

Envisioning Grays Harbor County Coastal Futures

Adapting to climate change impacts on coastal hazards

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Contributing Students:

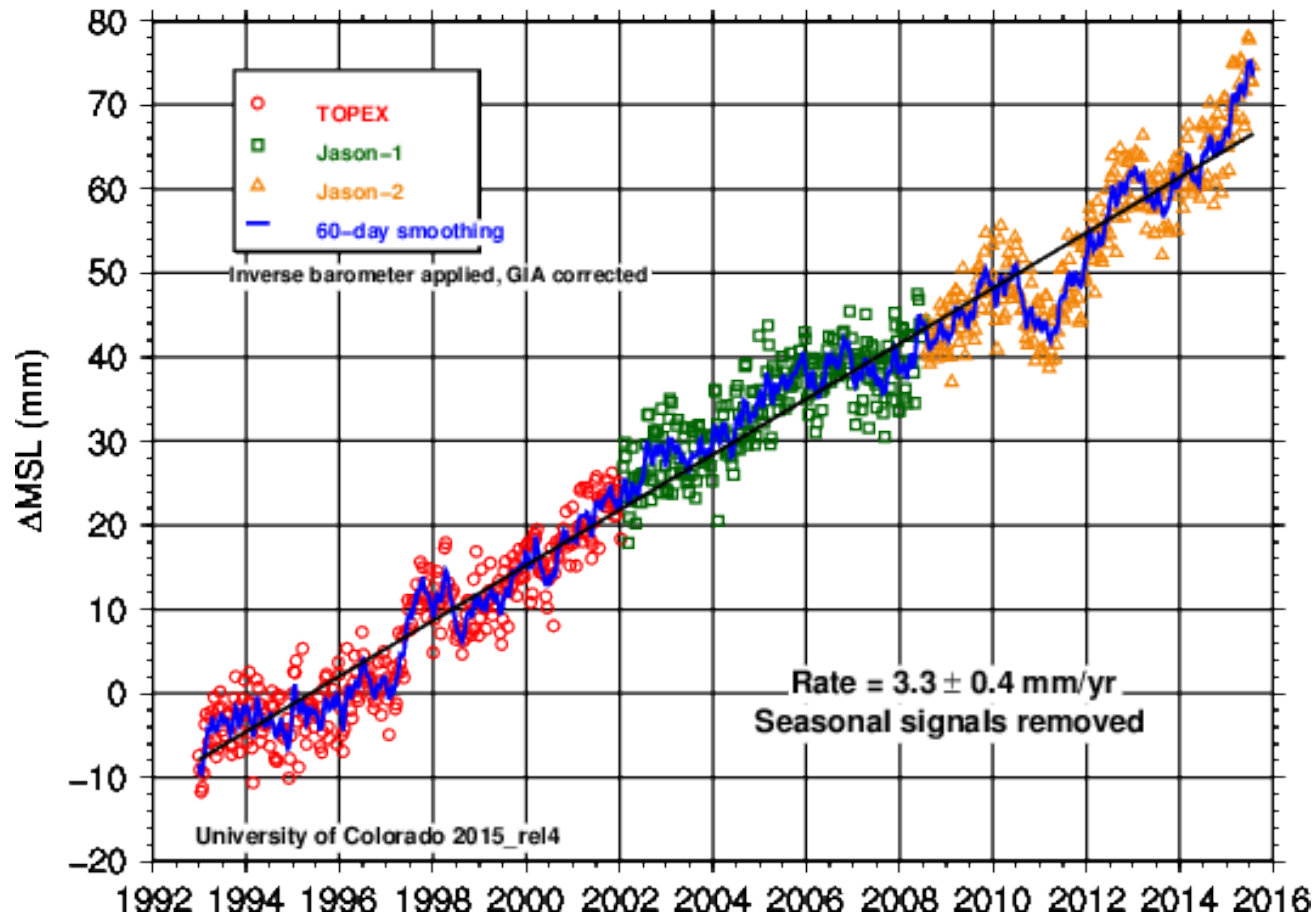
Janan Evans-Wilent , Alexis Mills, Eva Lipiec, Katy Serafin, Chad Zanocco, Lindsay Carroll

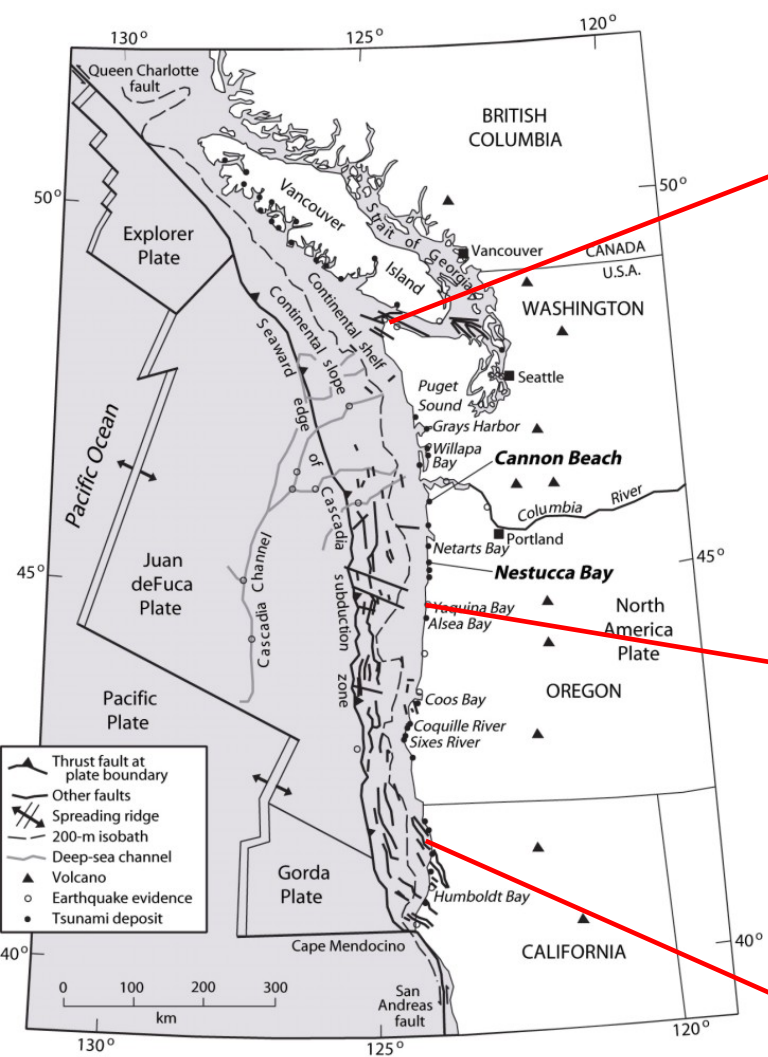
Climate Controls on *changing* Coastal Flood and Erosion Hazards

- Global rise in sea level (informed with regional variability)
- ENSO (El Niño - La Niña range)
- Trends and variability in storminess patterns (and the associated nearshore processes)

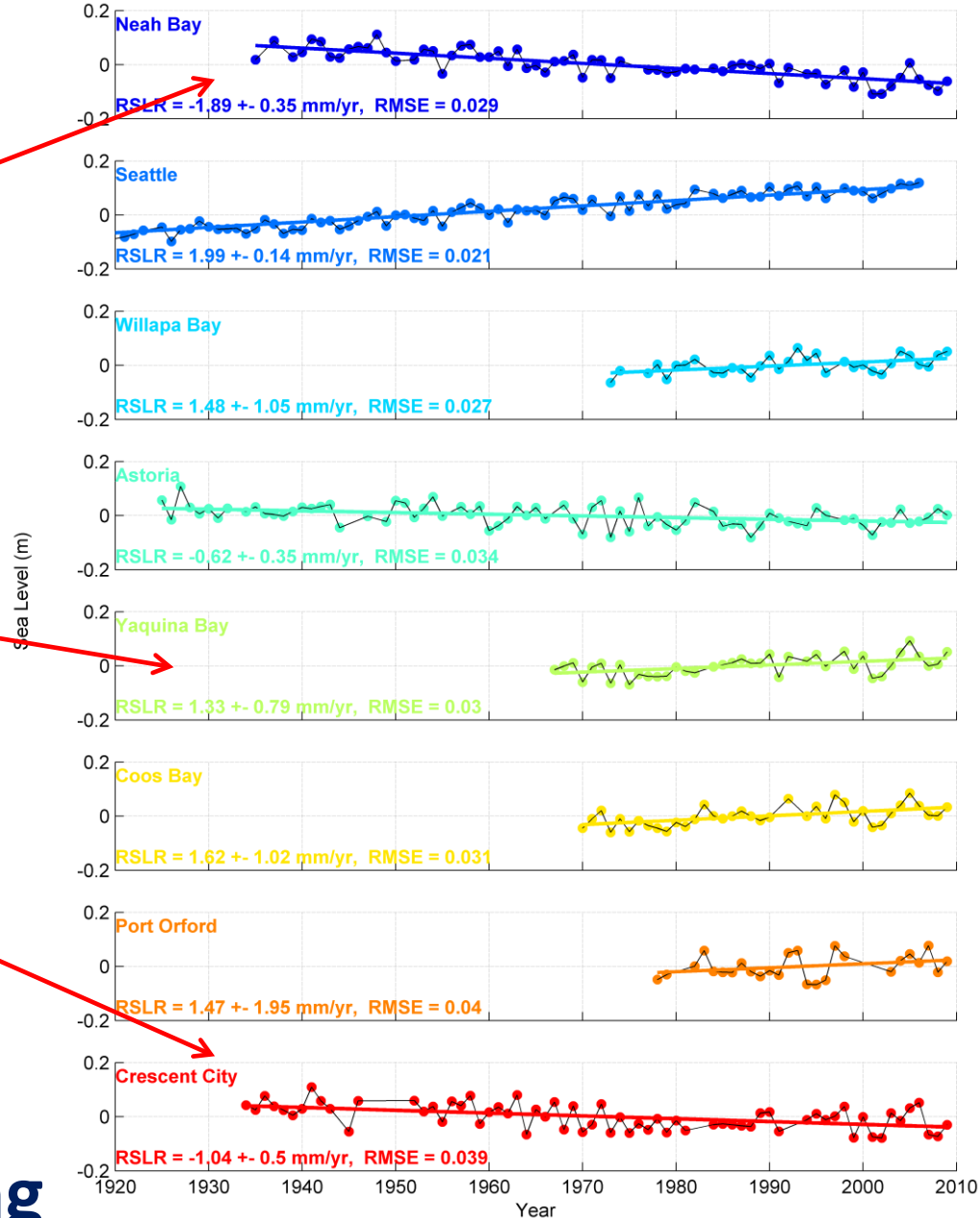
12 3'98

Global Mean Sea-level Rise (1993-2015)

