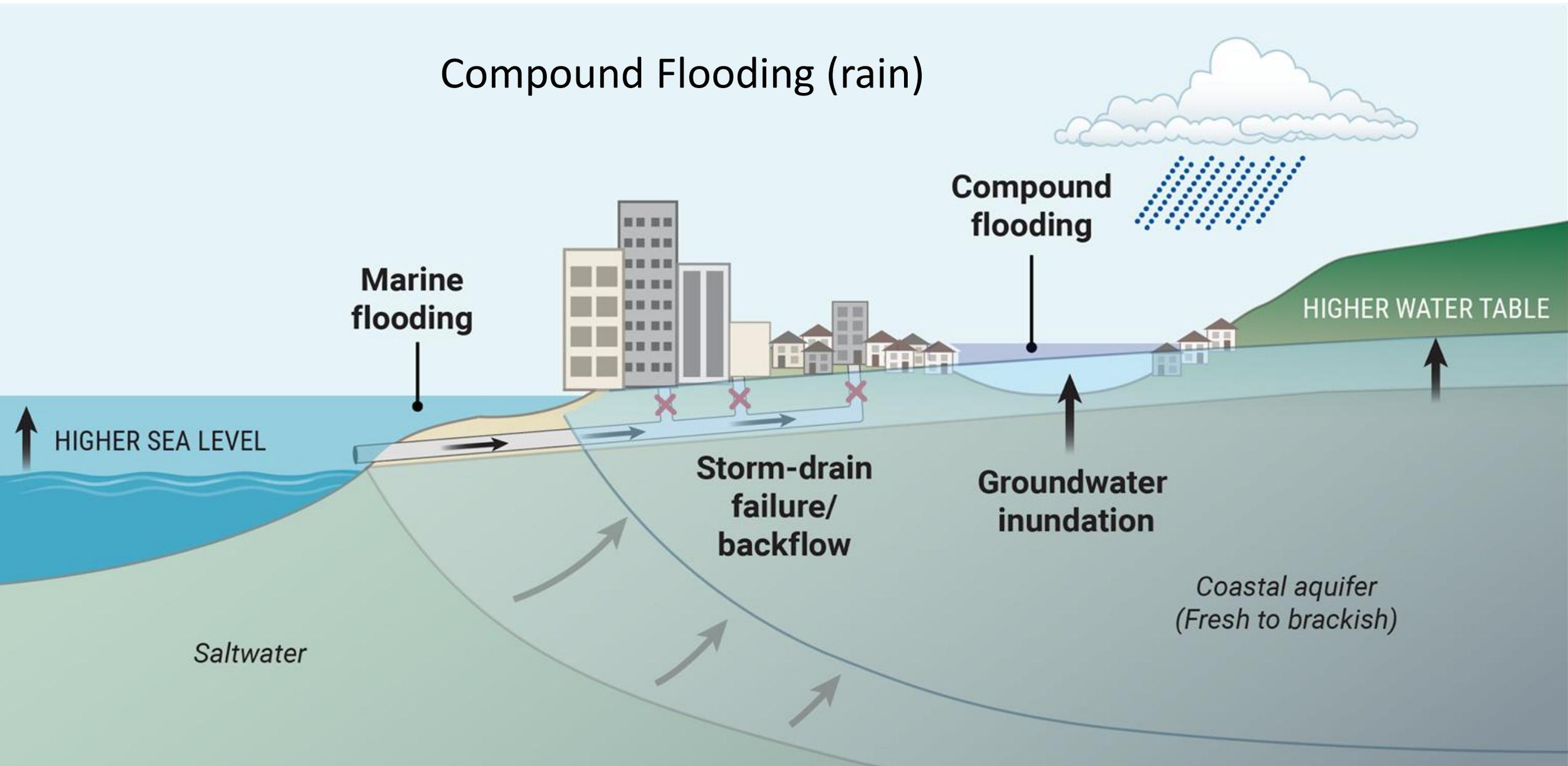
Groundwater Inundation



As sea level rises, so does
the water table



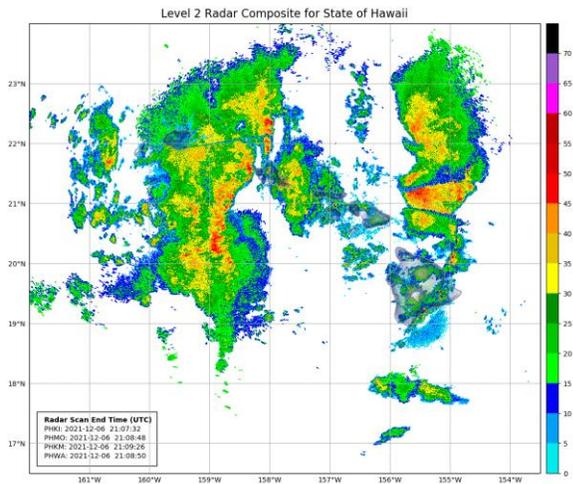
Compound Flooding (rain)



