SHORE FRIENDLY WORKSHOP:
PLANNING FOR CHANGE

KITSAP COUNTY | MARCH 25, 2023

SHORE FRIENDLY KITSAP

HERRERA
Science + Planning + Design

SPEAKERS

Jonathan Waggoner, PE
Coastal Engineer

Rachel Johnson, MS
Water Resources Engineer

HERRERA
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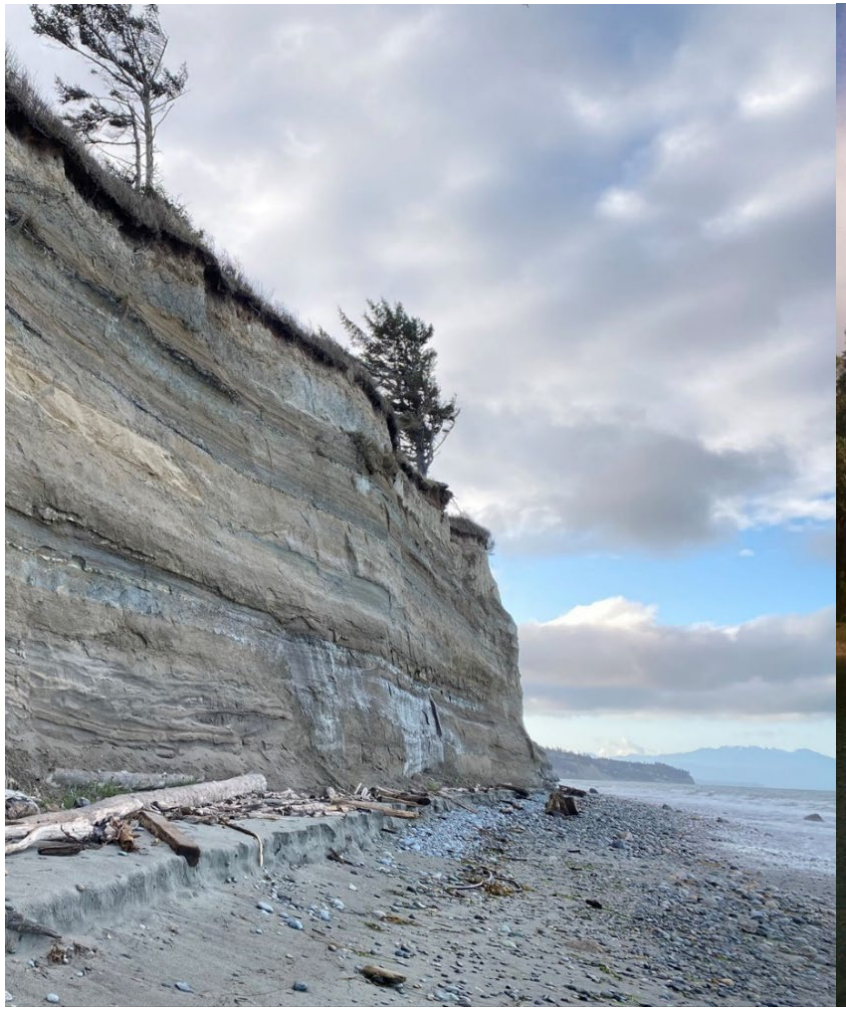
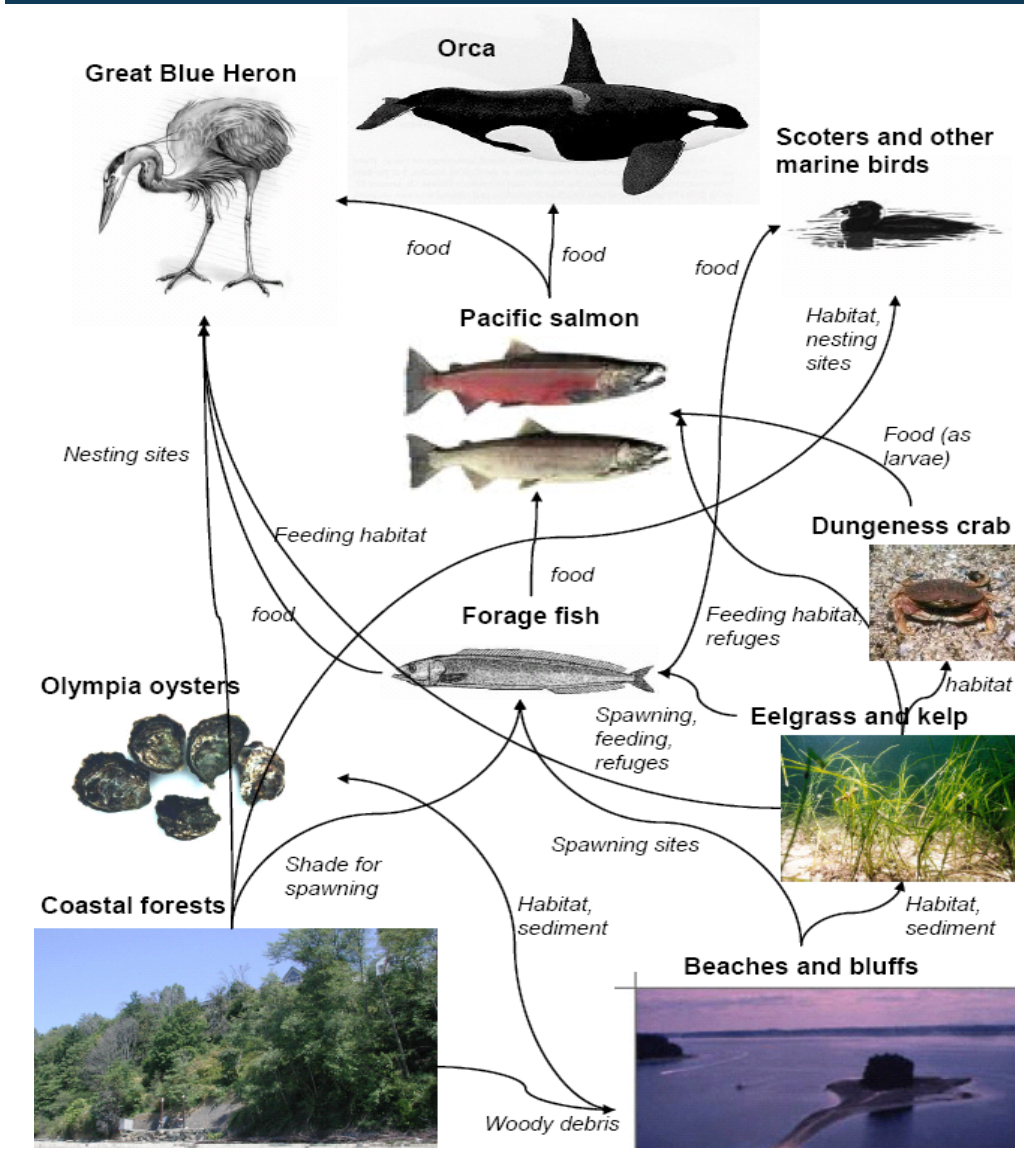
OVERVIEW

- Coastal Processes
- Climate Change on the Coast
- Adaptation Actions
- Q&A



COASTAL PROCESSES

PUGET SOUND INTERCONNECTED COMPONENTS



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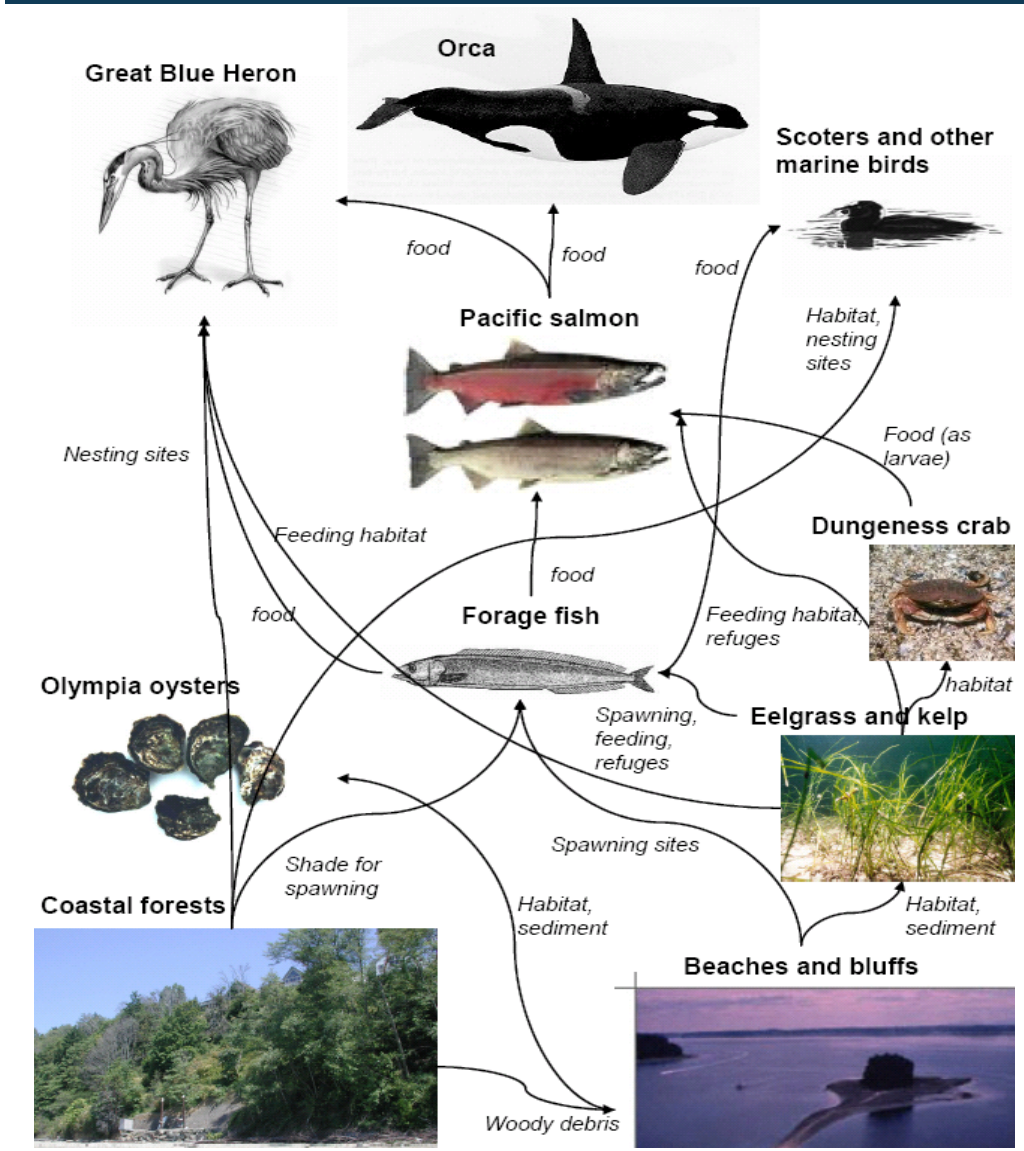
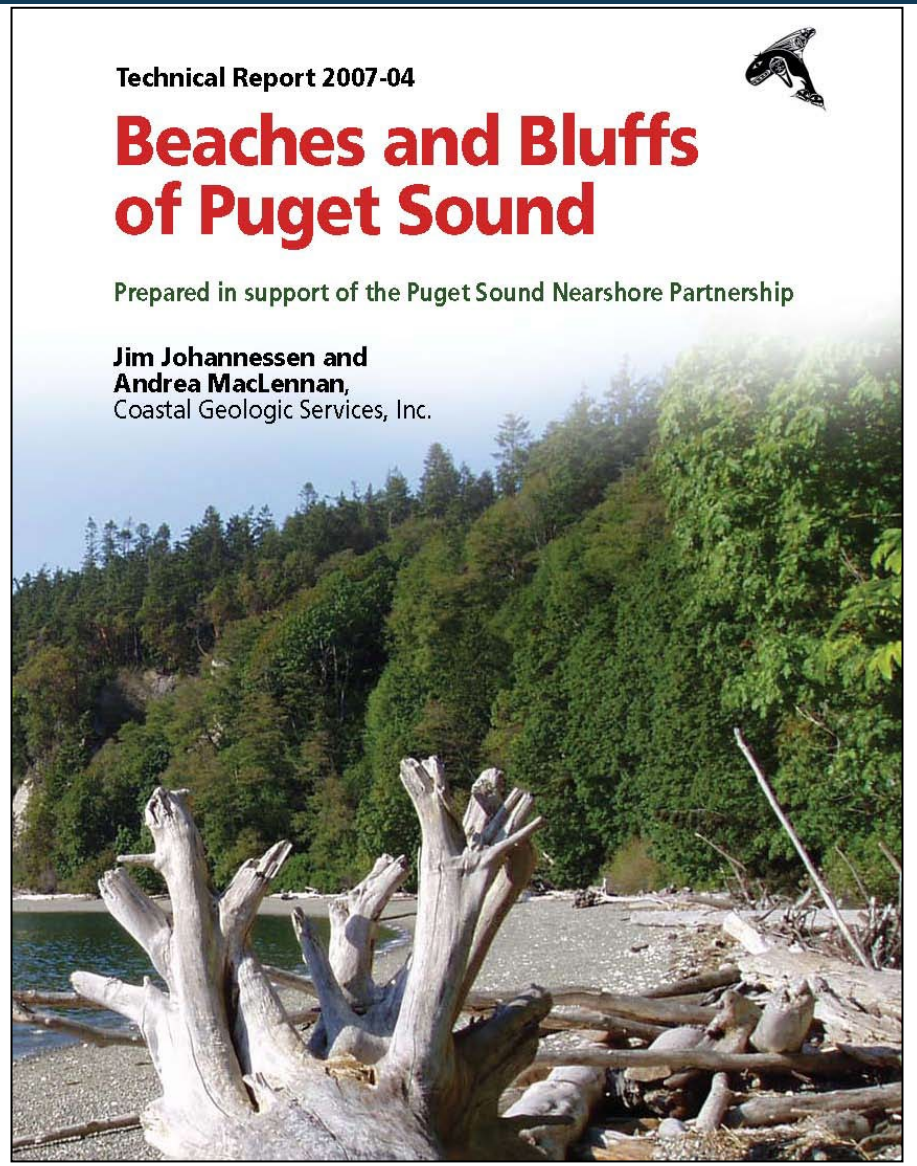
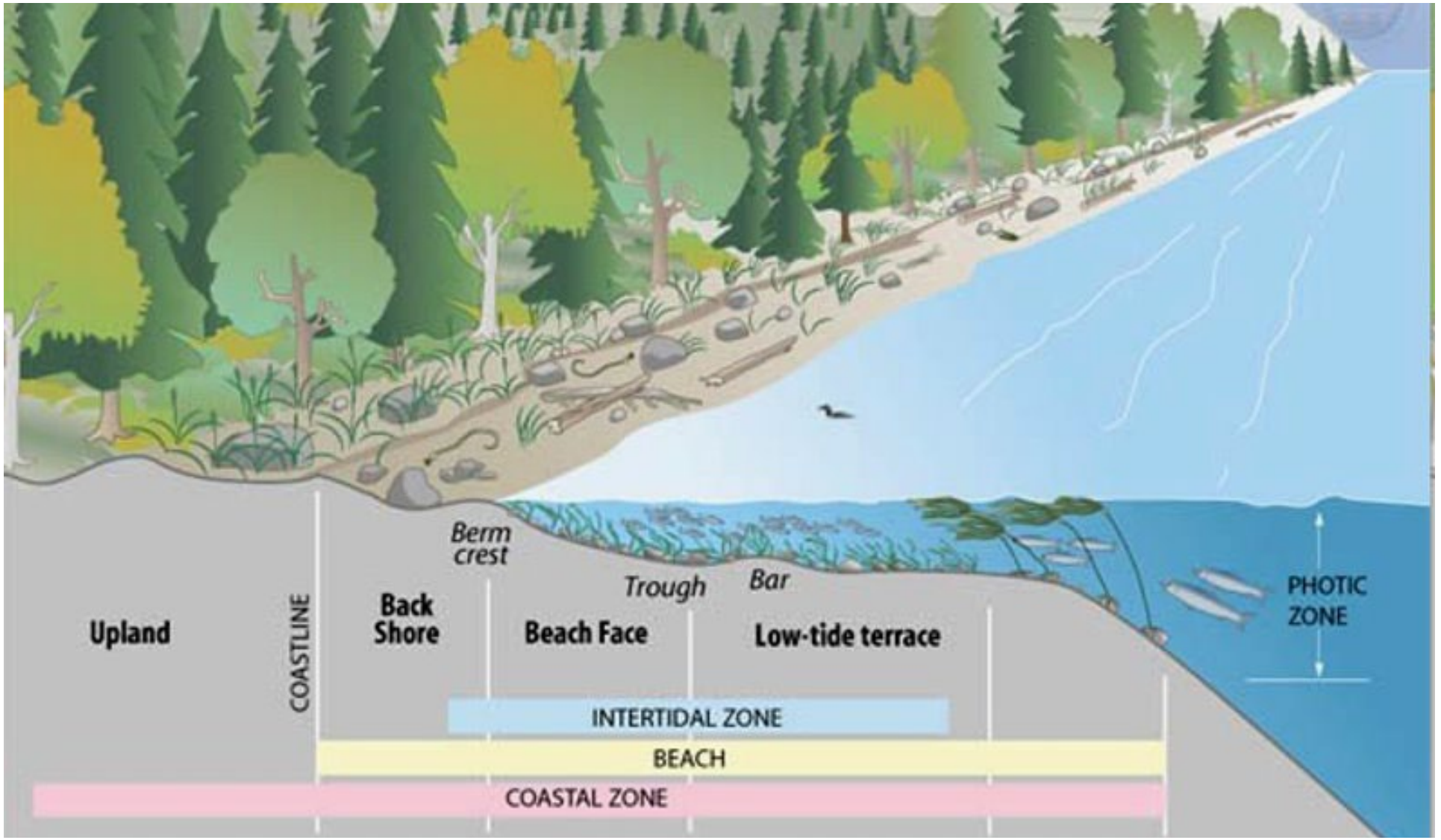
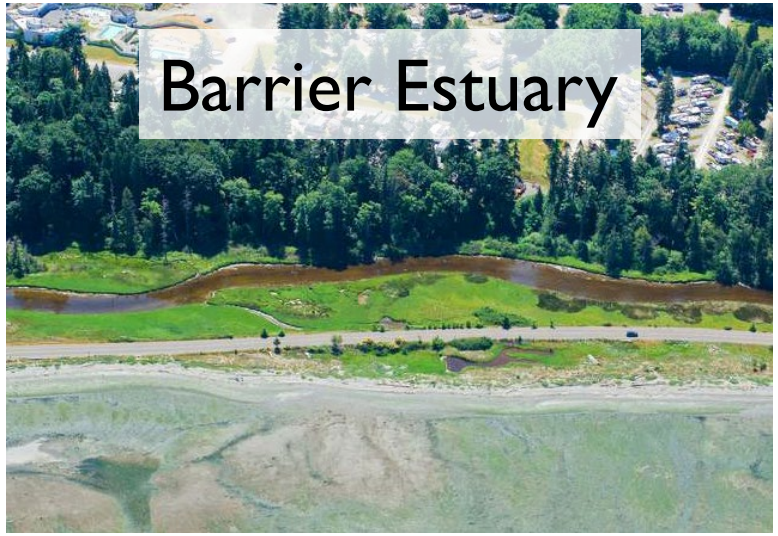




COASTAL SYSTEM IN PUGET SOUND



SHORETYPES OF PUGET SOUND



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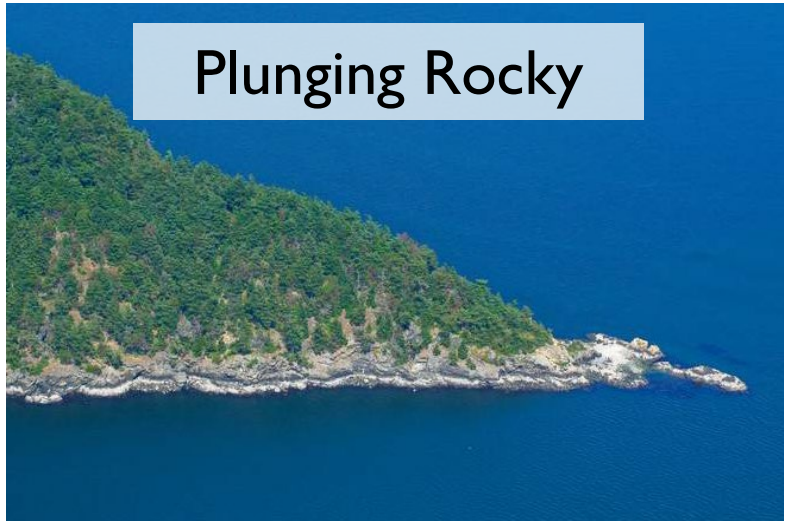
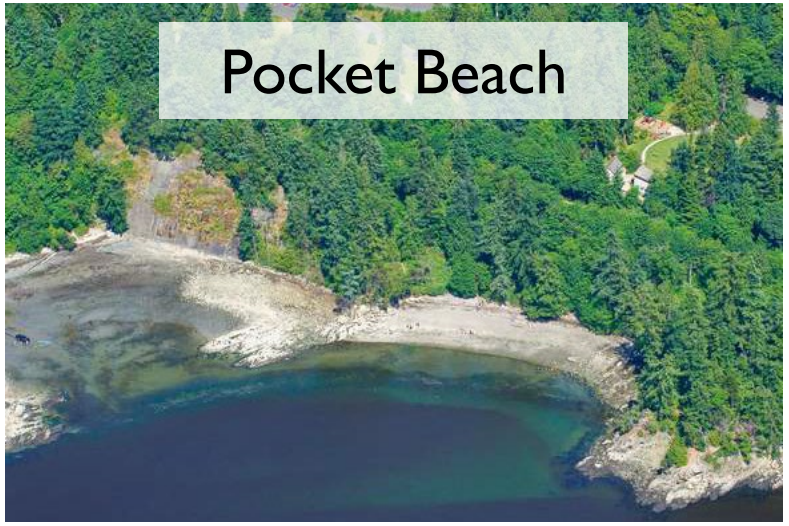
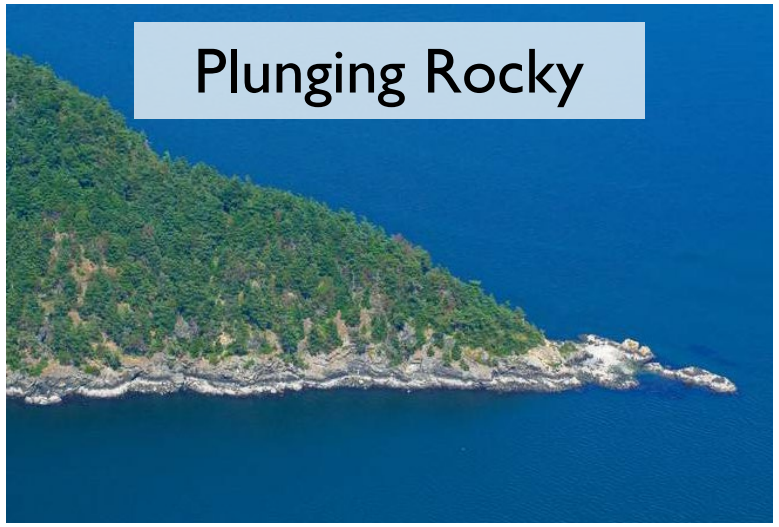