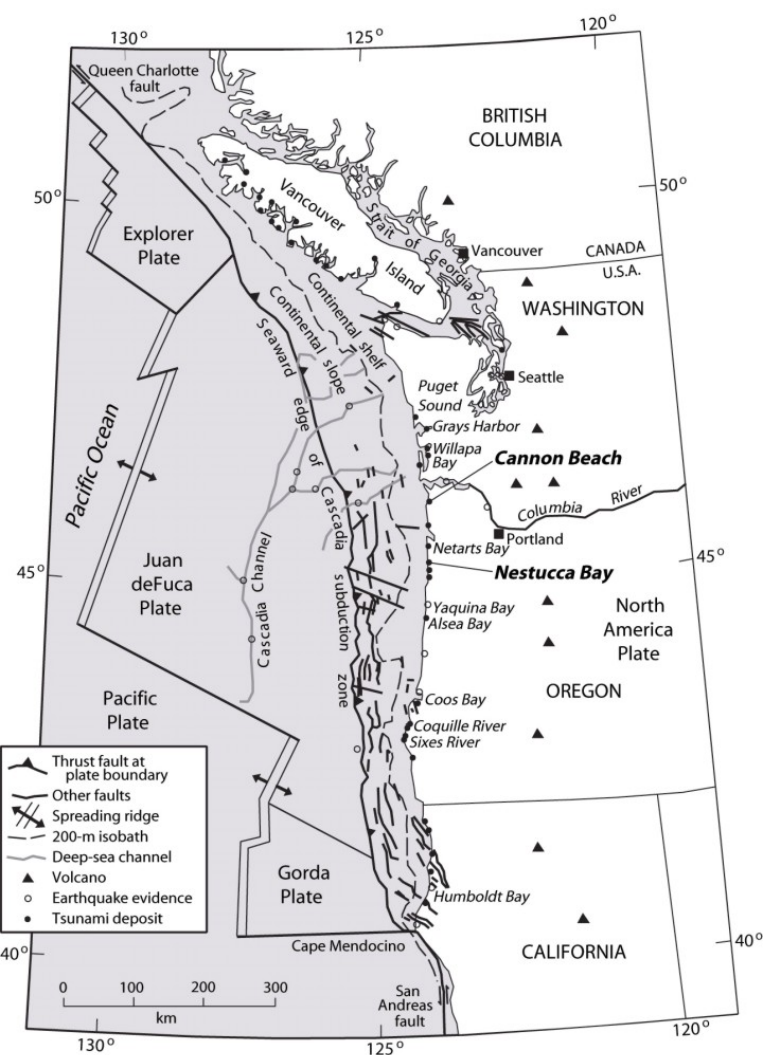




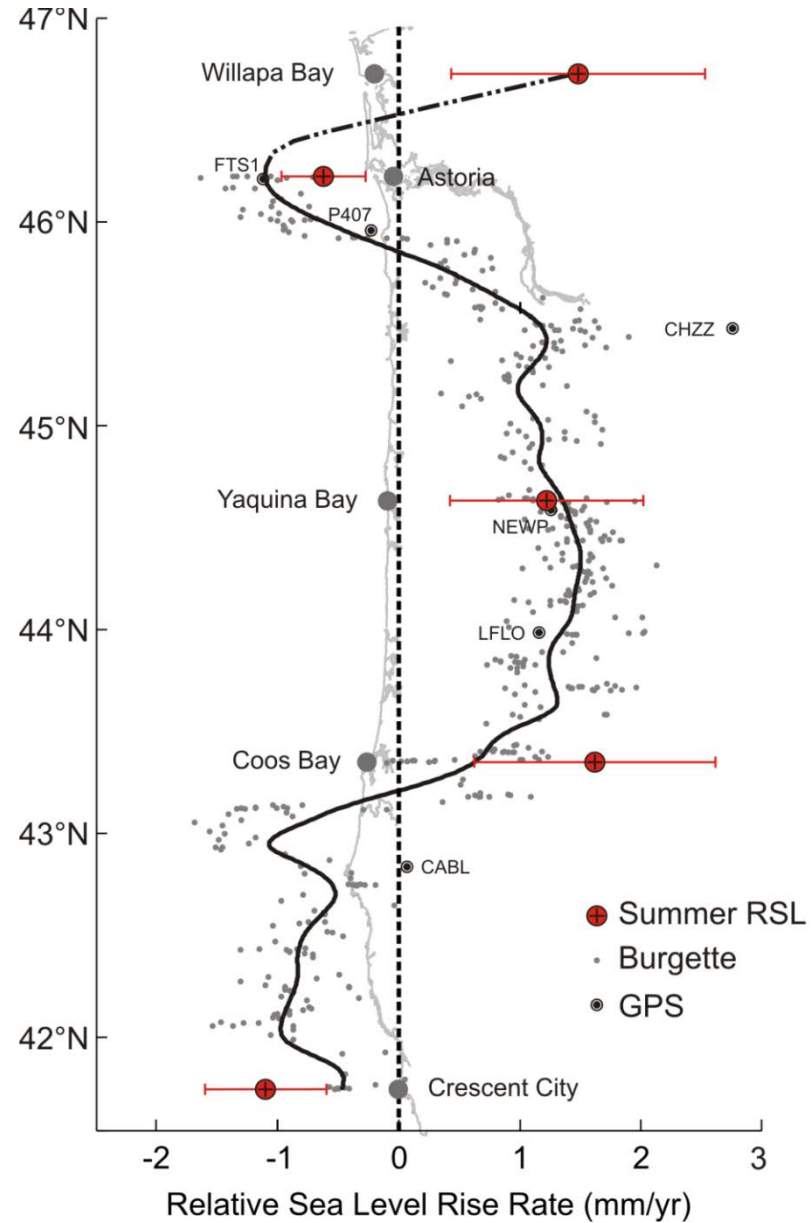
Geological and Hydrodynamic Setting of the PNW



Vertical land motions alter impacts of **SLR**



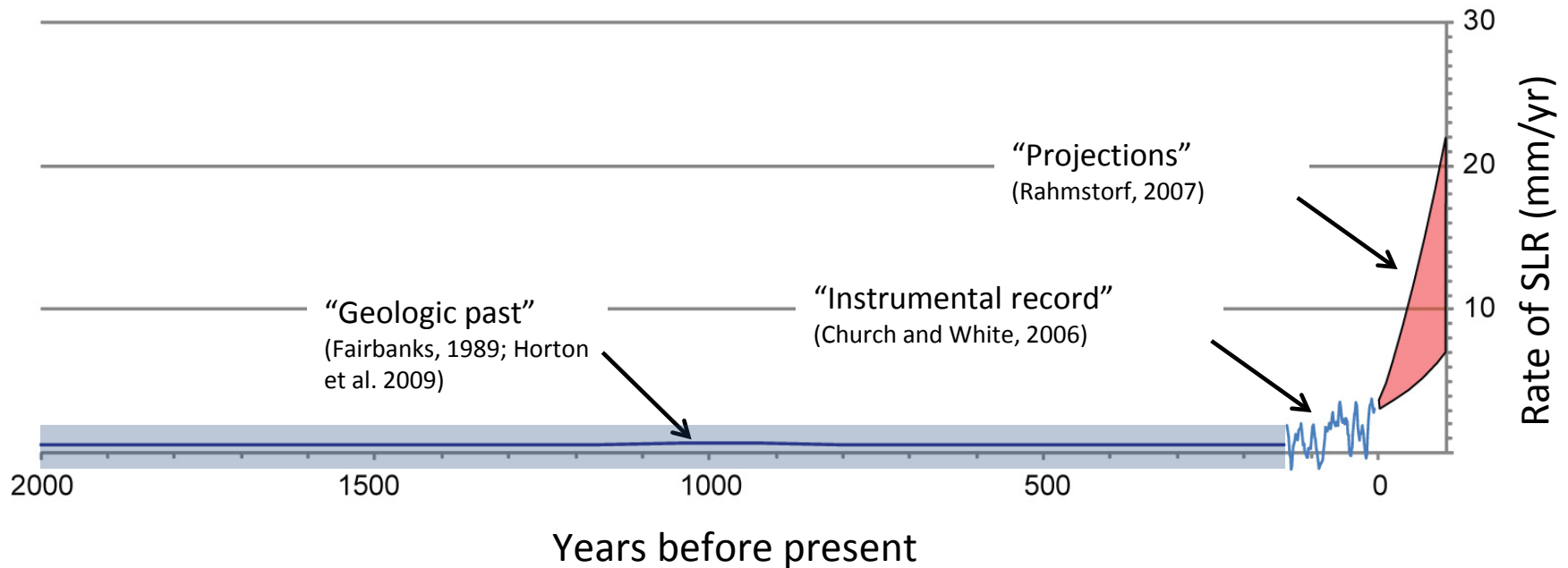
Geological and Hydrodynamic Setting of the PNW



Varying rates of uplift are reflected in RSLR

Komar, Allan, and Ruggiero, 2011.
after Burgette et al. 2009

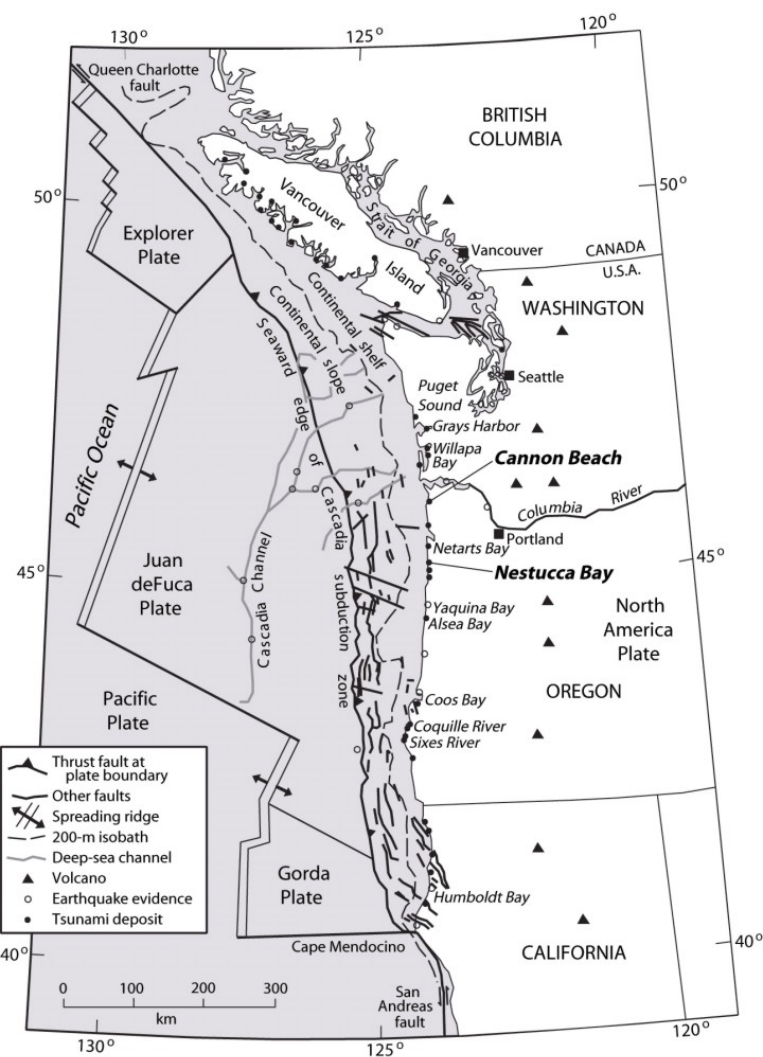
Past, present, and potential future rates of sea-level rise



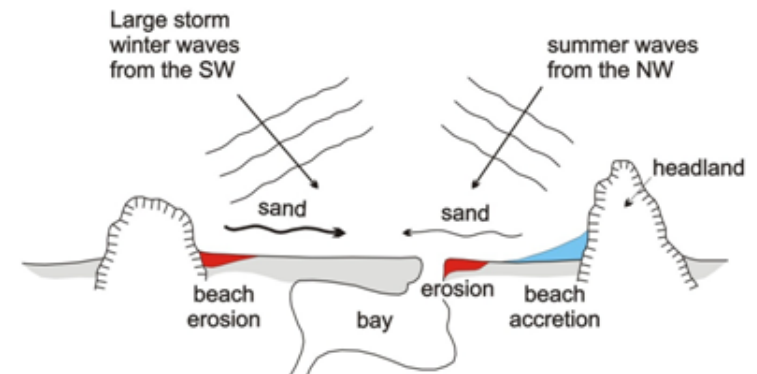
Uncertainty is increasing!

- **Wide range of SLR_{2100} estimates**

- 0.18-0.59 m (IPCC, 2007)
- Up to 2.0 m (Pfeffer et al., 2008)
- 0.5-1.4 m (Rahmstorf, 2007; 2010)
- 0.2-2.0 m (National Climate Assessment, 2012)
- .2-1.4 m (NRC Committee on SLR, 2012)
- .3 - .98 m (IPCC, 2013)



- High water levels (10s of cms)
- Larger than typical wave heights
- Anomalous wave approach angles
- Enhanced longshore and cross-shore sediment transport
- Hot-spot erosion

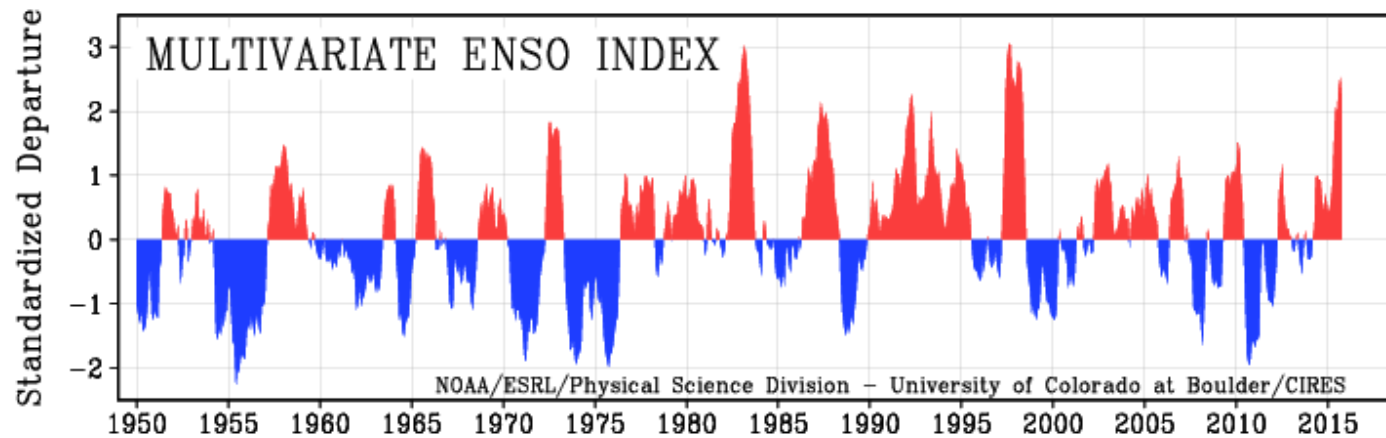
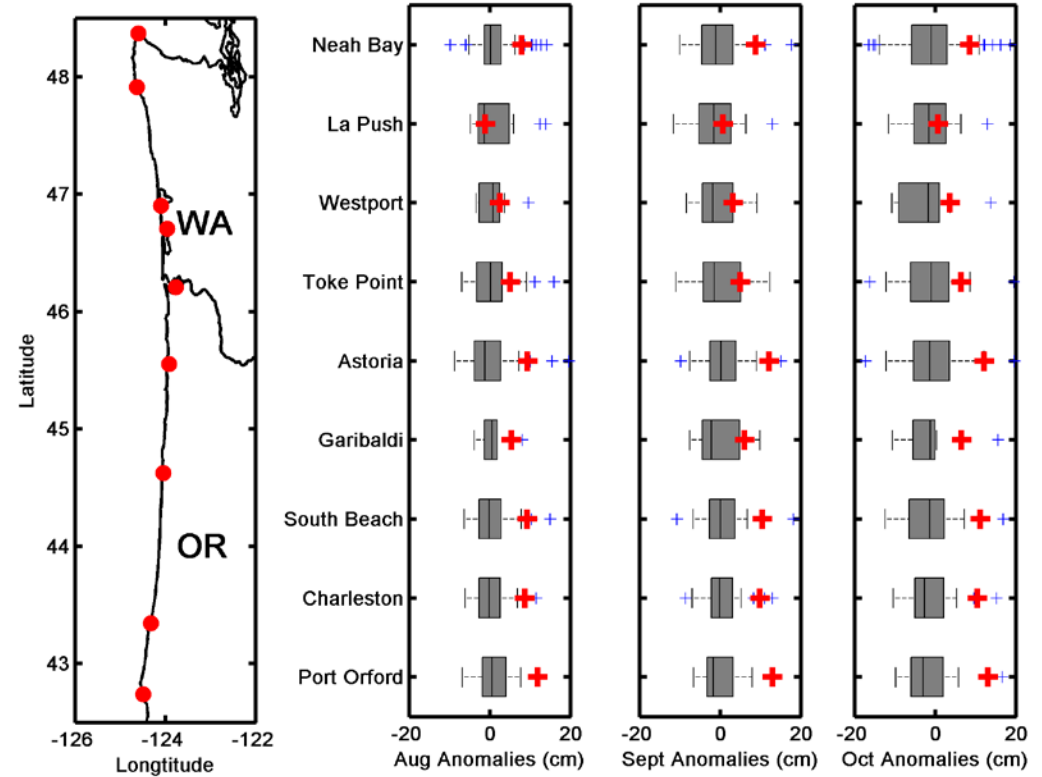


