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CoSMoS – Adapt

Assessing coastal adaptation strategies in California

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4TH INTERNATIONAL WORKSHOP ON WAVES, STORM SURGES, AND COASTAL HAZARDS
Incorporating the 18th International Waves Workshop

Project goals

1. Advance the characterization of coastal risks under climate change, including tipping points.

2. Quantitatively evaluate adaptation benefits, cost-effectiveness and equitable distribution.

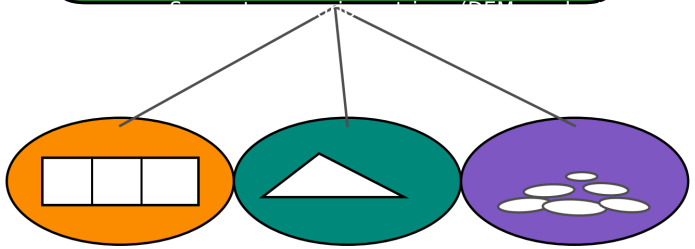
CoSMoS → CoSMoS-adapt

From hazard-focused modeling to adaptation-aware evaluation of coastal protection options

CoSMoS
(Coastal Storm Modeling System)
- Hydrodynamics & waves
- Coastal flooding & erosion

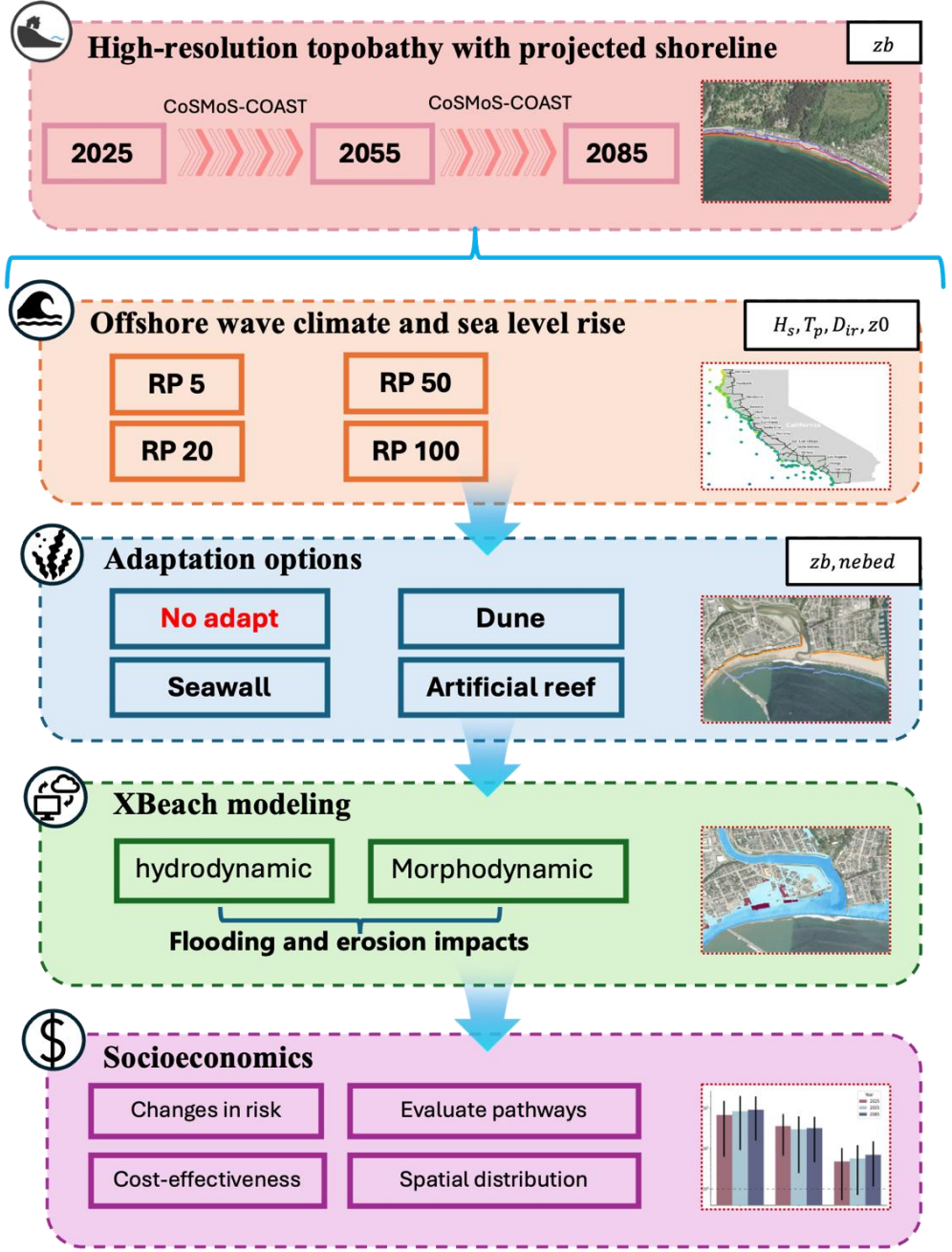
adds adaptation logic & evaluation

CoSMoS-adapt
Coastal protection options & tipping points
- Integrates adaptation modules
- Evaluates risk reduction by option



CoSMoS-adapt quantifies the performance of protection options across storm scenarios and elevations (DEMs).

Pilot cases



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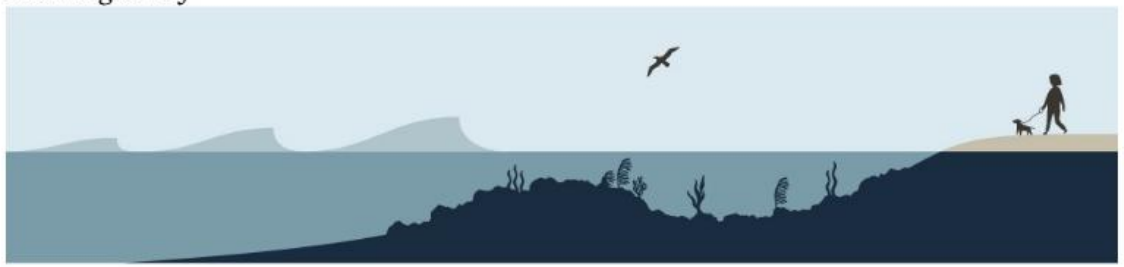
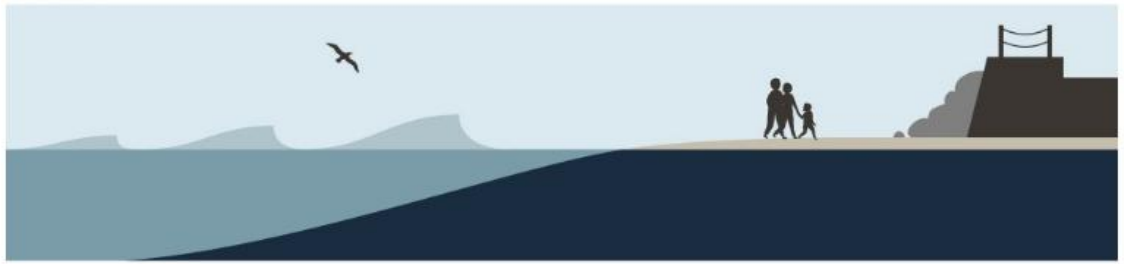
Adaptation options