Waikiki

Dec. 5, 2021

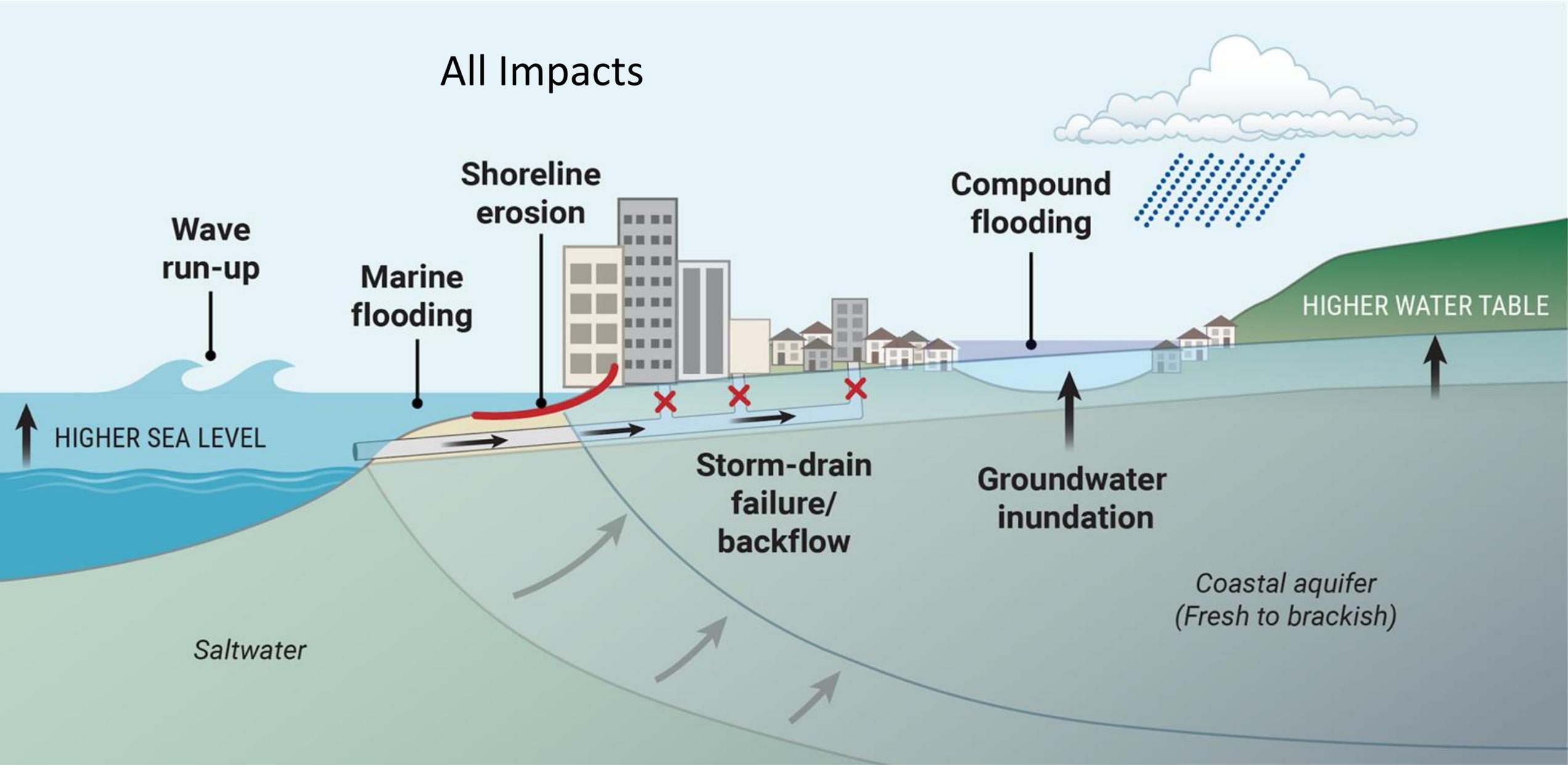
- Sea level rise flooding today involves
 - Rain
 - Extreme tides
 - Onshore winds
 - Large waves