Geological and Hydrodynamic Setting of the PNW

During **El Niños** the PNW effectively experiences decades worth of SLR for months

El Niños impact on the US West Coast

2015-2016 Event



Future frequency and magnitude of El Niños? More, less, no change from present-day??

nature
climate change

LETTERS

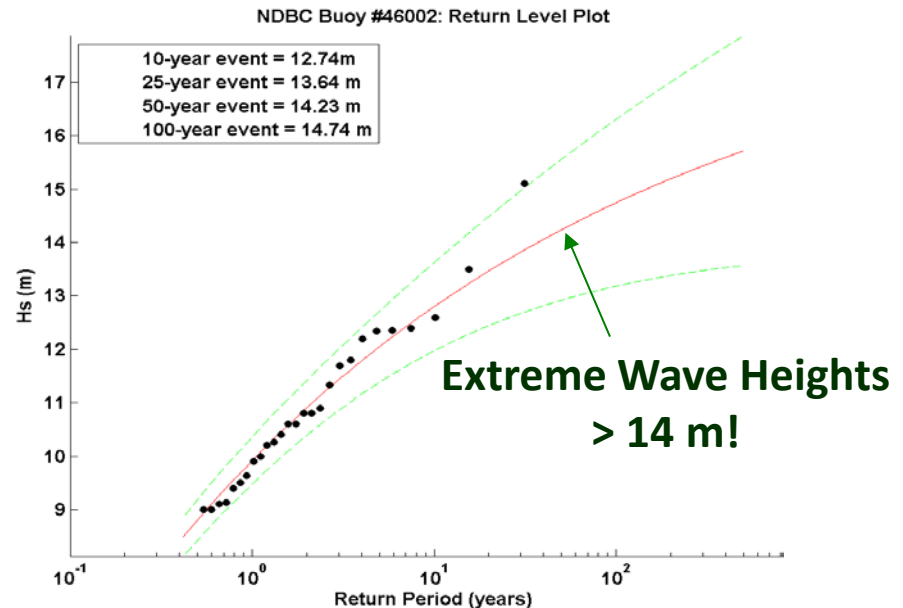
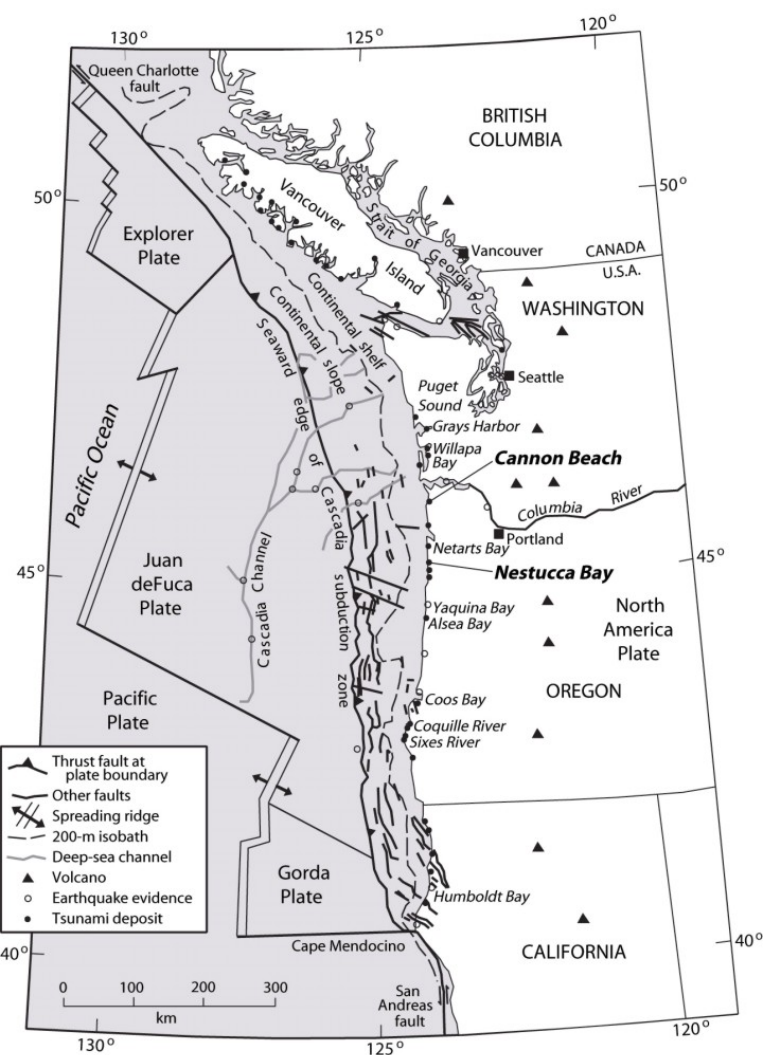
PUBLISHED ONLINE: 19 JANUARY 2014 | DOI: 10.1038/NCLIMATE2100

Increasing frequency of extreme El Niño events due to greenhouse warming

Wenju Cai^{1,2*}, Simon Borlace¹, Matthieu Lengaigne³, Peter van Rensch¹, Mat Collins⁴,
Gabriel Vecchi⁵, Axel Timmermann⁶, Agus Santoso⁷, Michael J. McPhaden⁸, Lixin Wu²,
Matthew H. England⁷, Guojian Wang^{1,2}, Eric Guilyardi^{3,9} and Fei-Fei Jin¹⁰