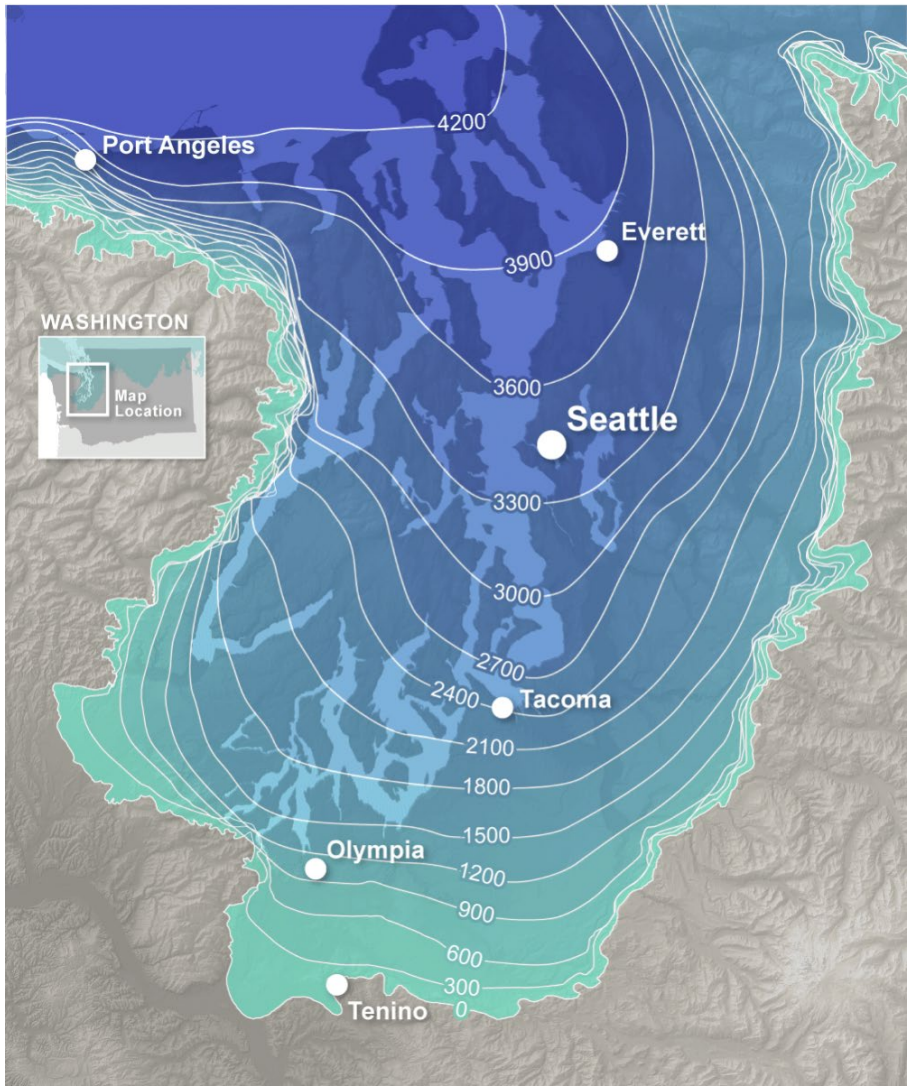
SHORETYPES OF PUGET SOUND

SHORETYPES OF KITSAP COUNTY



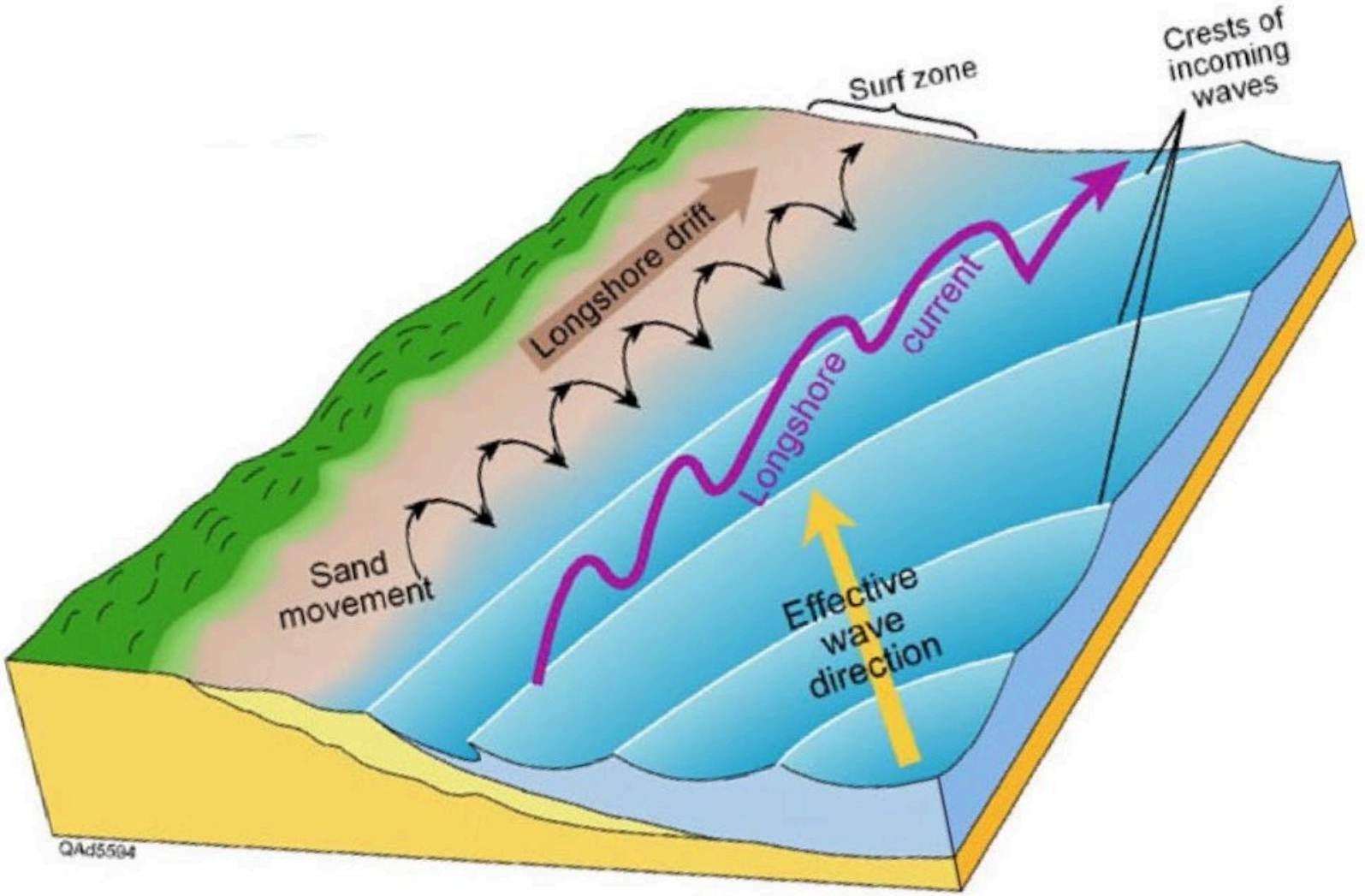


SHORE GEOMORPHIC HISTORY



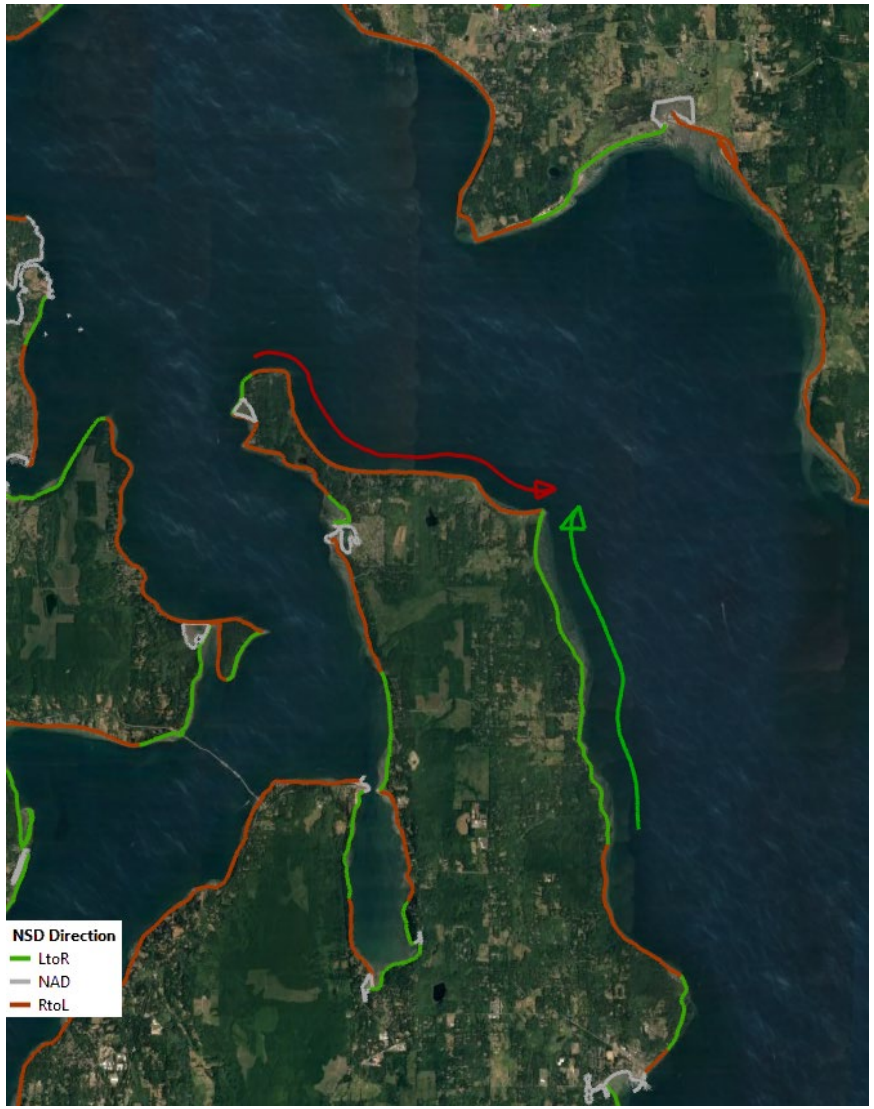
- Glacial legacy
- Vashon Stade: 13,000 -16,000 years ago
- Sub-glacial meltwater scoured N-S trending basins
- Ice melted, sea levels rose, land uplifted (5000 ya)
- Our modern shores began their evolution

LONGSHORE DRIFT



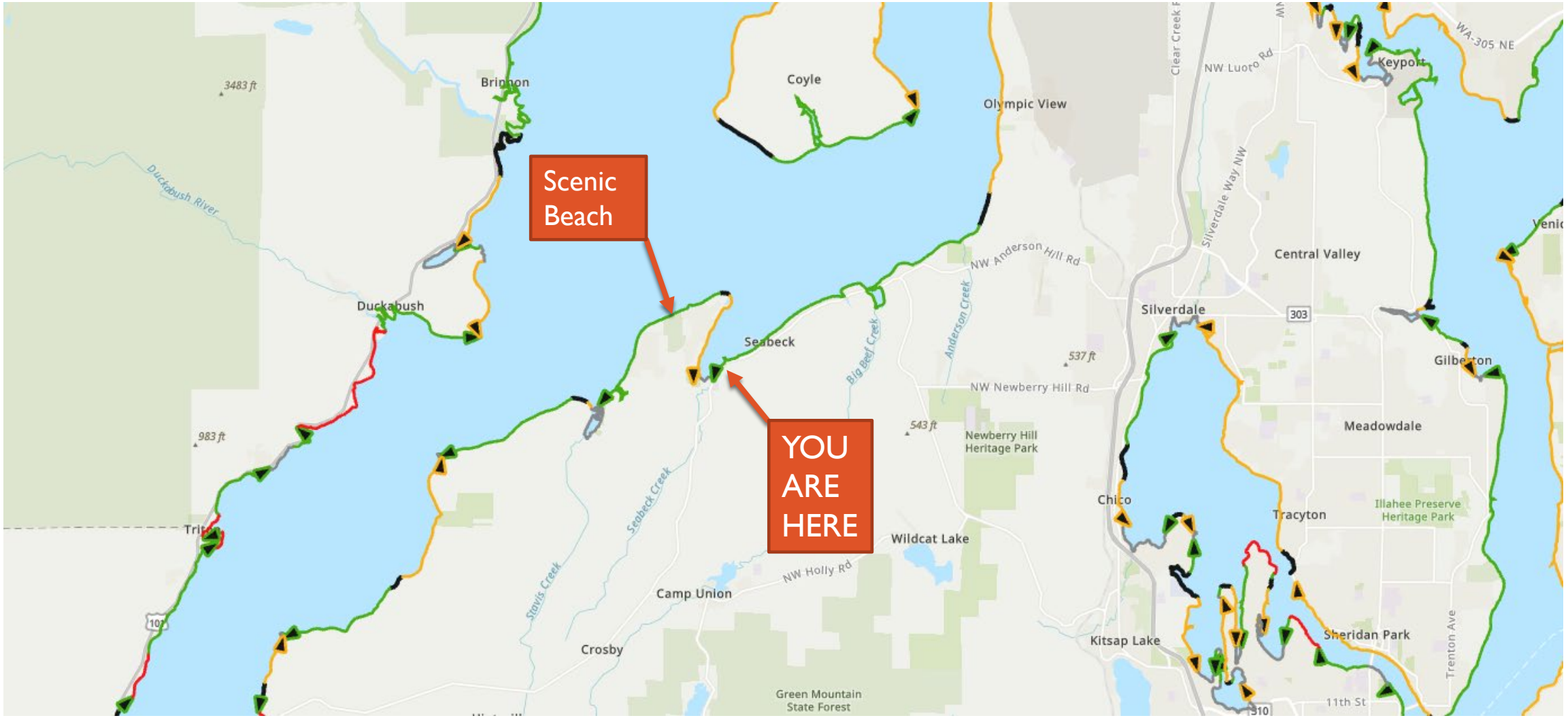
Net Shore-Drift is the long-term direction that sediment moves

NET SHORE-DRIFT CELLS



- Sediment system with predominant direction of littoral drift
- Landforms evolve over time in interdependent system
- ~900 cells in Puget Sound region
- Areas outside drift cells; NAD shores
- Divergence zones
- Obstructions to drift

NET SHORE-DRIFT CELLS



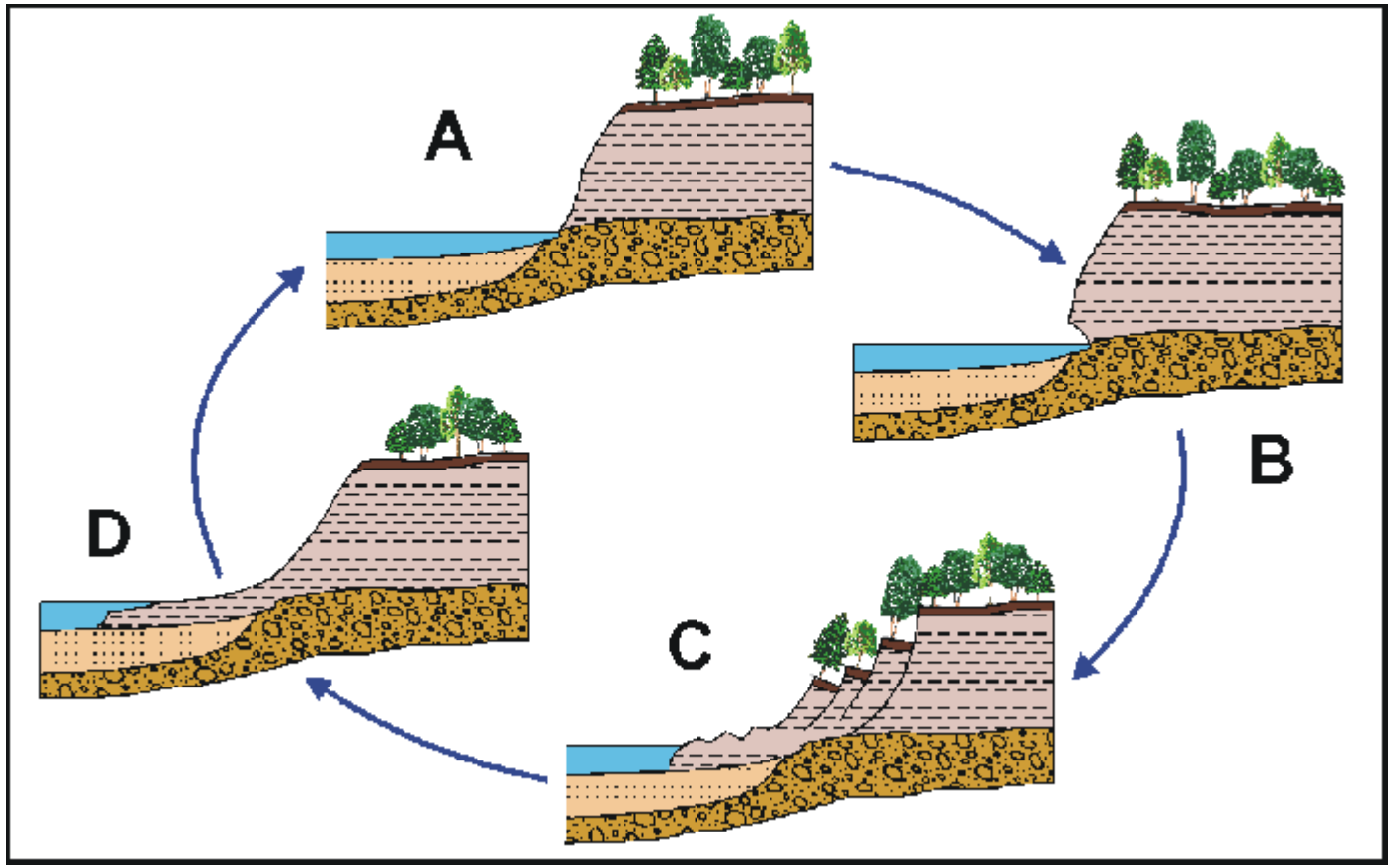
Screenshot from WA Dept of Ecology Coastal Atlas website

DRIVERS OF EROSION

- Coastal bluff erosion results from numerous interacting variables
  - Natural processes
  - Sea level, climate
  - Site specific drivers

Waves in Puget Sound are limited and are NOT the sole trigger of bluff erosion

DRIVERS OF EROSION

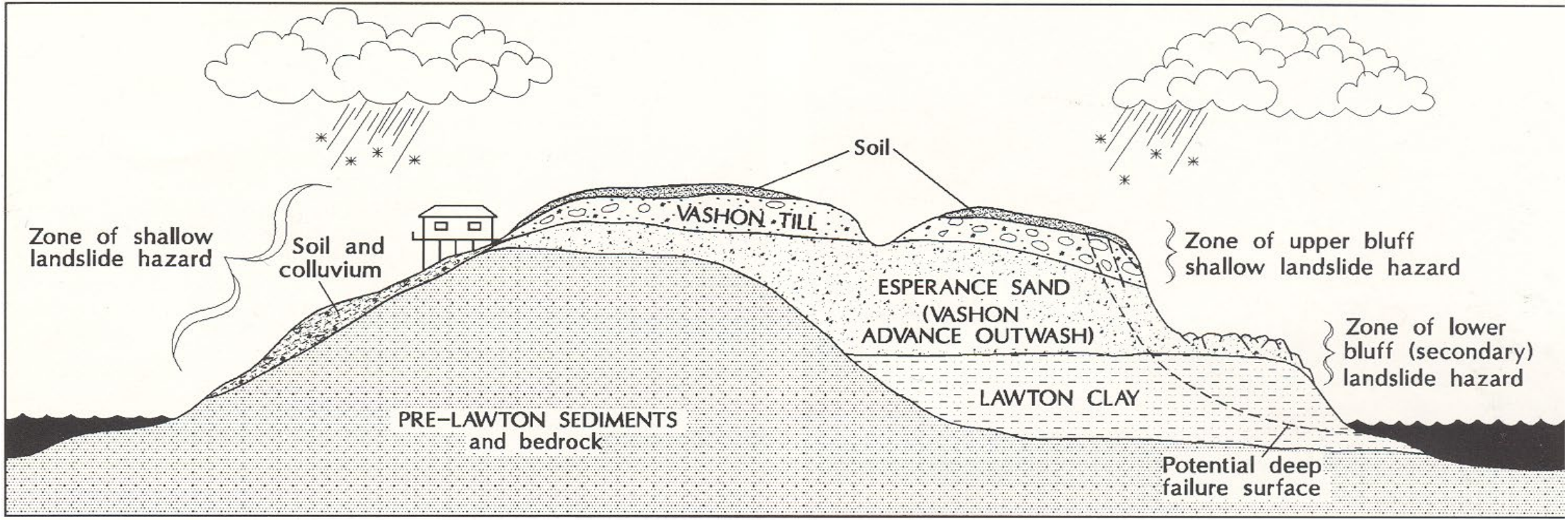


Salish Sea bluff erosion is often driven by a combination of variables:

- Marine induced erosion (shown here)
- Sub-aerial erosion (upland geology, hydrology, topography)
- Human-induced erosion (land management)

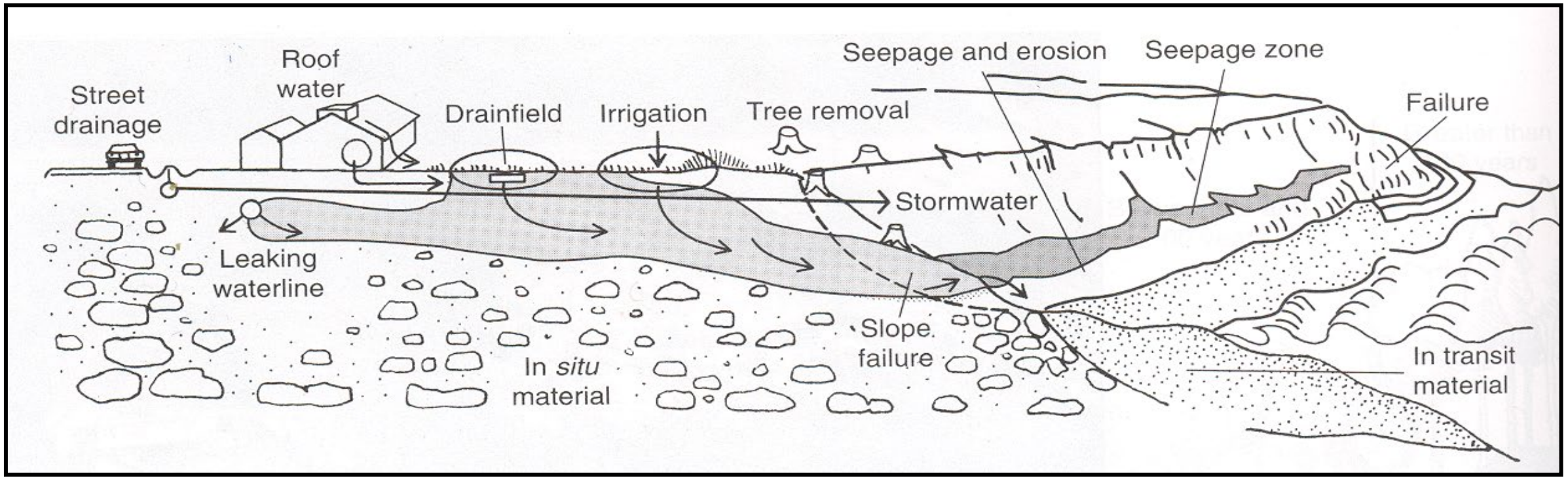
DRIVERS OF EROSION

Sub-aerial erosion: stratigraphy, heavy precipitation events, landslide history



DRIVERS OF EROSION

- Human-induced erosion
  - Overloading top of bluff, cutting into toe of slope, grading
  - Vegetation removal
  - Water additions- increased surface water run-off
  - Poorly maintained drainage



SHORELINE ARMOR

- Impacts of Shore Armor
  - Burial of beach and berm
  - Increase wave reflection
  - Beach erosion
  - Reduced sediment input
  - Impacts to littoral drift
  - Additional armoring
  - Habitats lost

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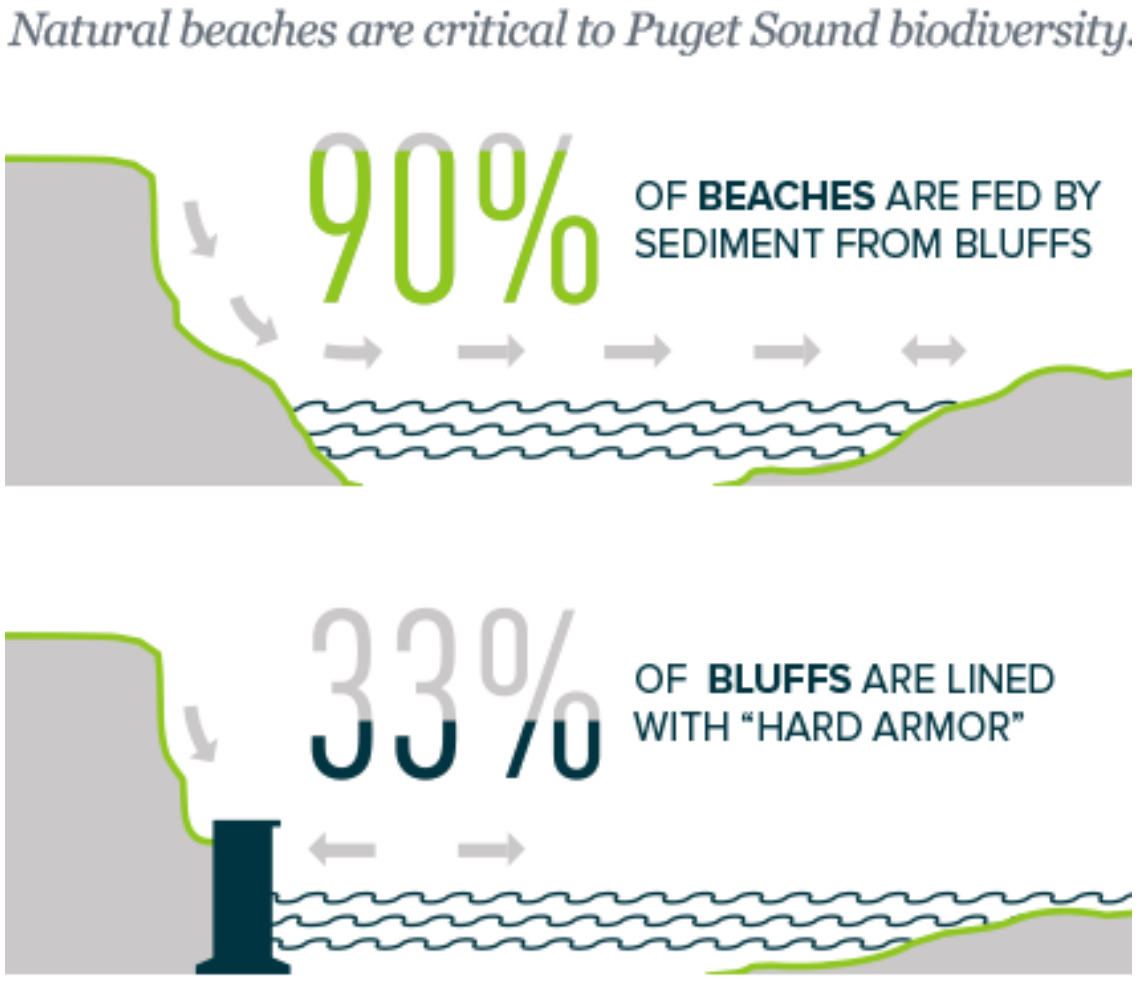

COASTAL PROCESSES SUMMARY

- Waves shape our coasts; formed by winds (except in Straits)

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- Coasts are continually evolving: *Erosion - Transport - Deposition*
- Net shore-drift *forms & maintains* beaches and nearshore habitats
- Net shore-drift cells are best unit for understanding coast

CLIMATE CHANGE ON THE COAST

Mycoast.org

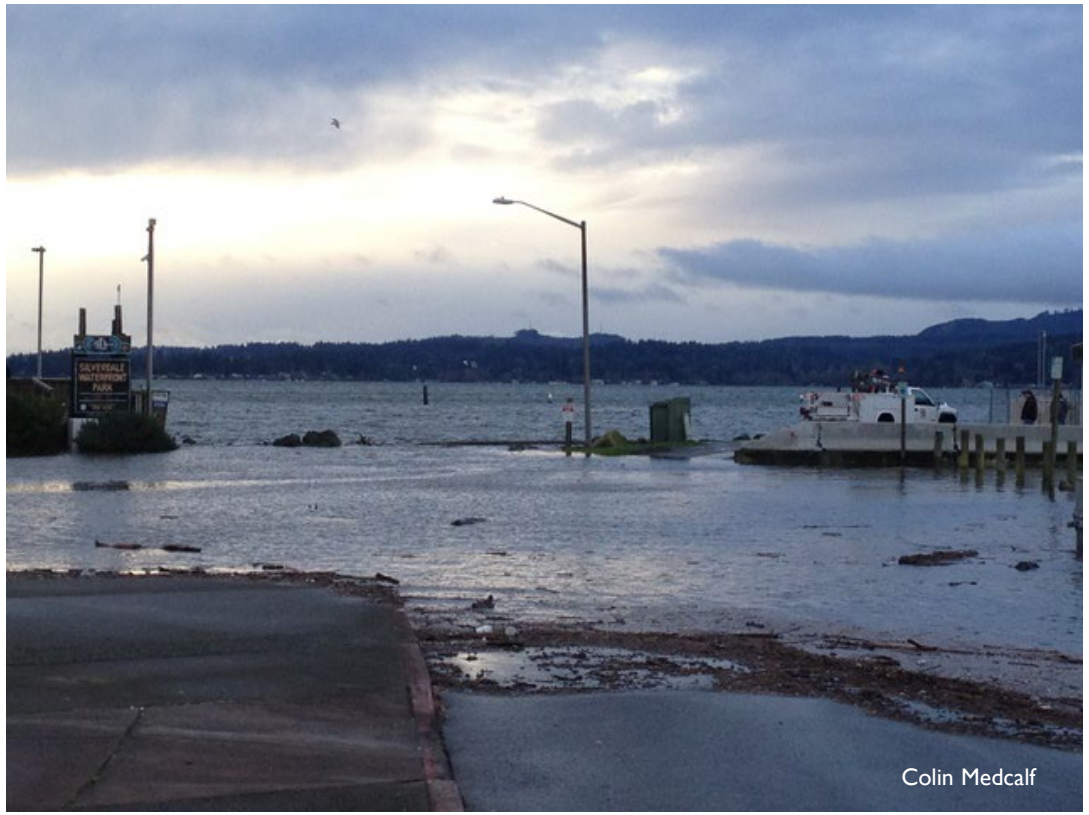
SIGNS OF CHANGE

Flooding

Erosion

KING TIDE – DECEMBER 27, 2022

Hansville



Silverdale Waterfront Park

KING TIDE – DECEMBER 27, 2022

Port Orchard

KING TIDE – DECEMBER 27, 2022

Port Gamble

Poulsbo

Mycoast.org

FLOODING

What causes coastal flooding?

