

## Envisioning a Resilient Oregon Coast:

Co-developing alternative futures for adaptation planning and decision-making

### 2<sup>nd</sup> Advisory Council Meeting

12 November 2019 (9:00 am – 12:00 pm)

Kearney Hall Room 301

### Meeting Objectives:

- Update the Advisory Council on project progress at beginning of year 2.
- Demonstrate initial capabilities of Envision model to facilitate actionable research on hazard planning for Cascadia Subduction Zone earthquake and tsunami.
- Harness the expertise of Advisory Council to develop actionable knowledge to inform statewide policies and localized decision-making.

## Envisioning a Resilient Oregon Coast:

Co-developing alternative futures for adaptation planning and decision-making

**Research Objective 1:** Identify and evaluate alternative strategies for chronic and acute hazard mitigation under multiple constraints to improve decision-making in coastal Oregon.

**Research Objective 2:** Understand and assess distributional consequences, social equity, and consistency concerns of coastal resilience decisions in coastal Oregon.

## Envisioning a Resilient Oregon Coast:

Co-developing alternative futures for adaptation planning and decision-making

**Outreach and Engagement Objective 1:** Harness the networked expertise of key local, county, state, and federal officials, NGOs, and academic leaders to develop actionable knowledge to inform coast-wide adaptation policies and localized decision-making.

**Outreach and Engagement Objective 2:** Increase community and state literacy and capacity for adaptation to chronic and acute hazards by providing strategies that illustrate community-valued socio-economic costs and benefits with realistic implementation timeframes.

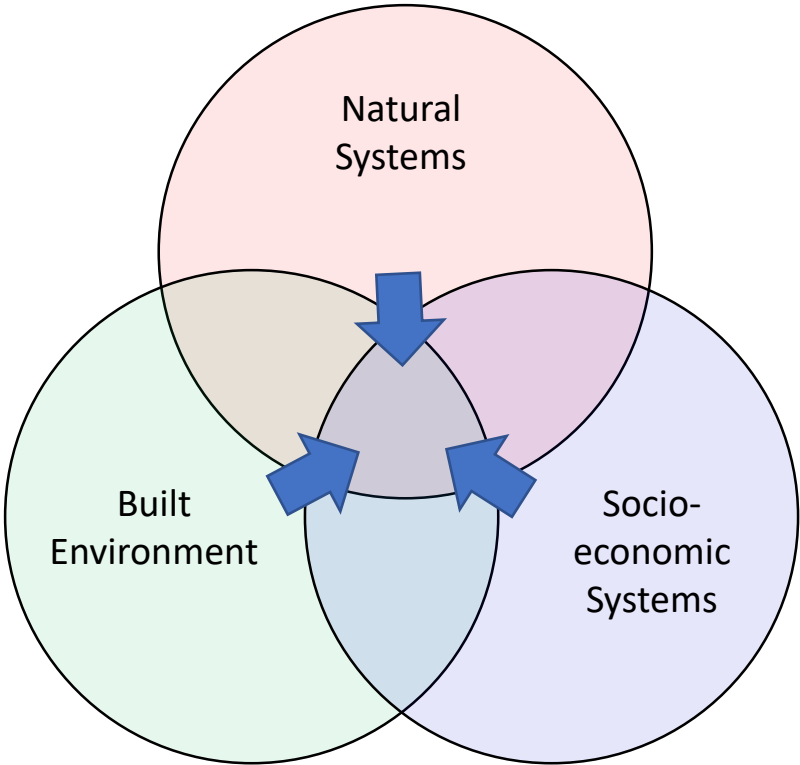
**Education Objective 1:** Train a cohort of transdisciplinary students in the co-production of actionable knowledge for hazard resilience, enhanced science and risk communication, and disciplinary excellence.

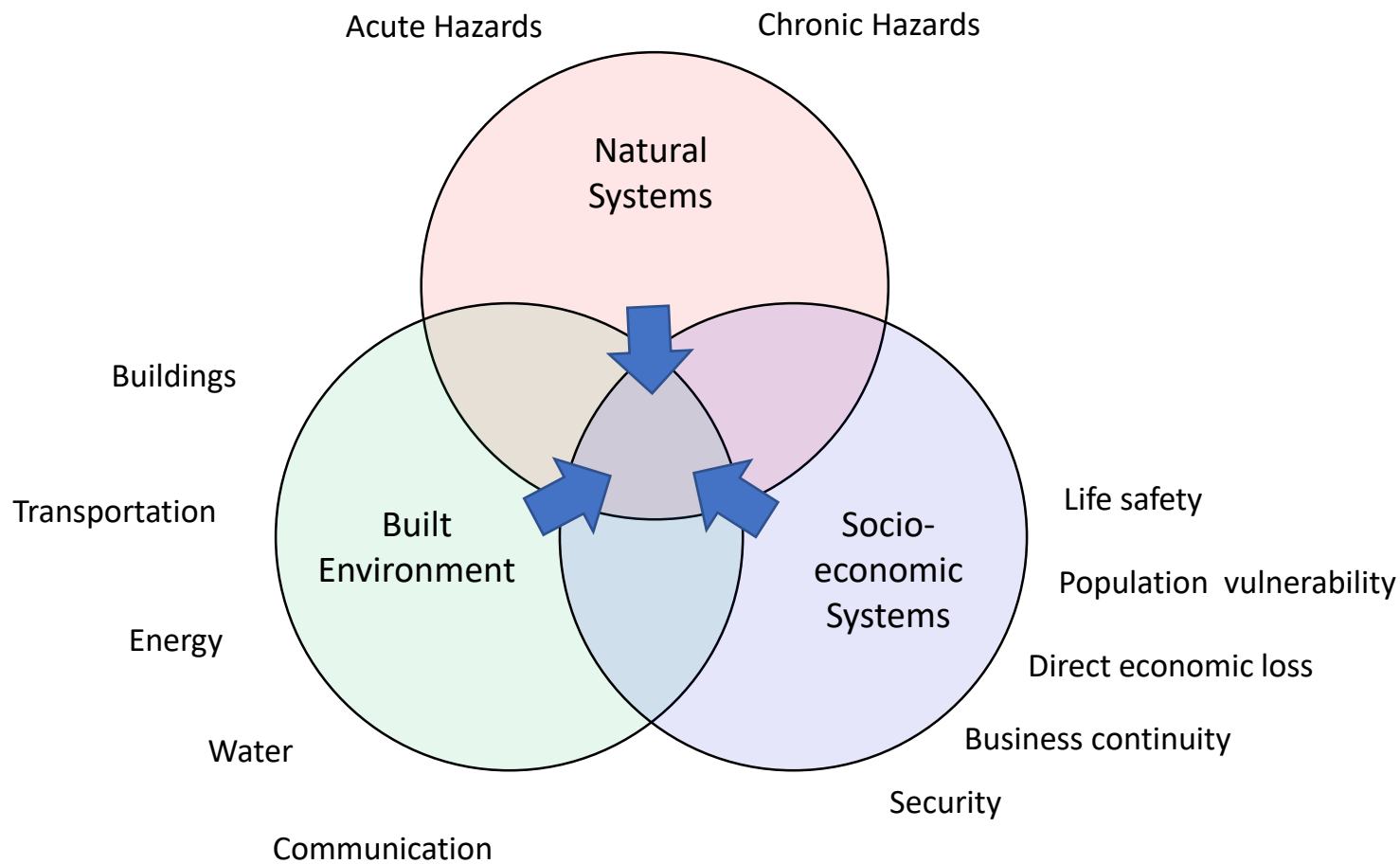
Earthquake  
Tsunami

Acute Hazards

Chronic Hazards

Sea Level Rise  
Storminess  
Flooding and Erosion







## OSU Project Team: Principal Investigators

**Steven Dundas:** Environmental economist focused on non-market valuation, coastal ecosystem services, climate change adaptation, and policy evaluation.



**Jenna Tilt:** Research social scientist focused on the relationship between environmental management, land use planning, and human behavior.

**Dan Cox:** Coastal hazards engineering and Director of the Cascadia Lifelines Project (CLiP).



**John Bolte:** Professor and Head of the Department of Biological and Ecological Engineering and is the lead developer of *Envision*.

**Peter Ruggiero:** Lead, takes an interdisciplinary approach to assessing the magnitude, frequency, and impacts of coastal hazards.



**Pat Corcoran:** Coastal hazards extension specialist with significant experience working with coastal stakeholders and the project team.

## OSU Project Team: Students

**Meredith Leung:** PhD student in the College of Earth, Ocean, and Atmospheric Sciences



**Katherine Stanton:** Graduate Student in the Anthropology Department under the School of Language, Culture and Society under the College of Liberal Arts



**Dylan Sanderson:** PhD student in the School of Civil and Construction Engineering



**Amila Hadziomerspahic:** PhD Student in Applied Economics





## Advisory Council Members

### **Federal Partners**

Brett Holt; FEMA  
Jarod Norton; USACE  
Gwen Shaugnessy, NOAA

### **County/Community Partners**

Sarah Absher; County Planner  
Tiffany Brown; County Emergency Mgmt.  
Regina Martinez; City Emergency Mgmt.  
Jay Raskin; Architect  
David Yamamoto; County Commissioner  
Kent Yu; SEFT Consulting

### **State Partners**

Michael Bufalino; ODOT  
Mike Harryman; State Resilience Officer

Meg Reed; Oregon DLCD (Heather Wade)  
Jonathan Allan; DOGAMI  
Althea Rizzo; Office of Emergency Management  
Jay Sennewald; OPRD

### **NGO/Other Partners**

Jack Barth; Dir. OSU Marine Studies Initiative  
Josh Bruce; Partnership for Disaster Resilience  
Phil Mote; Climate Impacts Research Consortium  
Charlie Plybon; Surfrider Foundation

**Envisioning Alternative Coastal Futures:** Develop the information and tools necessary to envision future scenarios, assess impacts and vulnerability associated with erosion and flood hazards, and initiate adaptation strategies.