Submerged reef

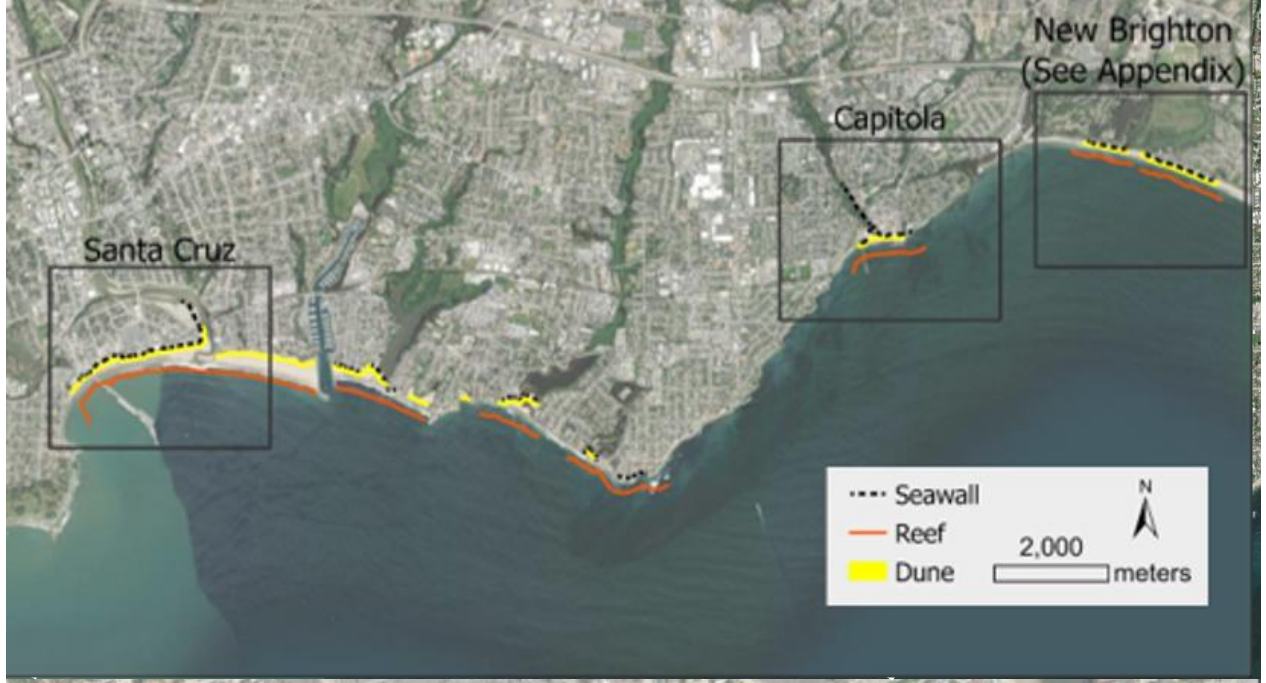


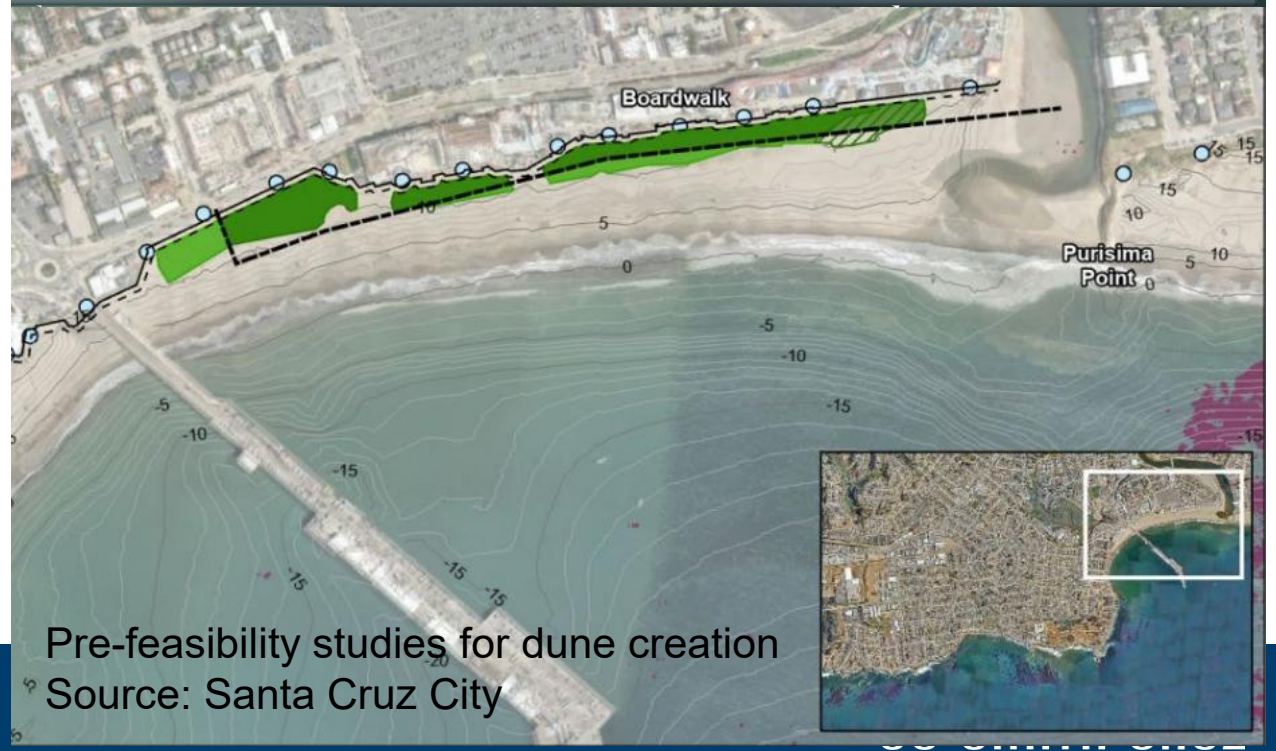
Dune

Seawall



Conceptual sketches of the three adaptation measures evaluated in this study: seawalls; dune restoration; and submerged reefs

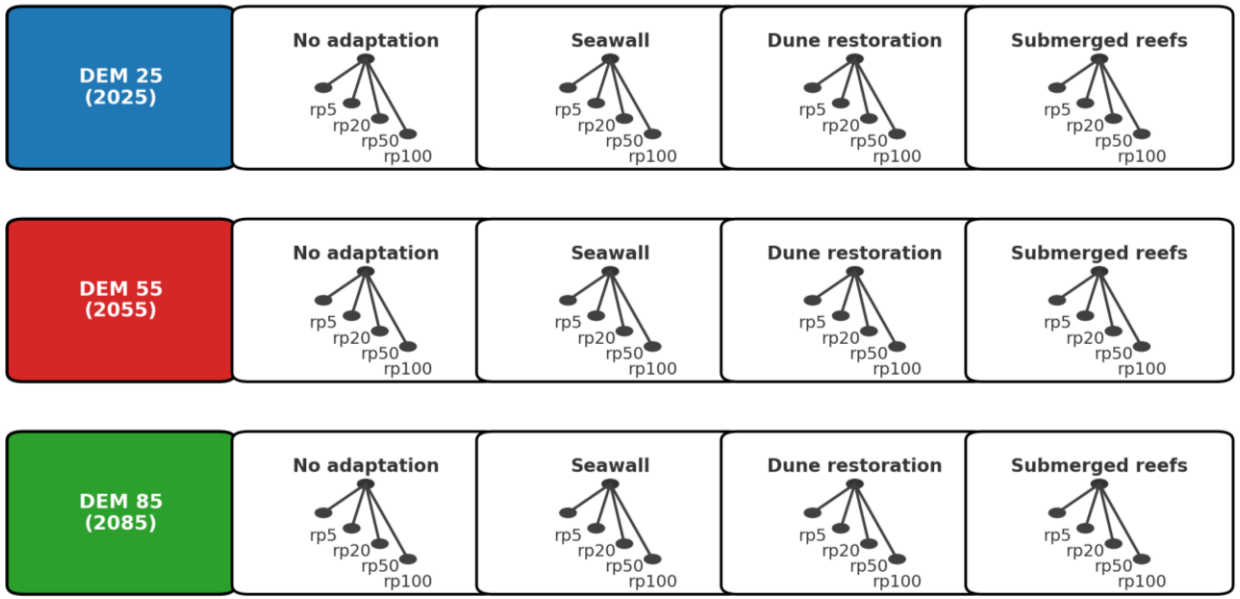




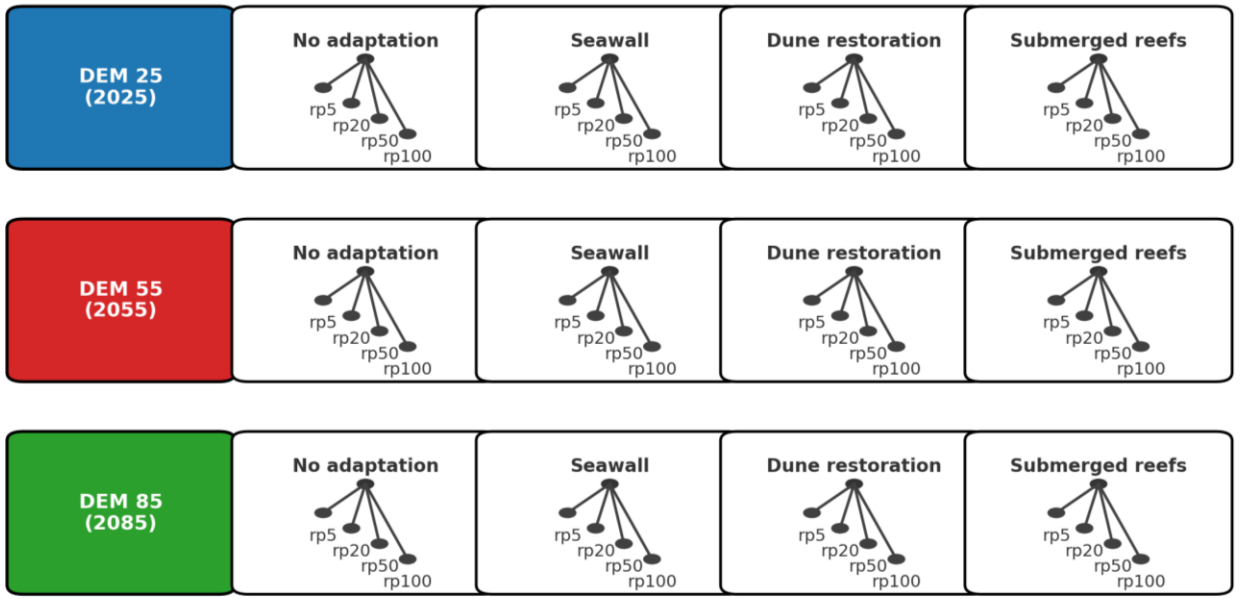
Pre-feasibility studies for dune creation
Source: Santa Cruz City