- Heavy precipitation events
- Increased river flows
- Sea level rise
- Wind-driven waves
- Storm surge
- High tides and king tides
- Tsunamis

FLOODING

What is intensified by climate change?

- Heavy precipitation events
- Increased river flows
- Sea level rise
- Wind-driven waves
- Storm surge
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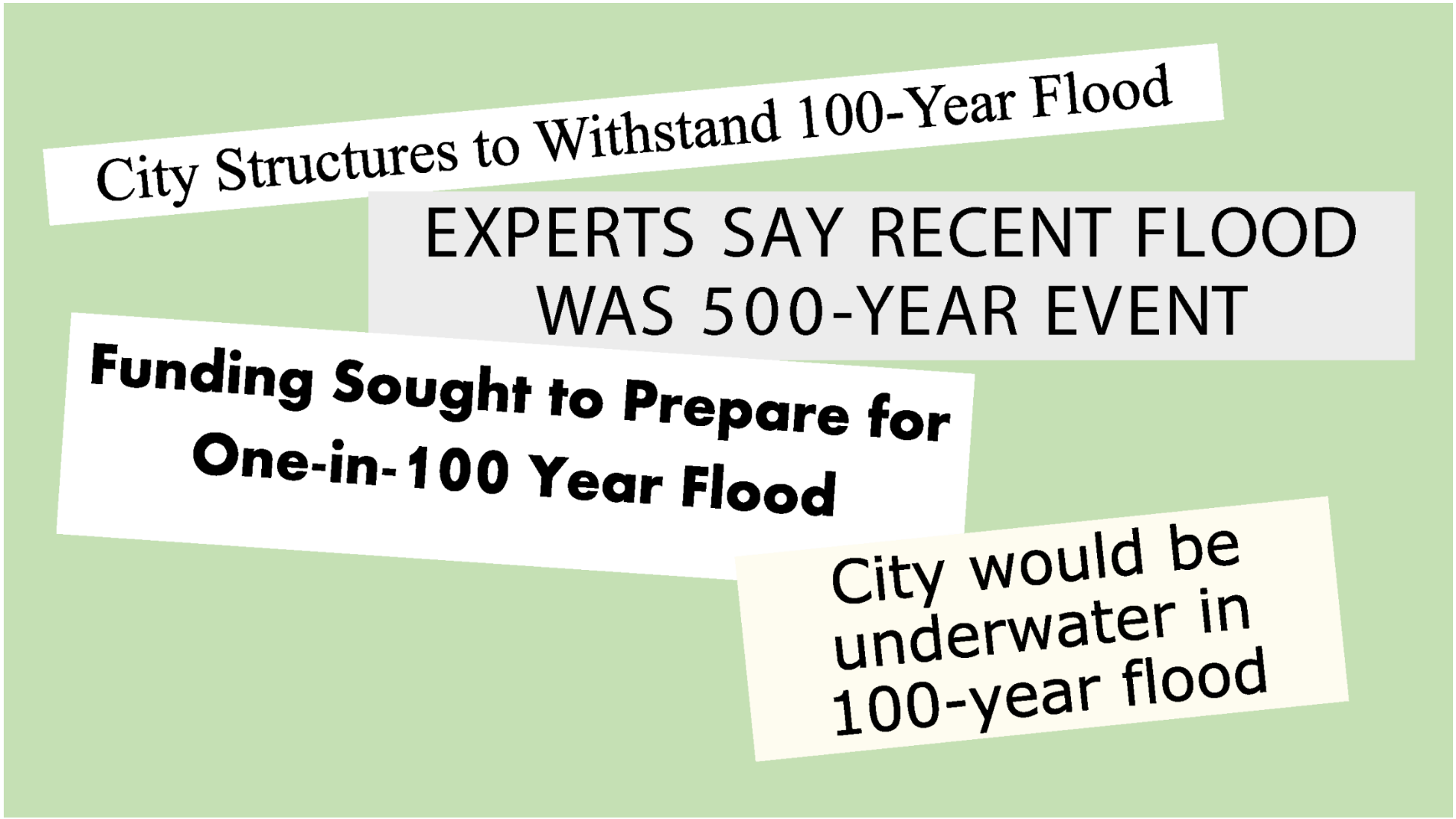
WHAT IS THE 'X-YEAR' EVENT?



WHAT IS THE '20-YEAR' EVENT?

20-year high tide/storm/flood =

1/20 or 0.05% chance of occurring *any* given year

WHAT IS THE '100-YEAR' EVENT?

100-year high tide/storm/flood =

1/100 or 1% chance of occurring *any* given year

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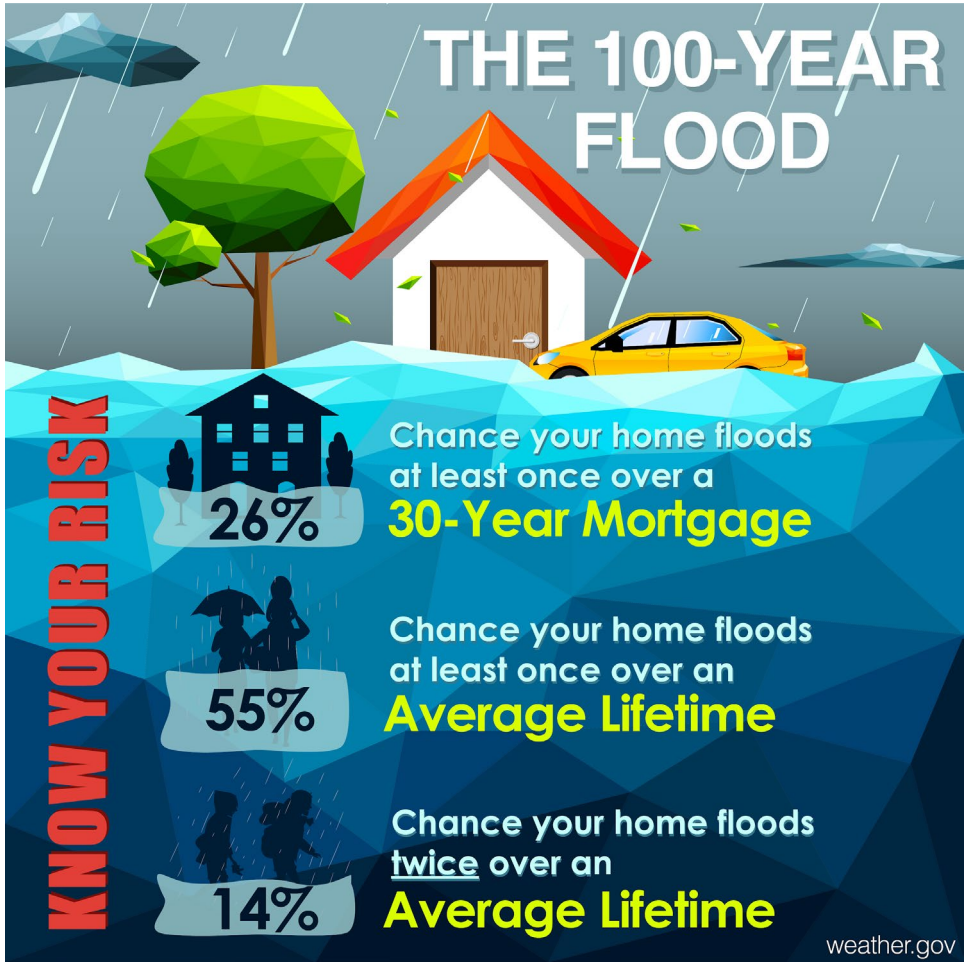

With climate change, events are becoming more frequent

EROSION

What causes erosion?

- Heavy precipitation events
- Flooding
- Sea level rise
- Wind waves
- Storms
- Human activities (shoreline development, vegetation removal, recreation, shoreline armoring, improper drainage)

EROSION

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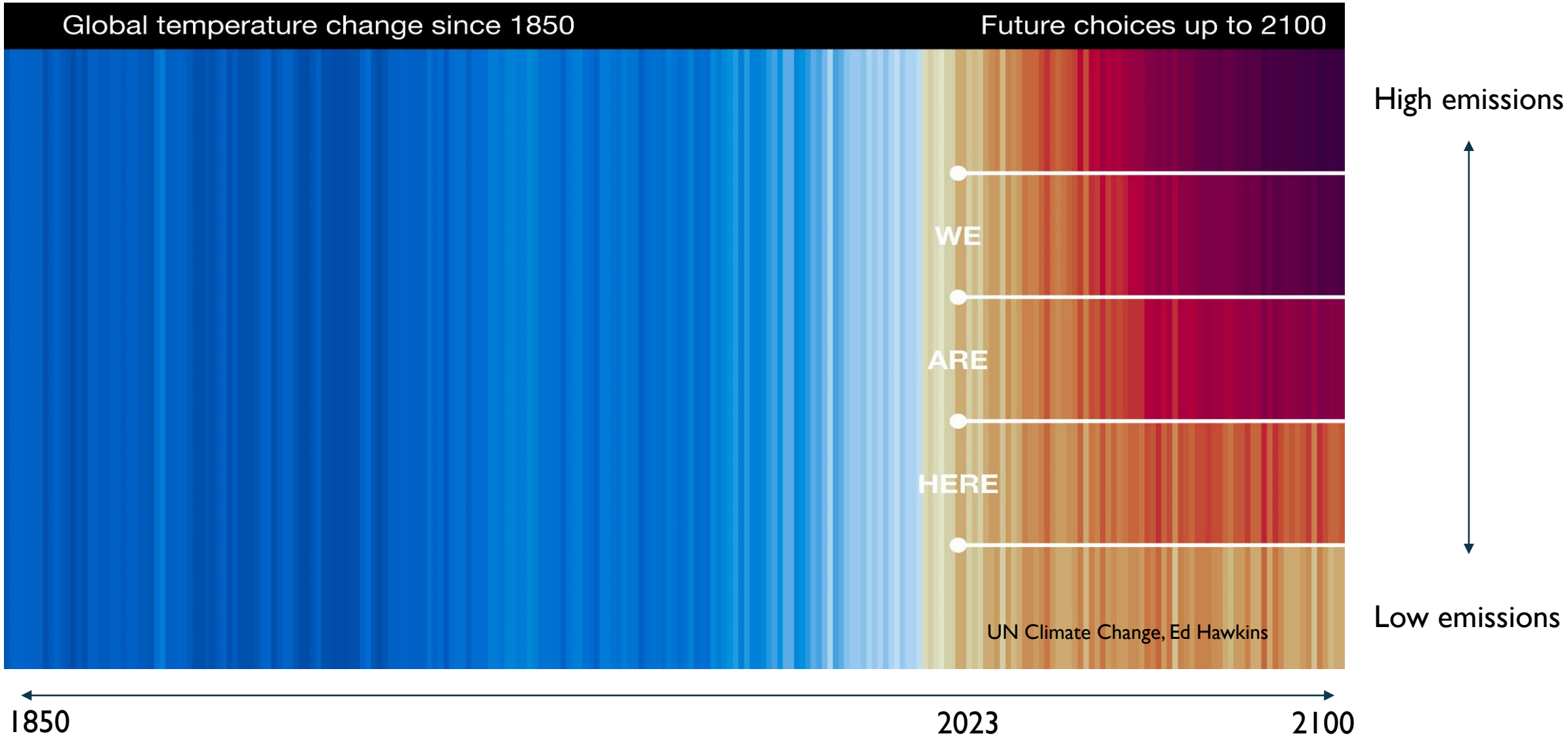
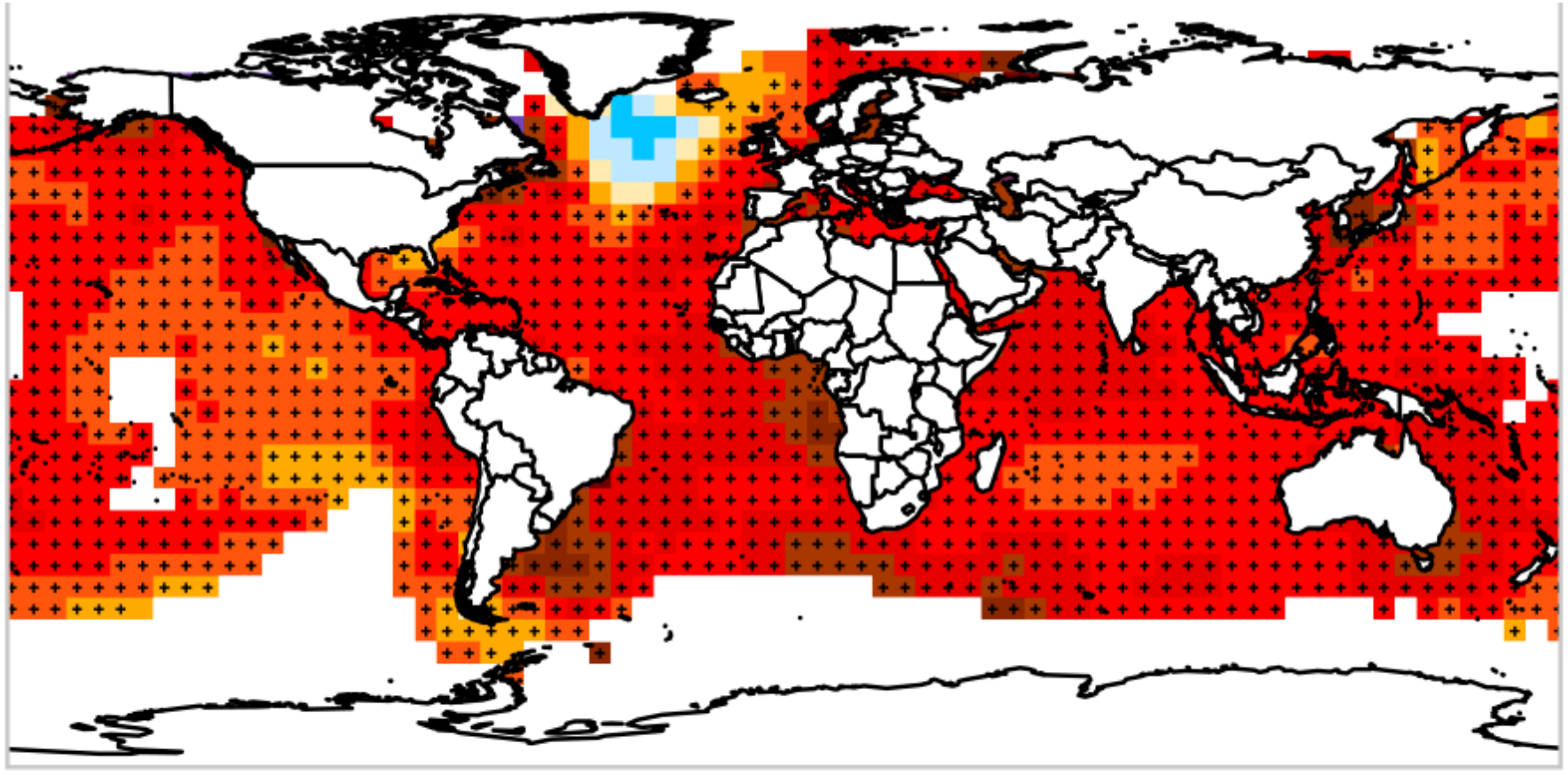
CLIMATE CHANGE DRIVERS – EMISSIONS AND TEMPERATURE



SEA LEVEL RISE: WHAT'S CAUSING IT?



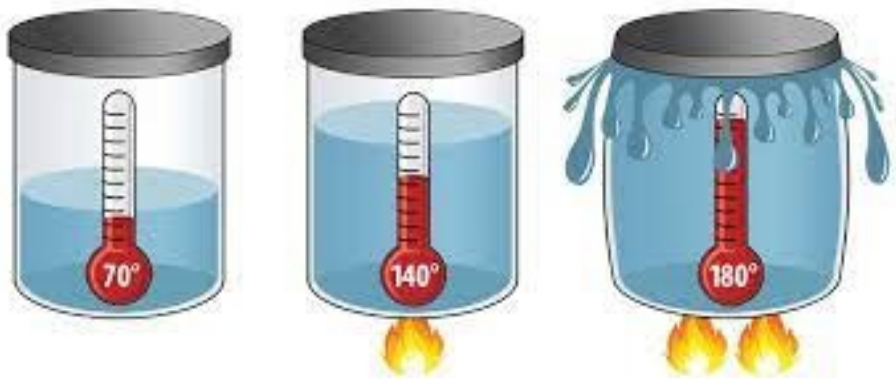
Change in sea surface temperature (°F):

-1 -0.5 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 Insufficient data

US EPA; NOAA

SEA LEVEL RISE: WHAT'S CAUSING IT?

1. Thermal Expansion



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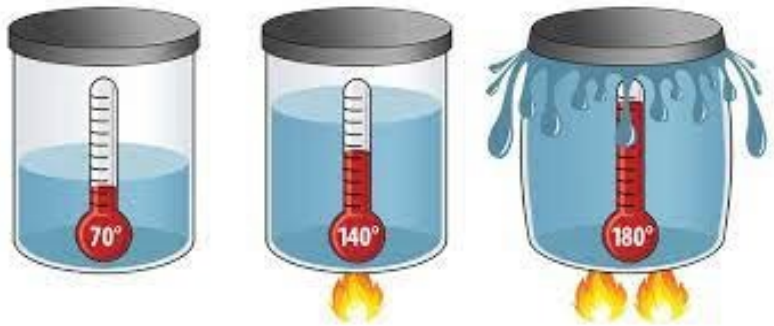
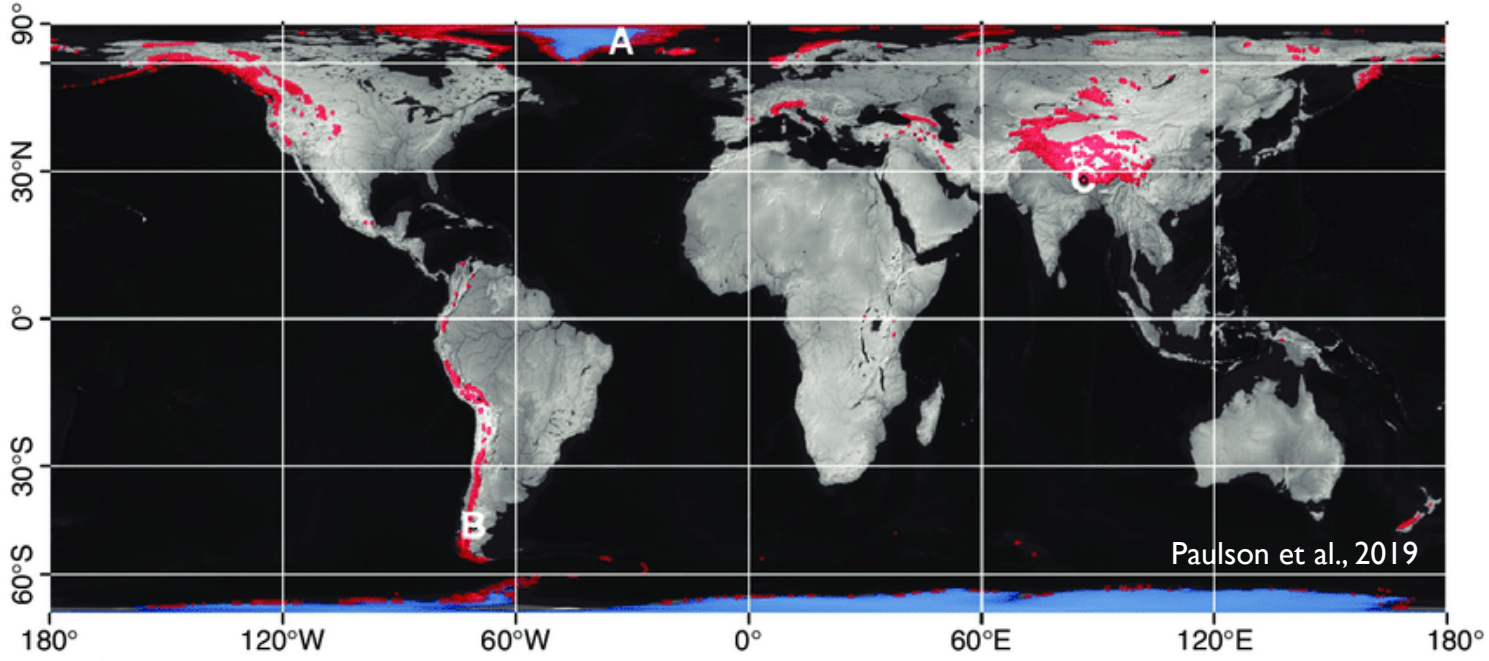


2. Melting of land ice – glaciers, ice caps, and ice sheets

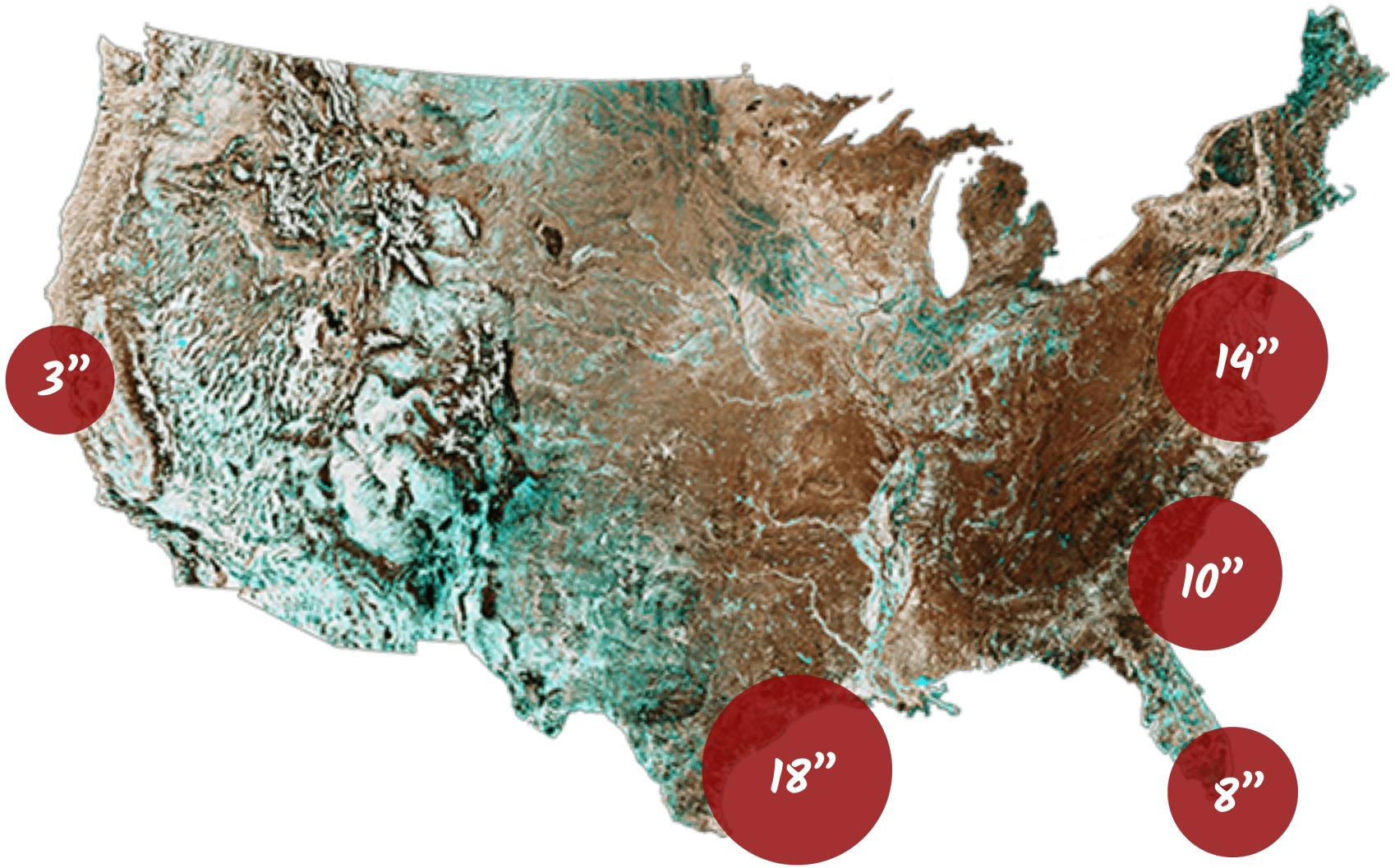


Ice caps

Glaciers and ice sheets

SEA LEVEL RISE: WHY IS IT DIFFERENT PLACE TO PLACE?