## Policy Scenarios

Status Quo



Protect

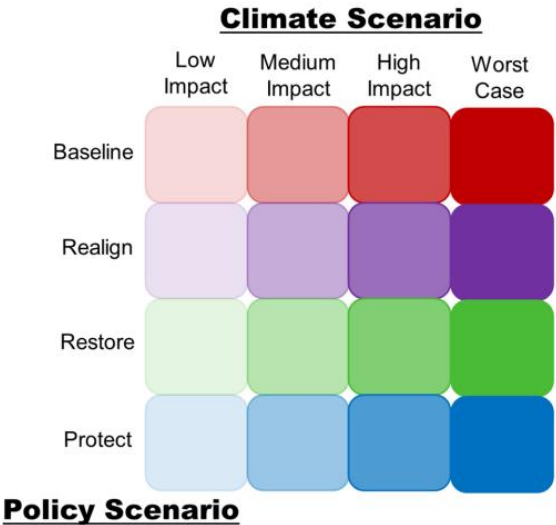


Realign

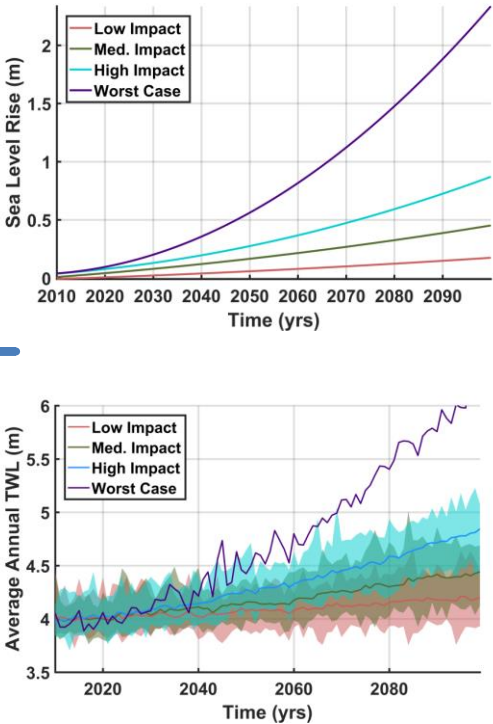


## Individual Policies

Policy	BL	RA	RS	PR
BPS Constr.				
BPS Mainten.				
BPS Nourish.				
DRP Constr.				
DRP Mainten.				
DRP Nourish.				
Hazard zone development restrictions				
Remove Buildings From Hazard Zone				
Remove Critical Infrastructure from Hazard Zones				
Raise or Move structure to a new location in the same tax lot				
Raise Critical Infrastructure				



## Climate Driven Forcing



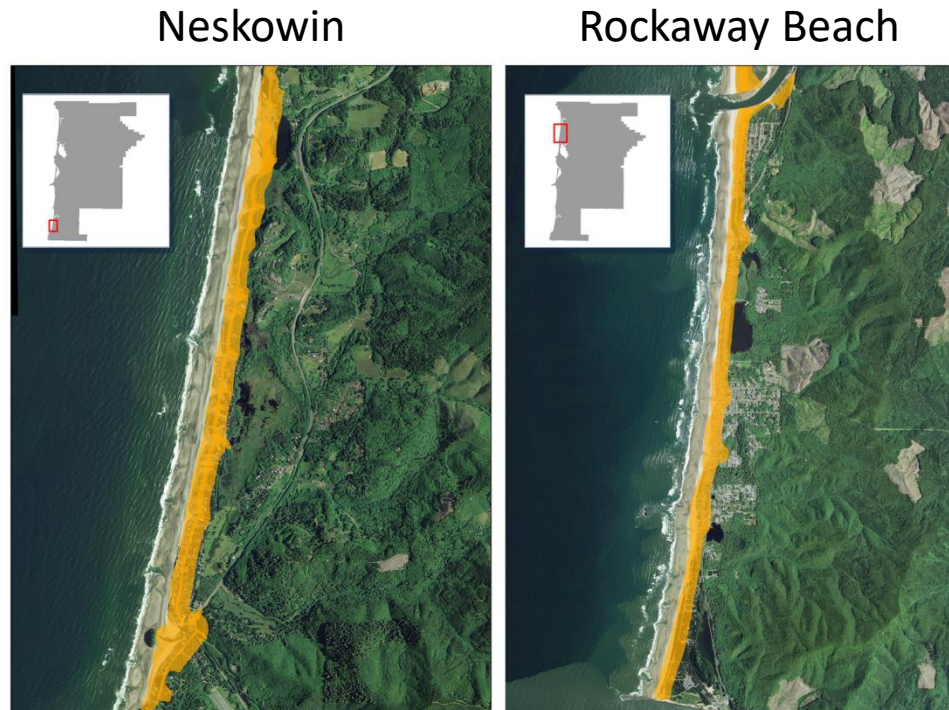
Low Impact Scenario  
Uses a low-end projection of SLR: Extremely likely to exceed (95%)

Medium Impact Scenario  
Uses a mid-range projection of SLR: More likely than not to exceed (50%)

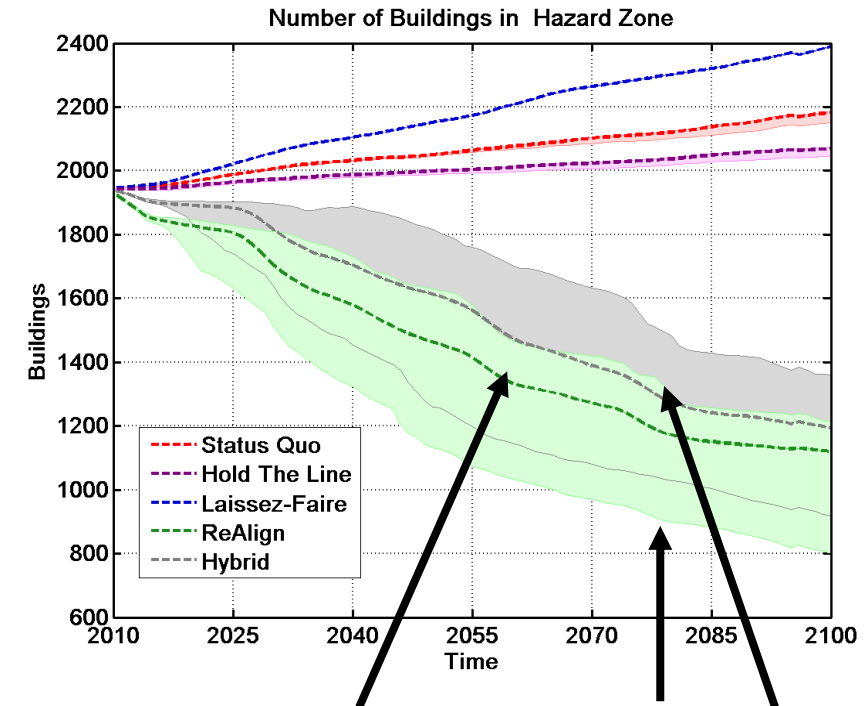
Medium Impact Scenario  
Uses a high-end projection of SLR: Extremely unlikely to exceed (5%)

Worst Case Scenario  
Uses a “Worst Case” Scenario: Project upper limit (0.1%)