Rain + High Tide = Compound Flooding



All Impacts

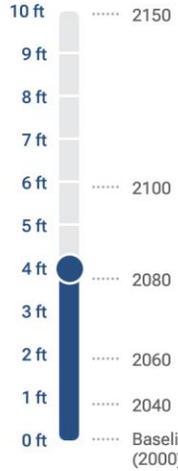


SEA LEVEL:
+ 4 ft

SEA LEVEL RISE SCENARIO ⓘ

Intermediate Intermediate High

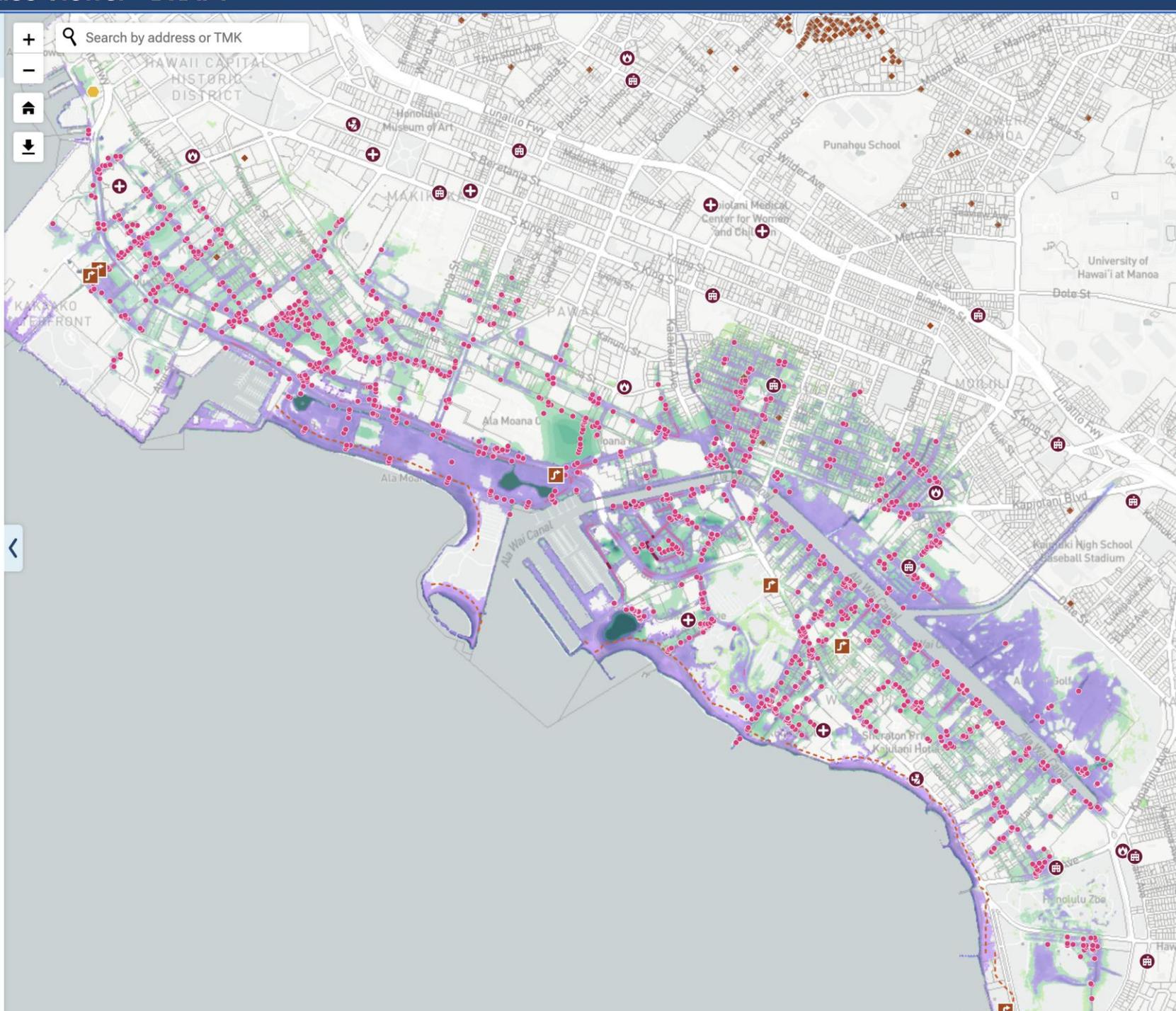
MHHW ⓘ EXPECTED BY



Timing of sea level rise based on local projections for:

MOKU O LO'E ISLAND

Data source:
2022 Sea Level Rise Technical Report



BASEMAPS

EXPOSURE

Unselect all

- Passive Flooding
- Marine Connected Flooding
 - Marine flooding: water depth
 - 0 ft
 - 10+ ft
- Lowlying Area
 - Lowlying: depth below sea level
 - 0 ft
 - 10+ ft
- Groundwater Inundation
 - 0 ft
 - 10+ ft
- Emergent and Shallow Groundwater
- Drainage Backflow
 - 0 ft
 - 10+ ft
- Annual High Wave-Driven Flooding
 - Water depth
 - 0 ft
 - 10+ ft
- Compound Flooding Scenario (December 2021 Kona storm)
 - Floodwater Depth
 - 0 ft
 - 10+ ft
- Future Erosion Hazard Zone
 - Shoreline Position
 - Transect Historical Change

IMPACTS

Unselect all

- Flooded Roads
 - Flood depth > 1 ft
 - Flood depth > 2 ft
- Stormwater Drainage Failure
 - Stormwater structures below sea level
- Critical Facilities
 - Hospitals and Clinics
 - Fire Stations
 - Police Stations
 - Public Schools
 - Wastewater Infrastructure
 - Electrical Infrastructure

OTHER OVERLAYS

Unselect all

- Community Plan Areas
- Moku Boundaries
- Ahupua'a Boundaries
- Neighborhood Board Areas