Inches of sea level rise since 1950



Sealevelrise.org

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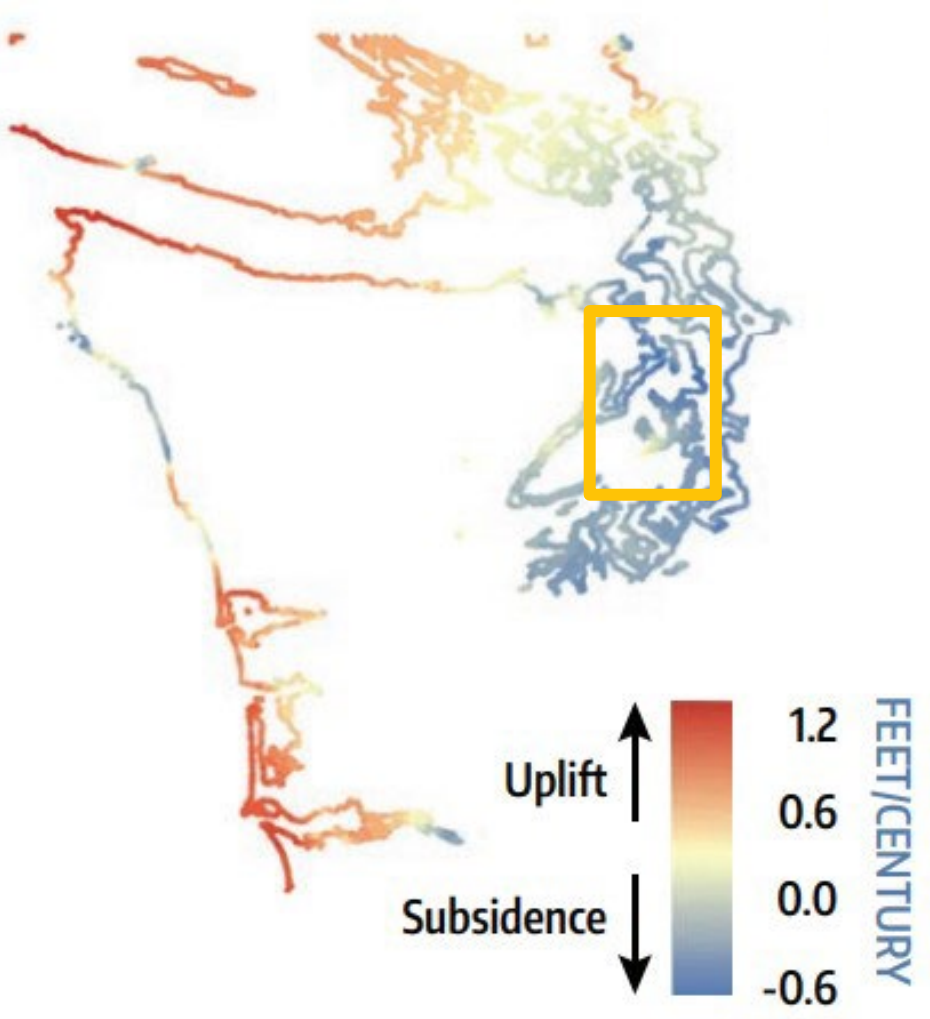

Miller et al., 2018

Vertical Land Motion

- Over time, land sinks and rises

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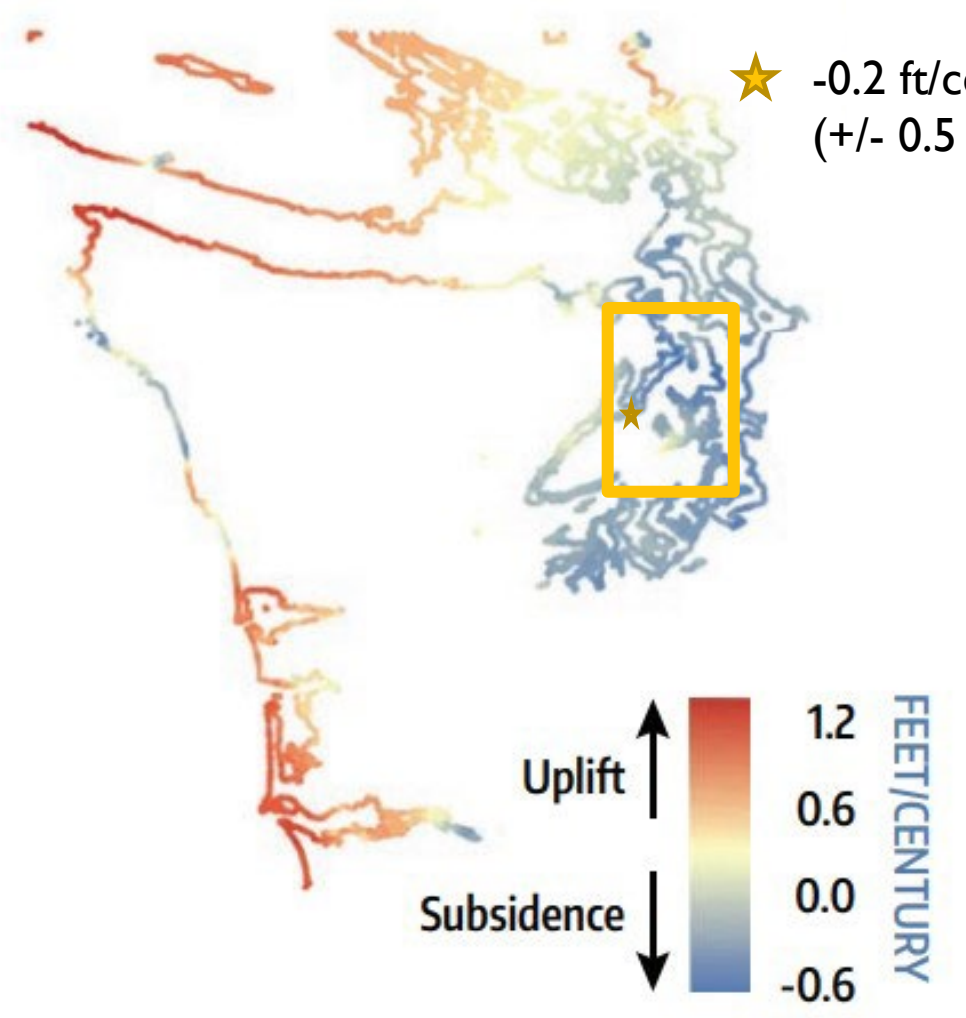

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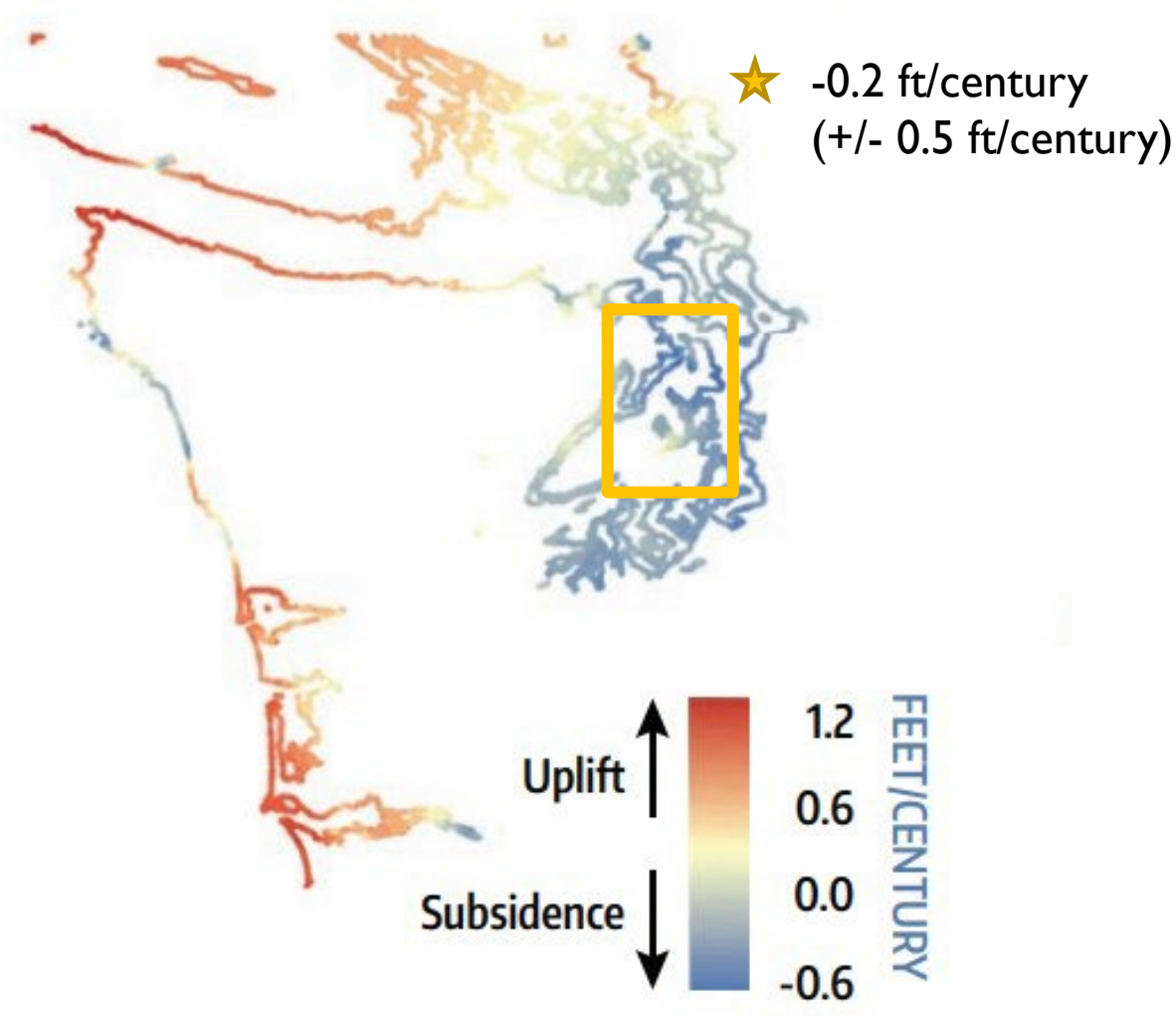


Miller et al., 2018

Vertical Land Motion

- Over time, land sinks and rises
- Localized
- Depends on geology, plate tectonics, land activities
- Sinking land = higher sea level rise

SEA LEVEL RISE:WHAT'S NEXT?

SEA LEVEL RISE: WHAT'S NEXT?

Select a location to view localized relative sea level rise (RSLR) projections.

Select County (optional)

Kitsap

Select WRIA (optional)

(All)

Select likelihood(s)

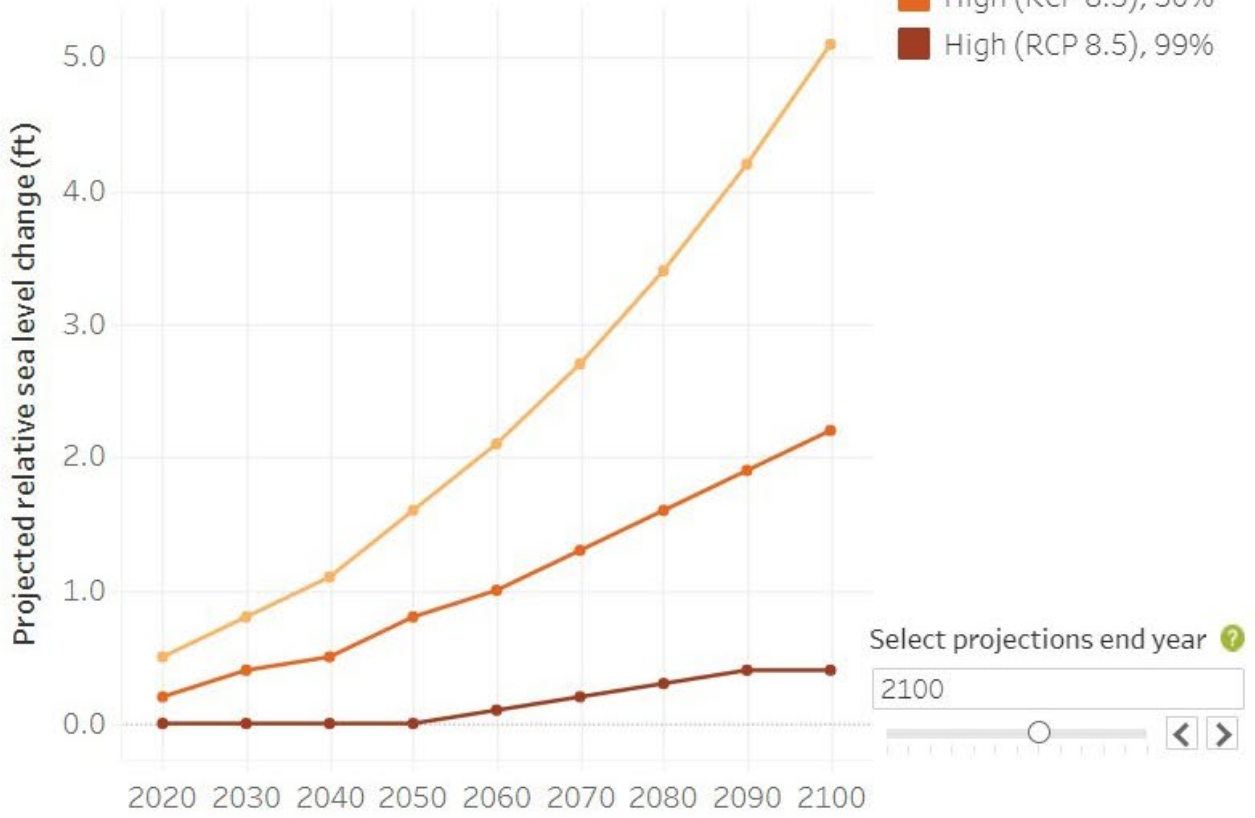
- [ ] 0.1%
- [x] 1%
- [ ] 5%
- [ ] 10%
- [ ] 17%
- [x] 50%
- [ ] 83%
- [ ] 90%
- [ ] 95%
- [x] 99%

Data Estimated for **47.7°, -122.8°**
County: Kitsap
WRIA: 15, Kitsap

RSLR for Selected Location

Projected changes relative to the average sea level over 1991-2009.

Hover for details.



Scenario, Likelihood

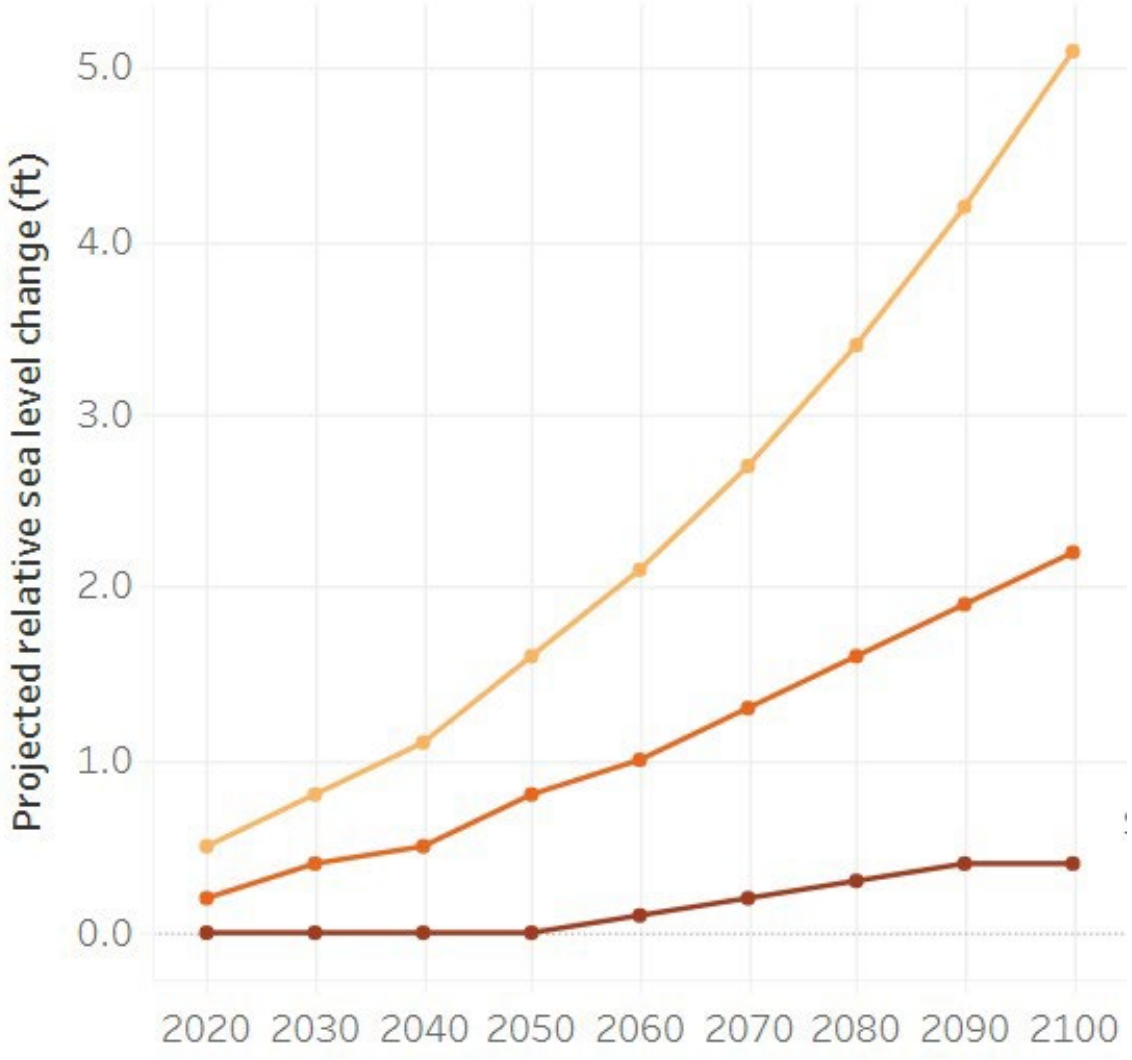
- High (RCP 8.5), 1%
- High (RCP 8.5), 50%
- High (RCP 8.5), 99%

Select projections end year

2100

University of Washington Climate Impacts Group

SEA LEVEL RISE: WHAT'S NEXT?



SLR projections near Seabeck

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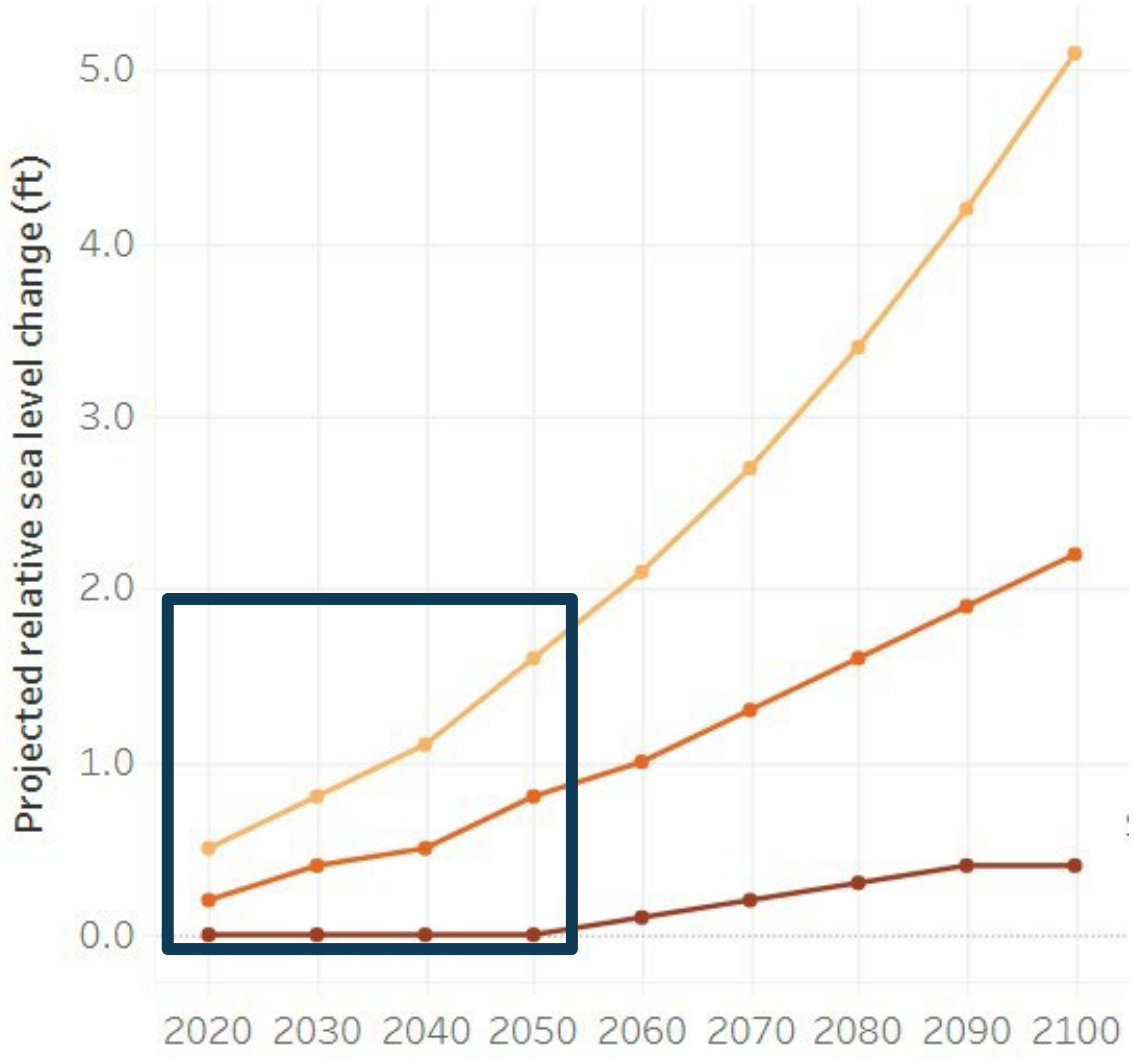
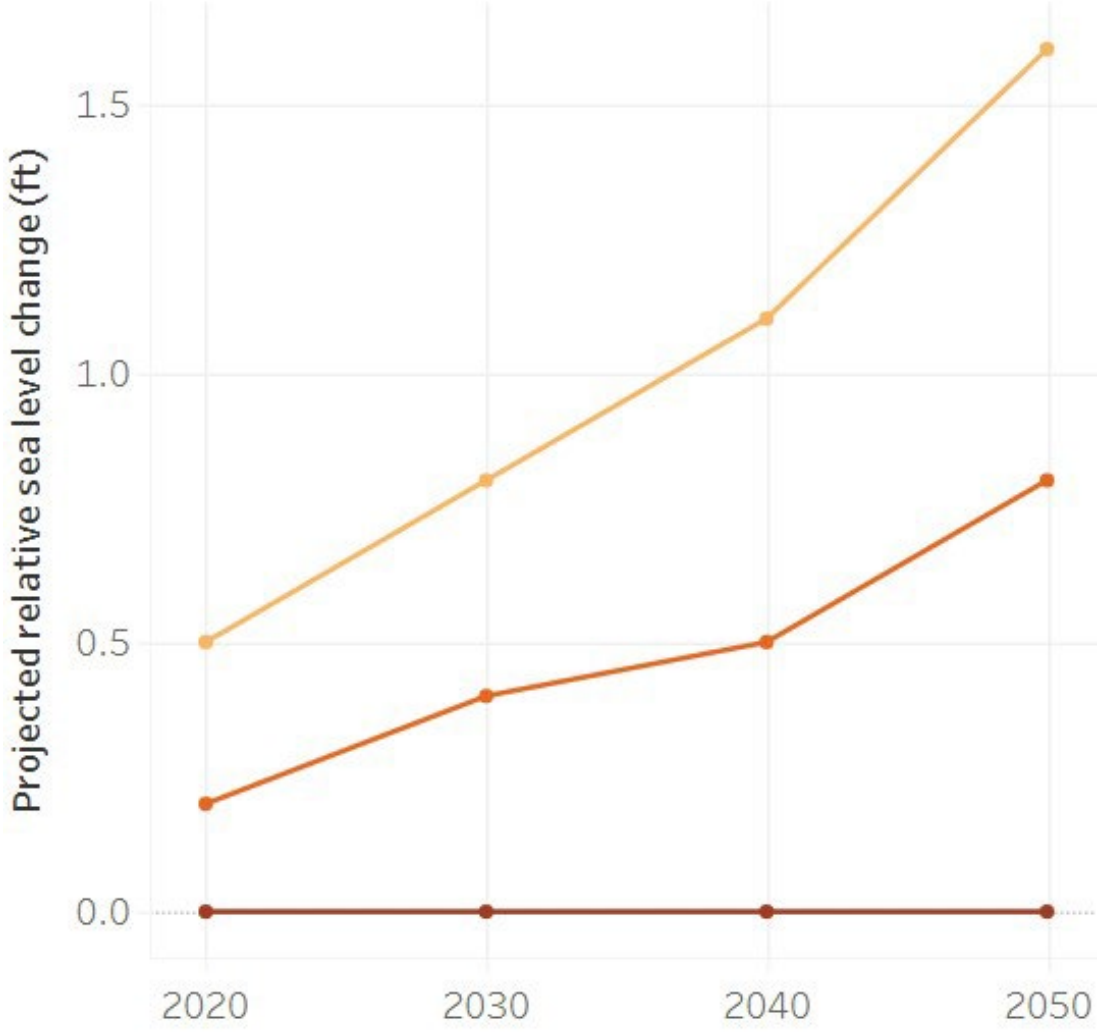


SLR projections near Seabeck

- Two timeframes
  - **Now – 2050**
  - **2050 - 2100**

SEA LEVEL RISE: WHAT'S NEXT? NOW - 2050



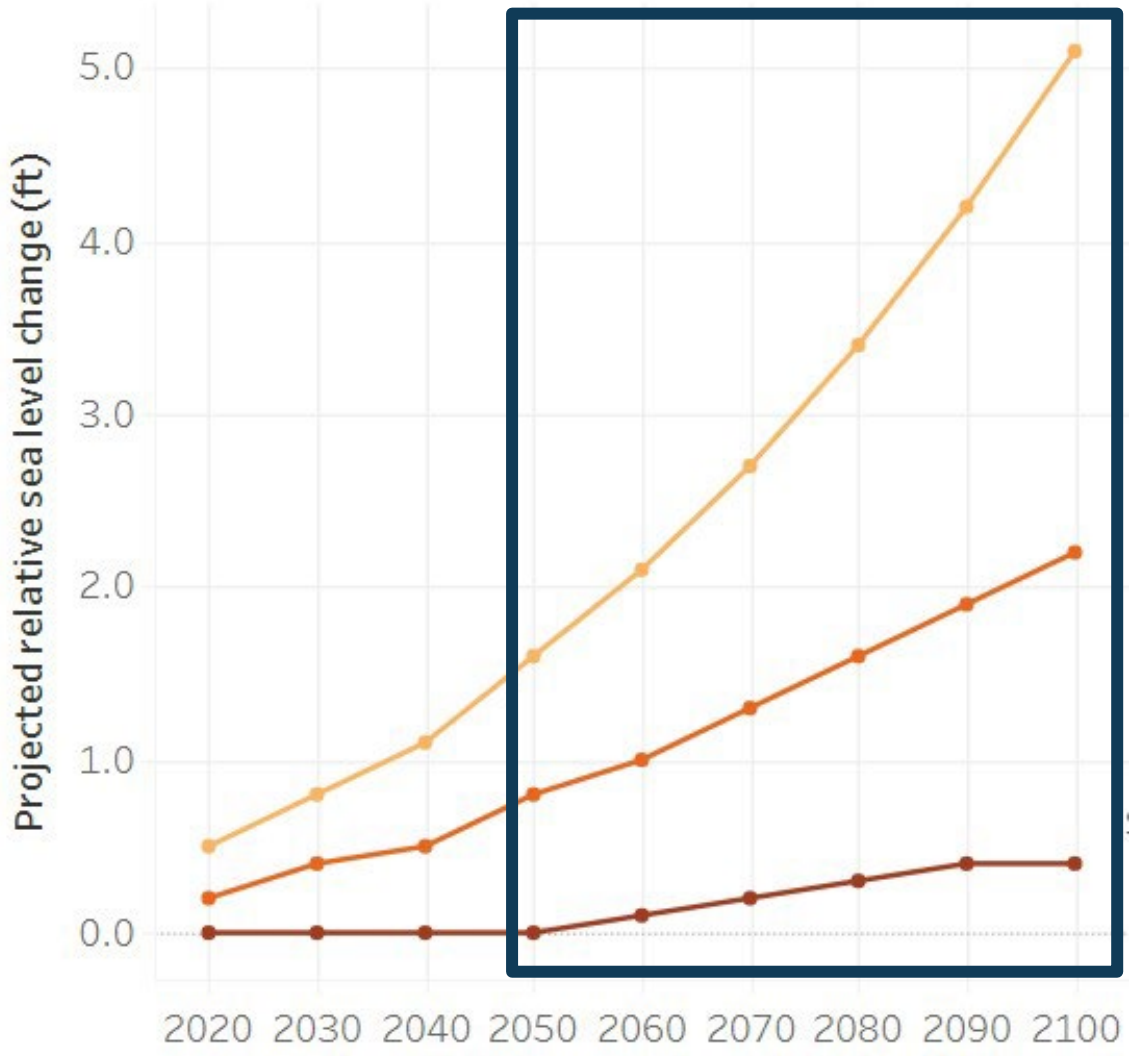
SLR projections near Seabeck

Relative to average sea level 1991 - 2009

Probability that water level will meet or exceed the value

Year	1%	50%	99%
2020	0.5	0.2	0.0
2030	0.8	0.4	0.0
2040	1.1	0.5	0.0
2050	1.6	0.8	0.0

SEA LEVEL RISE: WHAT'S NEXT?