## The effect of policies on development patterns



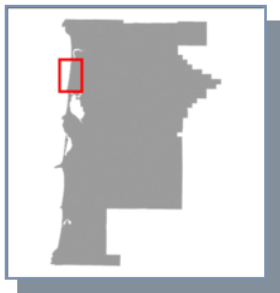
 Existing Chronic Hazard Zone



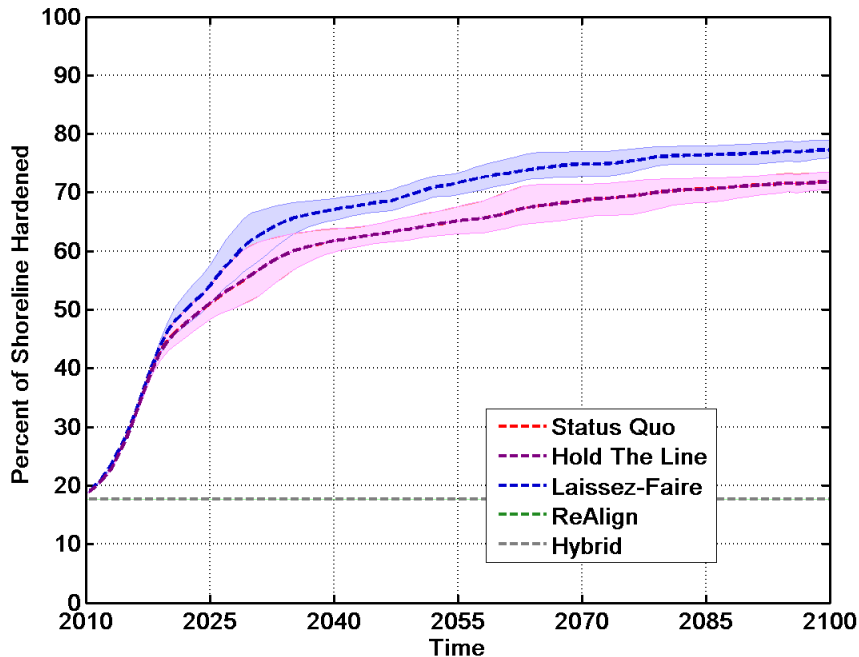
Medium impact  
climate scenario

High and low  
impact climate  
scenarios

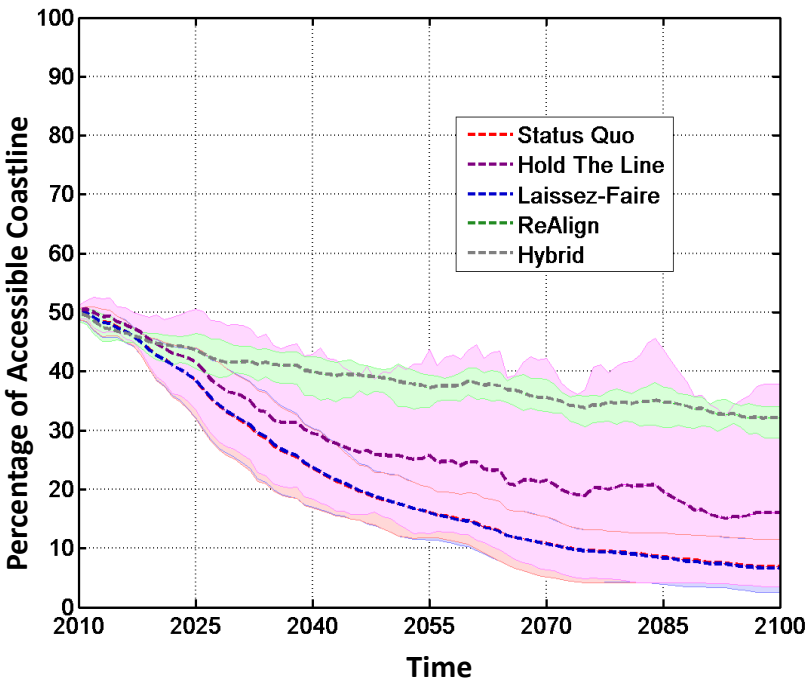
# Policy driven tradeoffs in resilience metrics



Percent Armored (Rockaway Beach)

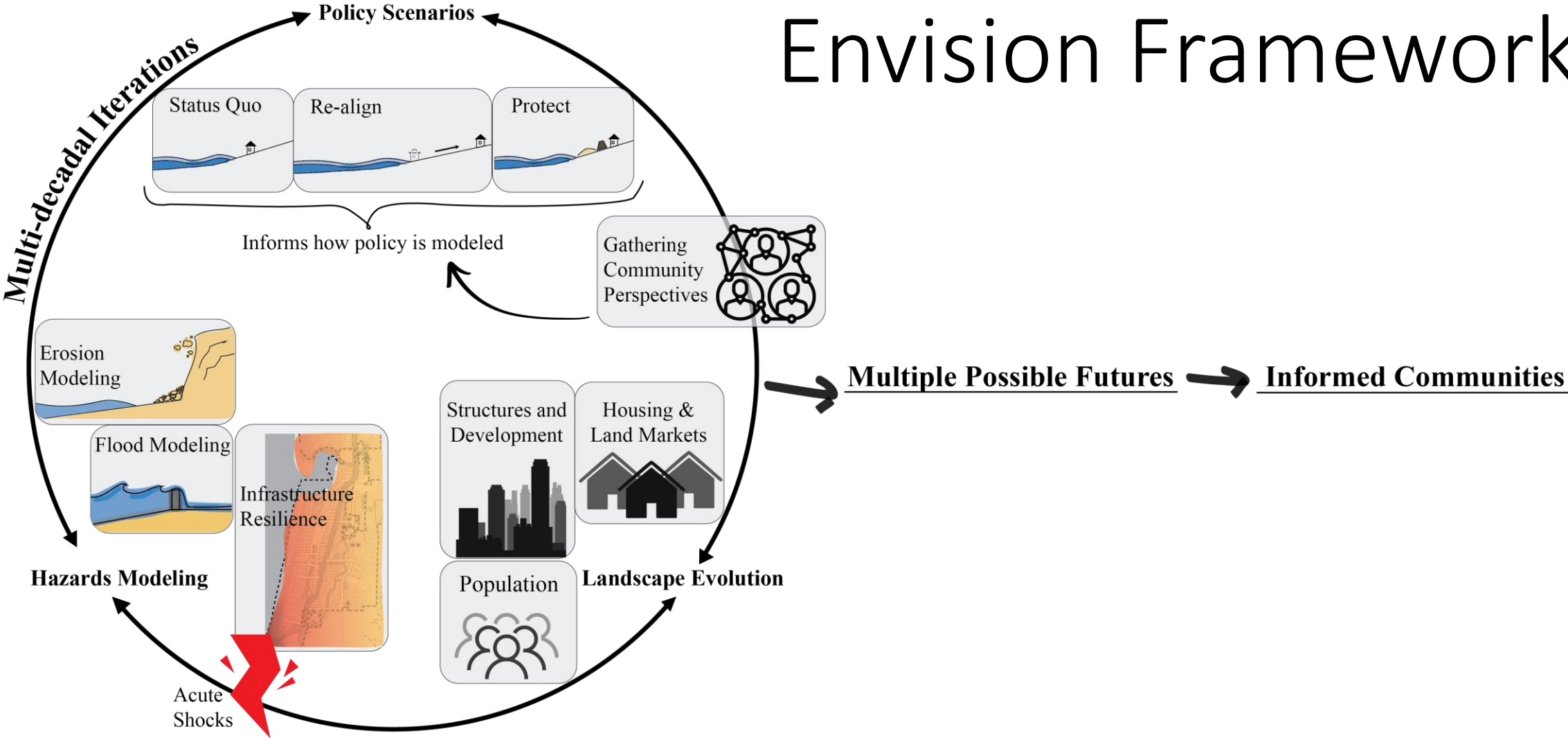


Beach Accessibility (Rockaway Beach)