Model runs

Hydro



Morpho

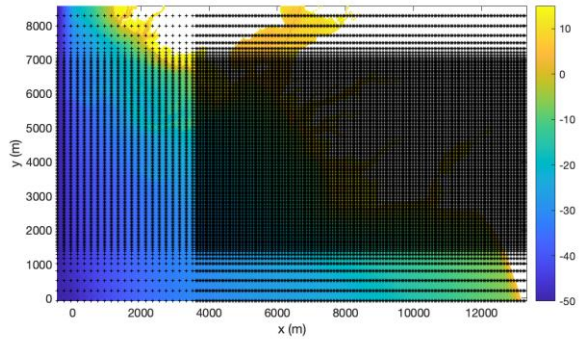


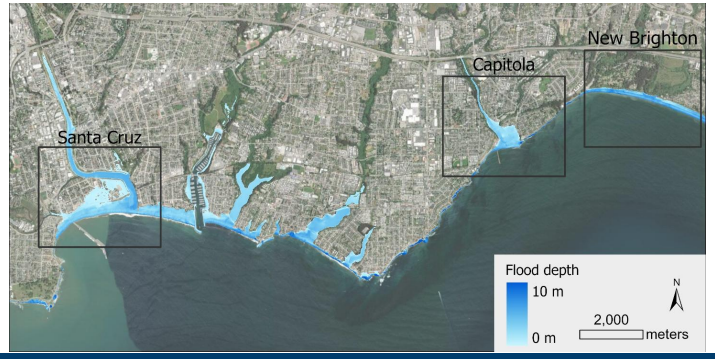
x 3 sites

Total = 288 model runs || 228 ||

High resolution flood hazard maps

Granularity to simulate adaptation options





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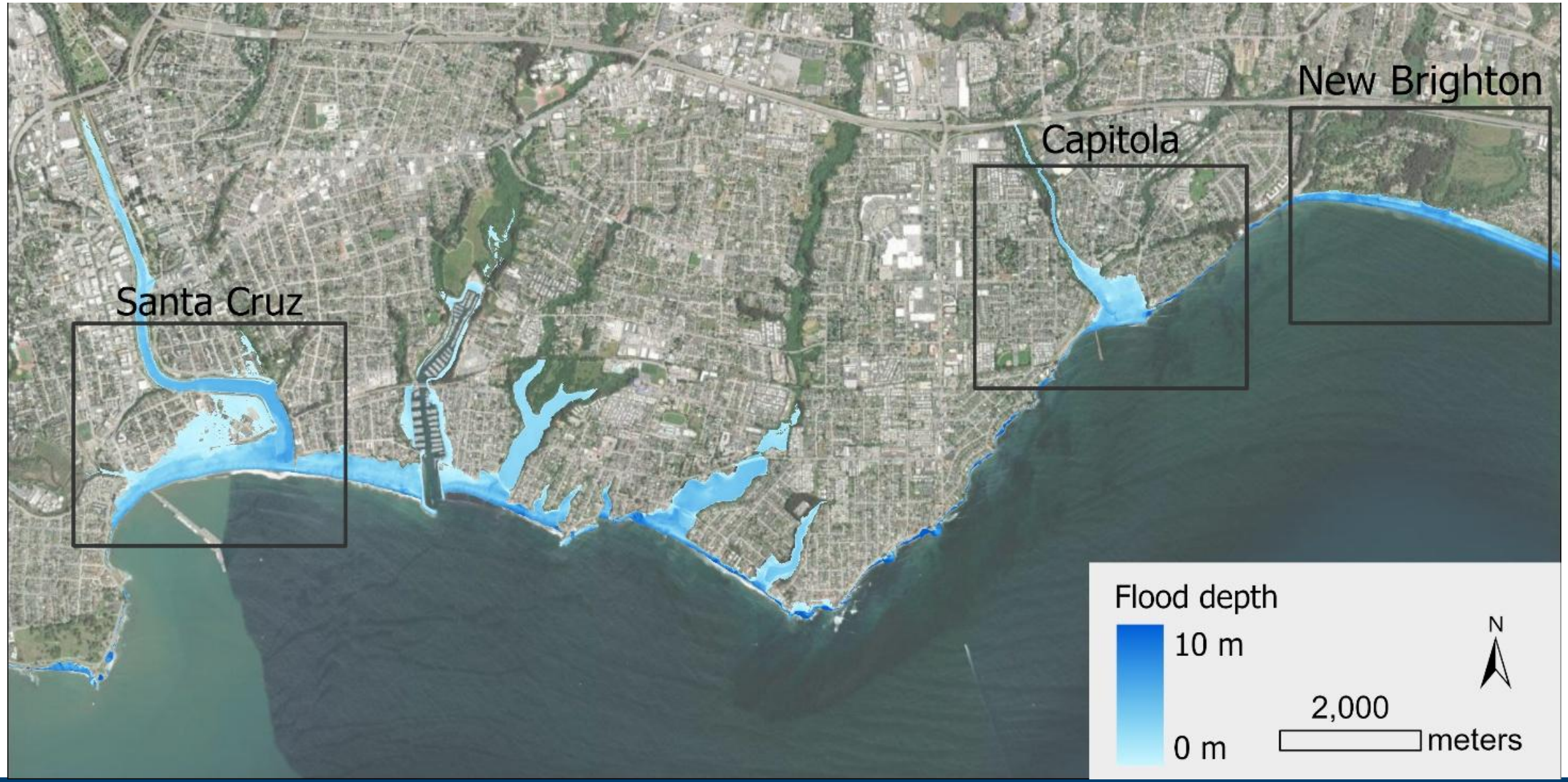
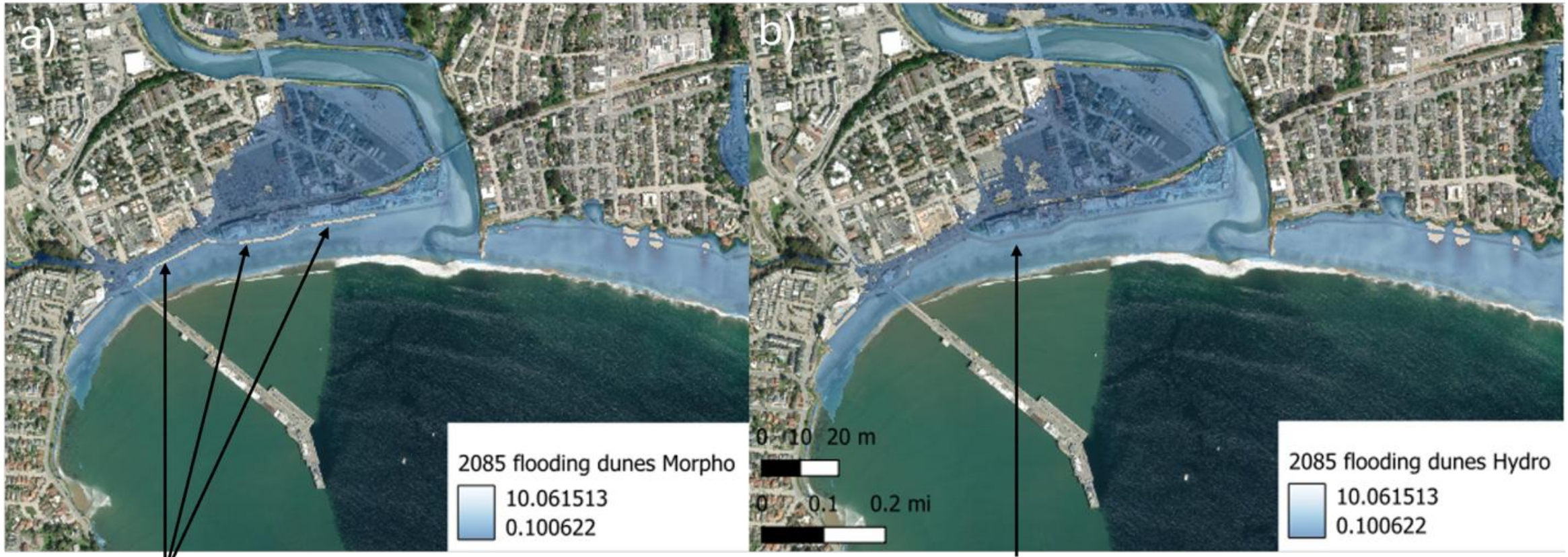
High resolution flood hazard maps