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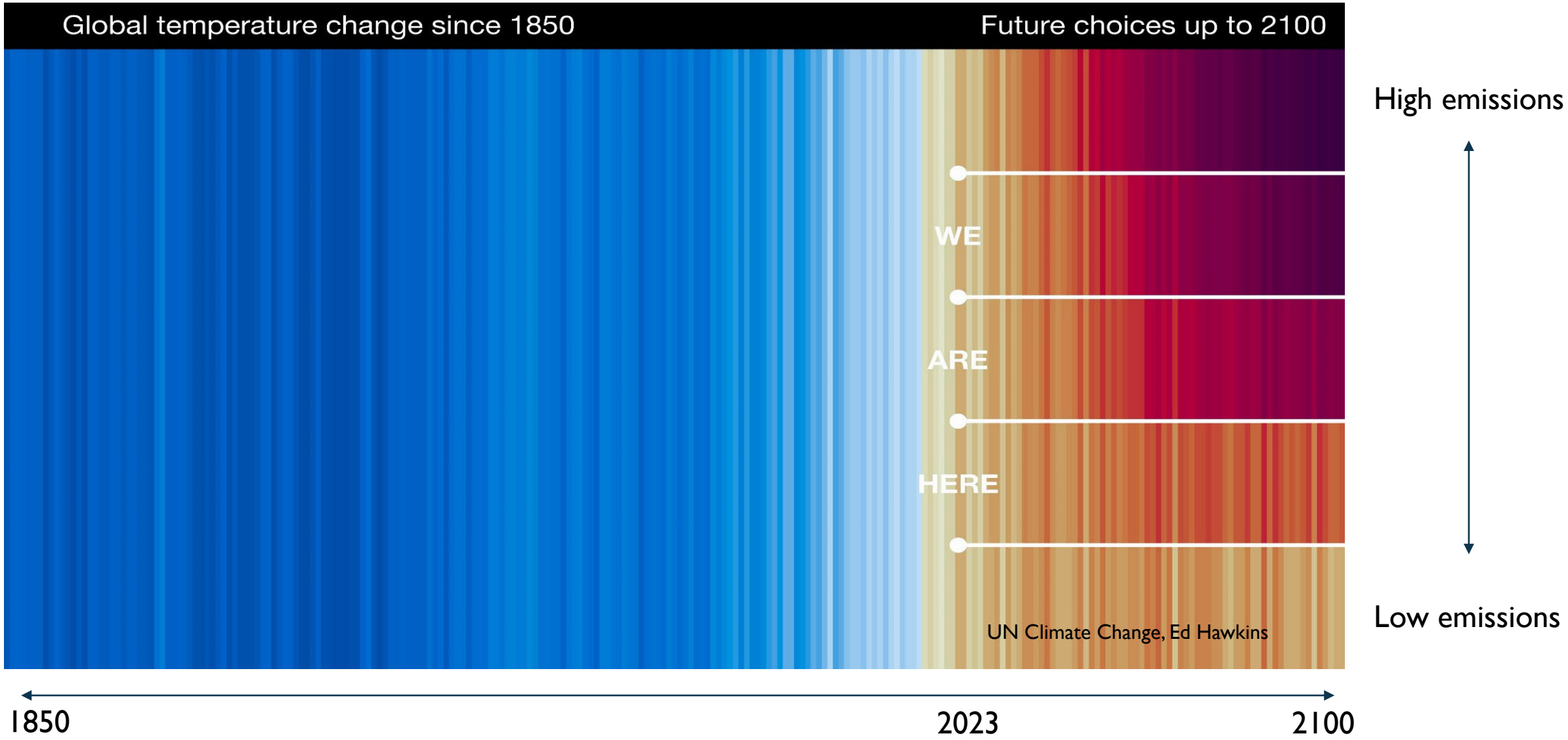
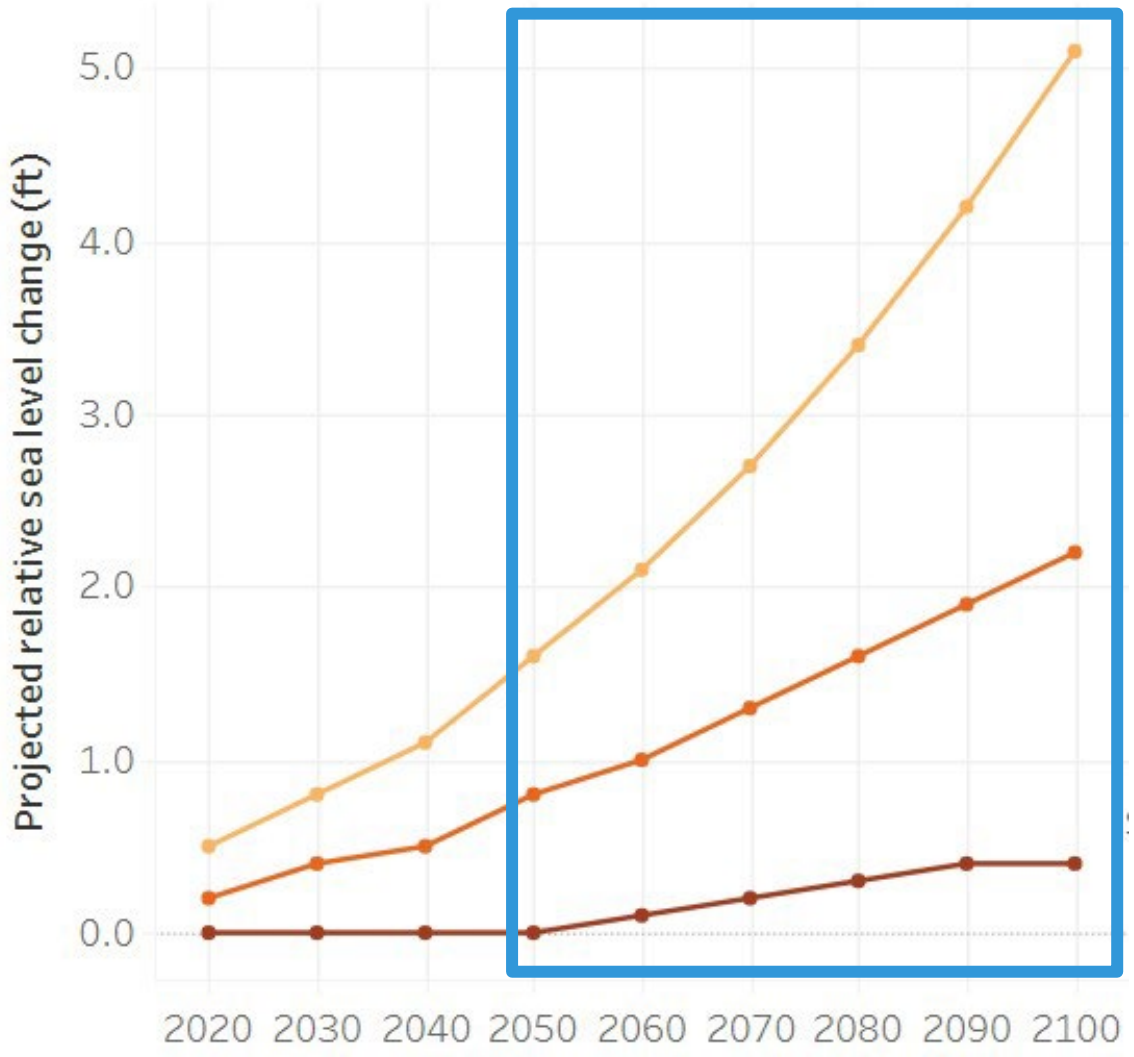
CLIMATE CHANGE DRIVERS – EMISSIONS AND TEMPERATURE



SEA LEVEL RISE: WHAT'S NEXT? 2050 - 2100



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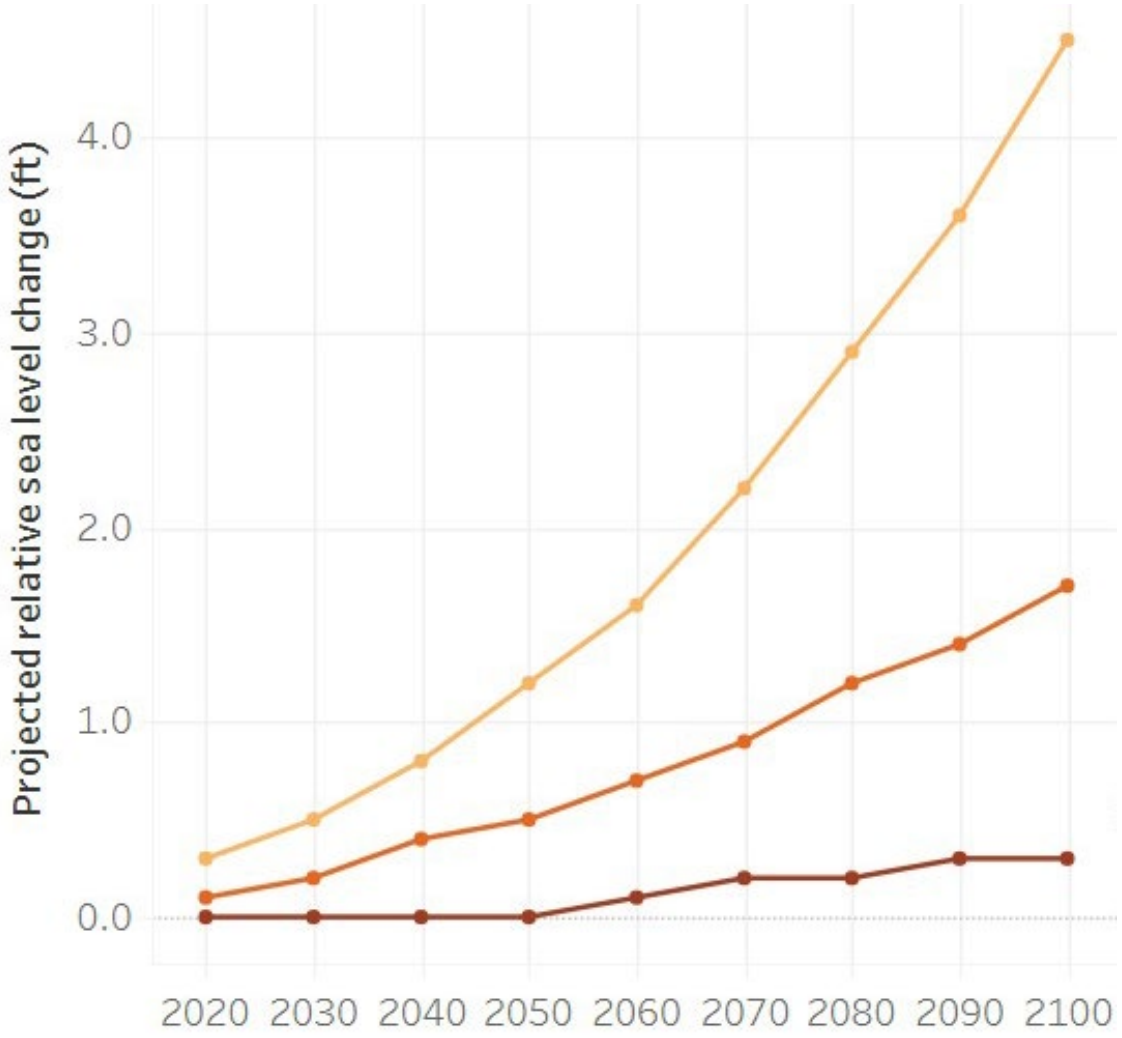
2060	2.1	1.0	0.1
2070	2.7	1.3	0.2
2080	3.4	1.6	0.3
2090	4.2	1.9	0.4
2100	5.1	2.2	0.4

University of Washington Climate Impacts Group

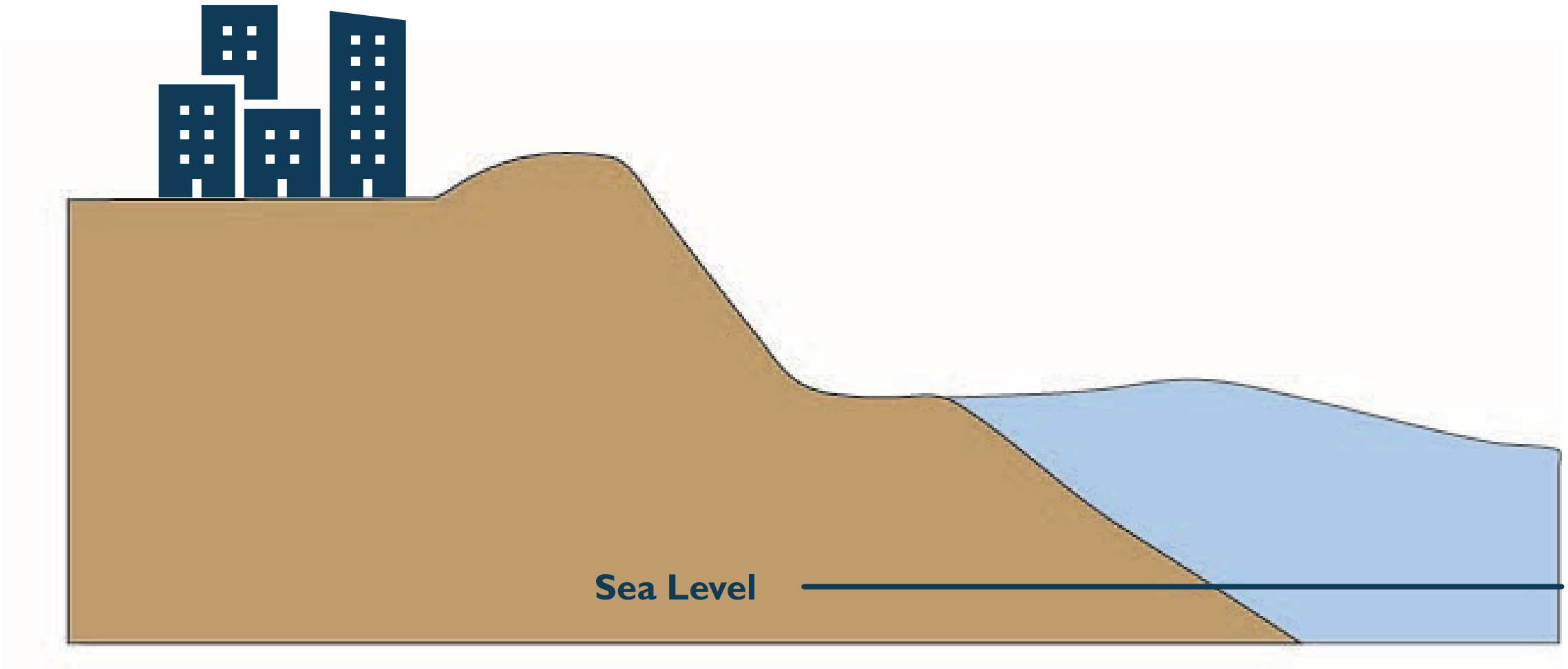
SEA LEVEL RISE: WHAT'S NEXT?



There are multiple possible futures based on past, present, and future emissions

- Sea level will increase under all
- Bigger range in the future

SEA LEVEL SETS THE BASELINE



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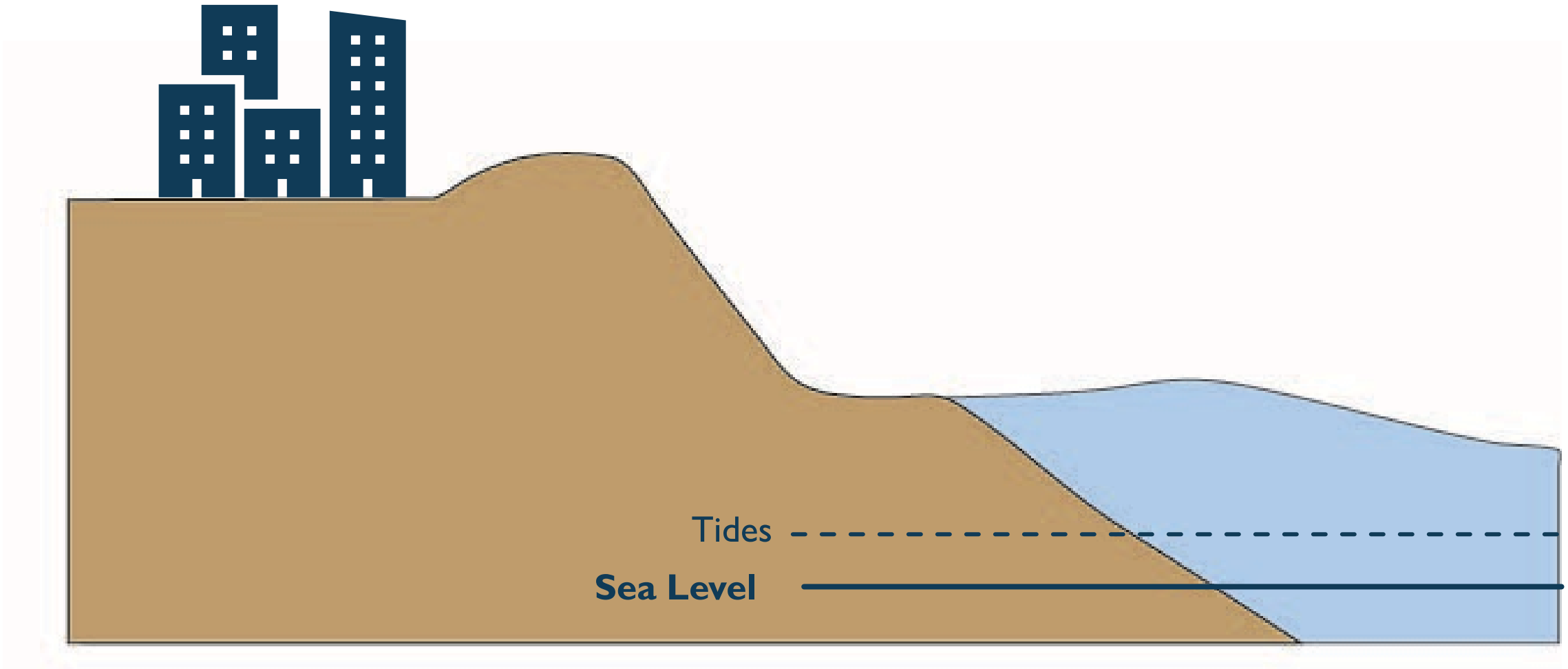

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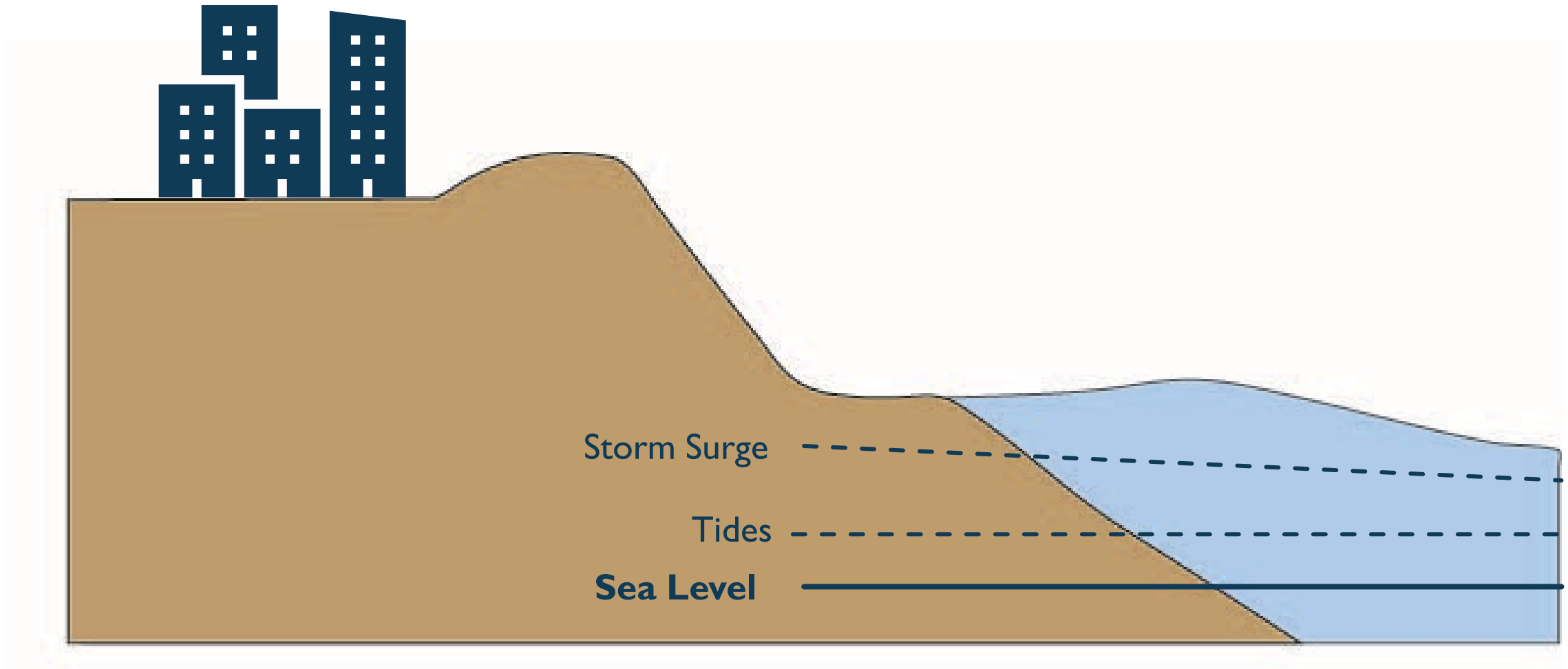

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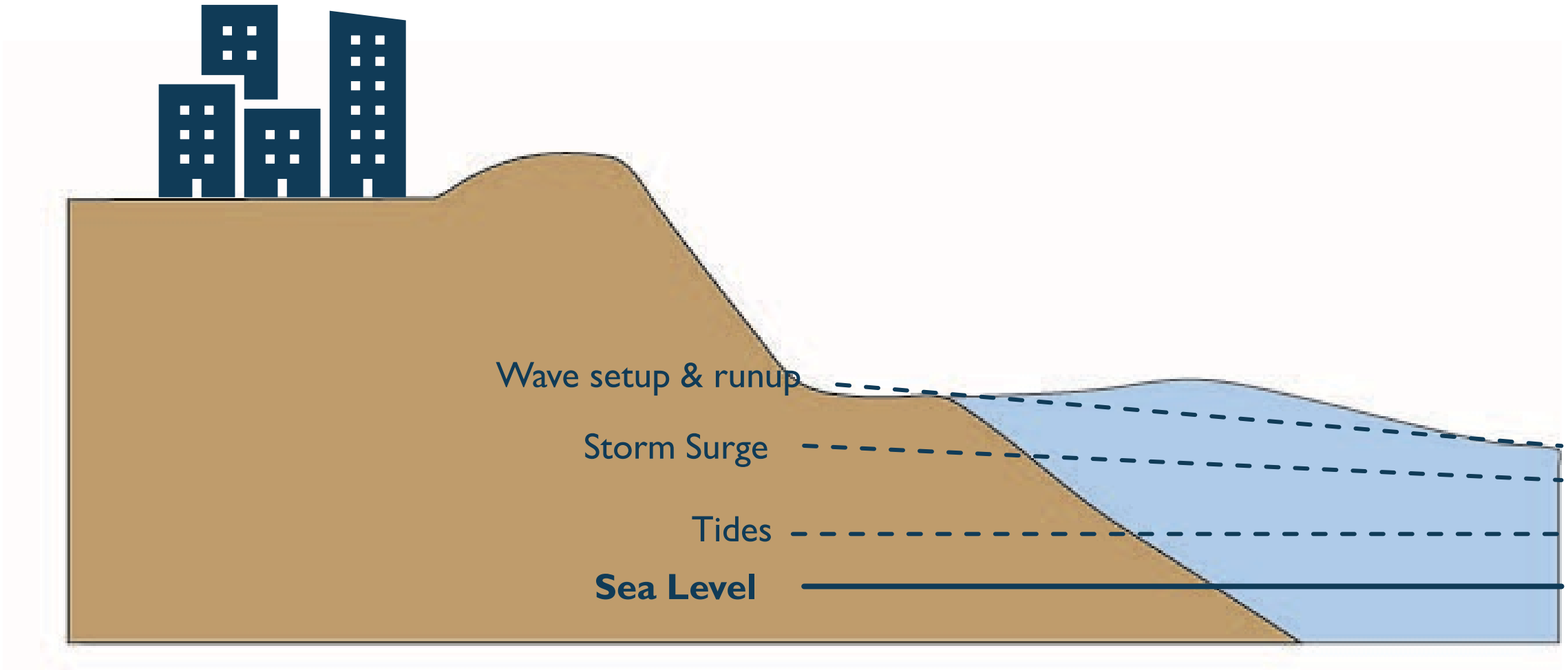
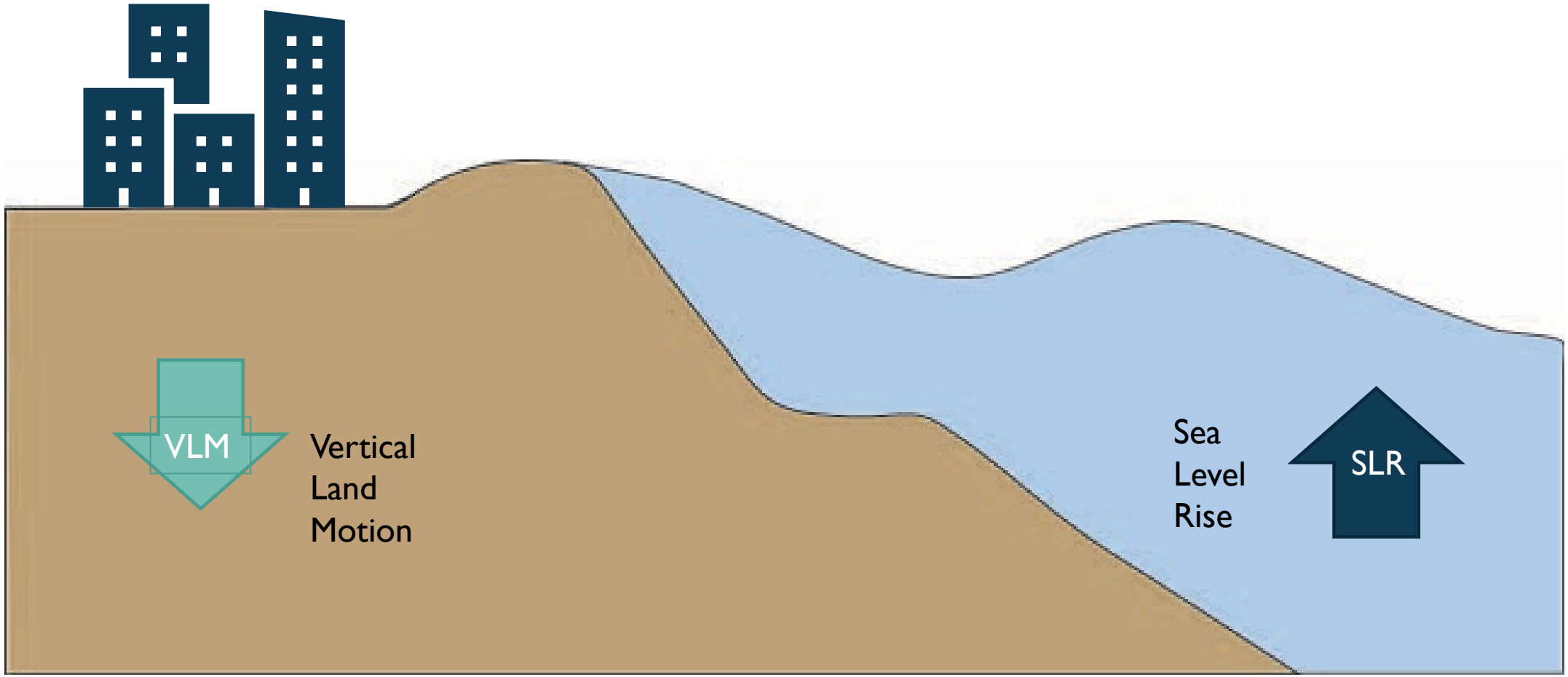
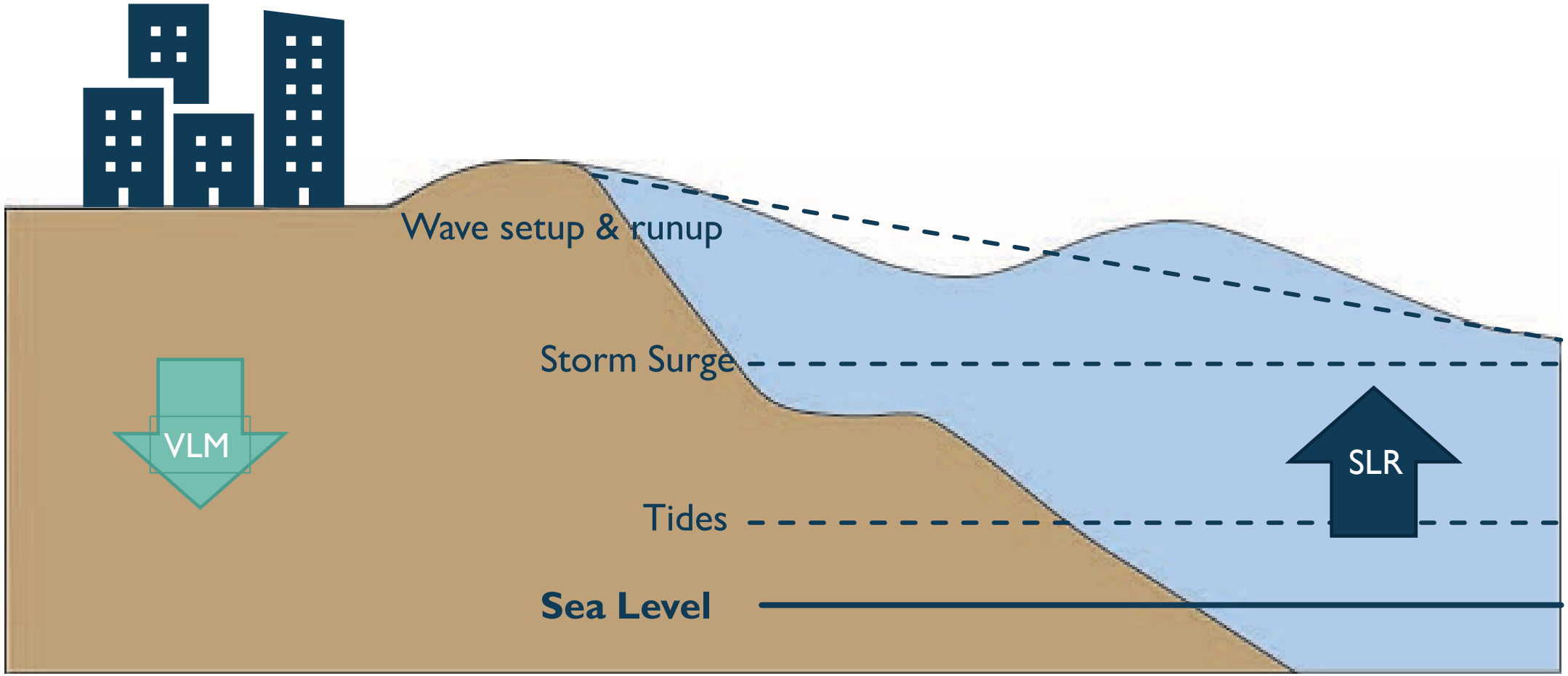