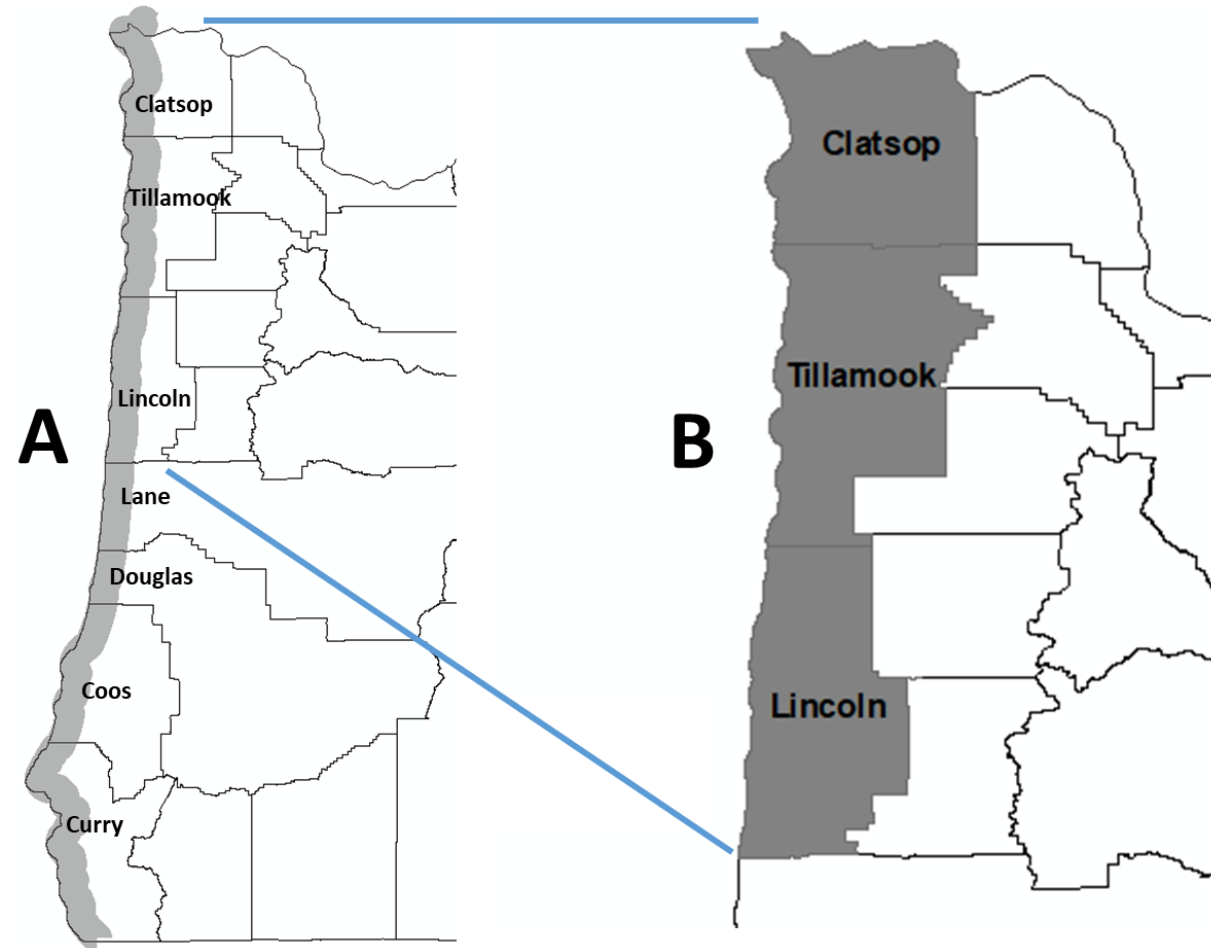




# Envision Framework

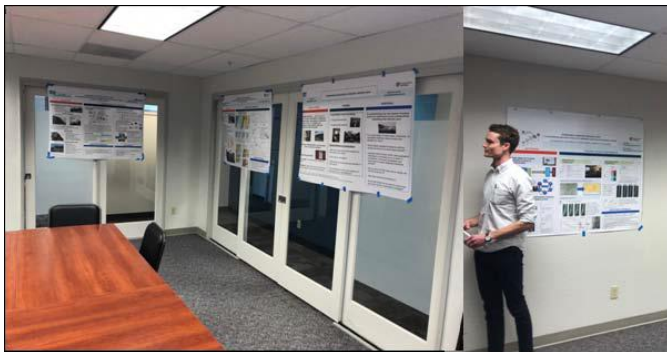


## Oregon Coast-wide study area and three county detailed study area



**At our last meeting (03/08/19) the key Advisory Council suggestions included:**

- 1) Additional follow-up with individual members of the Advisory Council from the OSU team;**
  - Meetings/discussions with Shaughnessy, Reed, Harryman, Crook, Plybon, others...
- 2) Interaction between the OSU team and the Coastal Caucus/legislature;**
  - Ruggiero testimony at House Committee on Natural Resources
  - Cox participation in Tsunami Line Working Group
  - Dundas participation in Goal 18 Working Group
  - Cox testimony on ASCE 7-16 Tsunami Provisions at OSSPAC meeting
  - Ruggiero, Cox, and Corcoran participation in Coastal Resilience Workgroup
- 3) Continued development of both our three-northern county Envision model and the statewide model incorporating acute and chronic hazards along with econometrics and social equity metrics;**
  - Today's presentation!
- 4) Development of the Oregon Coastal Resilience Explorer website**
  - <http://explorer.bee.oregonstate.edu/Topic/coastalresilience/>



## Alternative Futures Questions:

In the context of coastal community planning for climate change and extreme events,

1. What do you care about? In other words, what types of project output, endpoints, or quantified resilience metrics would most benefit your work?
2. What coastal policies would you most like to see incorporated into the project's framework? Should we be exploring other alternative future scenarios?
3. What is a useful planning horizon?
4. In this project we plan on adding more econometrics, social equity, and feedbacks between acute and chronic hazards. What else would you like to see us tackle?
5. Are there state-level programs or new initiatives in this area that we should be aware of? Do you know of other data sets or models we should be aware of?
6. Who else should be on our advisory council/ who should we be talking to?
7. Is there anything in the context of this project that you would like answered directly from coastal community members during our interviews and focus groups?
8. What else should we be doing to ensure that this work results in actionable knowledge?

## Framework for Assessing Resilience Strategies

### 1. Acute Hazard

- CSZ: Earthquake + Tsunami
- What scenario? (M7 – M9)
- Timeframe? (2030, 2050)
- ...

### 2. Policy Options

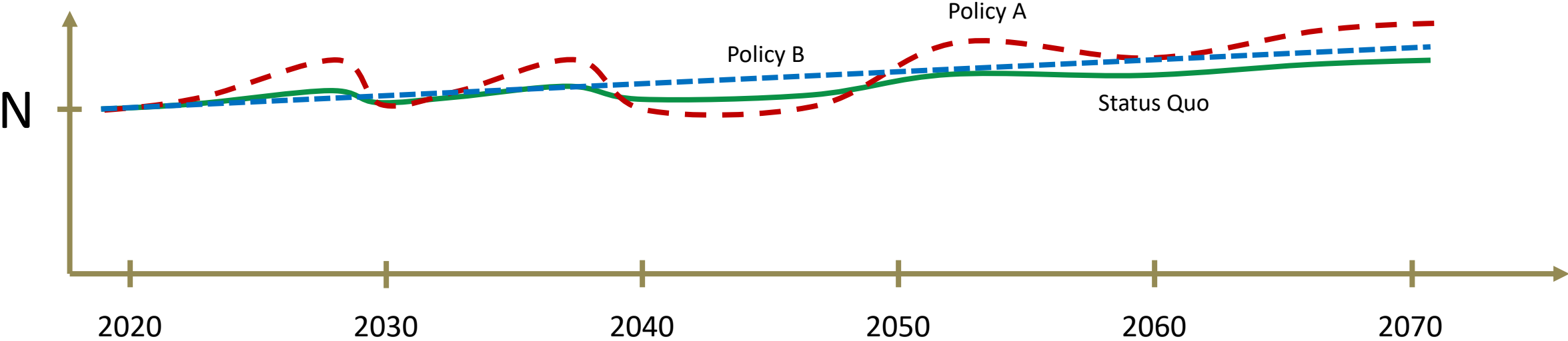
- Status Quo
- Protect (retrofit)
- Realign (moving, zoning)
- ...

### 3. Resilience Metrics

- Direct losses (life safety, capital)
- Indirect losses (recovery)
- Social equity (unequal loss)
- ...

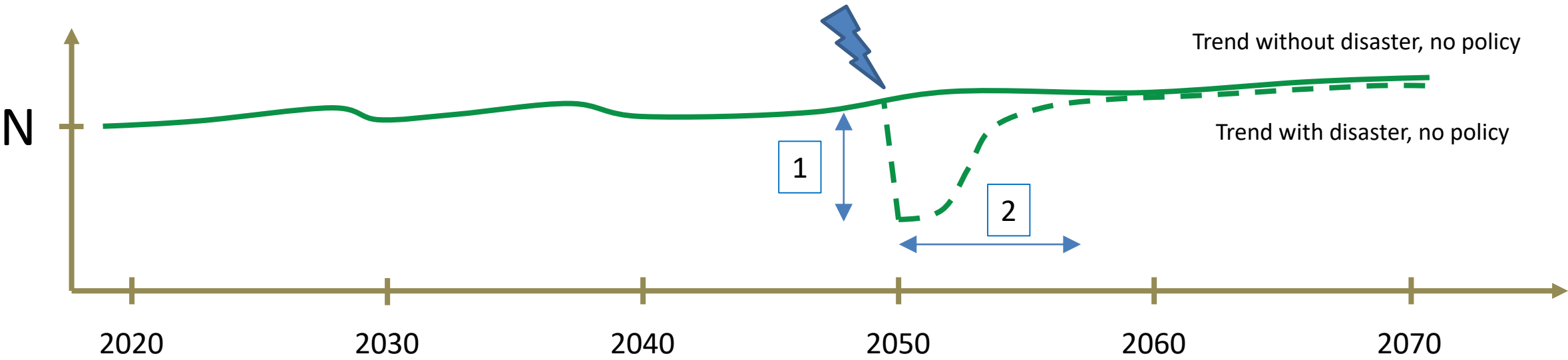


Landscape Evolution



# Resilience

Ability to absorb and recover quickly from a sudden stress

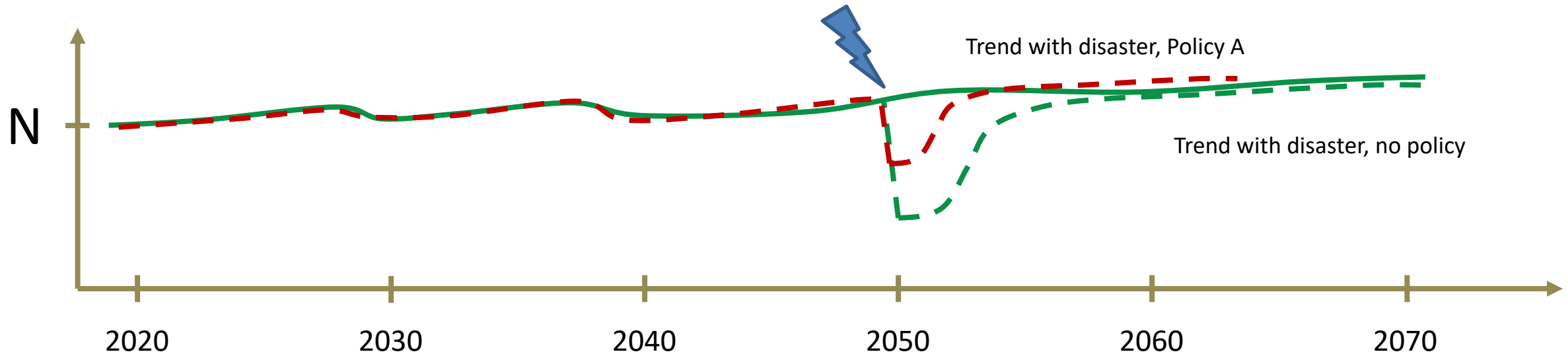


Metrics:

- 1. Direct Loss (initial shock)
- 2. Time to recovery (related to indirect losses)

## Resilience

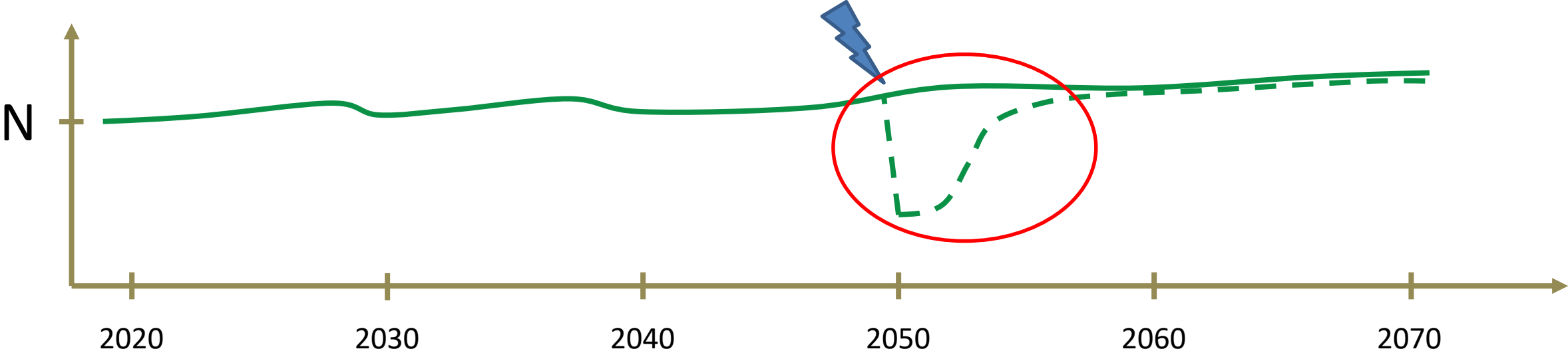
Ability to absorb and recover quickly from a sudden stress