Major ENSO events may double in frequency

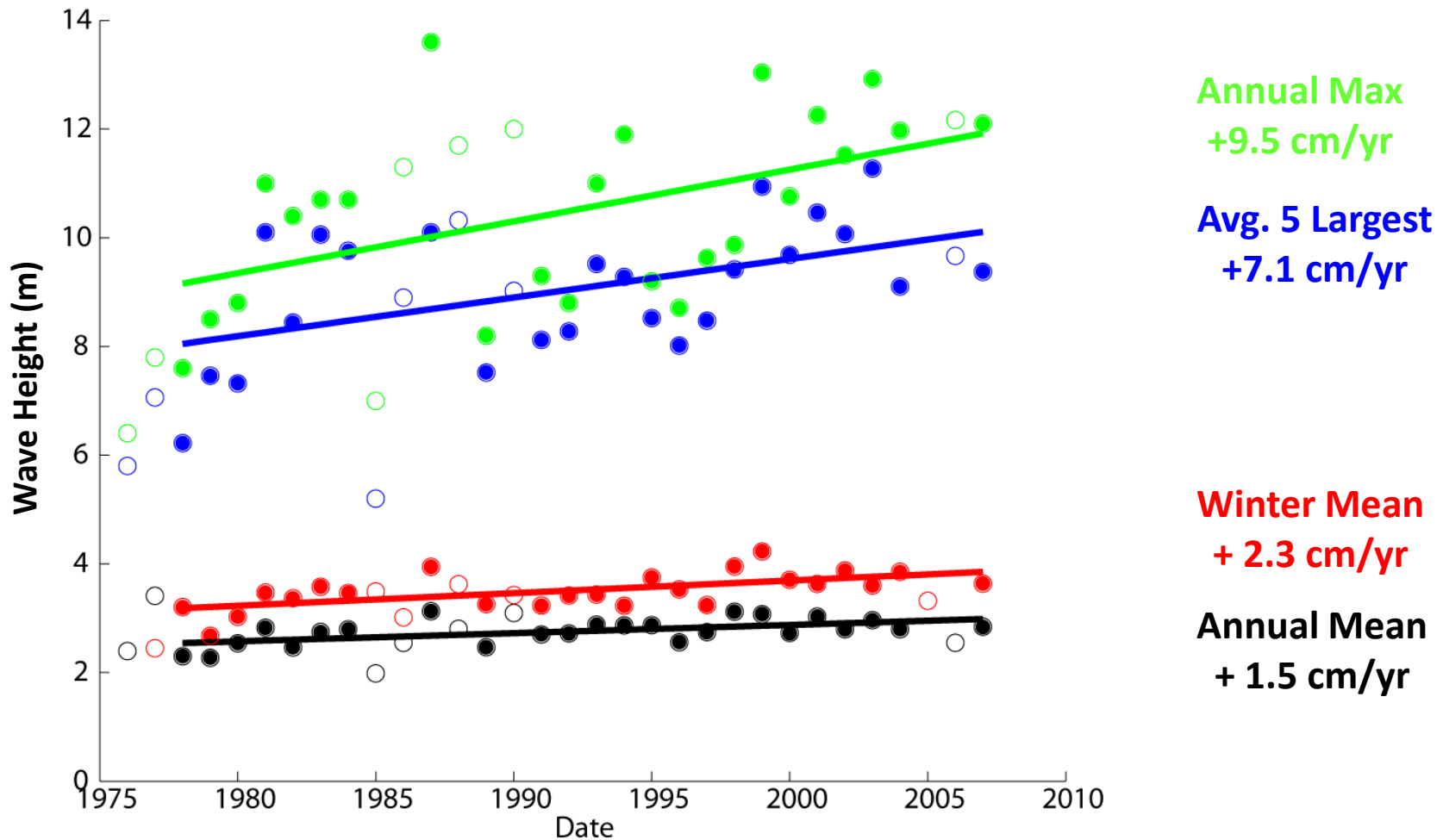




Geological and Hydrodynamic Setting of the PNW

One of the most intense **wave climates** in the world

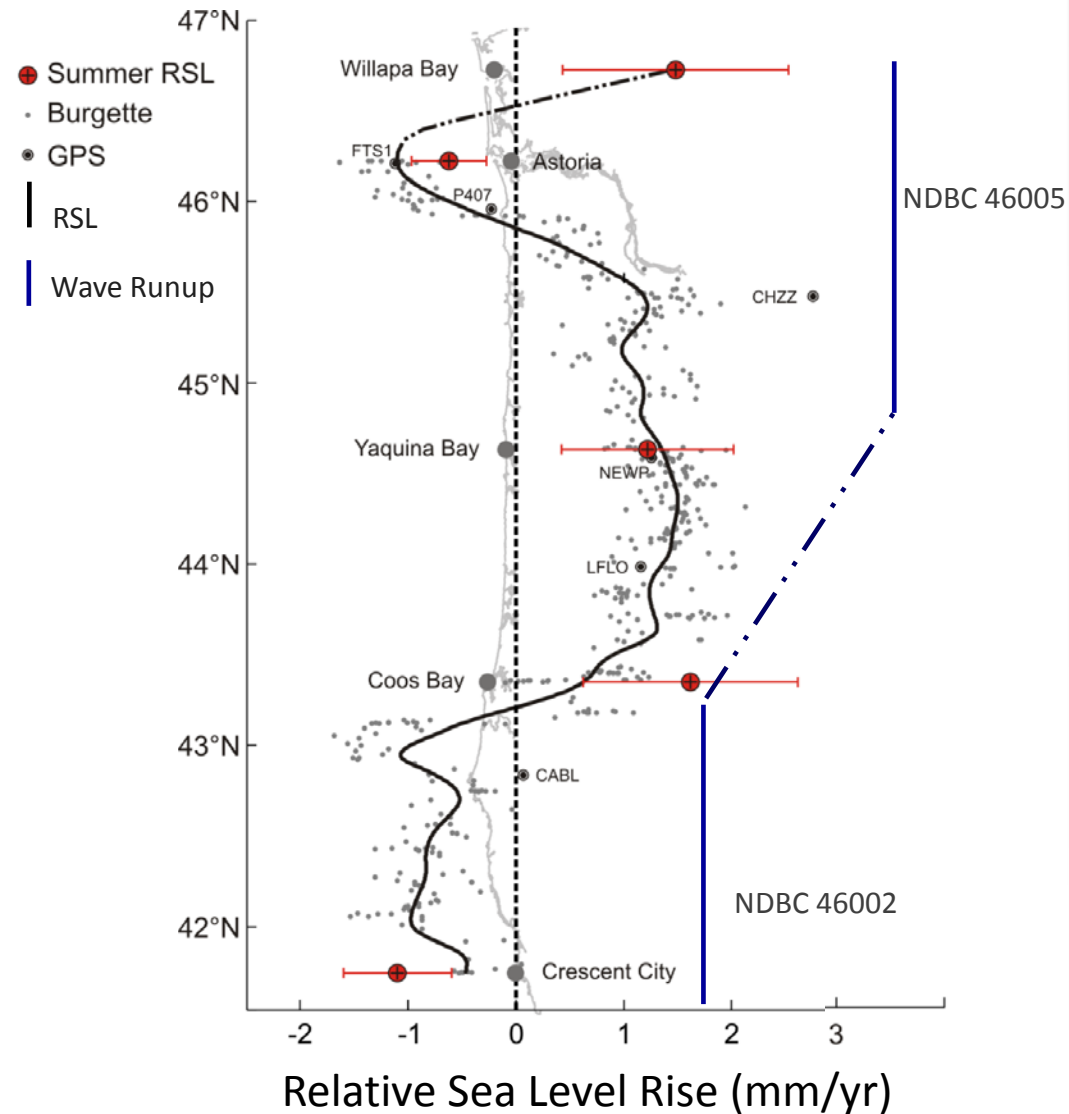
Increasing PNW wave heights



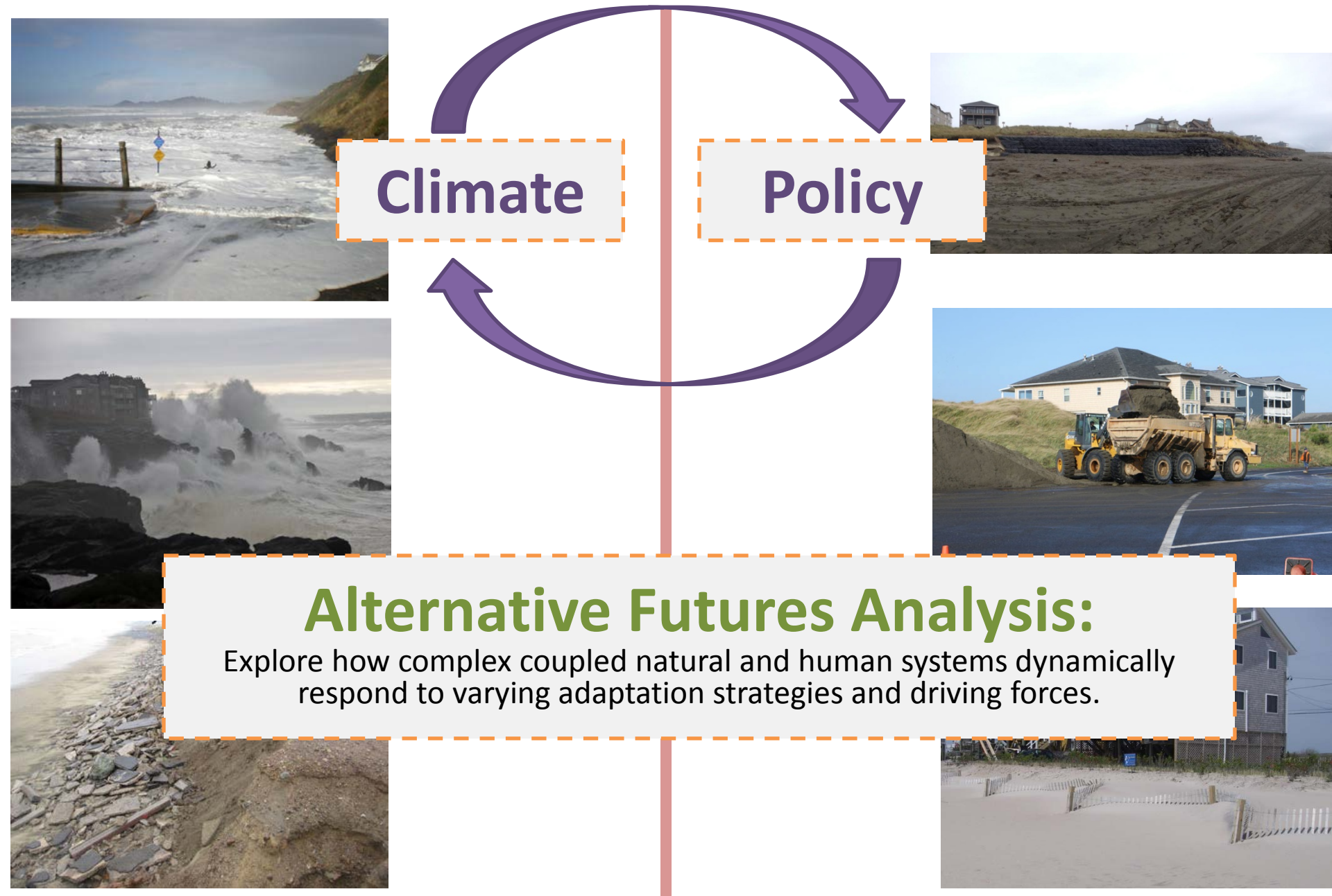
Over the last ~30 years *changing* wave heights have been more important than *changing* sea level over much of the PNW coast!



Ruggiero, 2013



Envisioning Coastal Futures



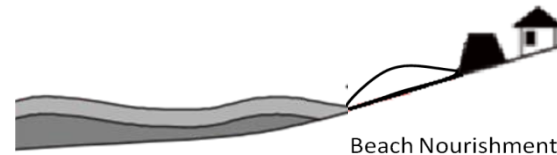
Tillamook County Coastal Futures Project



Objective: Collaboratively develop the information and tools necessary to envision future scenarios, assess impacts and vulnerability associated with climate change driven erosion and flood hazards, and quantitatively evaluate a range of adaptation strategies.



More riprap?



Nourish the coastline?

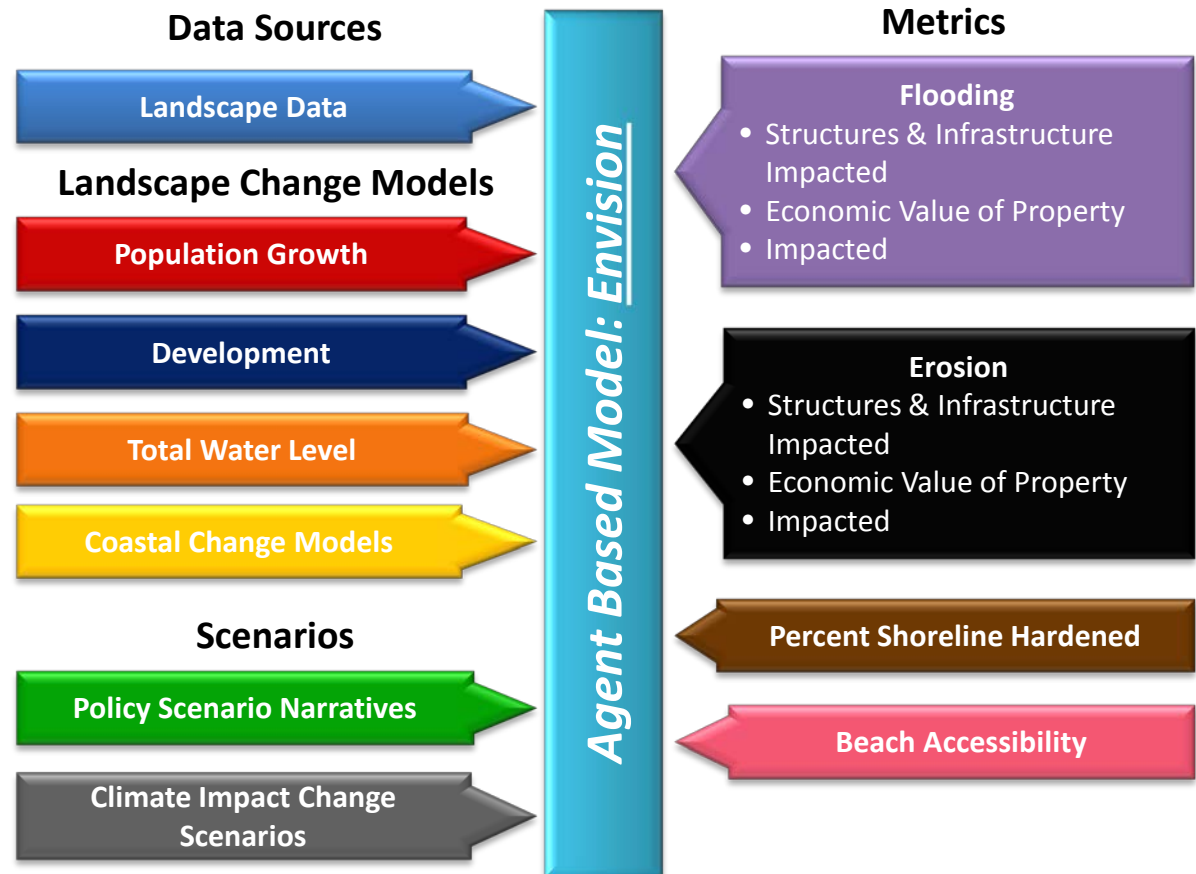


Move away from coast?

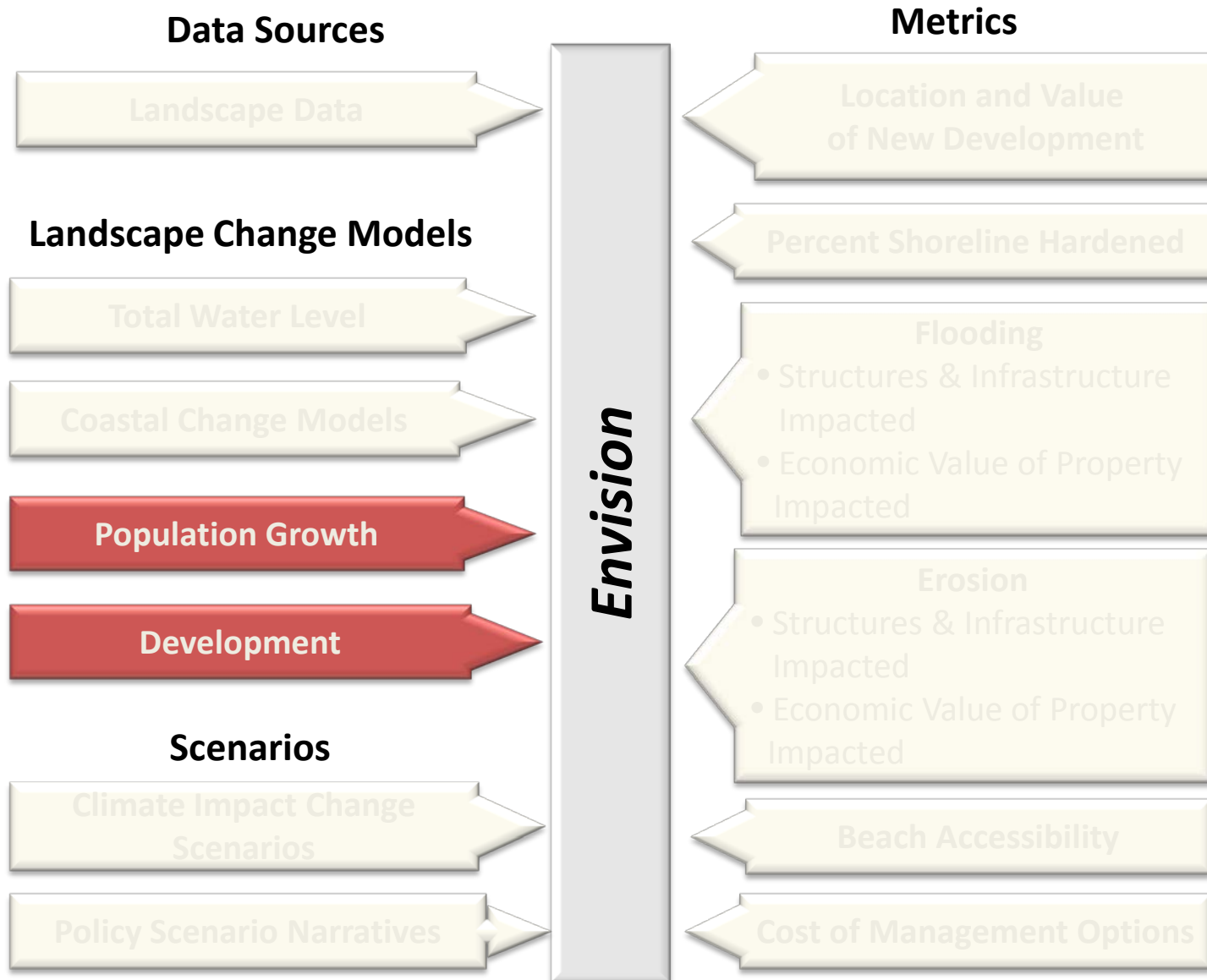
Alternative Futures Analysis: *Envision*



Bolte et al., 2007



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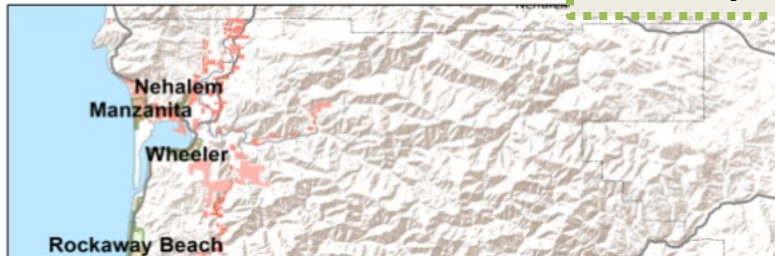
Tillamook County Coastal Futures Project