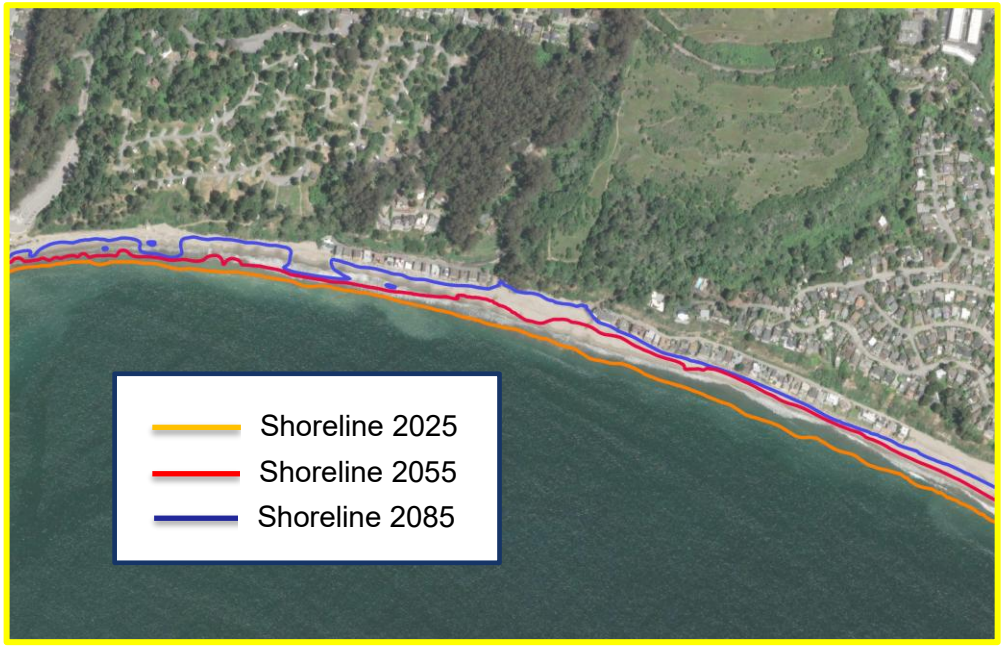


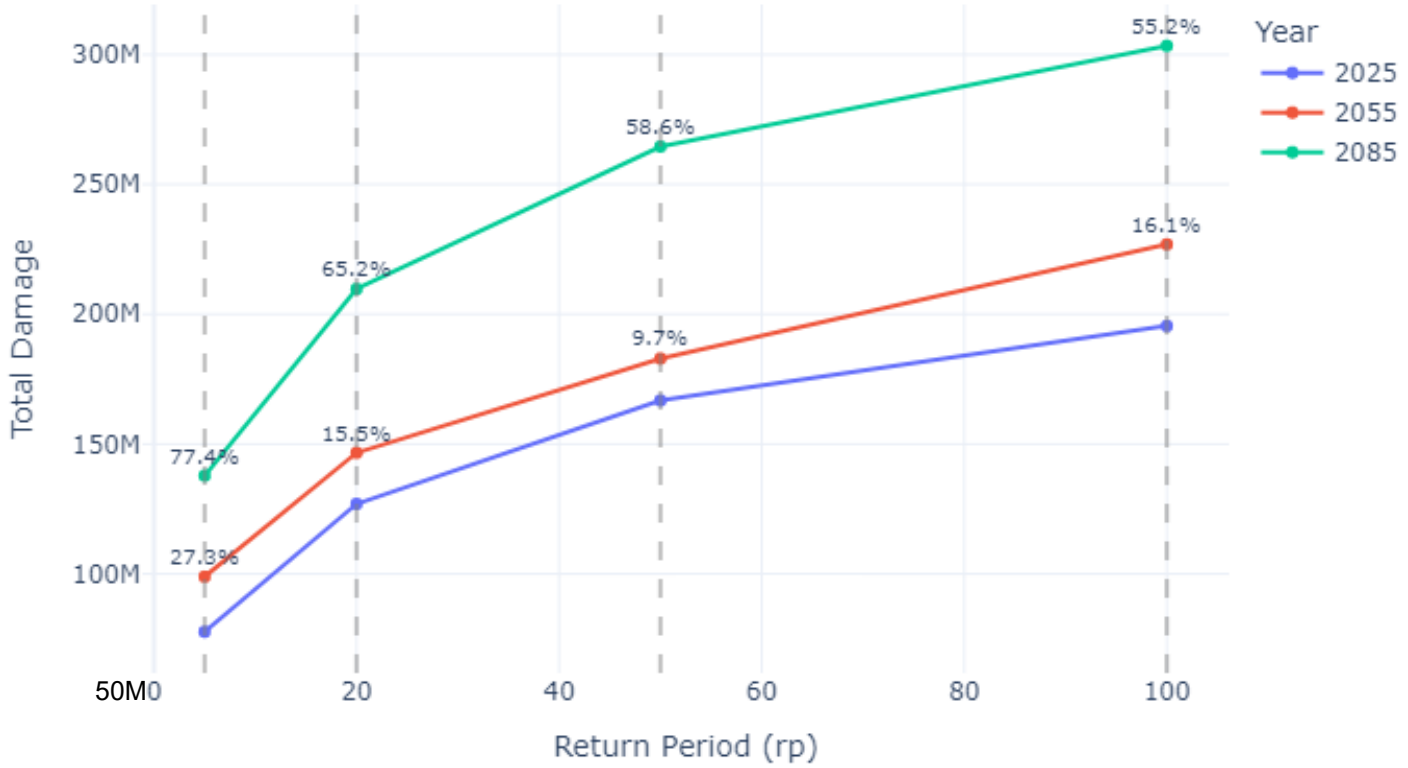


- Flooding is reduced by 3.4% when we activate the morphological module
- The dune is maintained in some sections whereas is completely over washed when the morphodynamics is not considered
- This leads into a reduction of dune life spam
- We need the morphological module when estimating the adaptation options and for the assessment of the tipping points