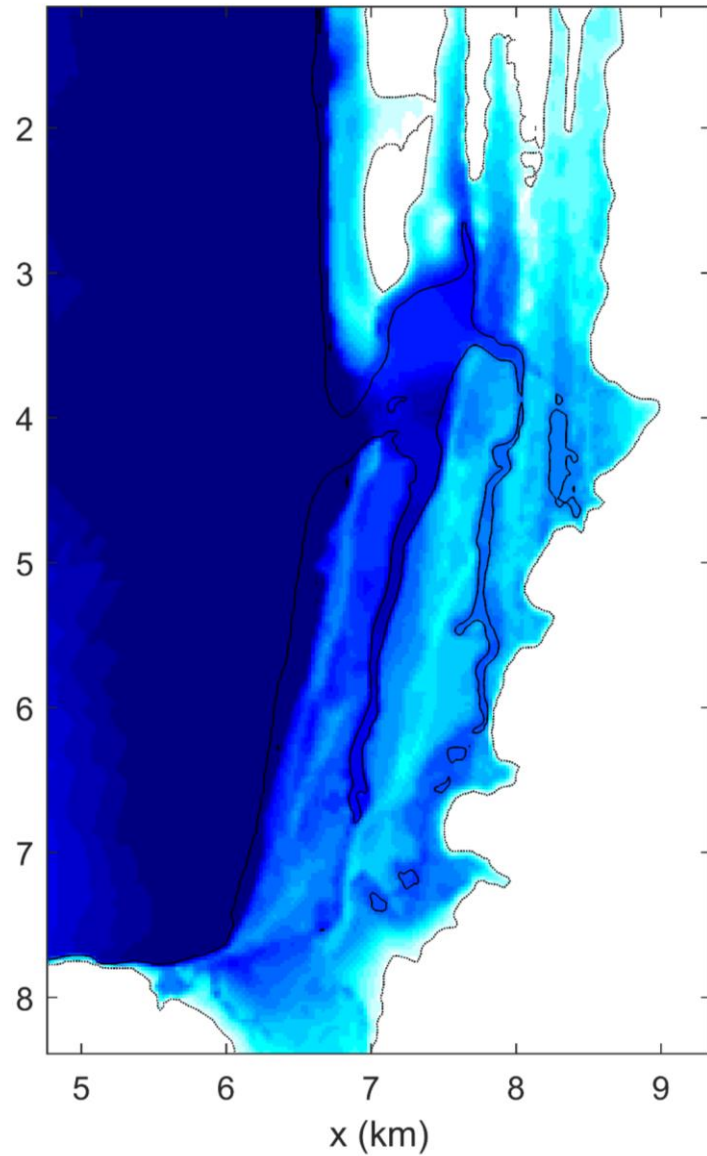
Q: What policy options can reduce losses and speed up recovery?

# Resilience

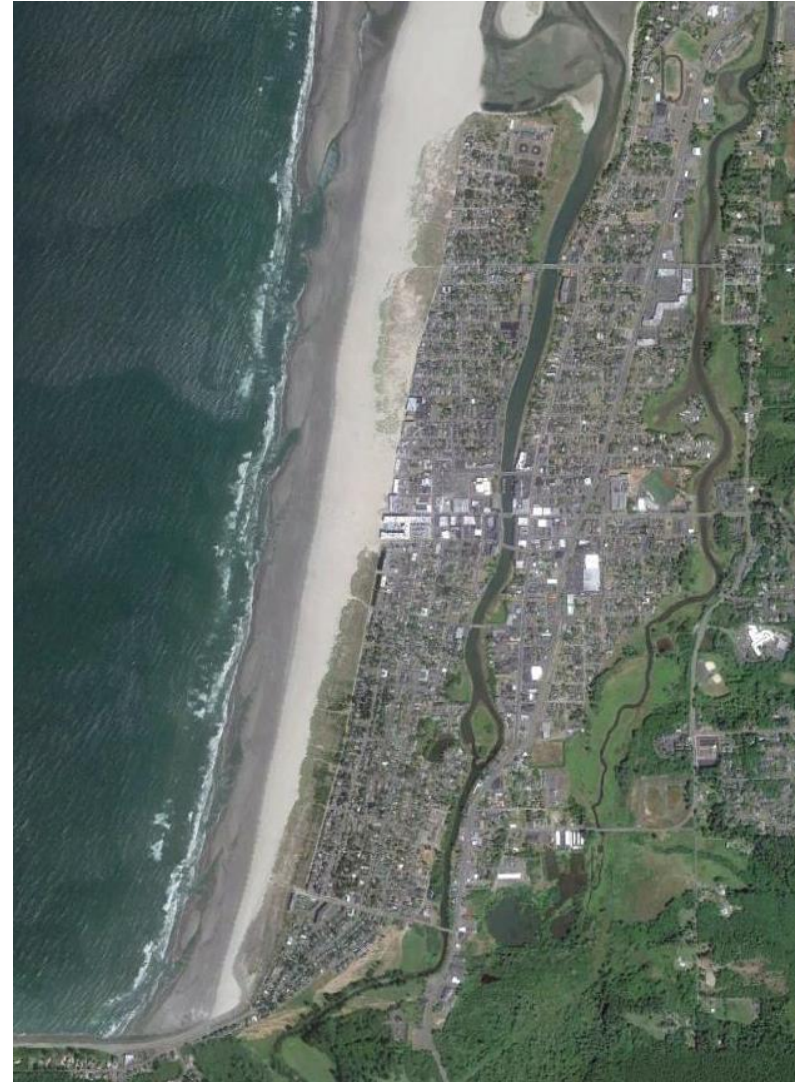
Ability to absorb and recover quickly from a sudden stress



Damage, Loss and Recovery modeling?



+



= ?