2010

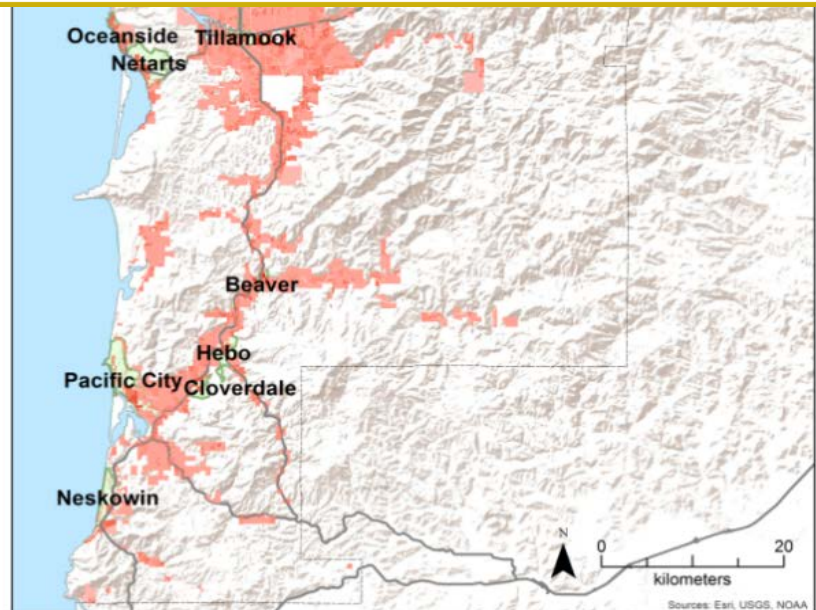
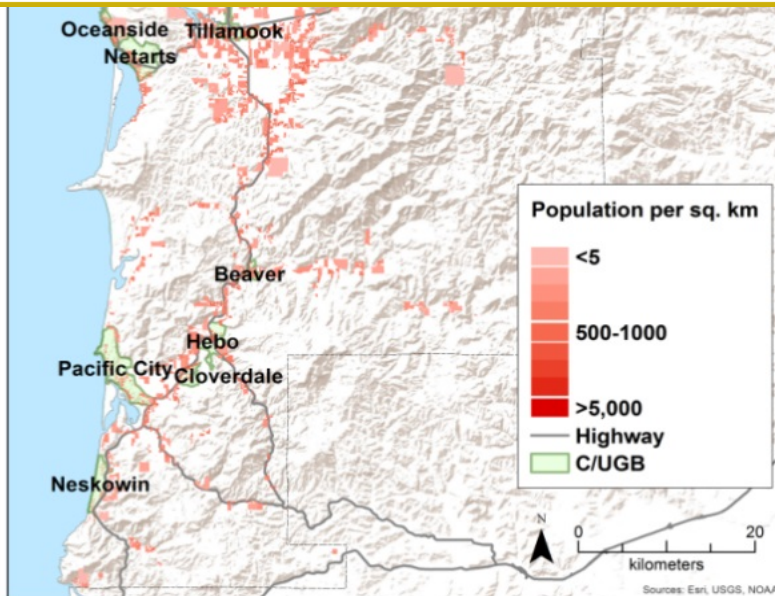
Population Growth and
Development Submodels

2100

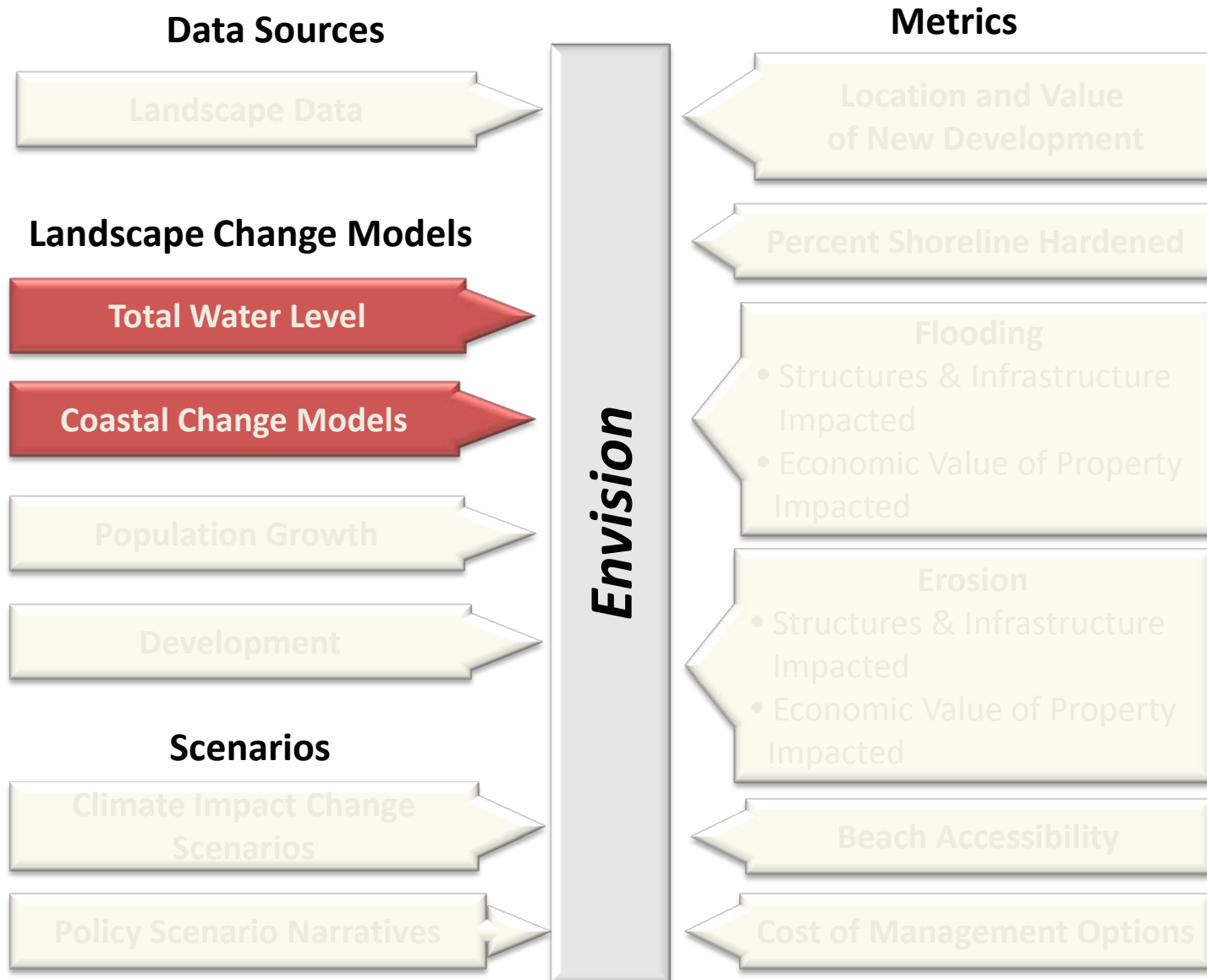


Assessed Value (\$)

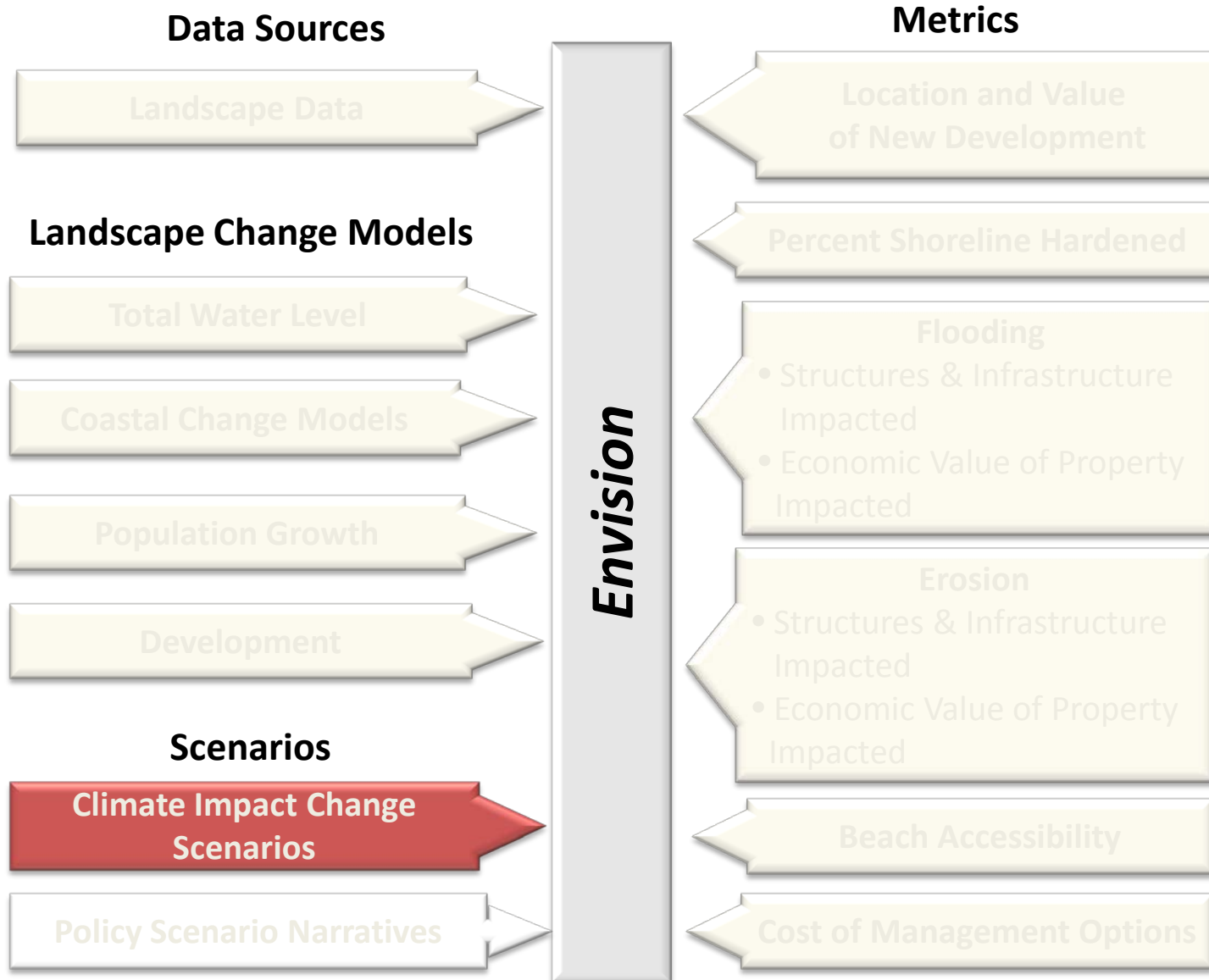
$= f \left(\begin{array}{l} \text{lot size, distance to shoreline, presence of BPS, distance to major highway,} \\ \text{number of buildings, geographic location (within growth boundaries)} \end{array} \right)$