SEA LEVEL SETS THE BASELINE



SEA LEVEL RISE DOESN'T ACT ALONE

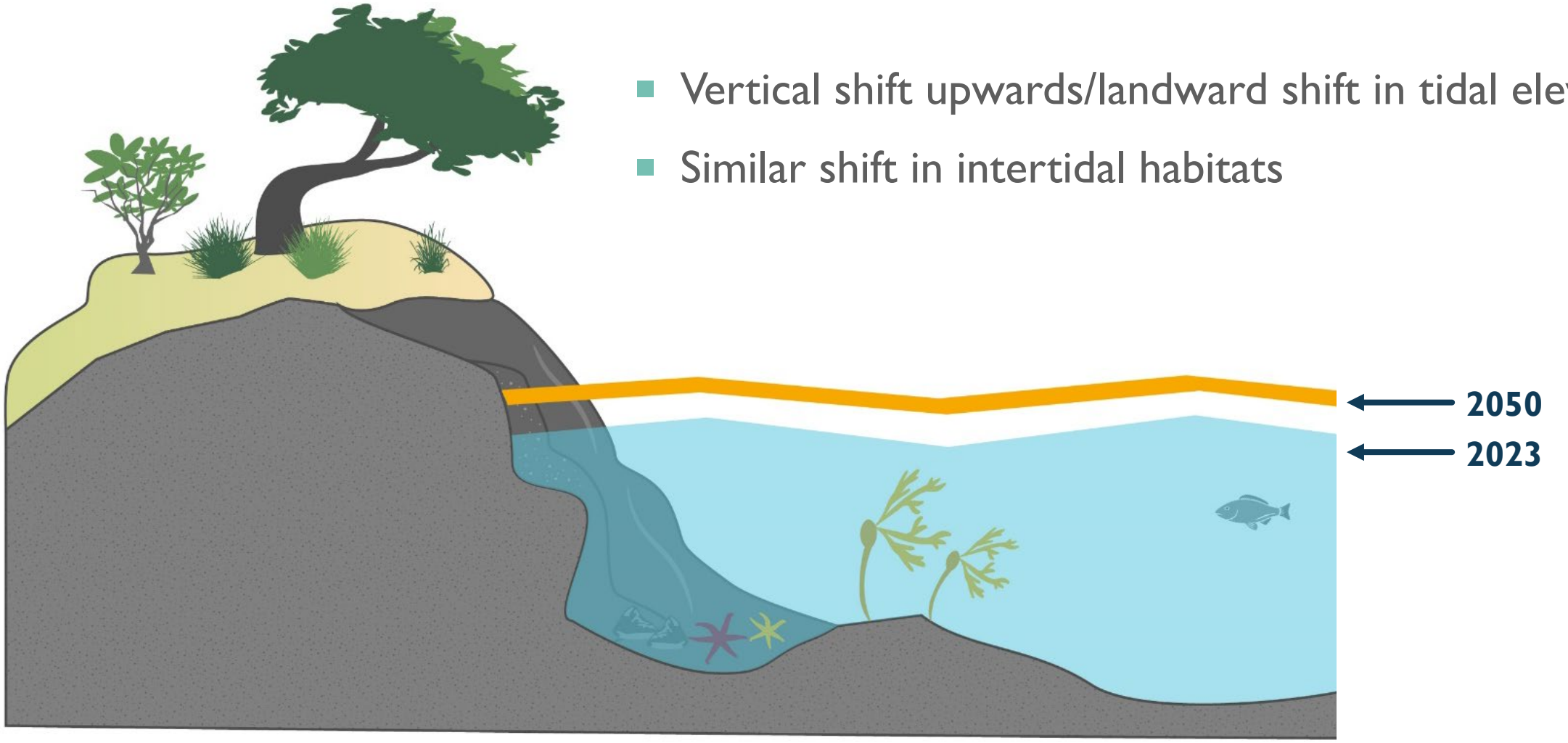


KING TIDE – DECEMBER 27, 2022

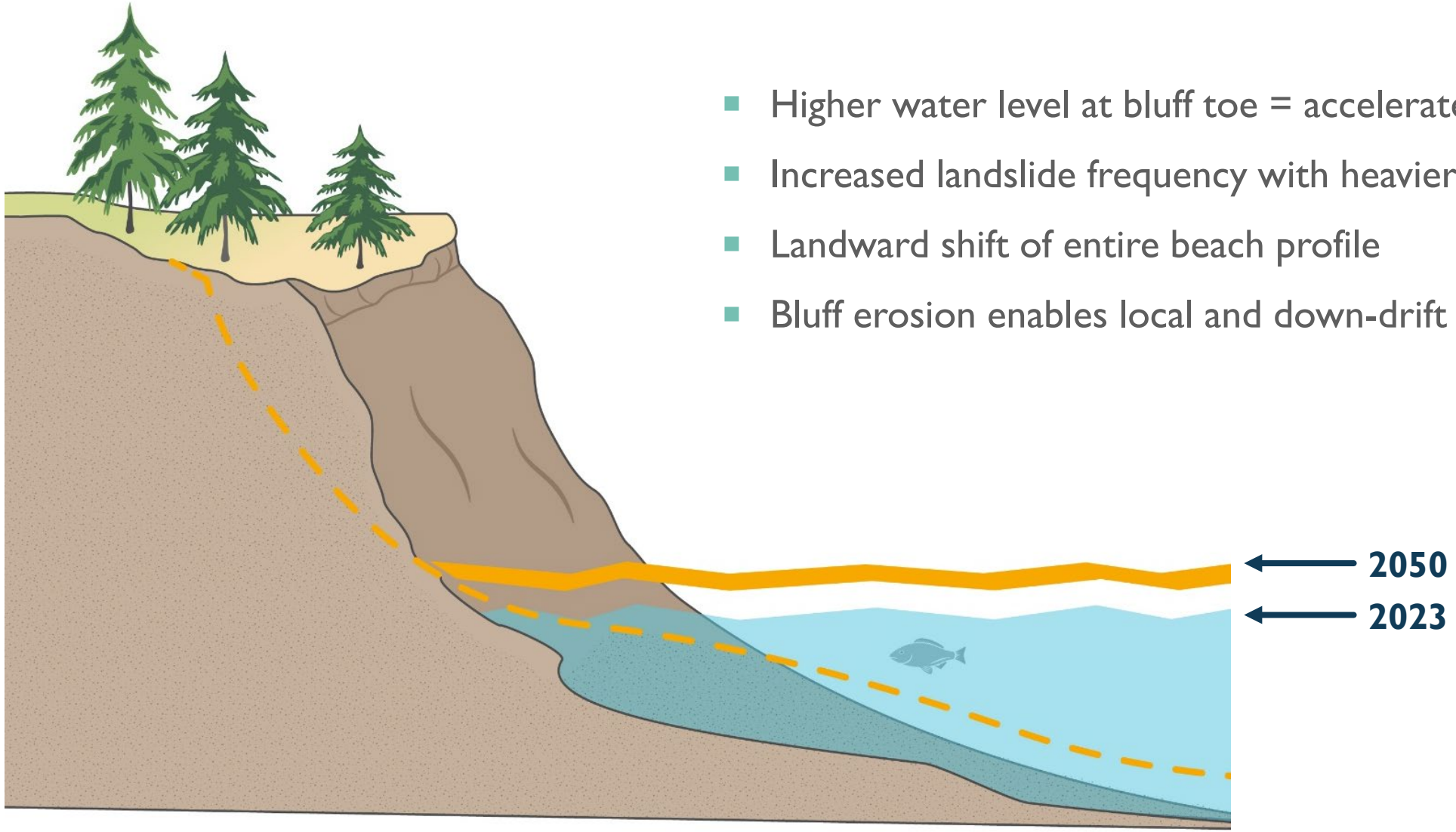
COASTAL PROCESSES AND CLIMATE CHANGE

ROCKY SHORE RESPONSE

- Vertical shift upwards/landward shift in tidal elevation
- Similar shift in intertidal habitats

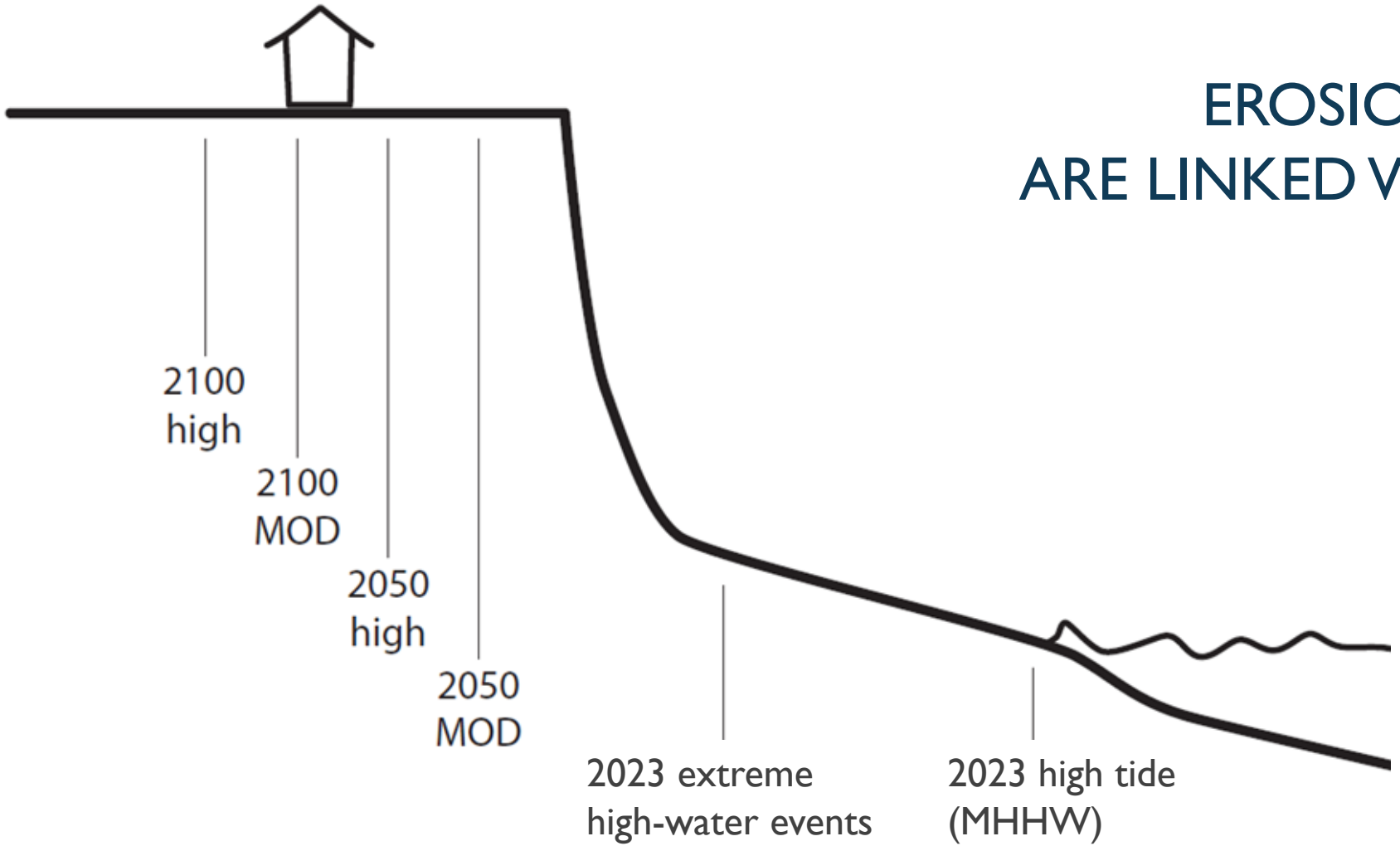


COASTAL BLUFF RESPONSE



- Higher water level at bluff toe = accelerated bluff recession
- Increased landslide frequency with heavier rainfall
- Landward shift of entire beach profile
- Bluff erosion enables local and down-drift beaches to adjust

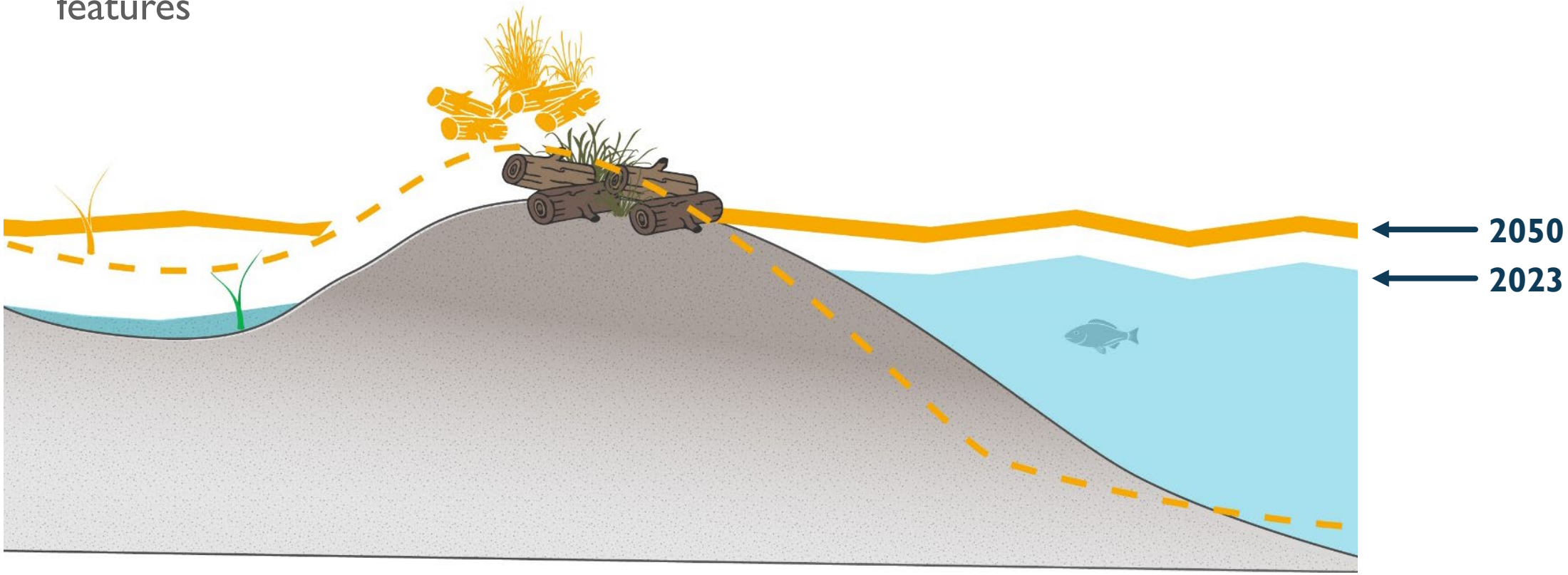
COASTAL BLUFF RESPONSE



EROSION RATES
ARE LINKED WITH SLR RATES

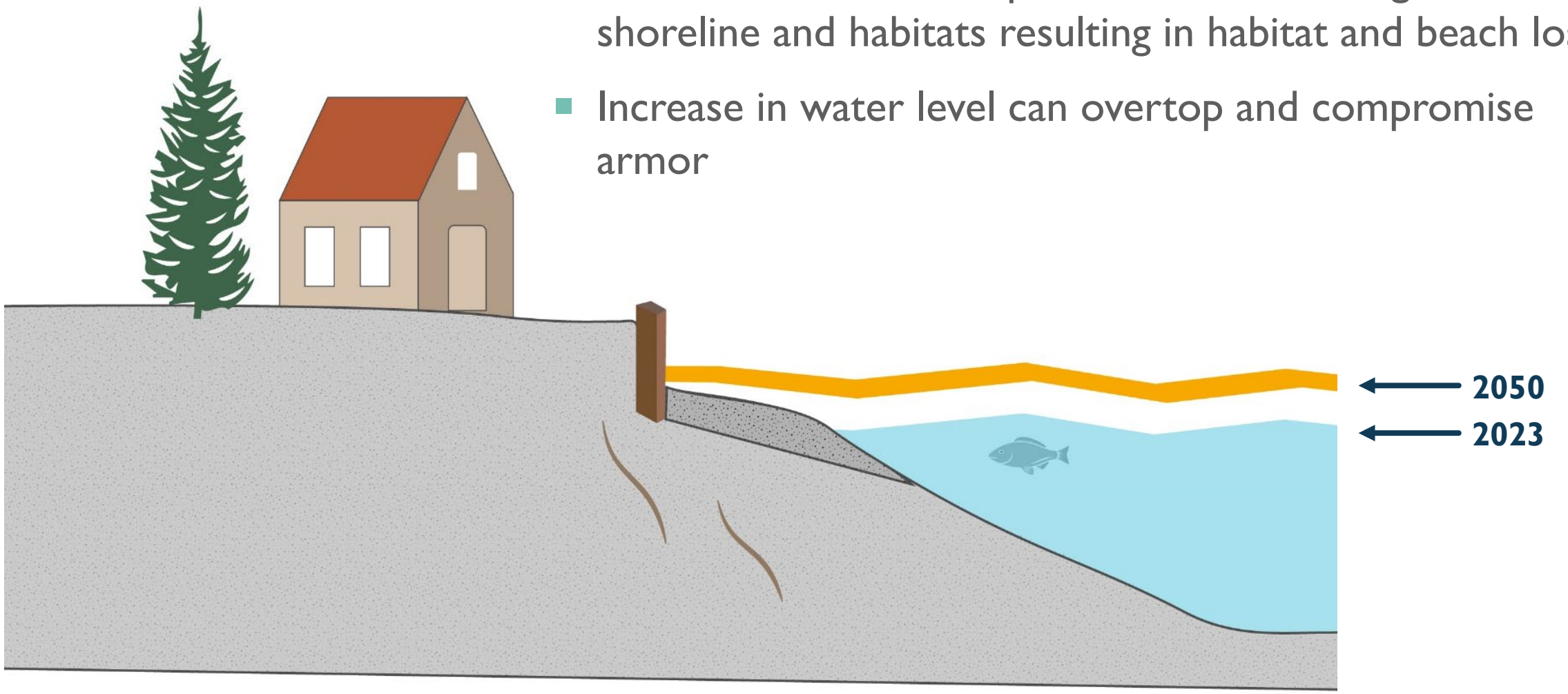
BARRIER BEACH RESPONSE

- Crest of berm builds higher and shifts landward via overwash
- Habitats, dune grass, driftwood, intertidal spawning shifts landward La
- Habitat/beach loss can occur where landward constrains limits natural migration of beach features



ARMORED SHORE RESPONSE

- Static shoreline armor prevents landward migration of shoreline and habitats resulting in habitat and beach loss
- Increase in water level can overtop and compromise armor



ADAPTATION ACTIONS

ADAPTING TO A 'NEW NORMAL'

Sunk Agarwal & Ian Baker

ADAPTATION TOOLBOX

Tools used depend on shoretype, hazard exposure, and local conditions and will change over time

Reslope and revegetate

Relocate and elevate

Nourish the beach

Manage drainage

Place logs

Enhance native vegetation

Fortify

ENHANCE NATIVE VEGETATION

ENHANCE NATIVE VEGETATION

ENHANCE NATIVE VEGETATION

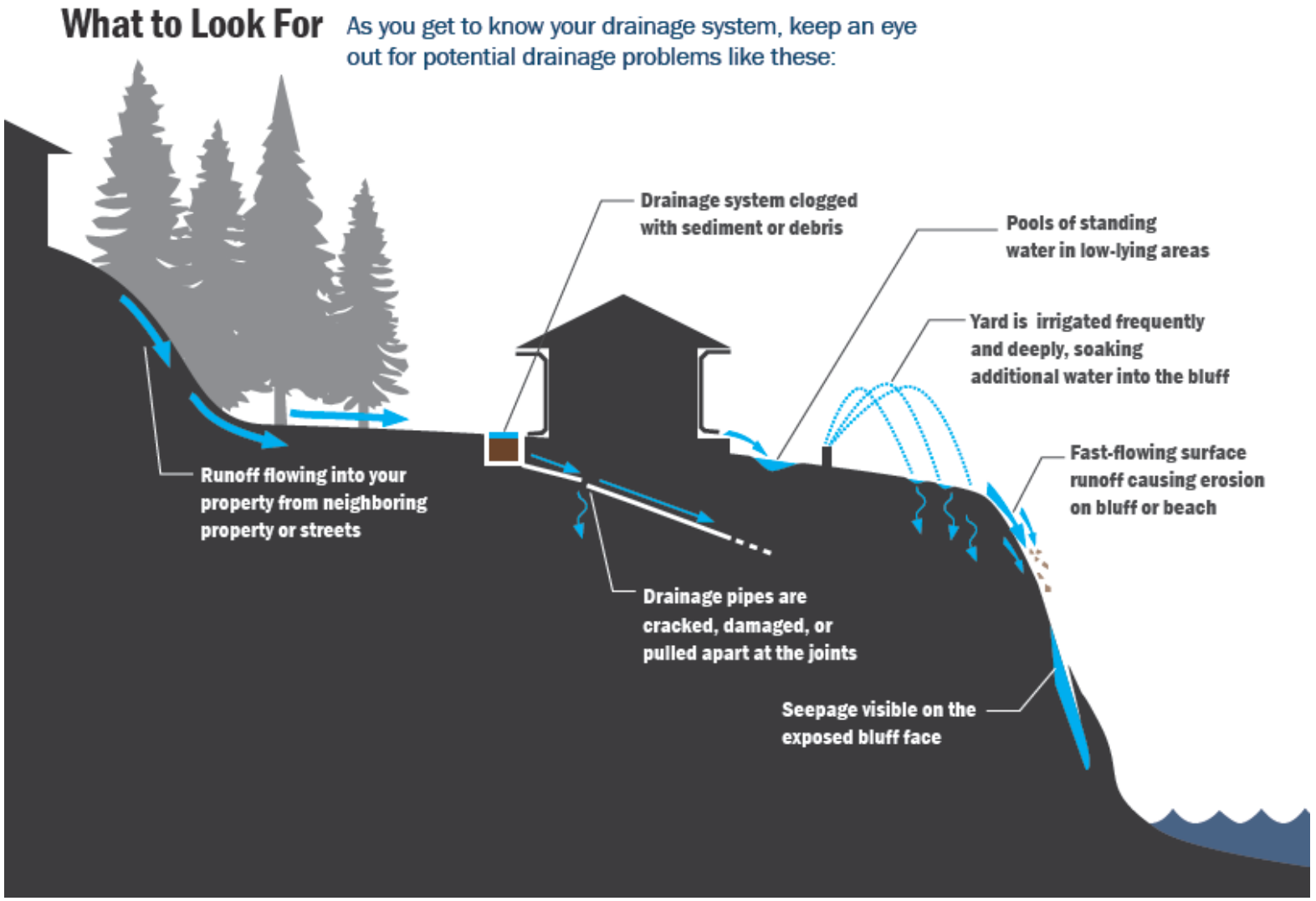
Benefits

- Reduce sheet flow
- Resist landslides
- Slope stability
- Provide habitat
- Absorb and filter rainfall