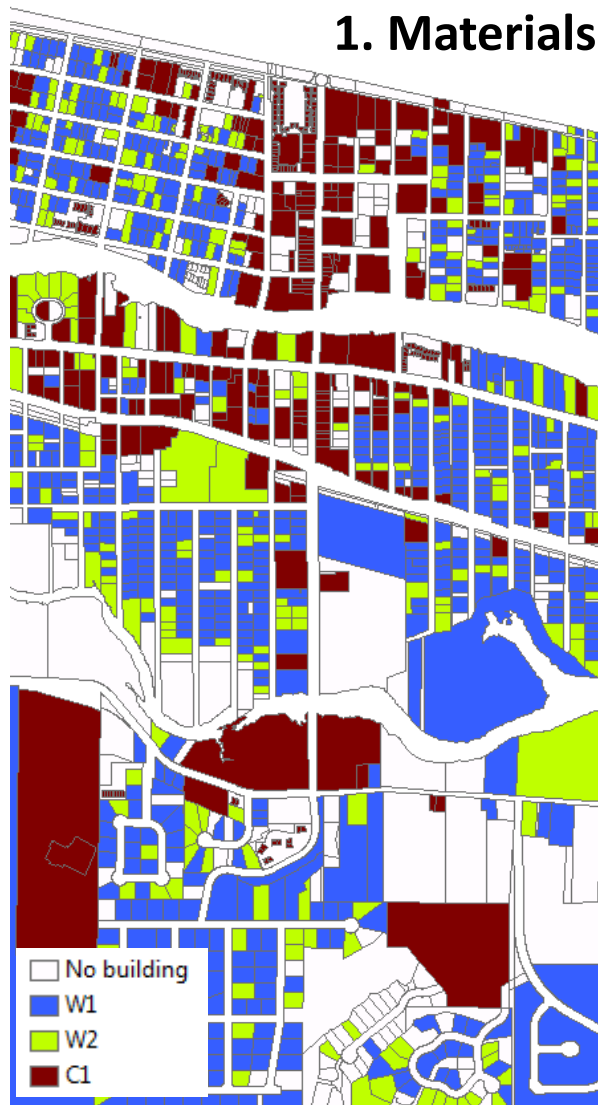


# Envisioning Oregon's Coastal Futures



## Building Classification

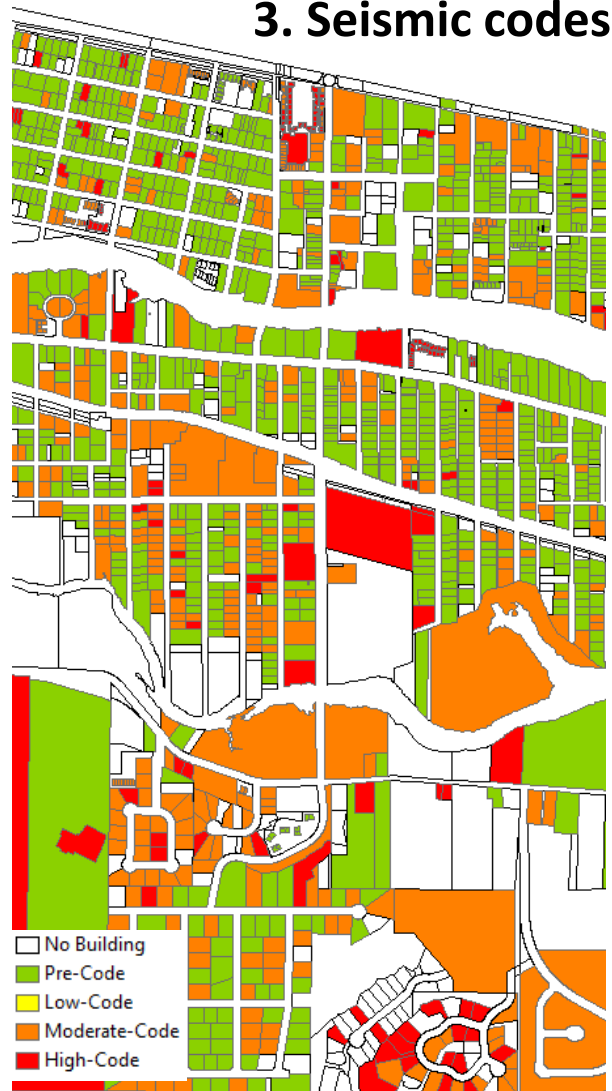
1. Materials



2. Floors



3. Seismic codes



## Example of building damage assessment (at AEP = 0.001)

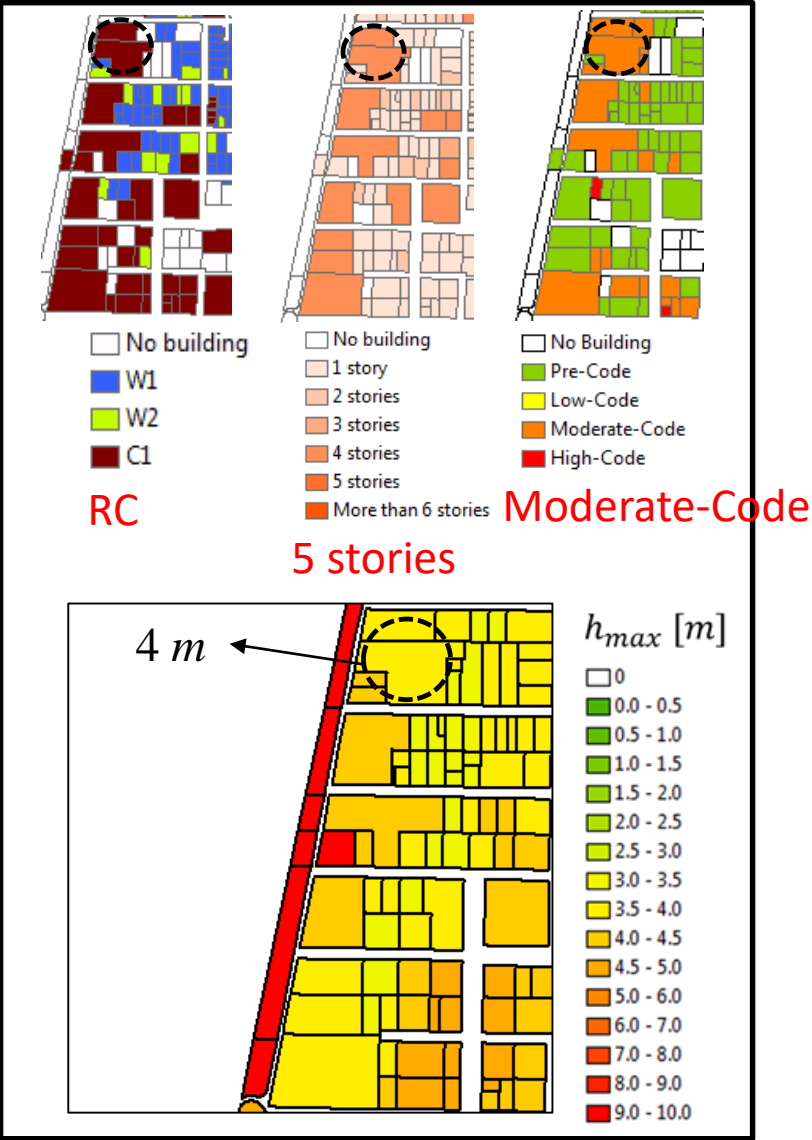


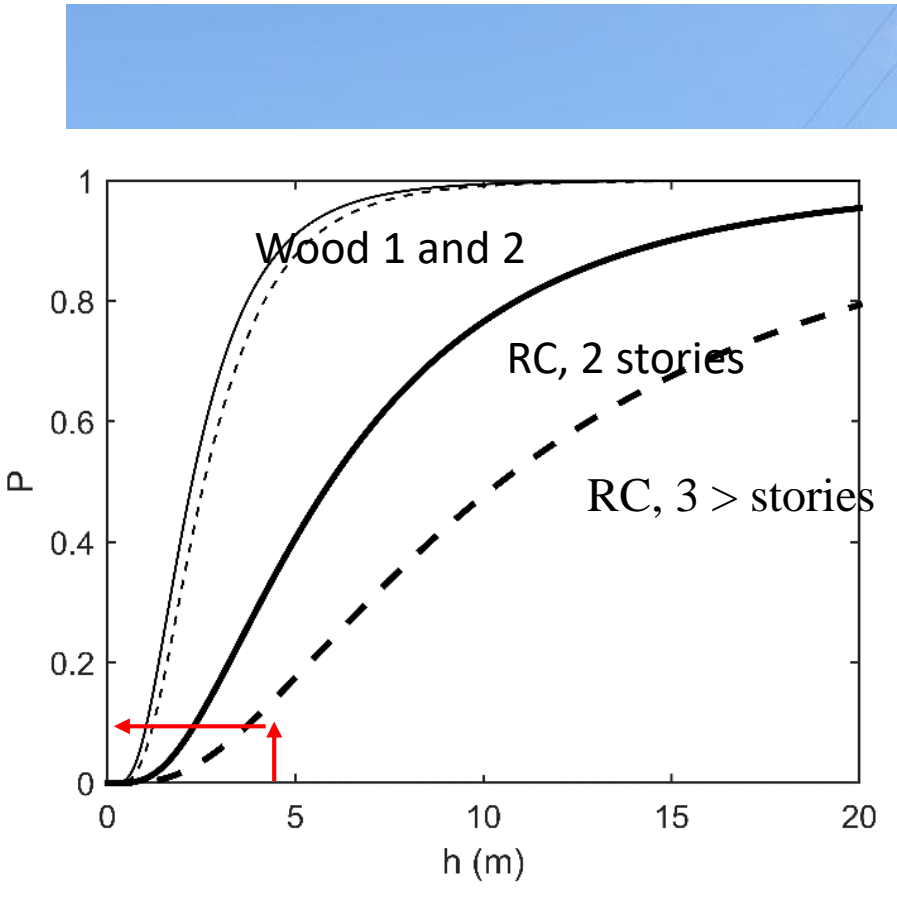
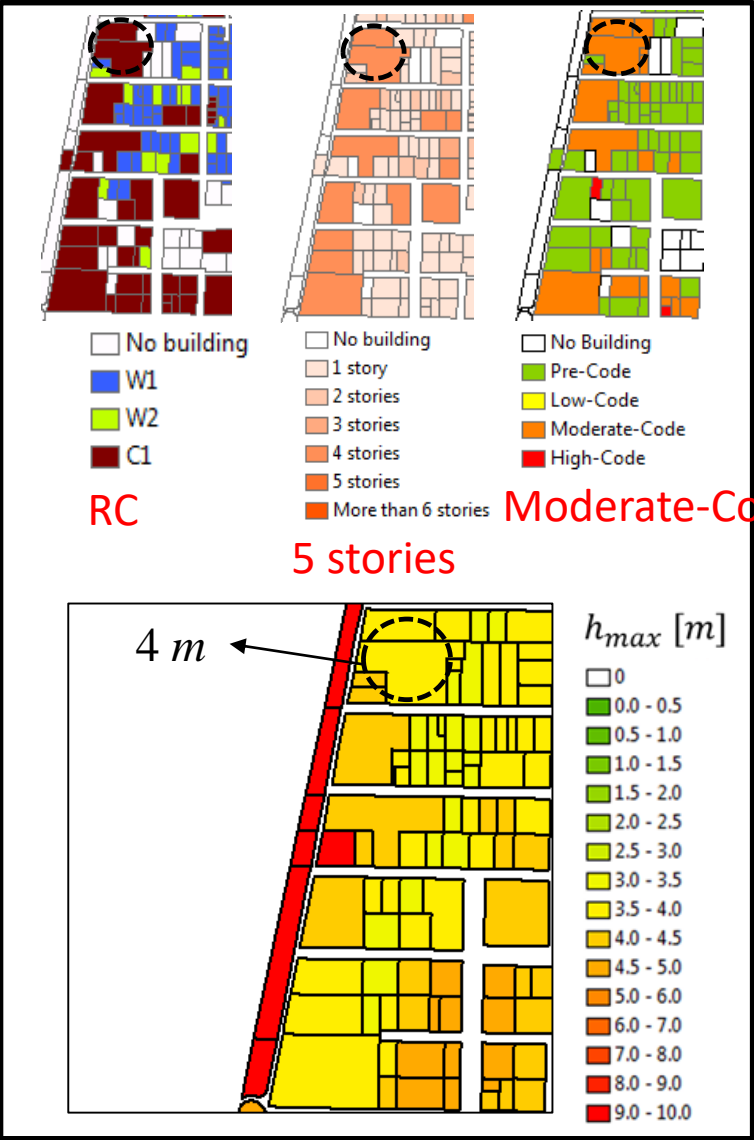
Photo taken by Hyongsu Park, at Seaside Field trip (July, 14, 2015)