Changes in risk over time

Not linear increase:
Effect of SLR and shoreline changes

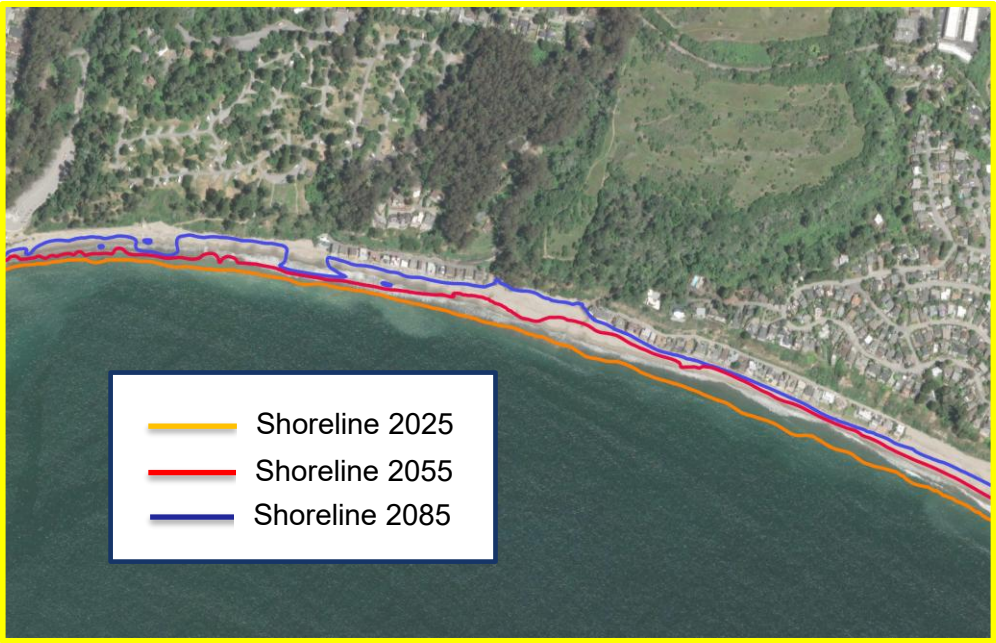


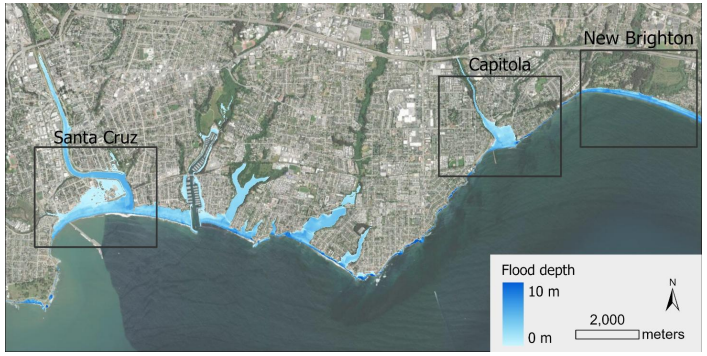


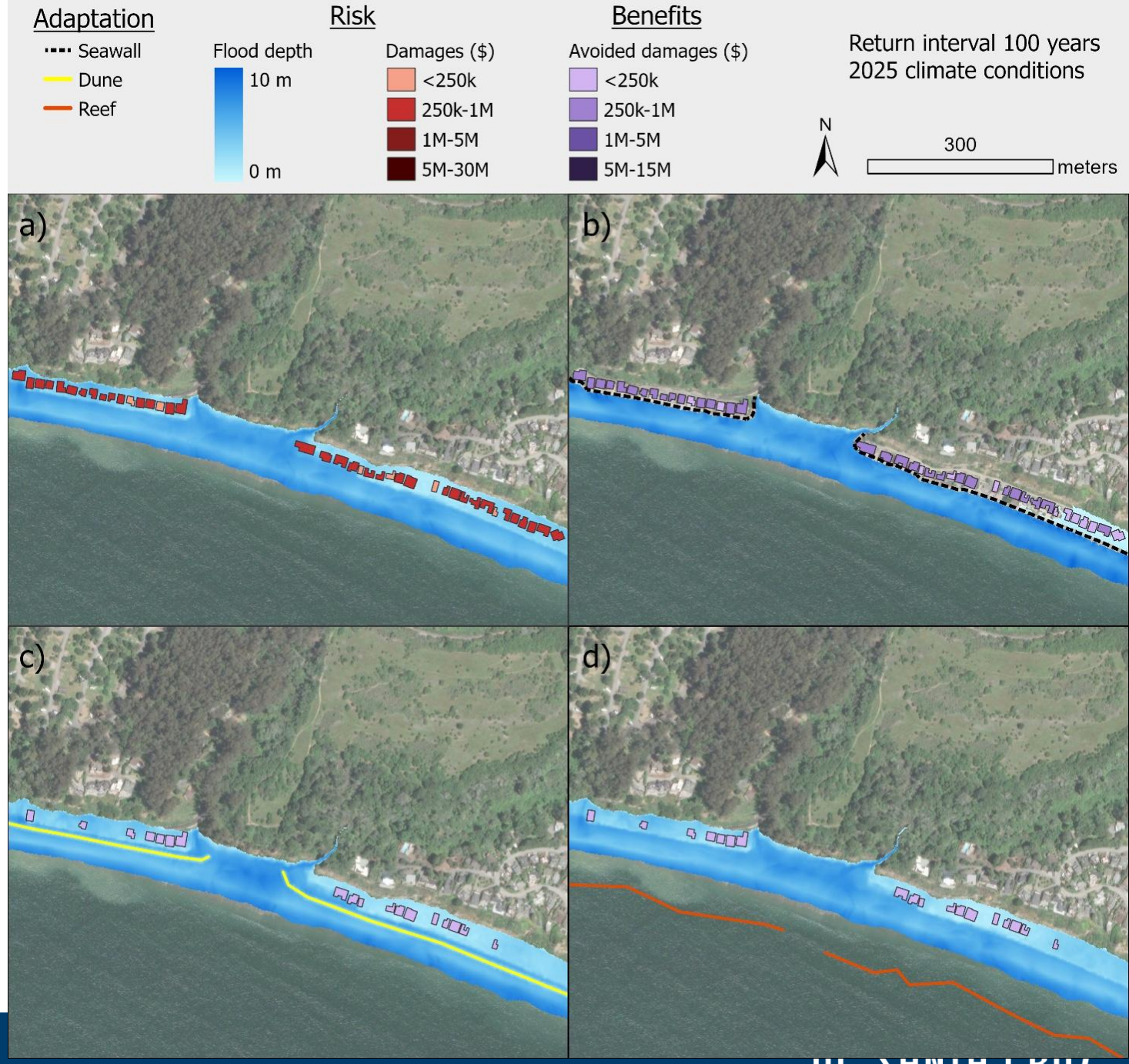
Total damages by return period for the baseline scenario (no adaptation), by year. The annotations marked increases in coastal flood damages with respect to the year 2025 across the region of study.

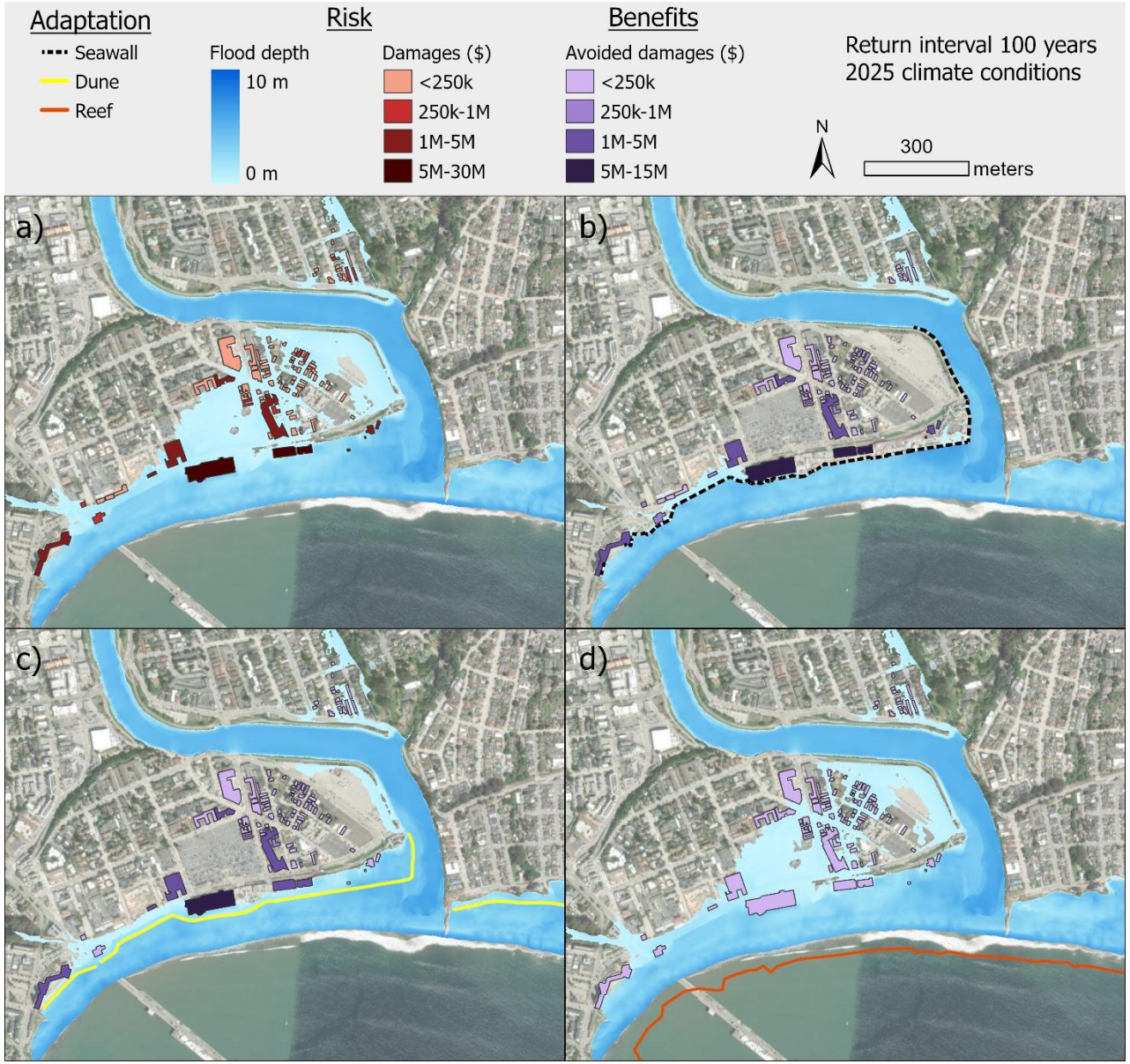
New Brighton State Beach

Shoreline retreat (erosion up to most of the beach zone) will increase flood risk.