Limitations

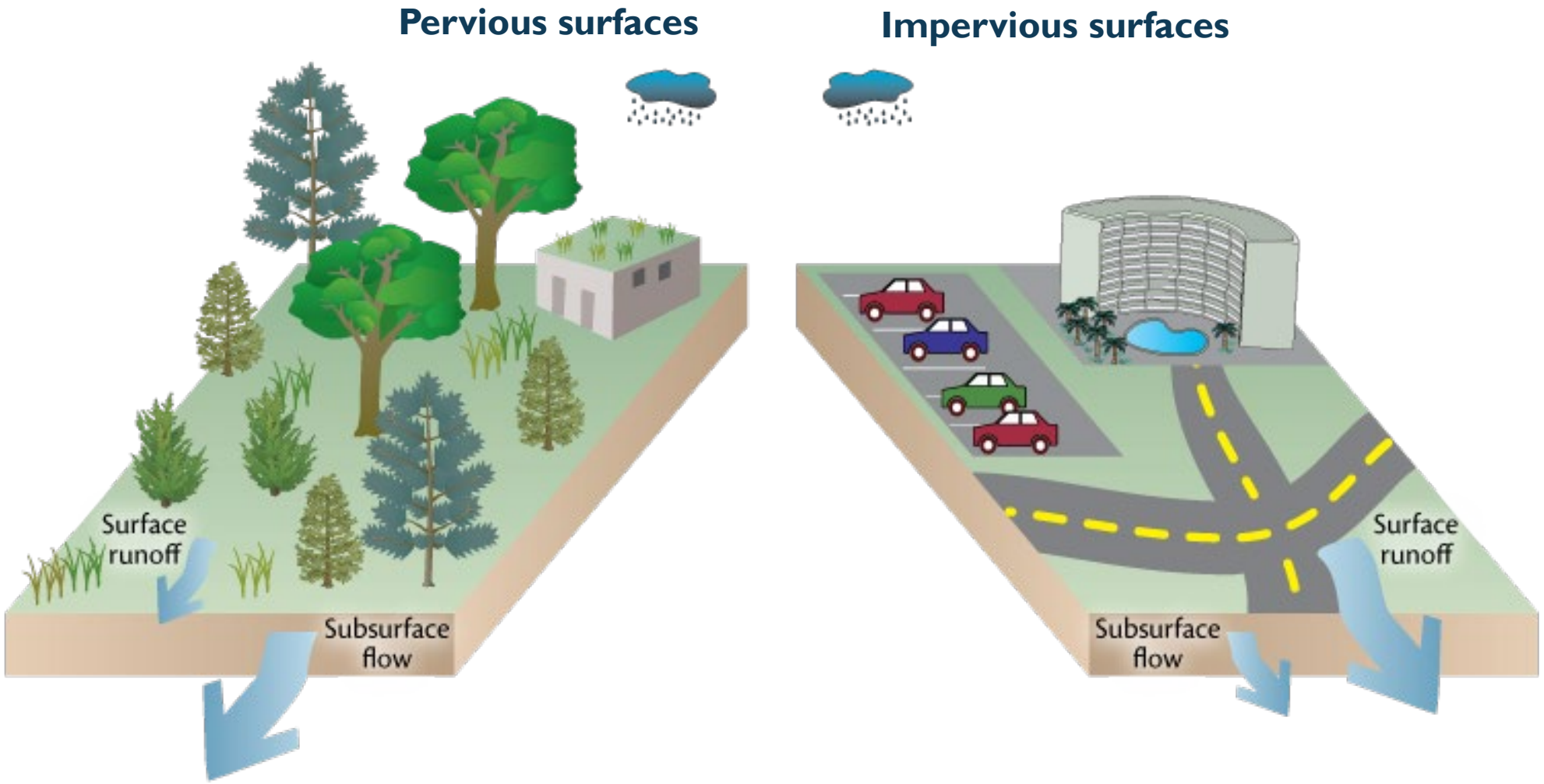
- May not work with higher sea levels

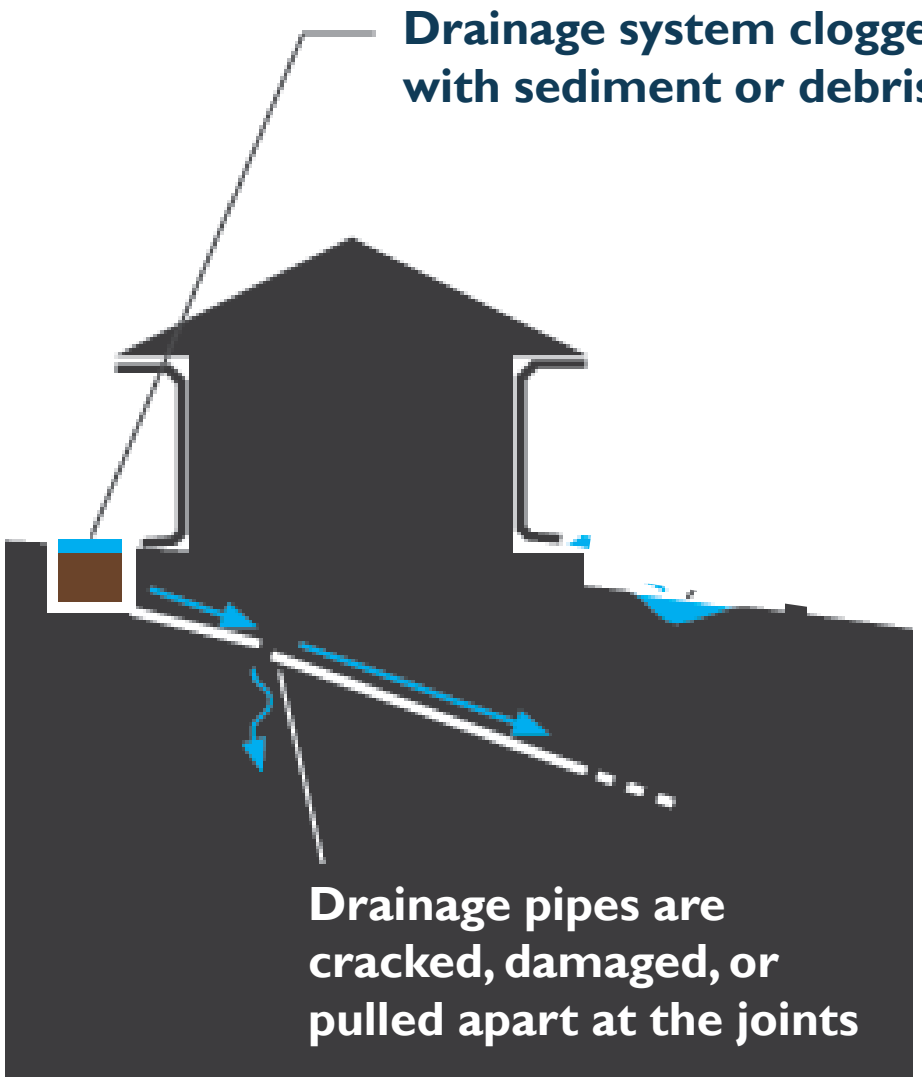
MANAGE DRAINAGE



MANAGE DRAINAGE

MANAGE DRAINAGE





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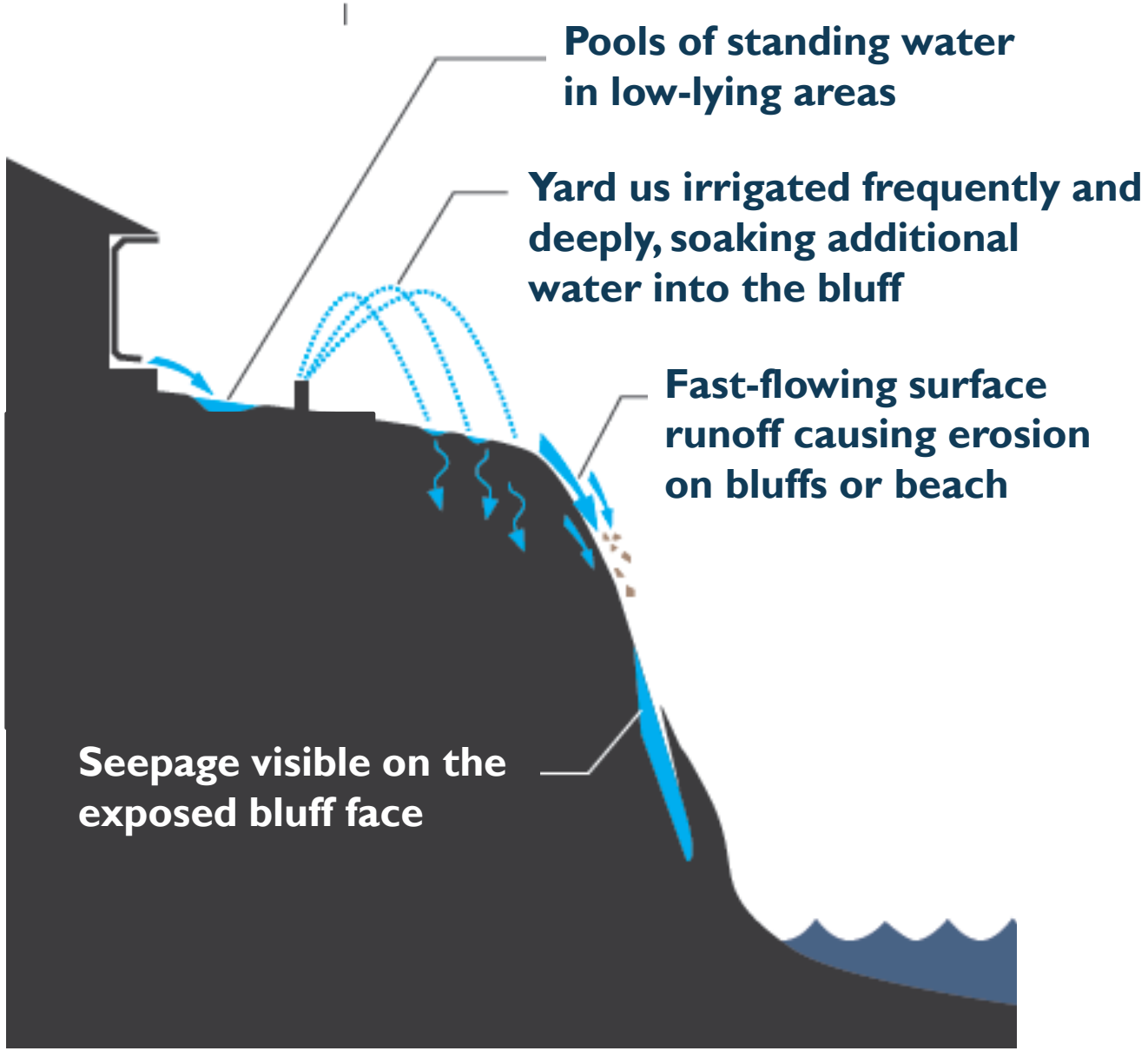

MANAGE DRAINAGE

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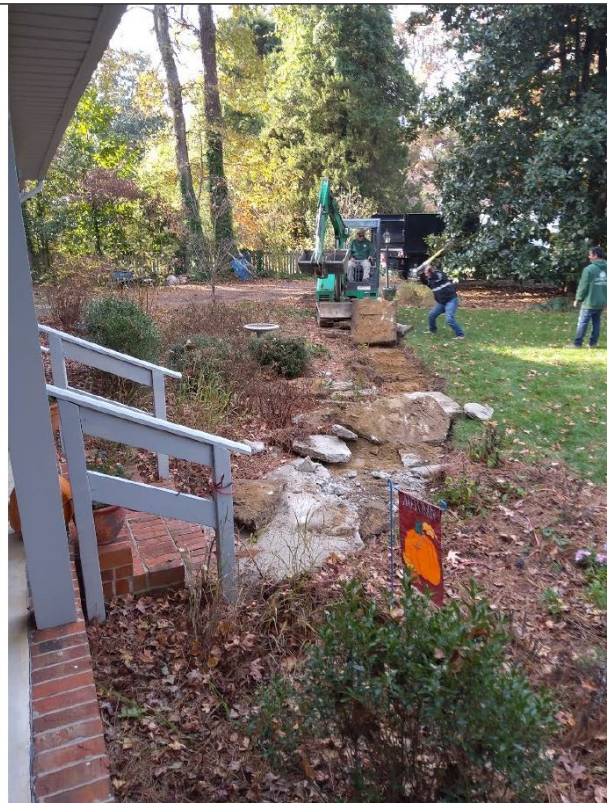
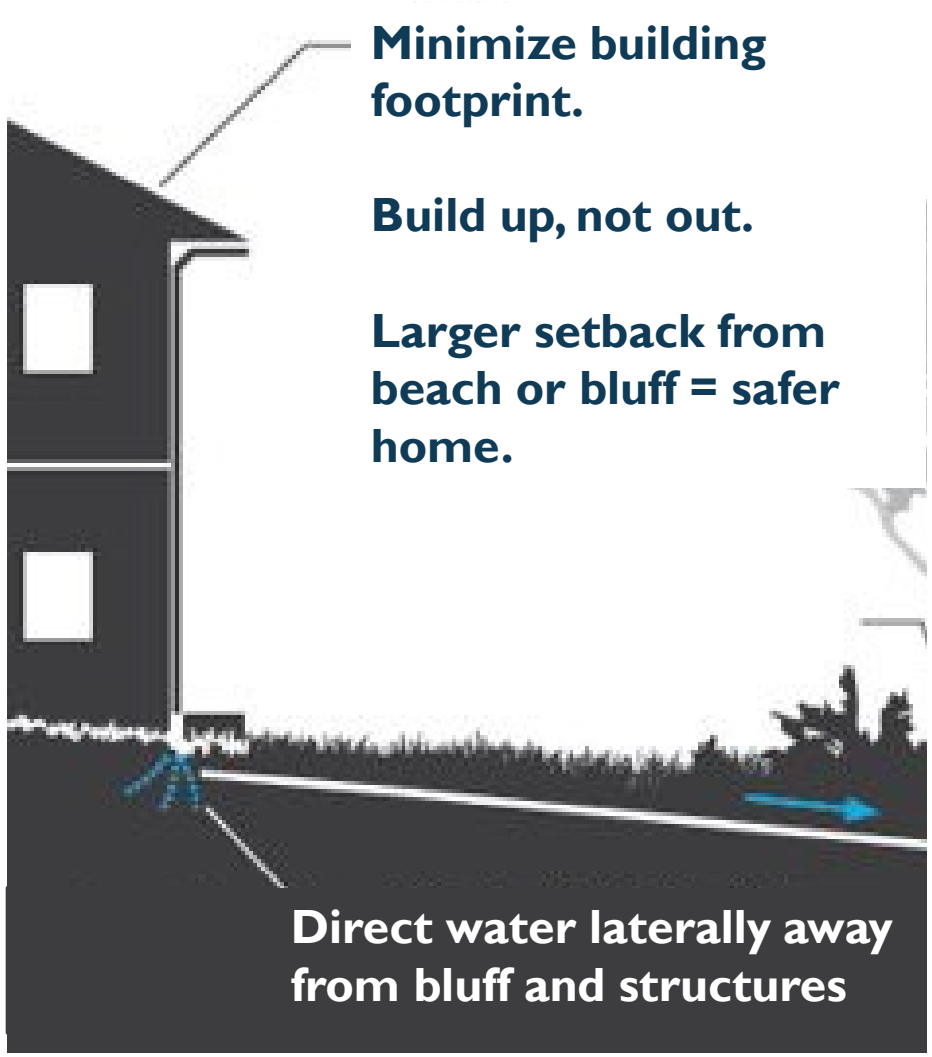
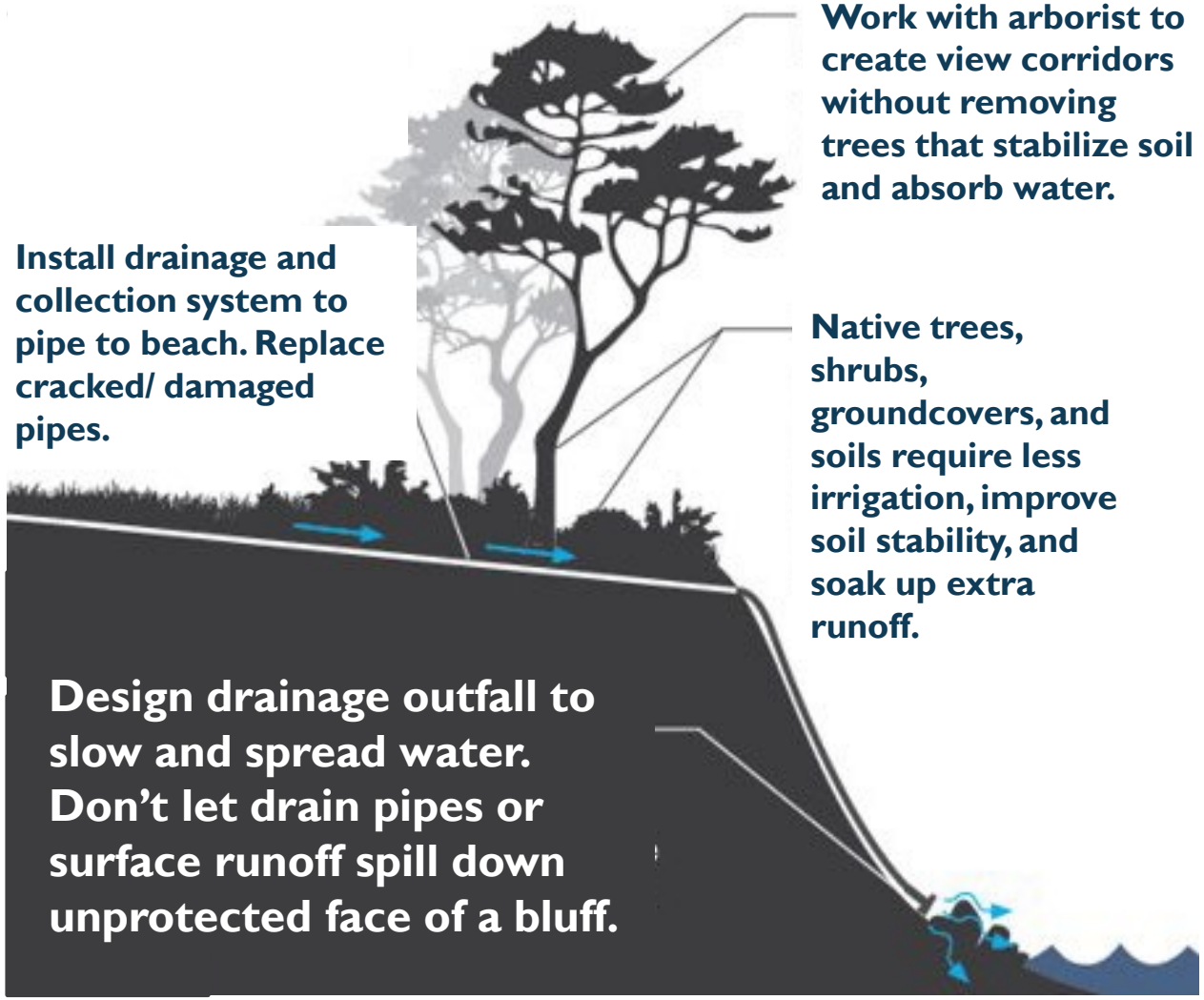


MANAGE DRAINAGE



MANAGE DRAINAGE



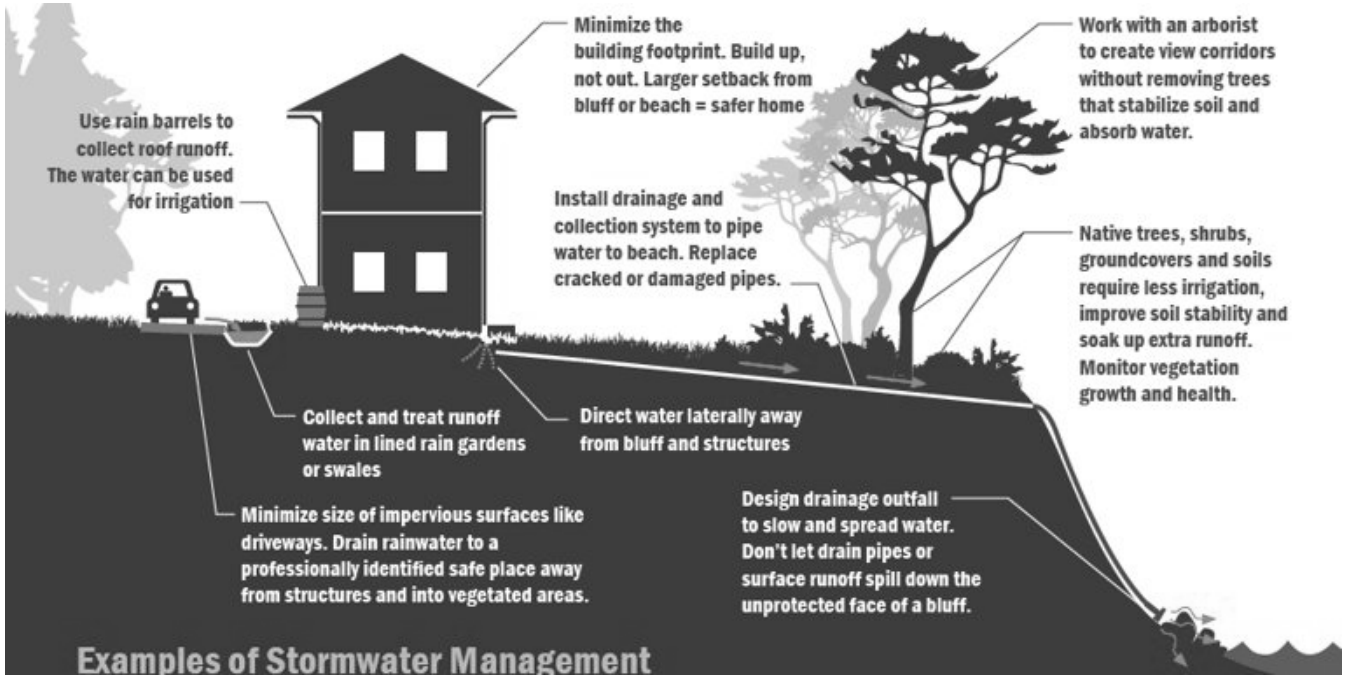
MANAGE DRAINAGE

Benefits

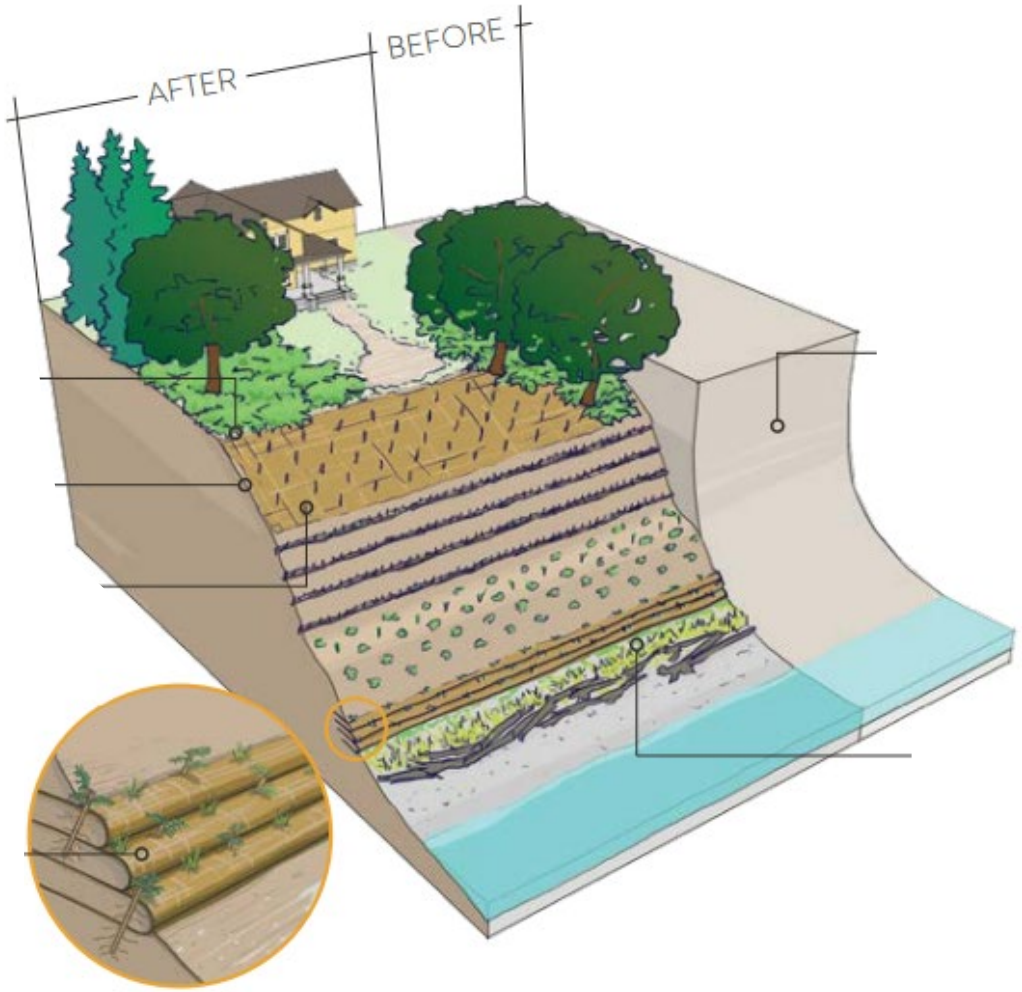
- Reduce seepage, pooling
- Reduce erosion on beach and bluff

Limitations

- Addresses only one cause of erosion issues
- Does not address natural bluff stratigraphy's influence on groundwater regime



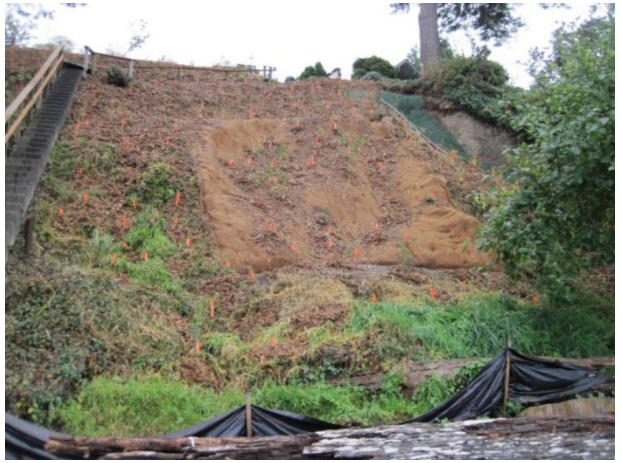
RESLOPE AND REVEGETATE



RESLOPE AND REVEGETATE

Step 1 – secure drainage issues & remove invasive species in phases

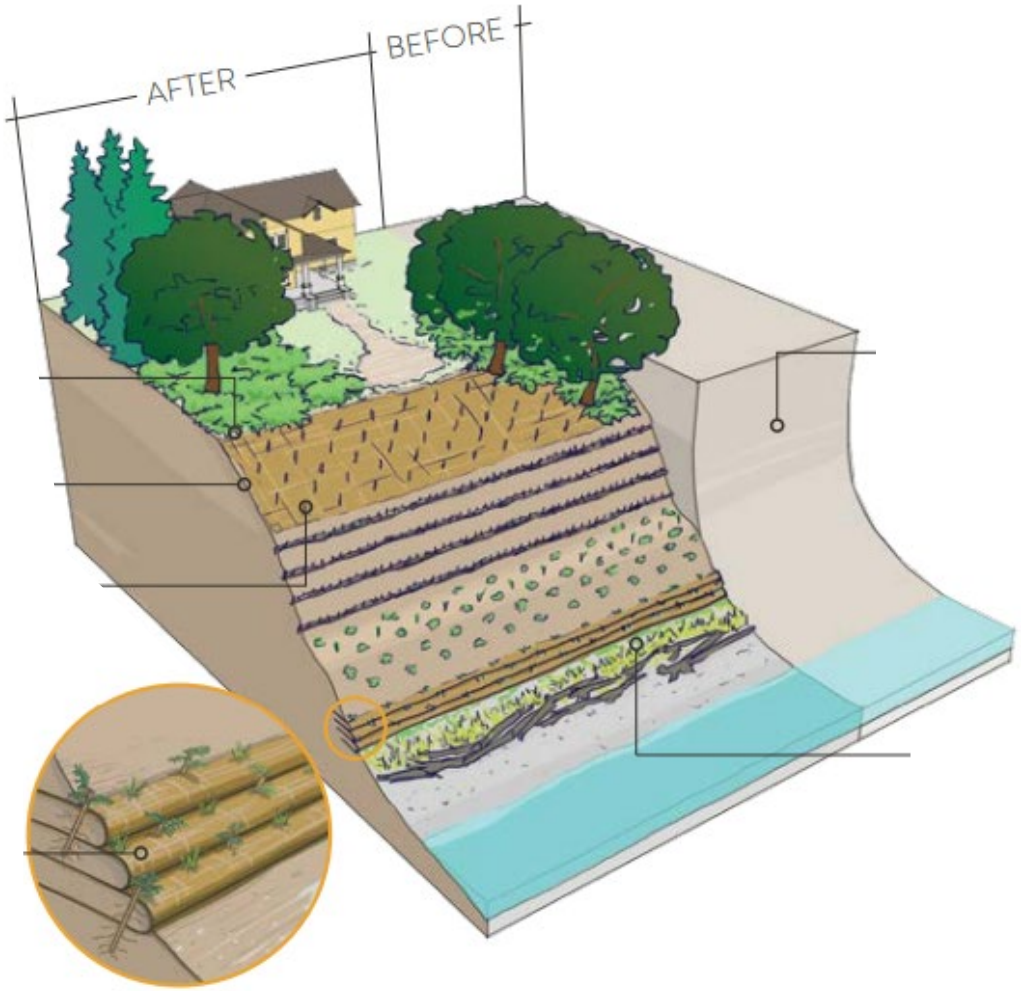
Step 2 – secure erosion control blankets



Final steps – place mulch (hog fuel) on slope and plant native vegetation densely.