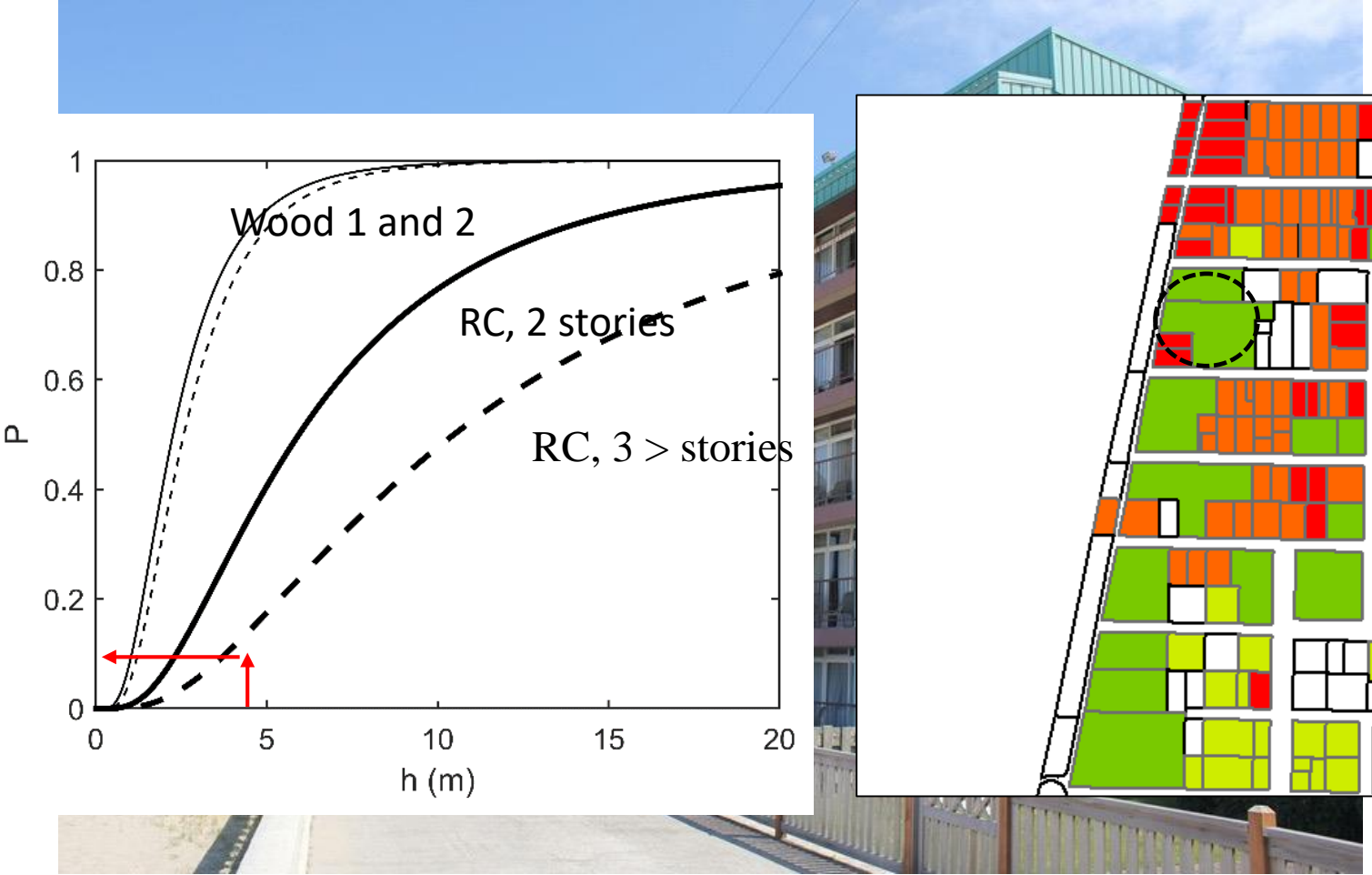
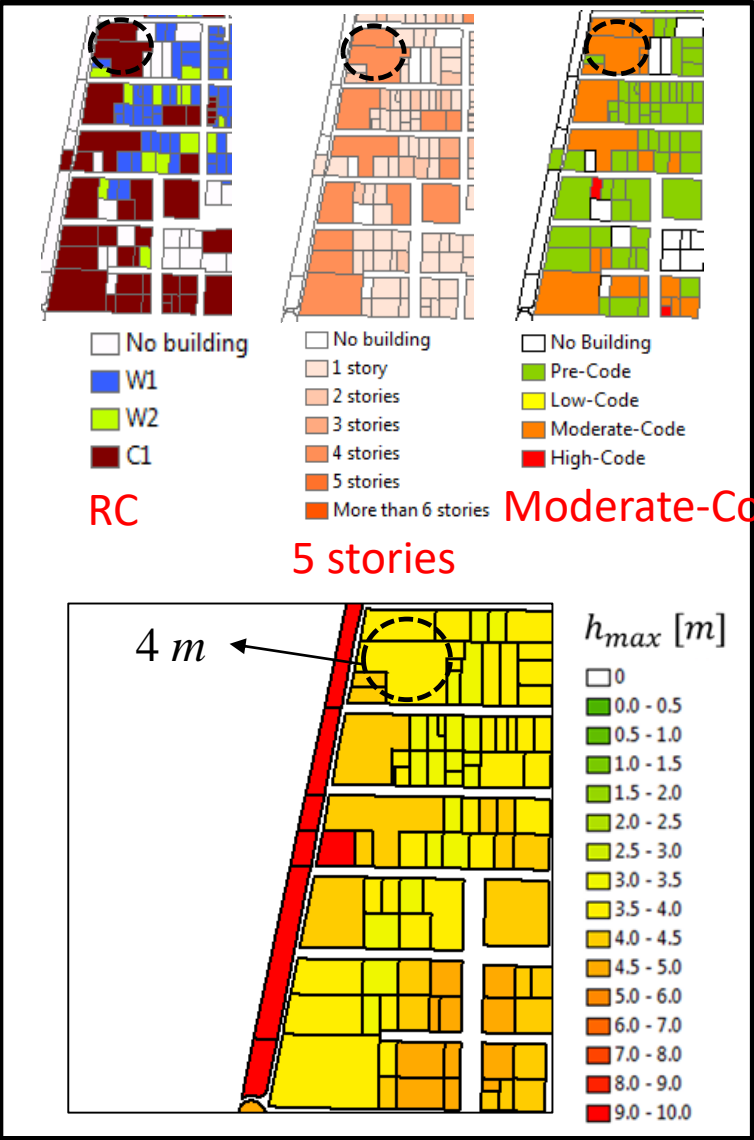
# Envisioning Oregon's Coastal Futures

Example of building damage assessment (at AEP = 0.001)