Tillamook County Coastal Futures Project



Tillamook County Coastal Futures Project

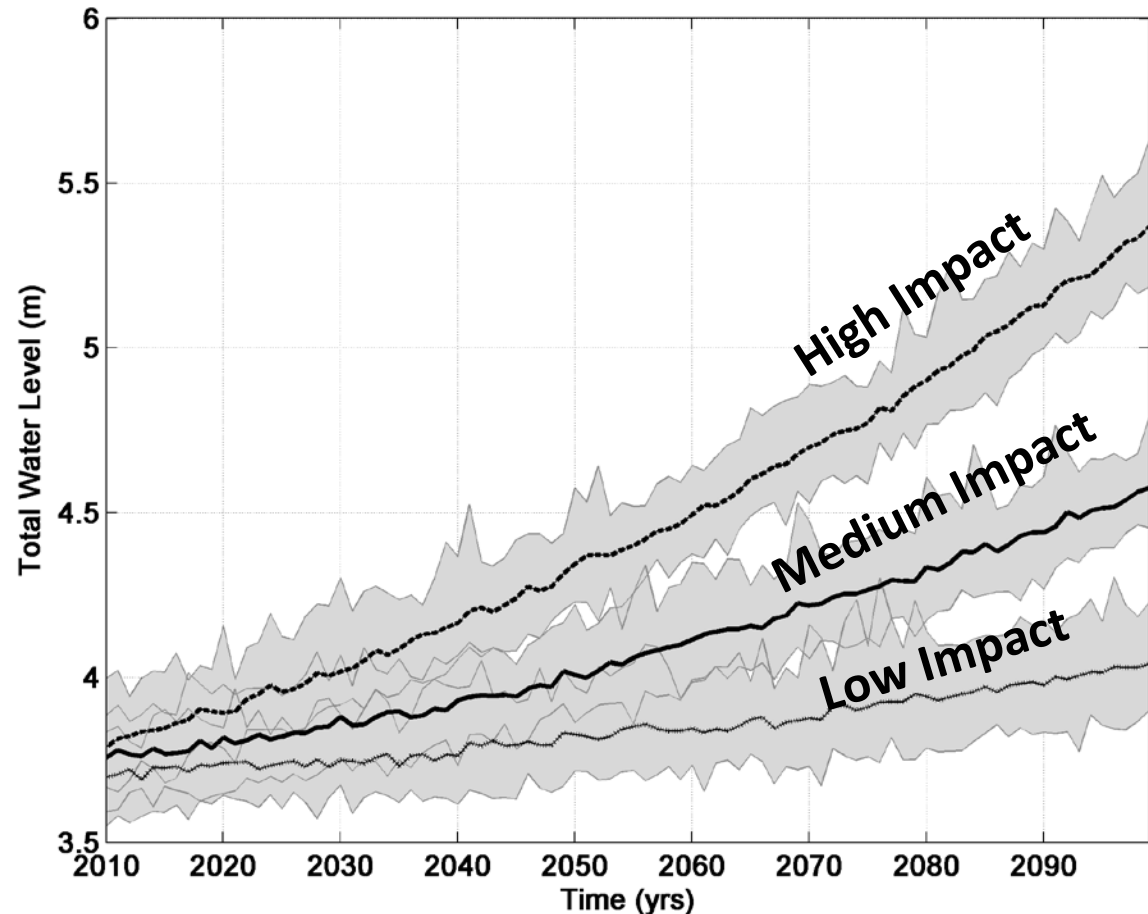


Climate Change Scenarios

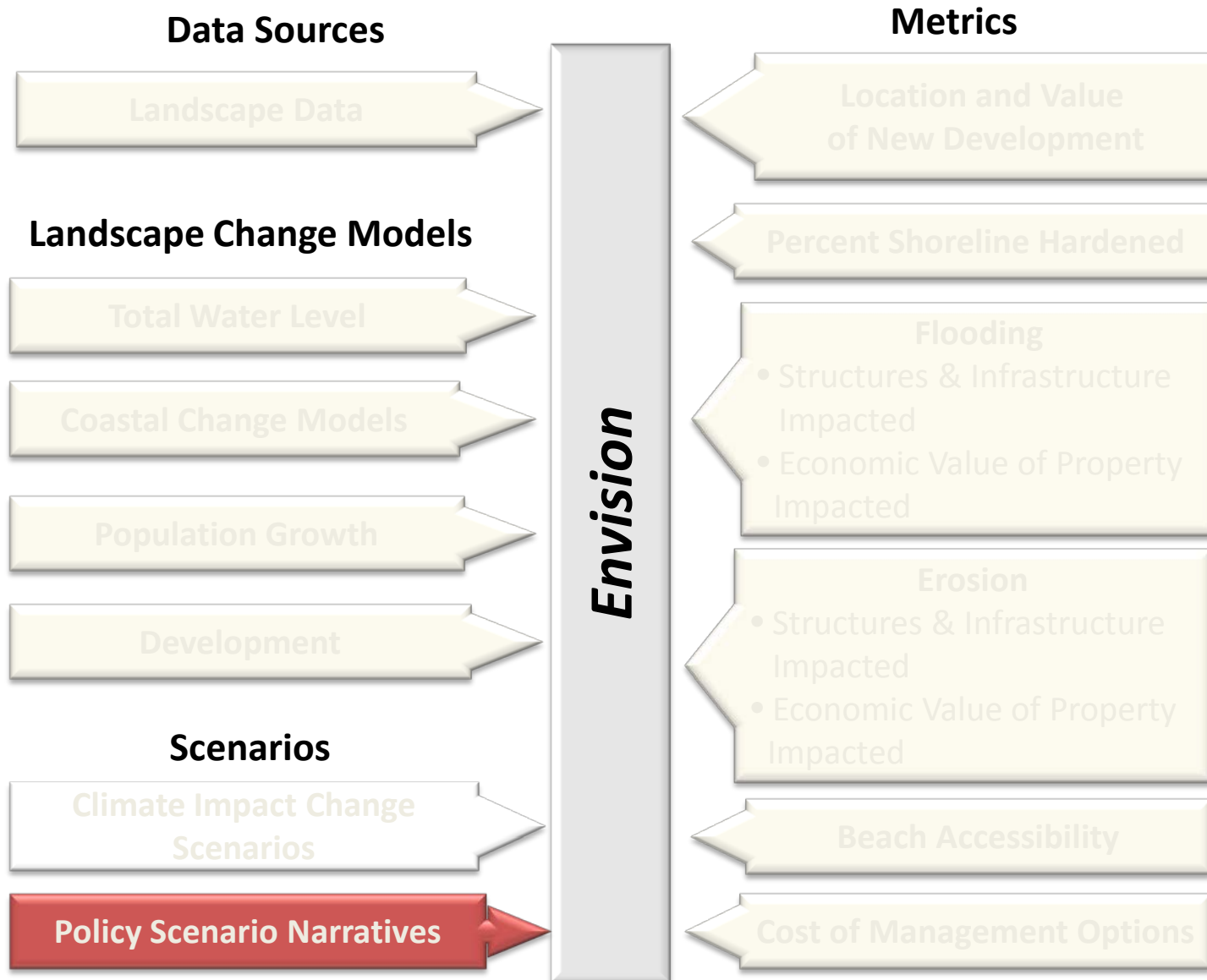
sea level rise

wave
variability

El Niño
variability



Tillamook County Coastal Futures Project



Co-development of Policy Scenarios



Policy Scenario Narratives



1. Status Quo

Continuation of present-day policies.

Example Policy: Maintain current backshore protection structures (BPS) and allow more BPS to be built on eligible lots.

Policy Scenario Narratives



1. Status Quo

2. Hold the Line

Policies or decisions are implemented that involve *resisting* environmental change (e.g. building or raising flood defenses, building or strengthening shoreline armor, nourishing beaches) in order to preserve existing infrastructure and human activities (e.g. beach access).

Policy Scenario Narratives



1. Status Quo



2. Hold the Line



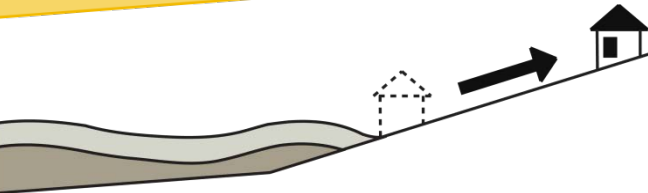
3. Laissez-Faire



4. ReAlign



5. Neskowin



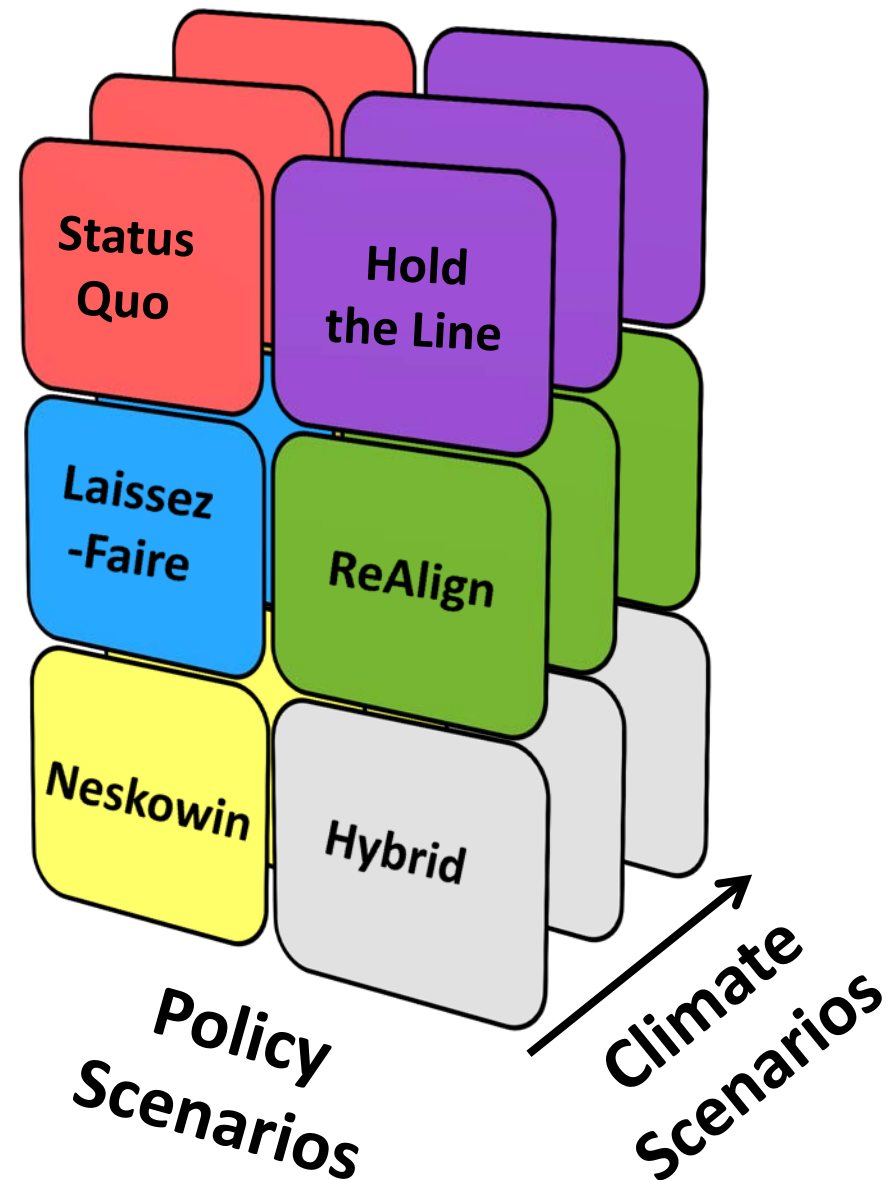
6. Hybrid

Implement policies in accordance with the **preferences established by the KTAN**

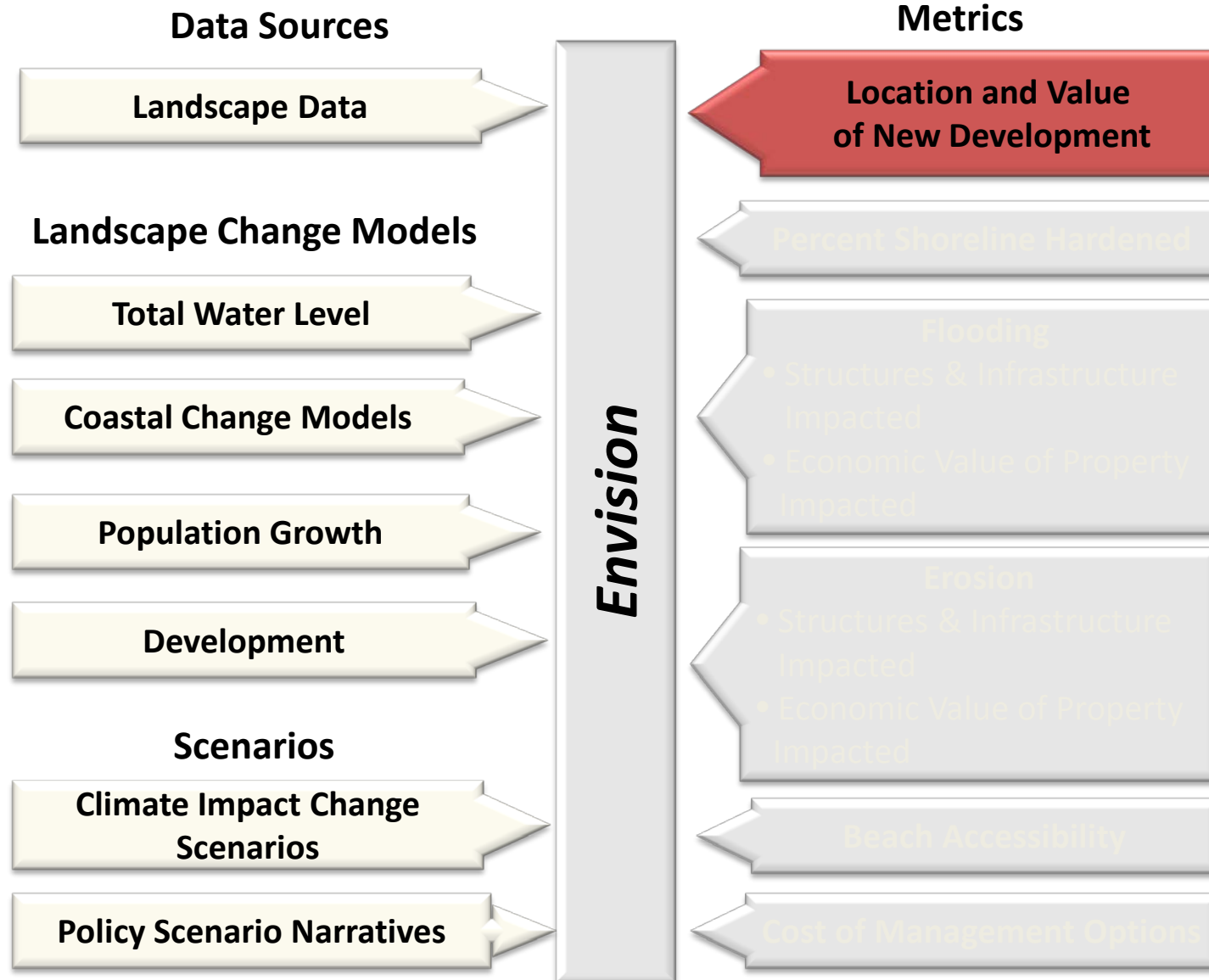
**Climate Scenarios
(Physical Drivers)**

X

**Policy Scenarios
(Human Drivers)**



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The effect of policies on development patterns

Neskowin



Rockaway Beach



DOGAMI Hazard Zone

Land Use Adaptation Policies—

- Prevent further development within hazard zone.
- Remove buildings from hazard zones through easements, etc.