*Plan for 5 or so yrs of maintenance depending on site or slope conditions.

RESLOPE AND REVEGETATE



Benefits

- Protect from erosion
- Enhance aesthetics
- Wildlife habitat

Limitations

- Not appropriate for high bluffs
- Requires space for regrading

NOURISH THE BEACH

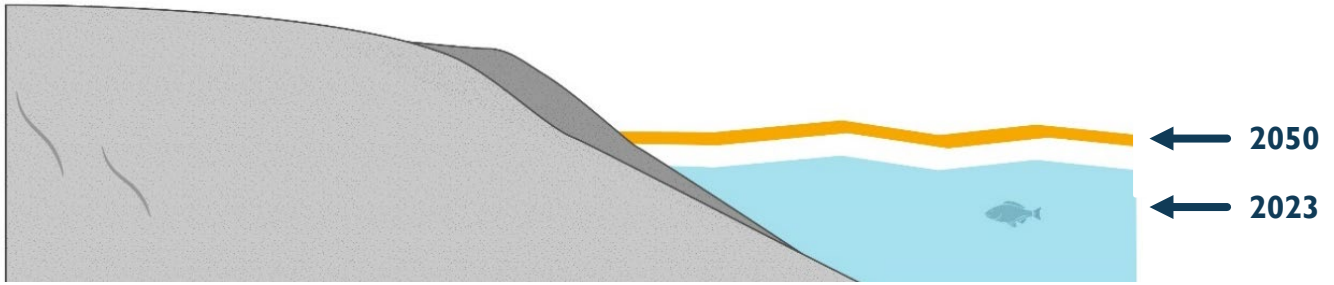
Benefits

- Build a berm to absorb wave energy
- Rebuild beach area
- Recreation area

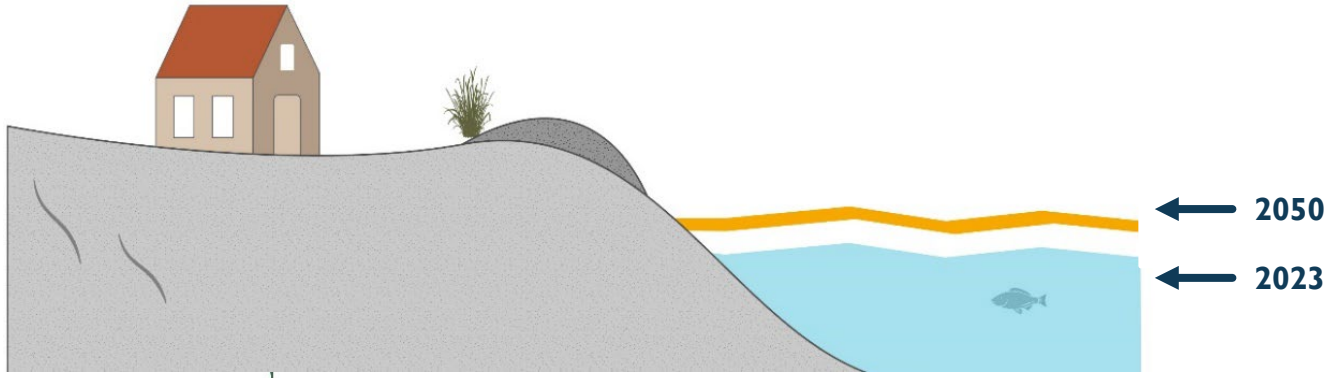
Limitations

- Not adequate for long-term
- Must be renourished over time (decades)

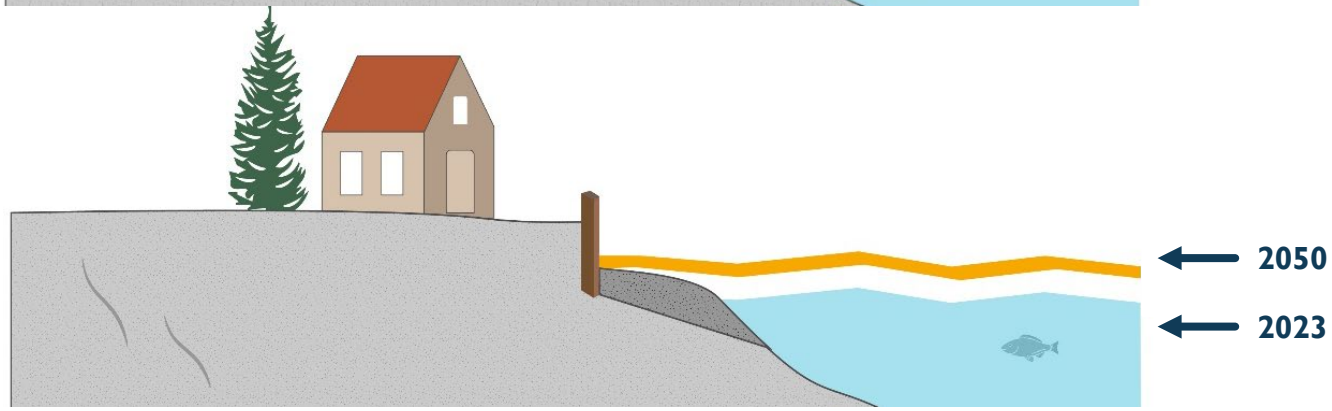
NOURISH THE BEACH



Nourish the entire beach profile



Build a storm berm to absorb wave energy and curb flooding



Compensate (short-term) for lost sediment supply or habitat loss

PLACE LOGS

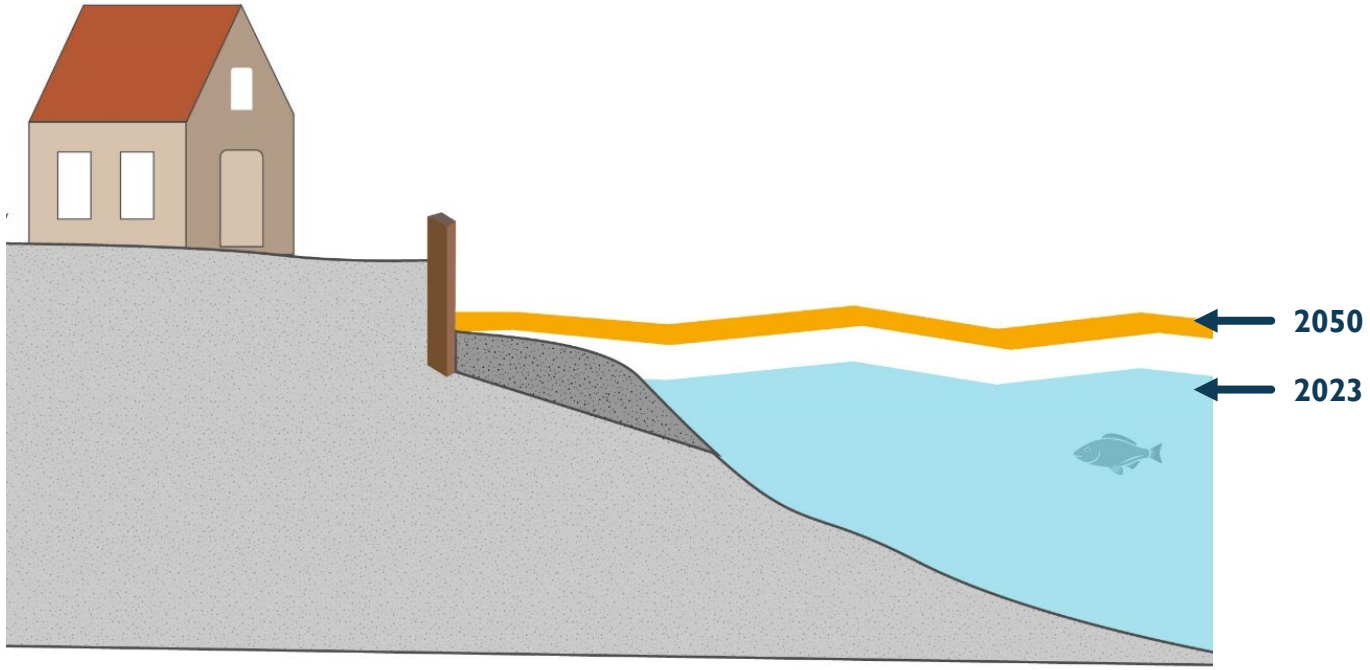
Benefits

- Slow erosion
- Encourage deposition of wind-blown sand & vegetation
- Buffer wave attach

Limitations

- Need adequate backshore area
- Logs can batter bank toe
- Number of logs reduced over time (especially with root mass)
- Not adequate for long-term

FORTIFY



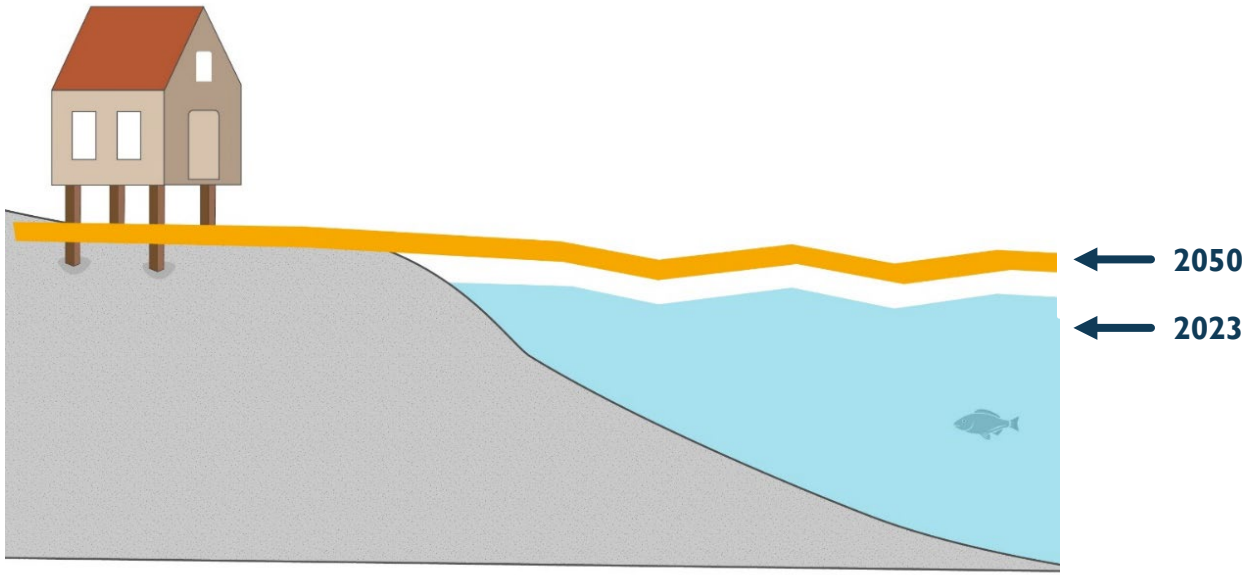
Benefits

- Slow erosions

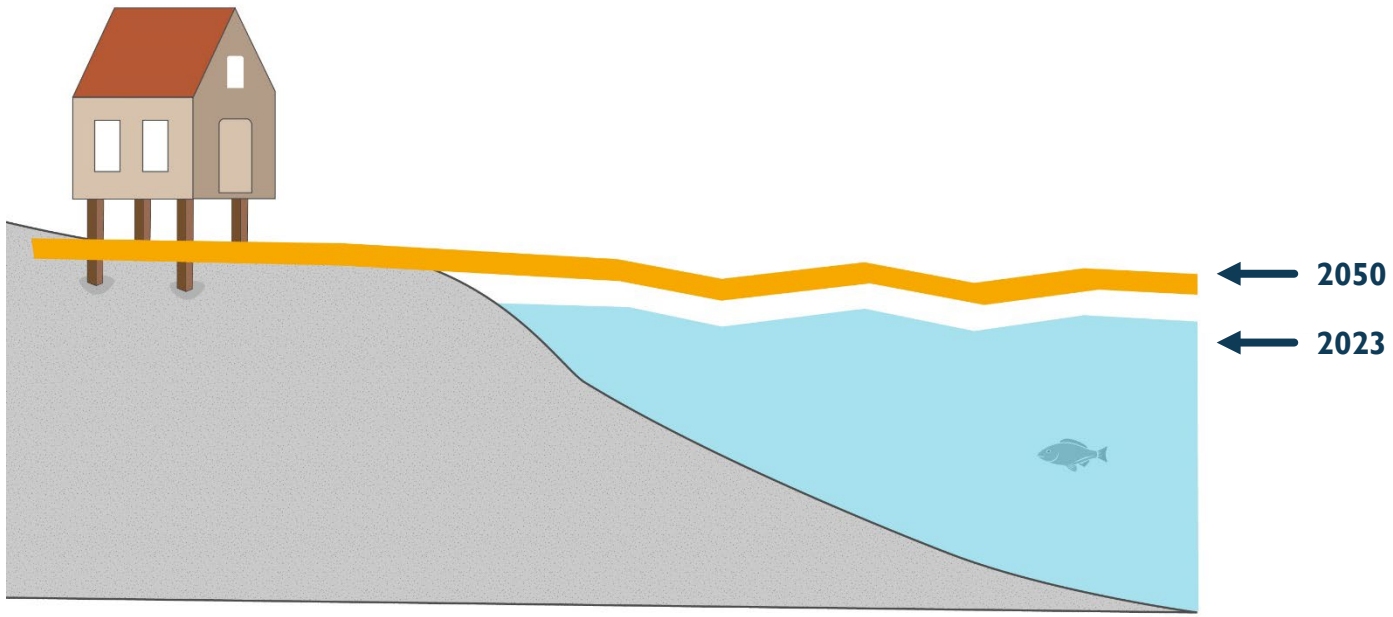
Limitations

- Flood risk often remains
- Does not stop all bluff erosion
- Requires re-engineering over time due to changing conditions (freeboard)
- Backshore and intertidal habitat loss

ELEVATE



ELEVATE



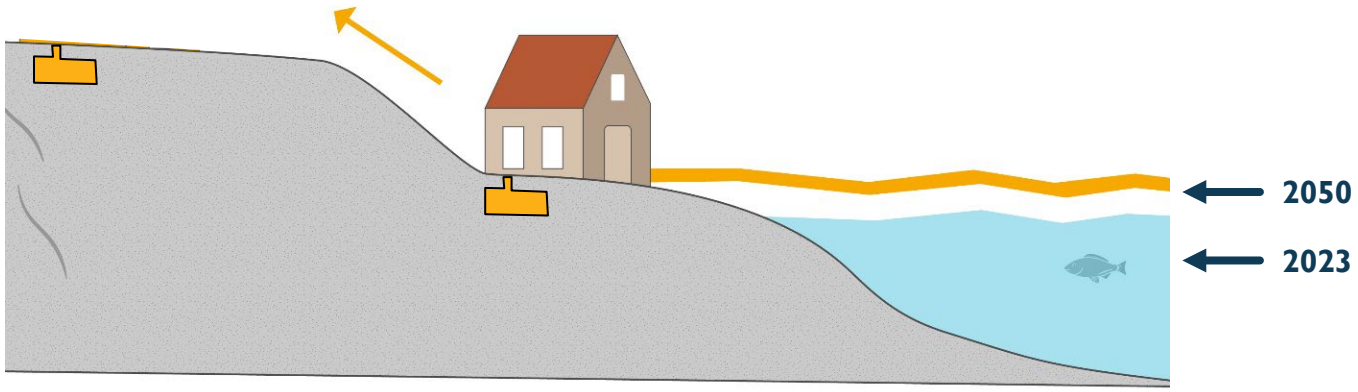
Benefits

- Reduces flood risk

Limitations

- Will not stop erosion
- Driftwood damage
- Septic, drainfields
- Short-term solution

REPLACE SEPTIC WITH UPLAND COMMUNITY SEPTIC



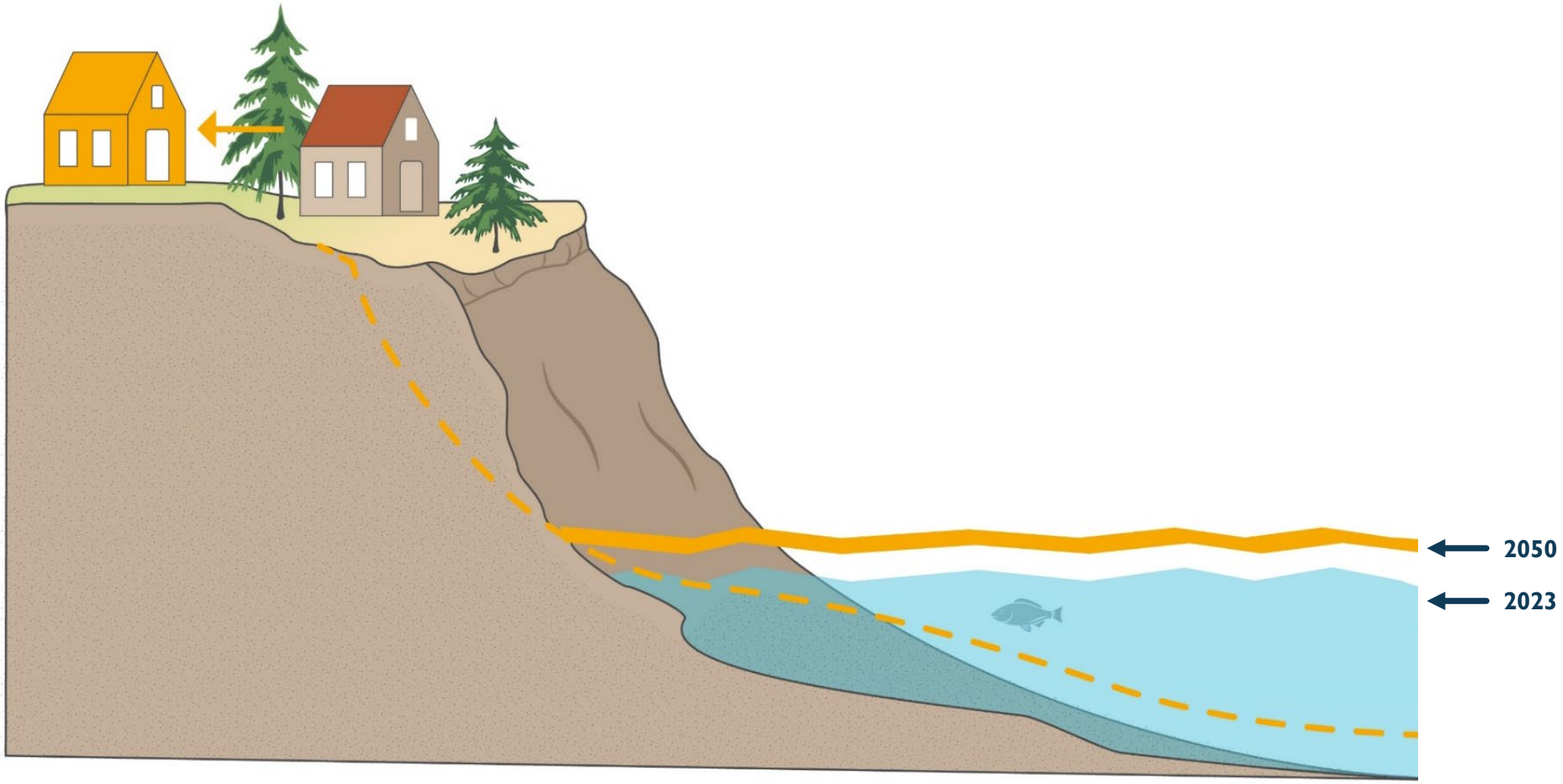
Benefits

- Benefits at community-scale
- Shared costs across community
- Supporting load programs
- Mitigates water quality impacts

Limitations

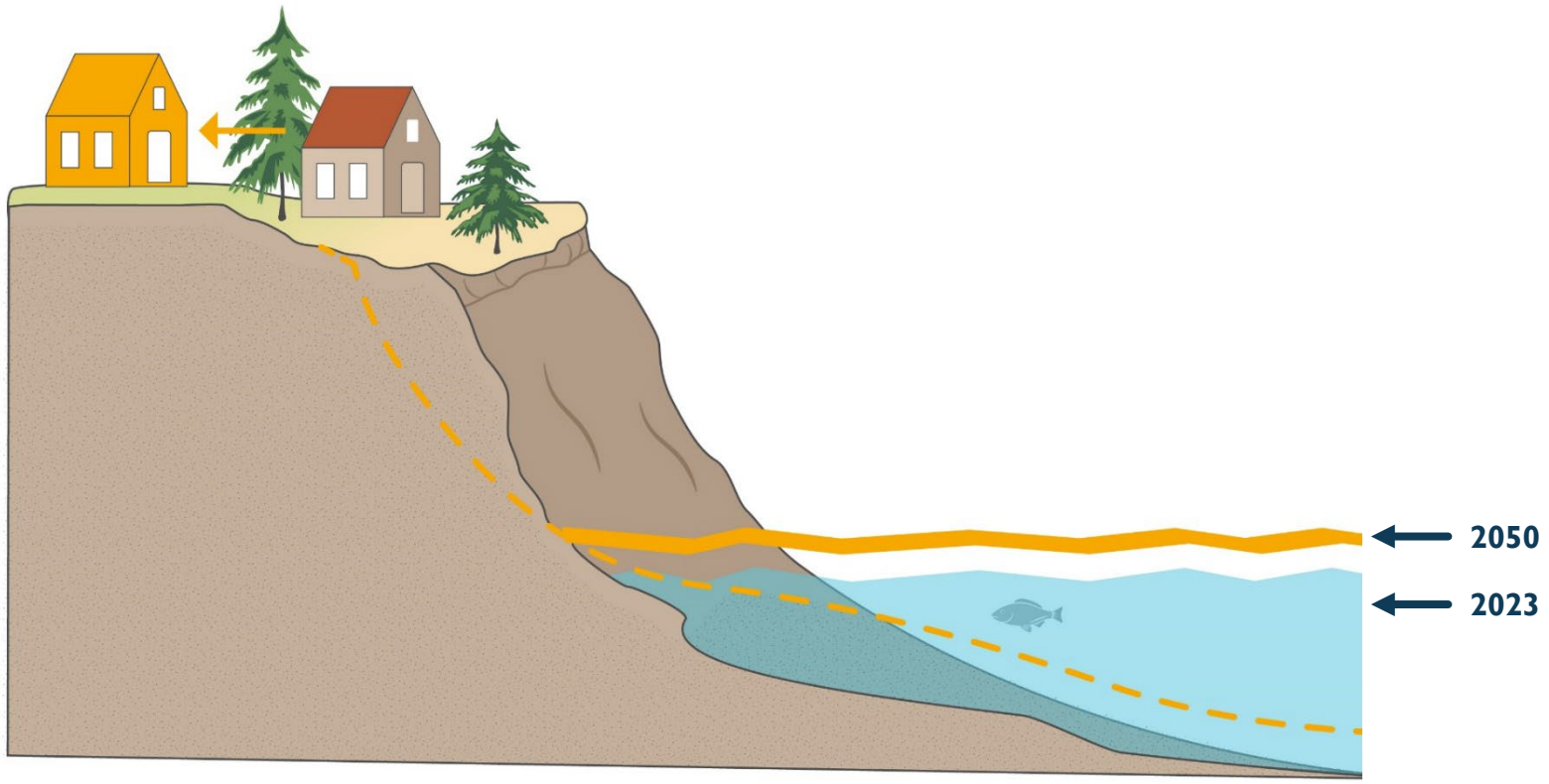
- Requires adequate upland area for relocation

RELOCATE



RELOCATE

RELOCATE



Benefits

- Mitigates risk of erosion and flooding
- Long-term solution
- Cheaper than engineered approaches
- Most effective for highly vulnerable structures

Limitations

- Requires adequate upland area for relocation

ADAPTATION TOOLBOX

Tools used depend on shoretype, hazard exposure, and local conditions and will change over time

Reslope and revegetate

Relocate and elevate

Nourish the beach

Manage drainage

Place logs

Enhance native vegetation

Fortify

TAKE ACTION: SLOW THE RESPONSE & BE PREPARED FOR FUTURE

THE TIME TO START IS NOW

SHORE FRIENDLY KITSAP

PLAN A FREE SITE VISIT TO MAKE A PLAN FOR YOUR PROPERTY

ADJUST AS YOU GO