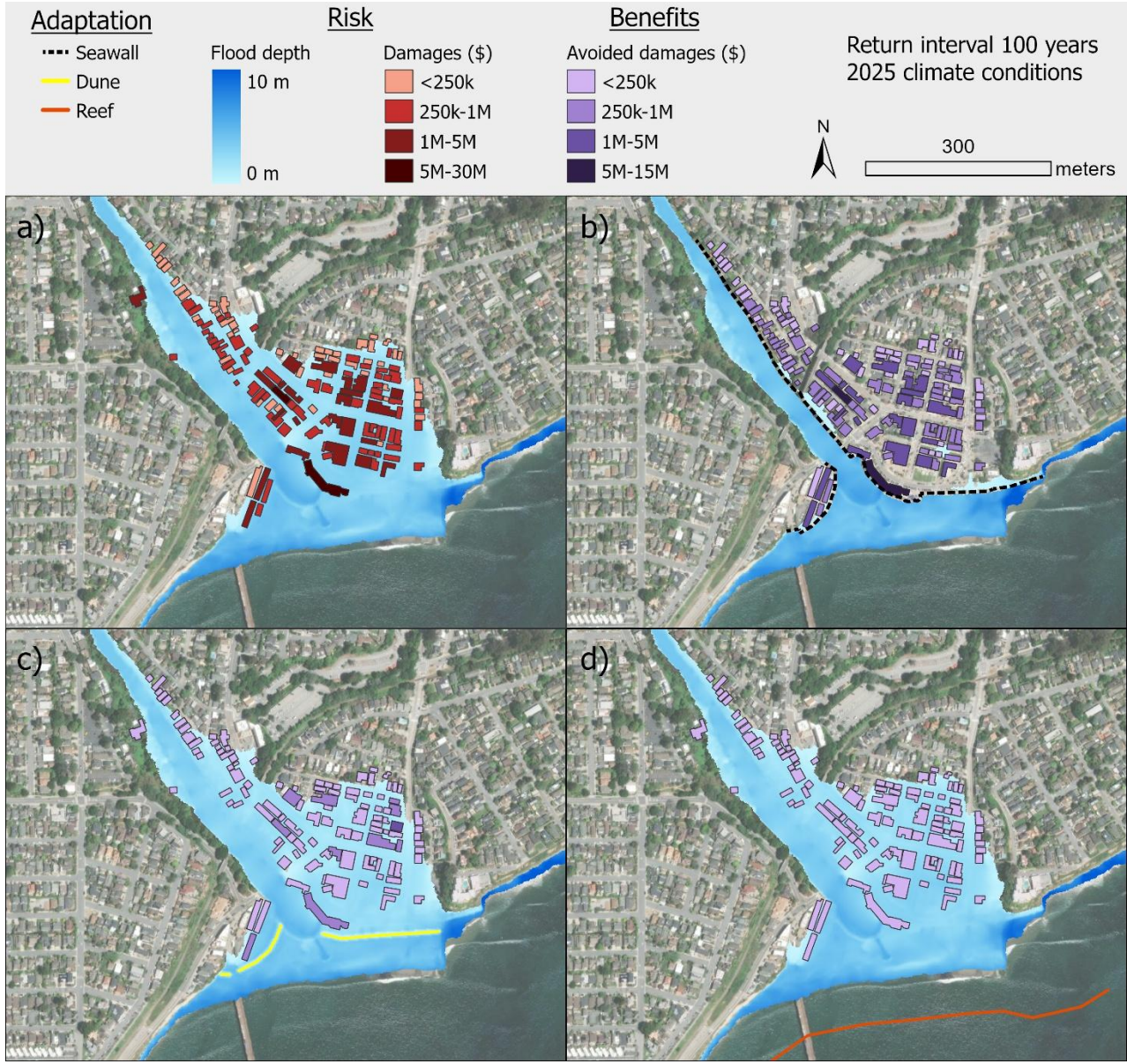








Effects of adaptation options on present-day risk in Main Beach, Santa Cruz area



Effects of adaptation options on present-day risk in Capitola

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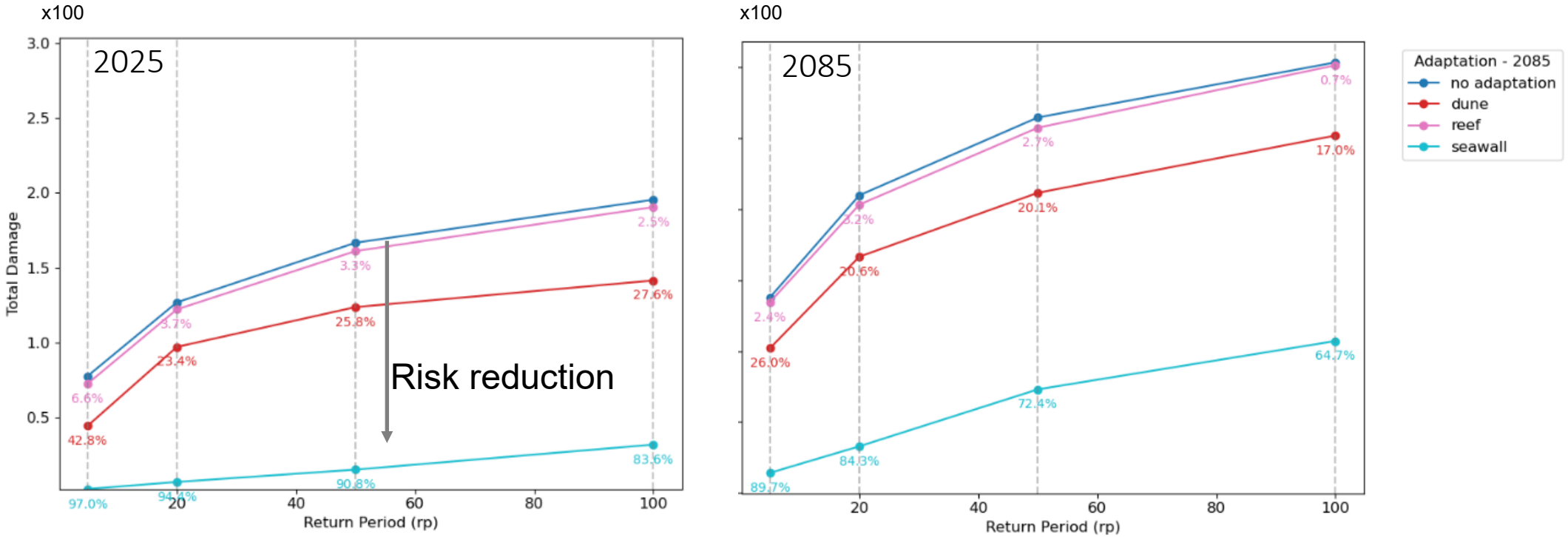
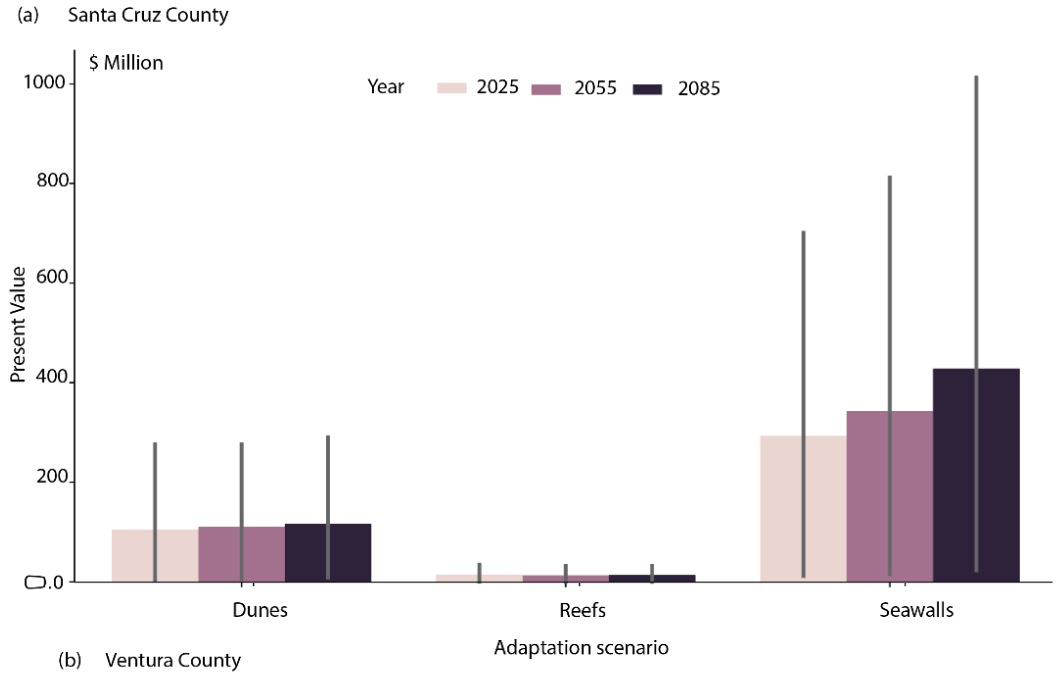
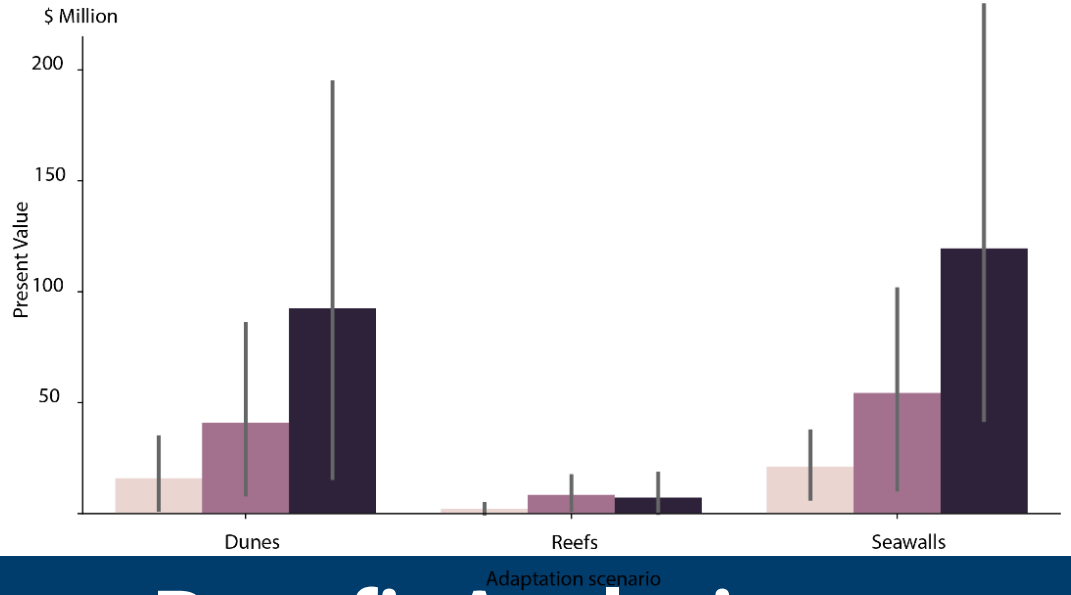
Effects of adaptation (now and future)