The effect of policies on development patterns

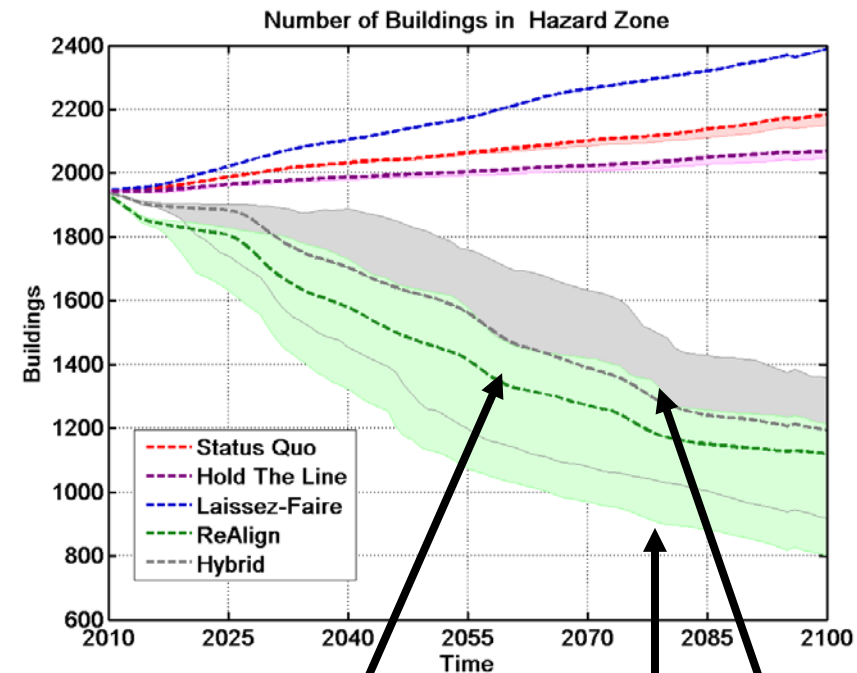
Neskowin



Rockaway Beach



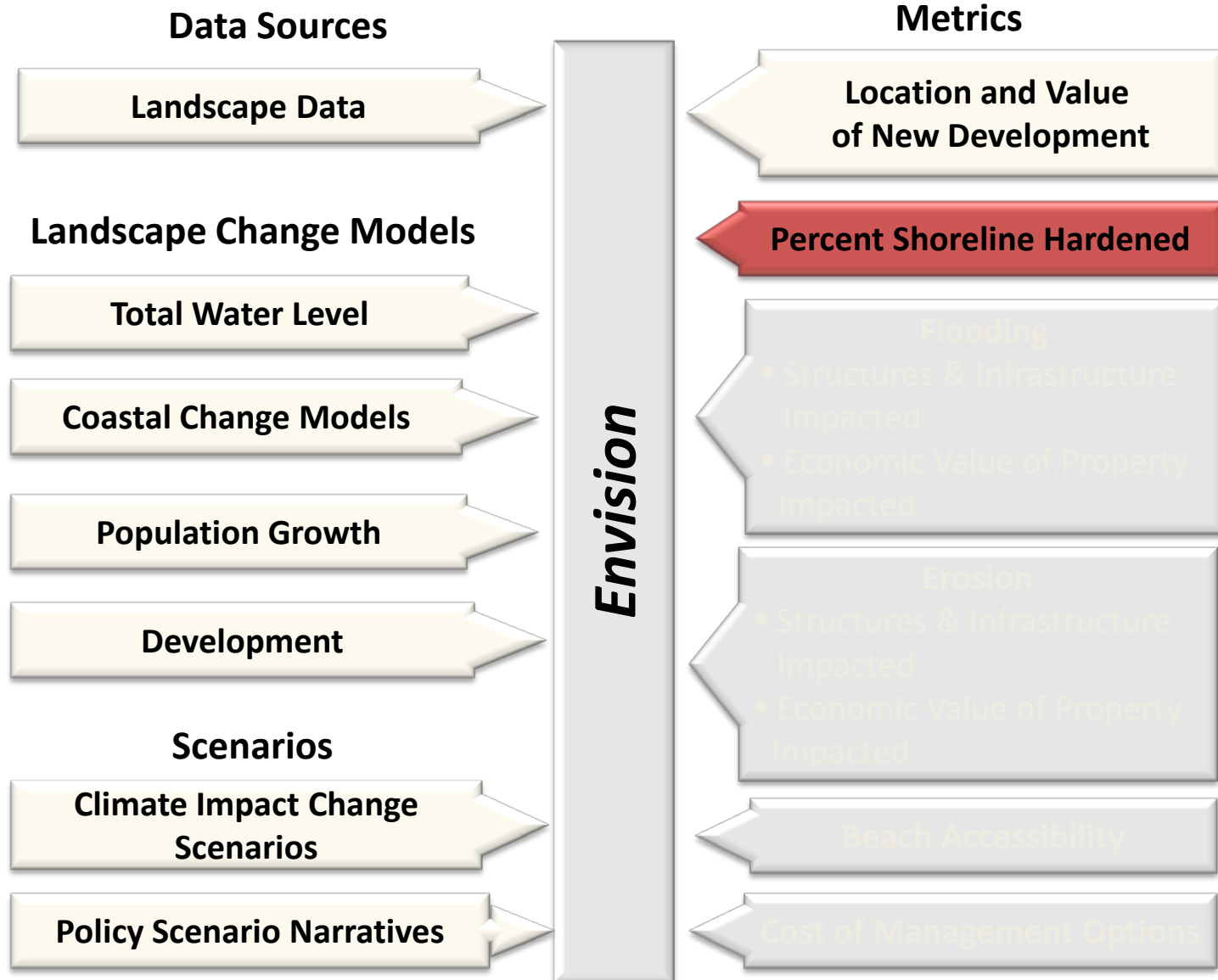
DOGAMI Hazard Zone



Medium impact
climate scenario

High and low
impact climate
scenarios

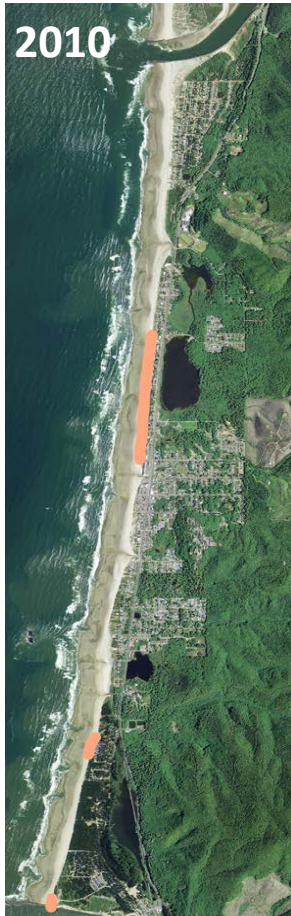
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Coastline armored in response to erosion

Rockaway Beach Littoral Sub-Cell

Existing BPS New BPS



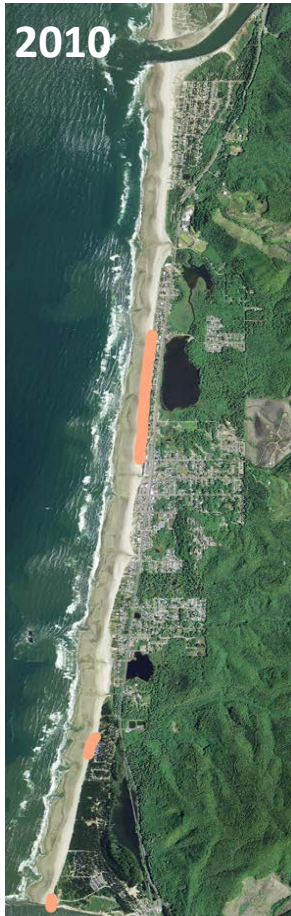
Present Day



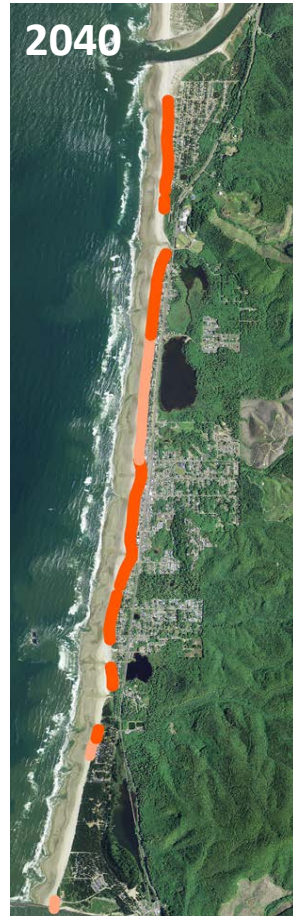
Coastline armored in response to erosion