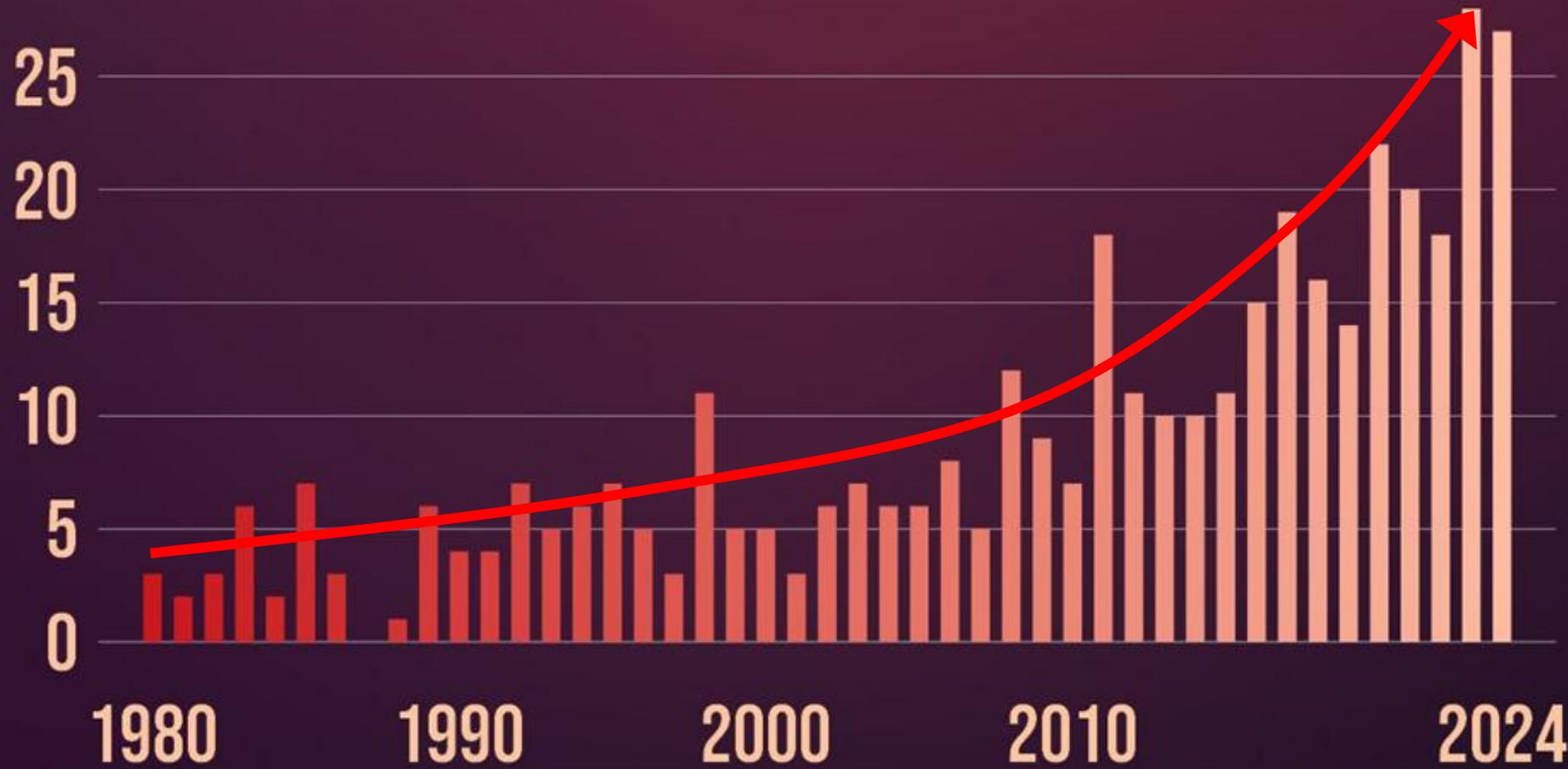
Thank you for your Time

Hawaii Climate Summary

- Sea level has risen about 5 inches since 1970, the pace is accelerating; projections show up to 3.5 feet additional rise by 2100 under intermediate scenarios, threatening beaches, homes, roads, and freshwater through saltwater intrusion.
- Average air temperature has increased by at least 3°F statewide since 1950, with Honolulu rising about 3.6°F over the same span; further increases of 1.8–7.2°F are projected by the end of the century depending on emissions.
- Annual rainfall has declined across most islands, especially leeward areas, increasing the risk of drought and reducing freshwater supply; wet season precipitation for the last decade ranked among the lowest on record.
- Droughts are more frequent, longer, and more severe, with about 90% of Hawaii now receiving less rainfall than a century ago and ecological impacts intensifying, particularly for native forests and agriculture.
- Wildfires are increasing in frequency, extent, and severity, culminating in events like the 2023 Maui fire disaster, attributed to hotter, drier conditions and rapid spread of invasive grasses.
- Coral reefs are under extreme stress: ocean warming, acidification, and bleaching threaten to destroy up to 90% of reefs even if warming is kept to 1.5°C, with economic impacts projected to exceed \$1 billion per year by 2050 due to reef loss.
- Coastal flooding, groundwater inundation, and chronic high tide events are now regular threats for low-lying areas, especially former wetlands and fill lands, making infrastructure and homes increasingly vulnerable.
- Heavy rainfall events are becoming more intense and more frequent, while wet season rainfall on average is declining—a pattern that increases risk for both drought and flash floods.
- Trade wind patterns have shifted; decreased frequency of cooling northeast trades increases exposure to heat waves, poor air quality, and amplifies urban heat.

U.S. BILLION-DOLLAR DISASTERS

Annual number of events



- As the planet warms, extreme weather events are becoming more frequent and intense
- Since 1980, the U.S. suffered 403 billion-dollar weather disasters that claimed 17,000 lives and caused more than \$2.9 trillion in direct costs.
- The average length of time between disasters fell from 82 days during the 1980s to 19 days during the last 10 years

No disasters in 1987. Data through 12/31/2024.

Source: NOAA/NCEI