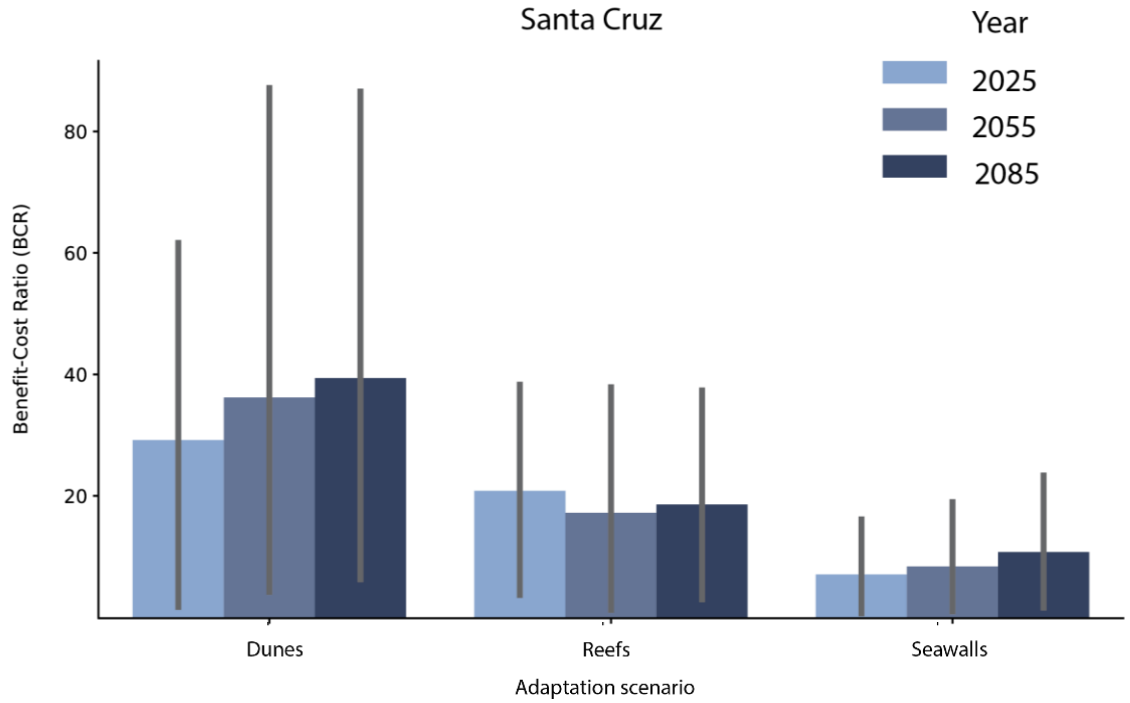
Effects of adaptation in Santa Cruz, in year 2025 (left), compared to 2085 (right) in the Santa Cruz region. Adaptation options reduce proportionally more risk at present (i.e. they can be considered more effective compared to existing risk), given the increase in risk in the future, the total economic benefits of adaptation increase.

Present values ($ million)





Benefit Cost Ratios (BCR)



Dune restoration projects seem to be the best NBS for Santa Cruz and Ventura

Cost Benefit Analysis

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Conclusions

- Considering various **temporal scales** resulted in detecting **non-linear changes** in risks, which are **accentuated over the second half of the century**.
- The **framework** can be applied at scales of **~15 to 20 km sections of shoreline**, being able to capture county scales.
- **Evaluatio**n of adaptation options needs to consider **short-term** and **long-term** responses in beach and dunes as they can materialize in **local changes in risks and cost effectiveness** of adaptation options.
- **Cost effectiveness evaluation based** on various **metrics** and consideration of direct and indirect damages can provide **important insight into the variability of cost effectiveness of intervention**.
- We need the **morphological module when estimating the adaptation options and** for the assessment of the **tipping points**

Thank you

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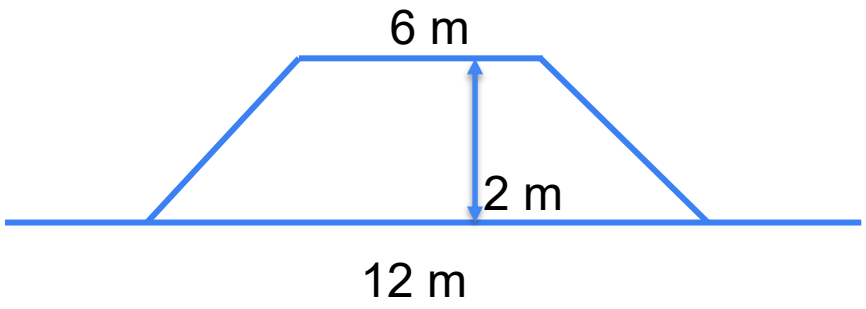
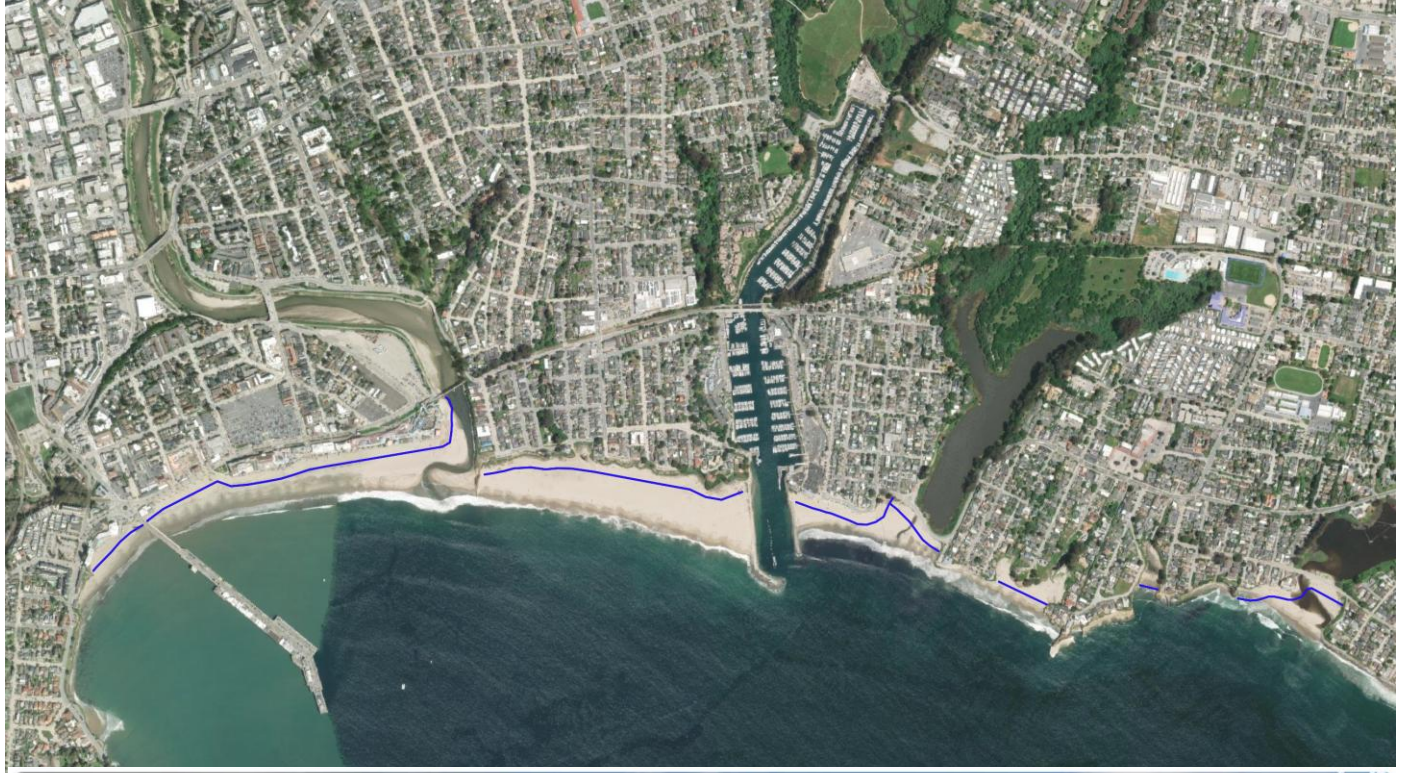
Adaptation option 2: suitability criteria

Dune:

- 30 m offshore from non-erodible line
- 2 m height
- 6 m length for dune crest
- Section ~ similar to sand placements in the area.