Rockaway Beach Littoral Sub-Cell

Existing BPS New BPS



Present Day



Status Quo

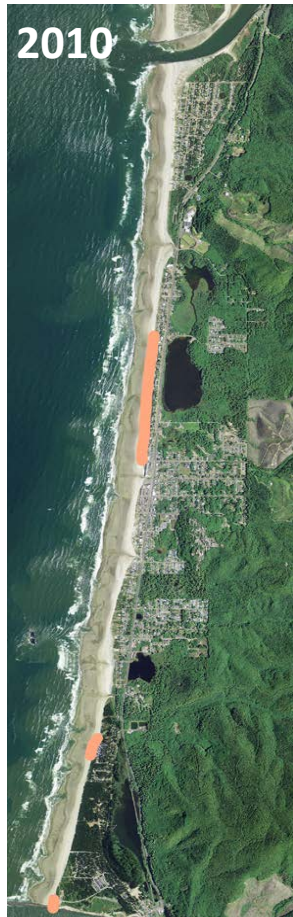


Medium Climate Impact Scenario

Coastline armored in response to erosion

Rockaway Beach Littoral Sub-Cell

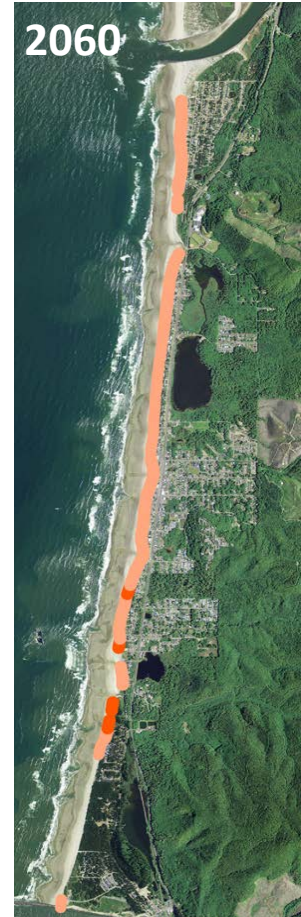
Existing BPS New BPS



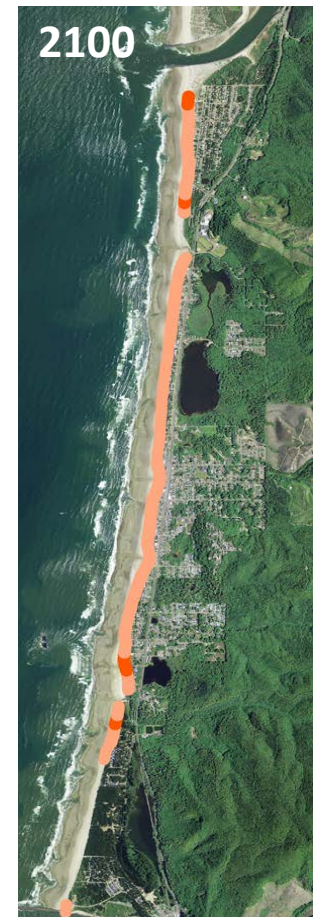
Present Day



Status Quo

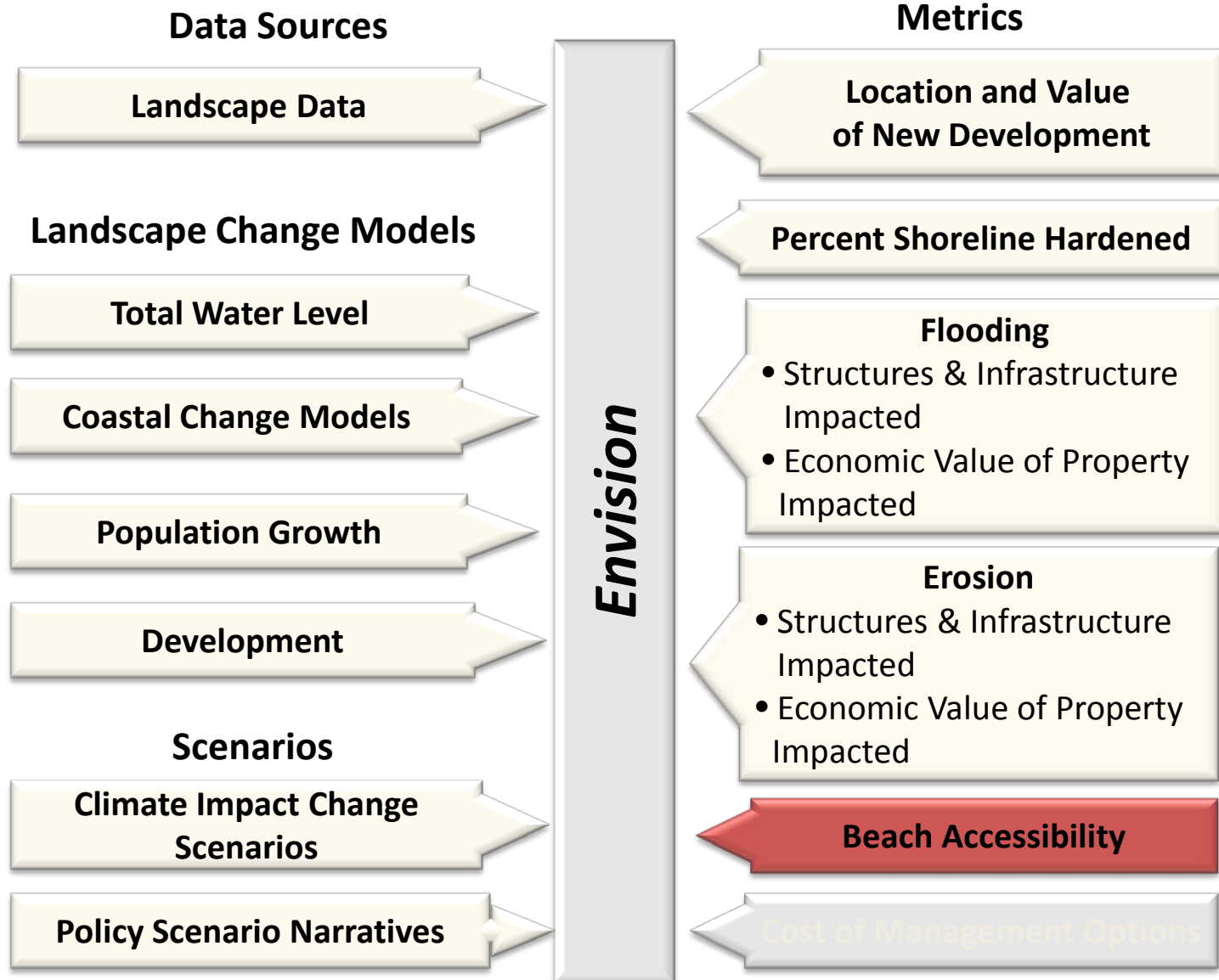


Status Quo



Status Quo

Tillamook County Coastal Futures Project



Beach Accessibility



2010



Present Day



— Limited Beach Access

— Unlimited Beach Access

Beach Accessibility



— Limited Beach Access

— Unlimited Beach Access

2010



Present Day

2100



Status Quo

2100



Hold the Line

2100



Laissez-Faire

2100



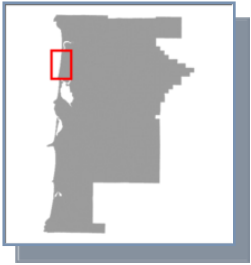
ReAlign

2100

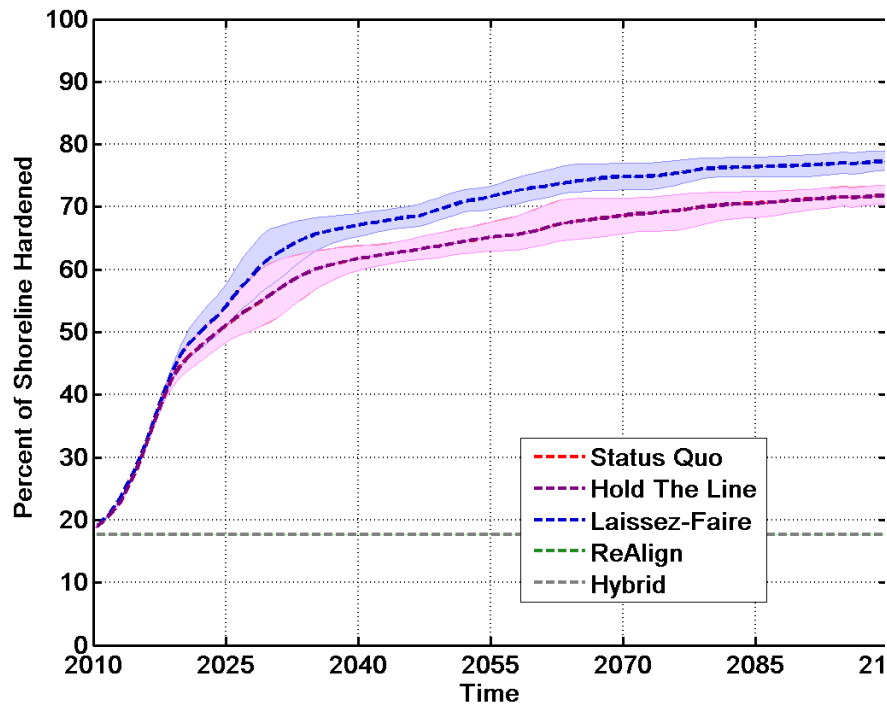


Hybrid

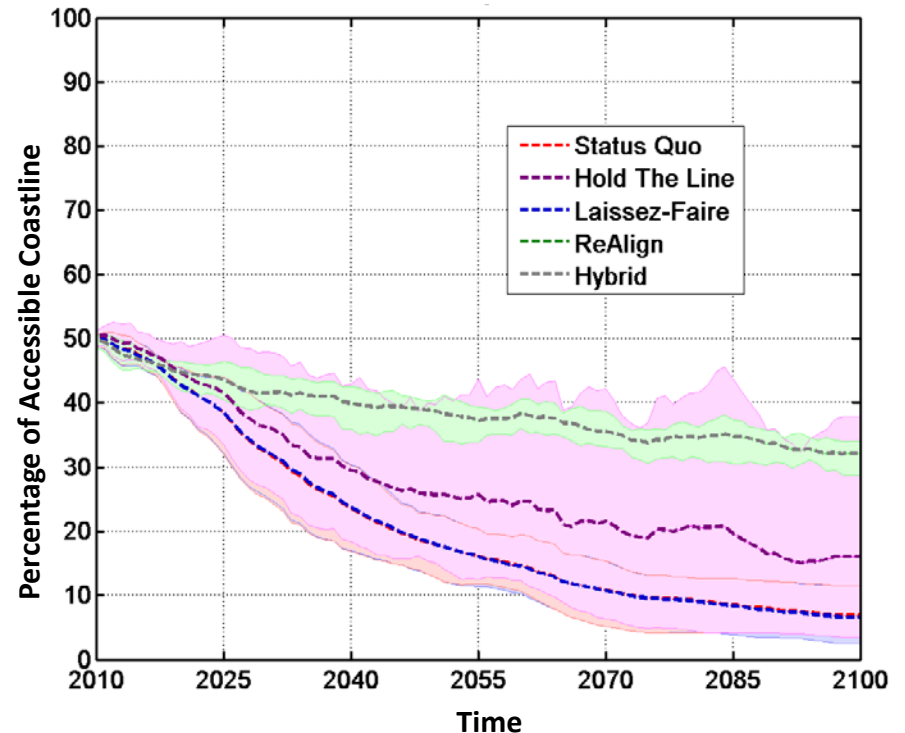
Shoreline Armoring vs. Beach Accessibility



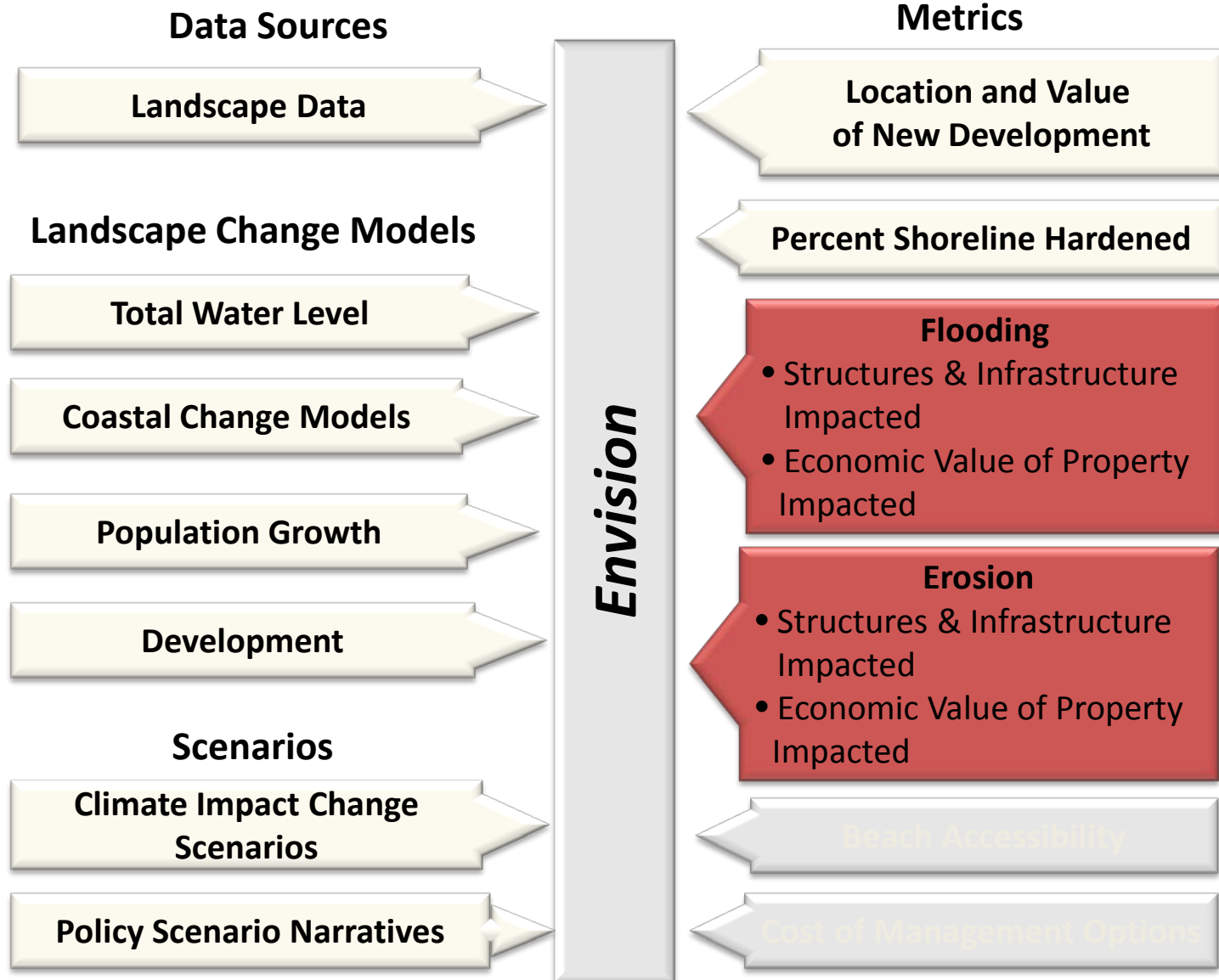
Percent Armored (Rockaway Beach)



Beach Accessibility (Rockaway Beach)

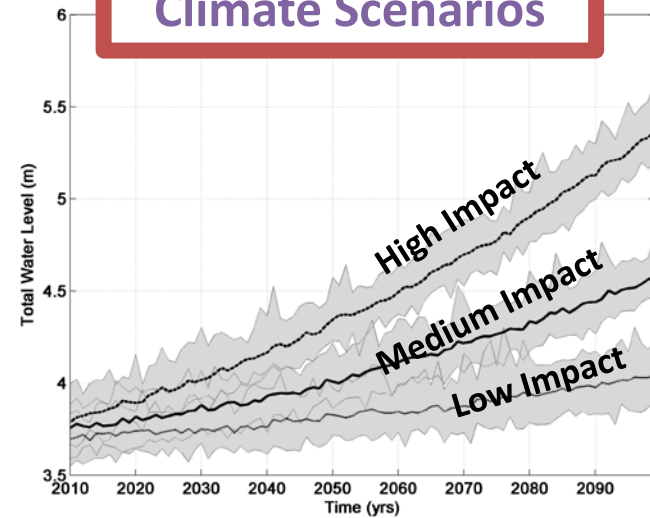


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Which drivers (human and physical) cause the greatest variation in landscape metrics?

Climate Scenarios



Physical

1. Status Quo



2. Hold the Line



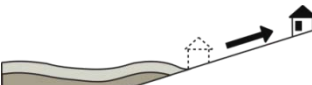
3. Laissez-Faire



4. ReAlign

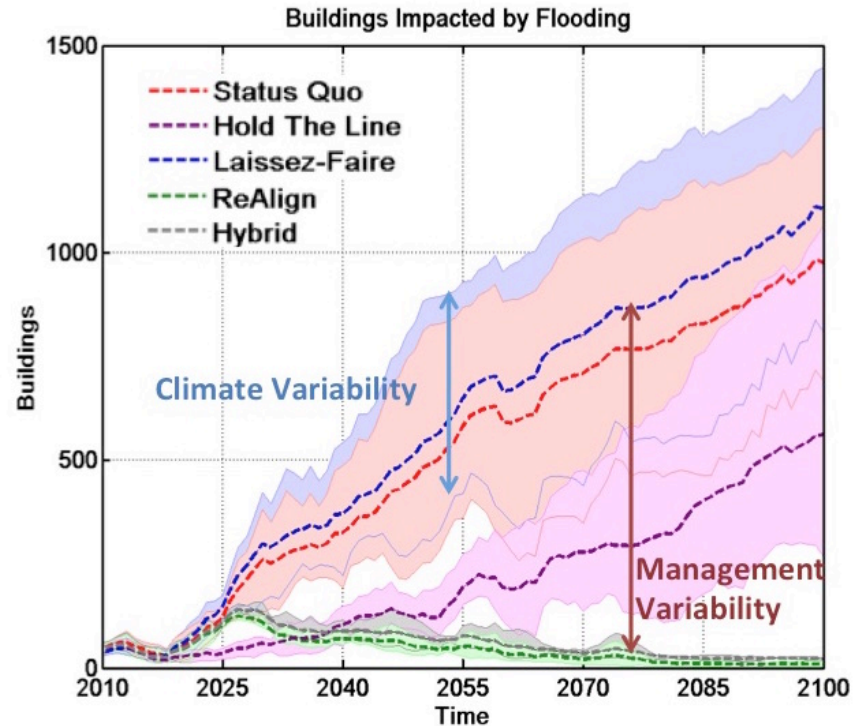


5. Hybrid



Human

Policy Scenarios



Envisioning Coastal Futures



Next Steps

- Initiate the **Grays Harbor County, WA, Coastal Futures Project**
 - Recruit a stakeholder network to co-explore alternative Grays Harbor County coastal futures
 - Co-develop policy and climate scenarios to incorporate and explore in Envision
 - Begin dialogue regarding how the approach and findings might inform land use planning.