Adaptation option 3: Reef

wave breaking region

$$\gamma = H/h$$

Further optimization of reef design based on wave breaking region may be considered.

But we need to build reefs at different contour lines based on local breaking scenarios.

Dark purple color indicates $0.45 < \gamma < 0.55$ for RP50 without adapts

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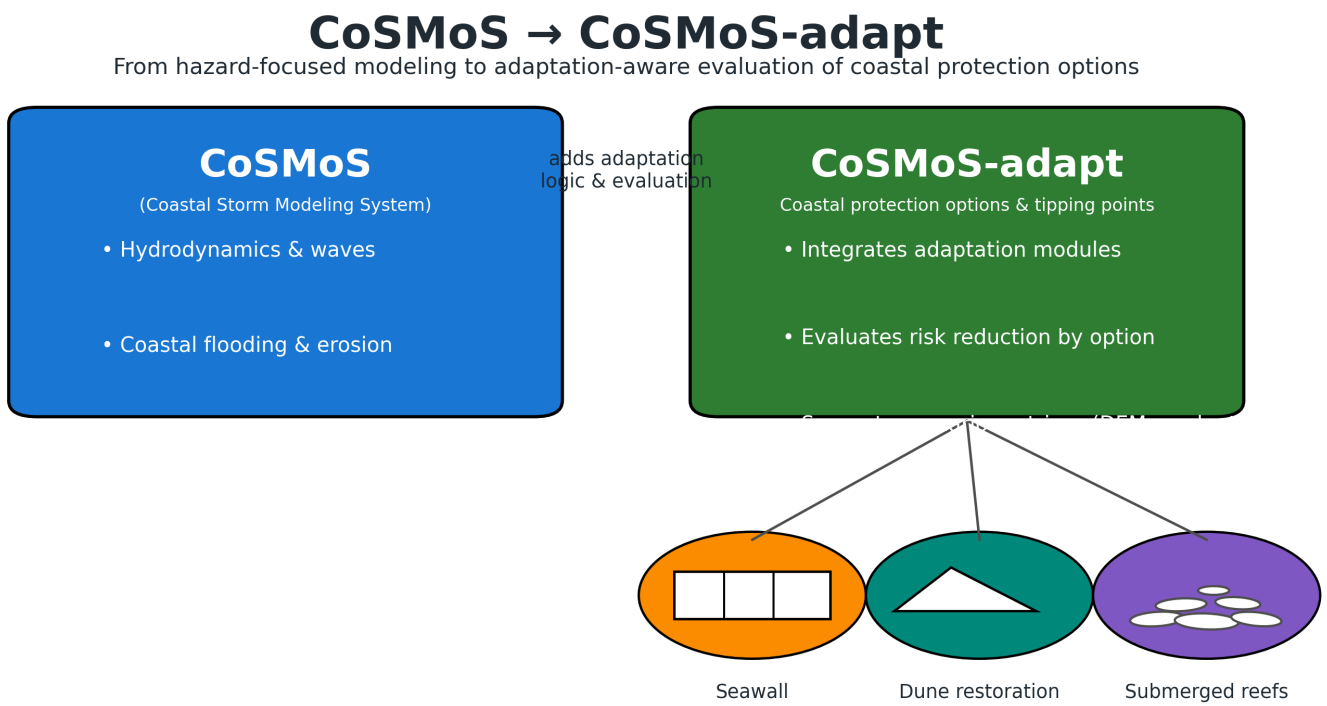

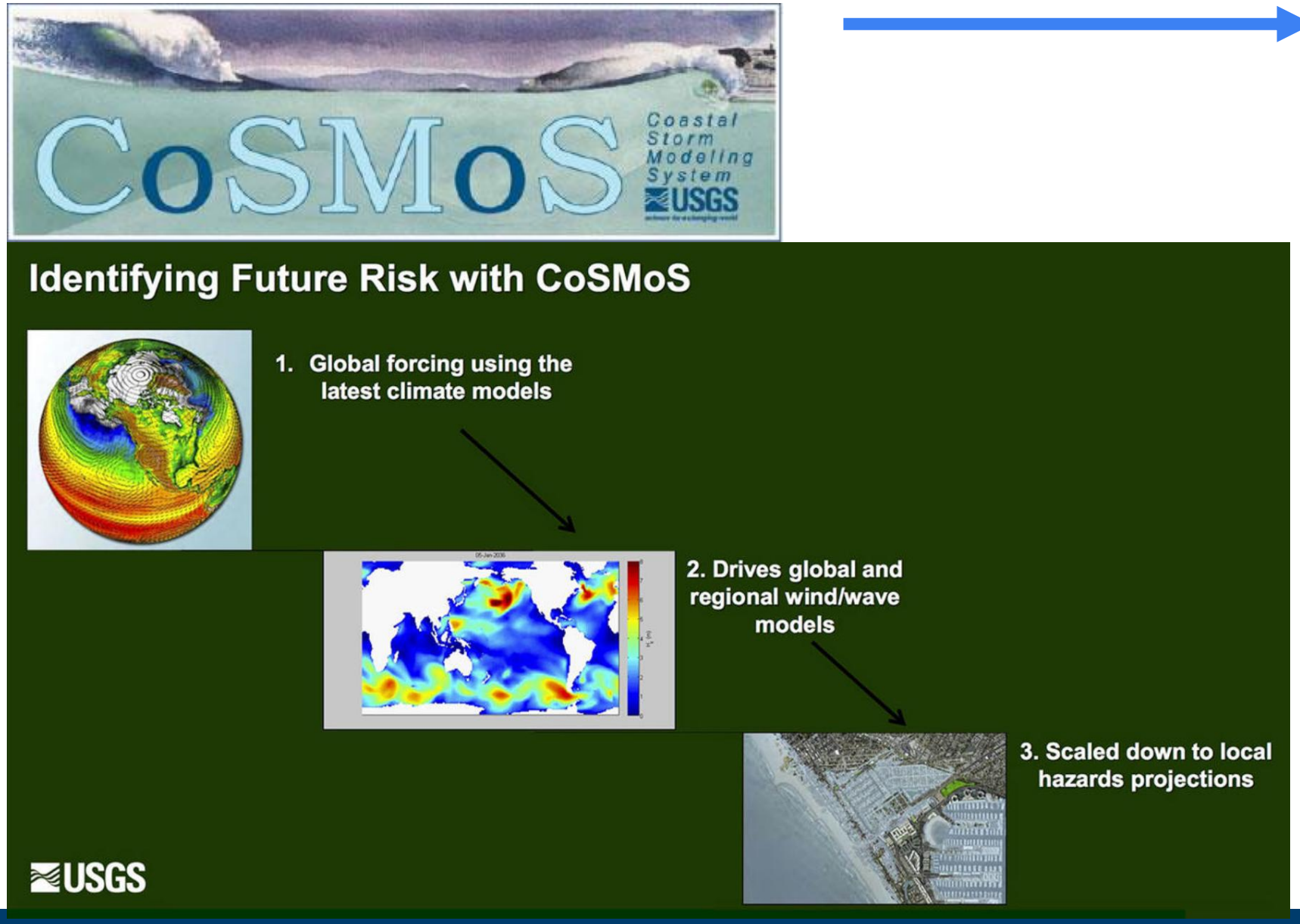

ADAPT

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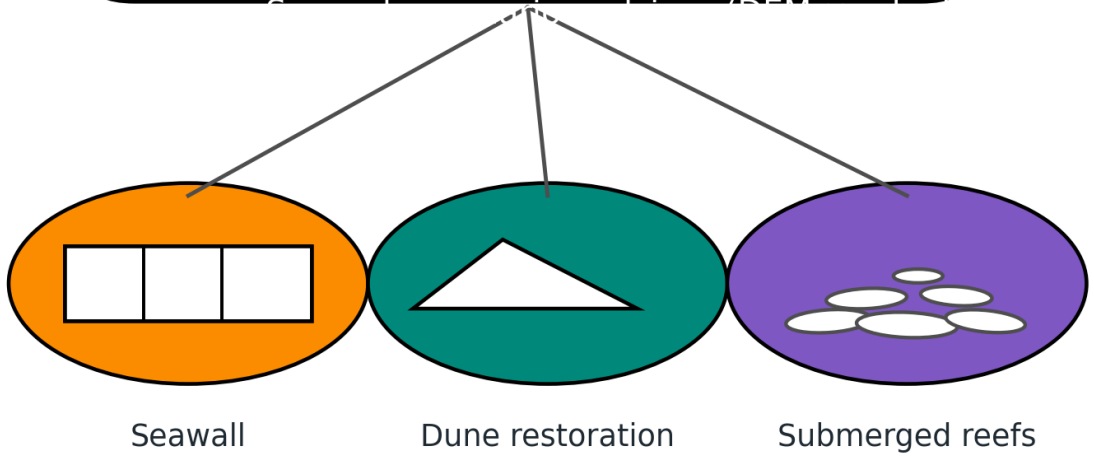

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