Fragility curves (Suppasri et al., 2013) for collapse damage

## Example of building damage assessment (at AEP = 0.001)



Fragility curves (Suppasri et al., 2013) for collapse damage

## Example of building damage assessment (at AEP = 0.001)

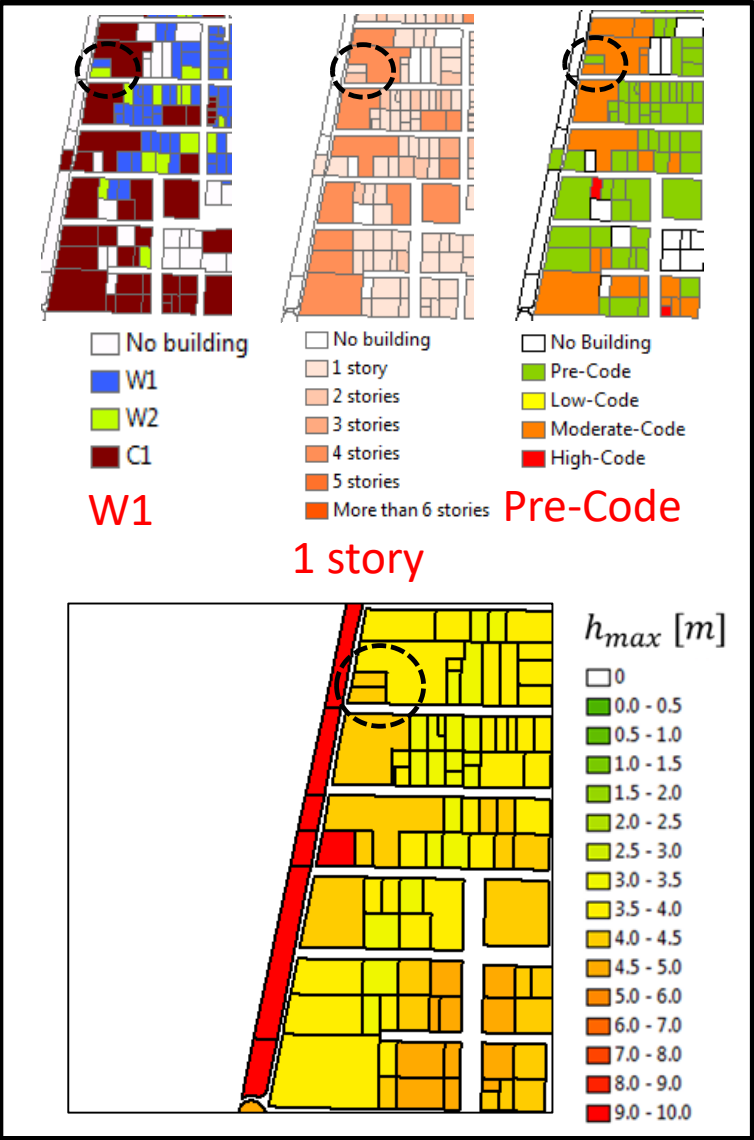
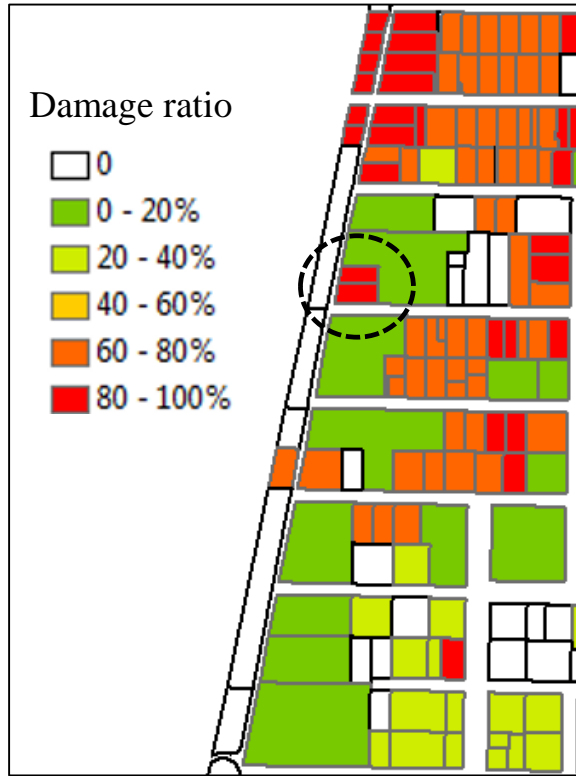
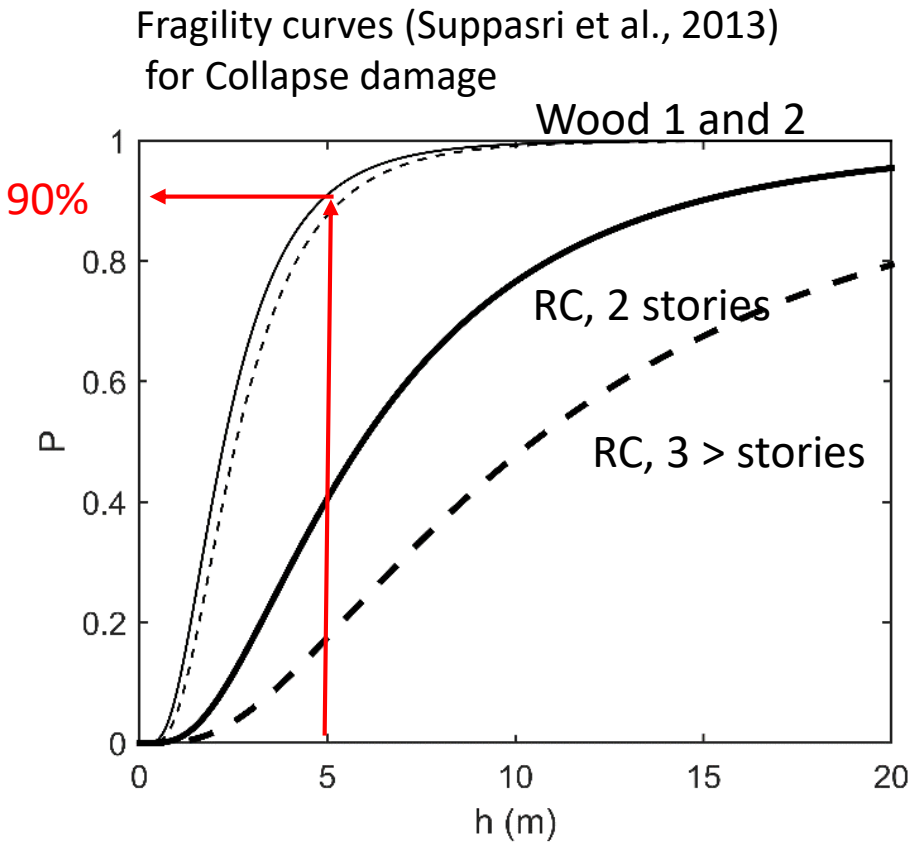
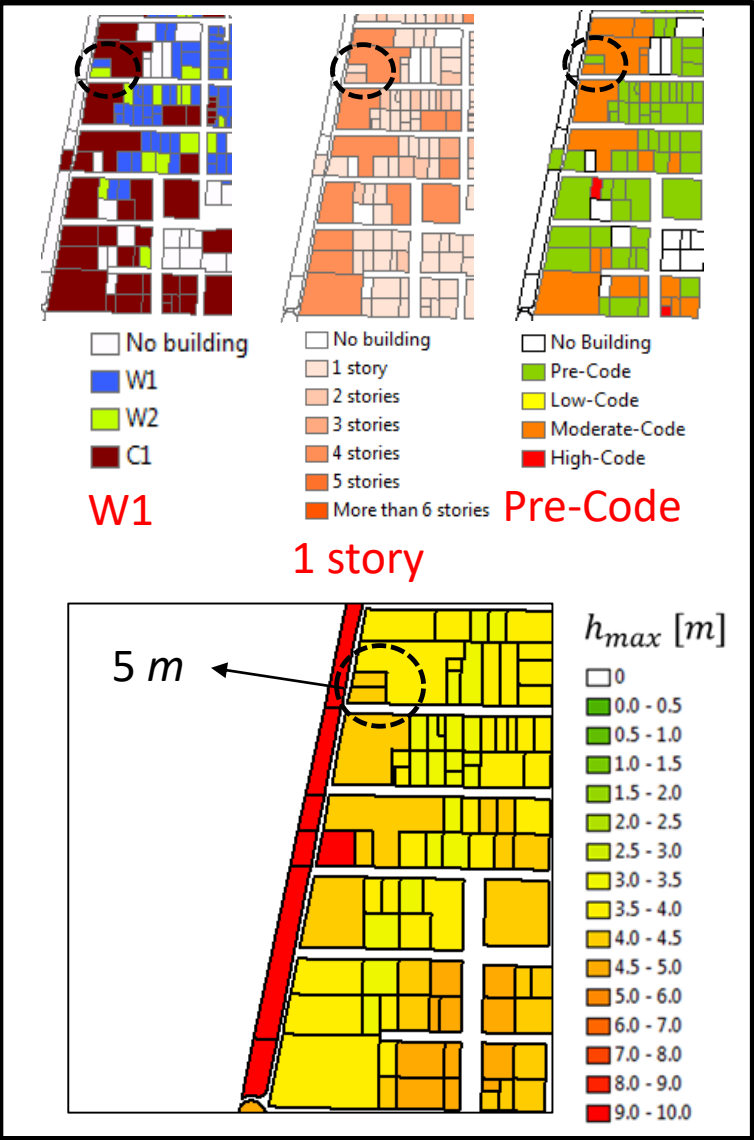


Photo taken by Hyoungsu Park, at Seaside Field trip (July, 14, 2015)



# Envisioning Oregon's Coastal Futures

Example of building damage assessment (at AEP = 0.001)



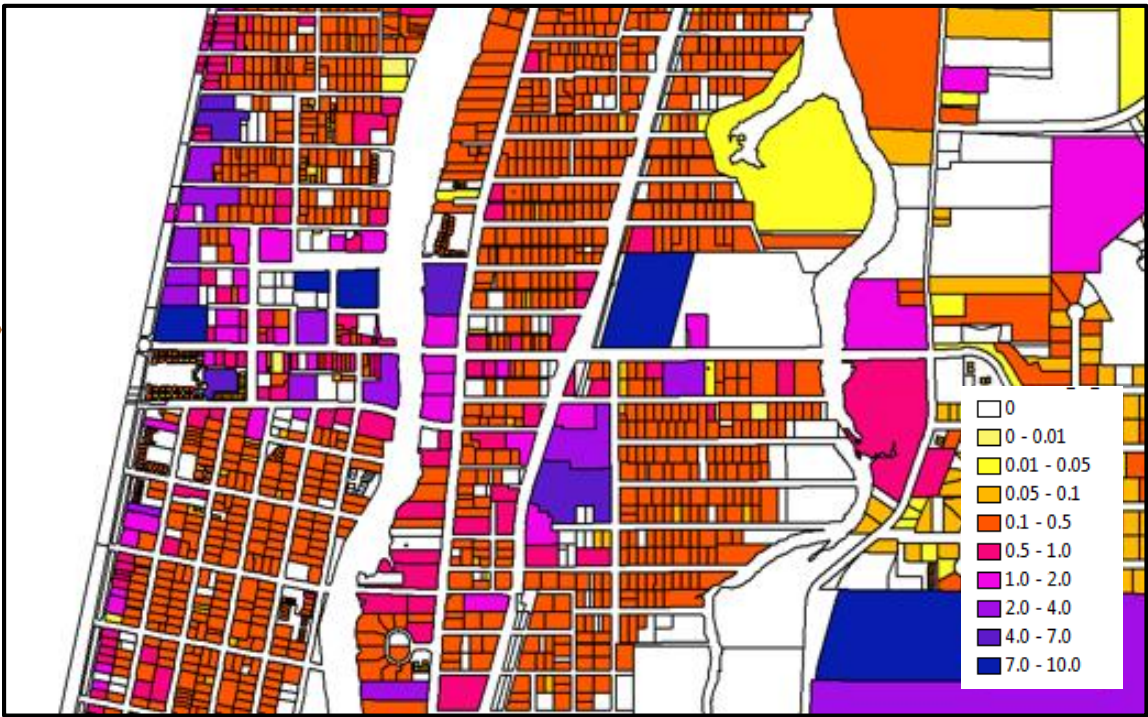
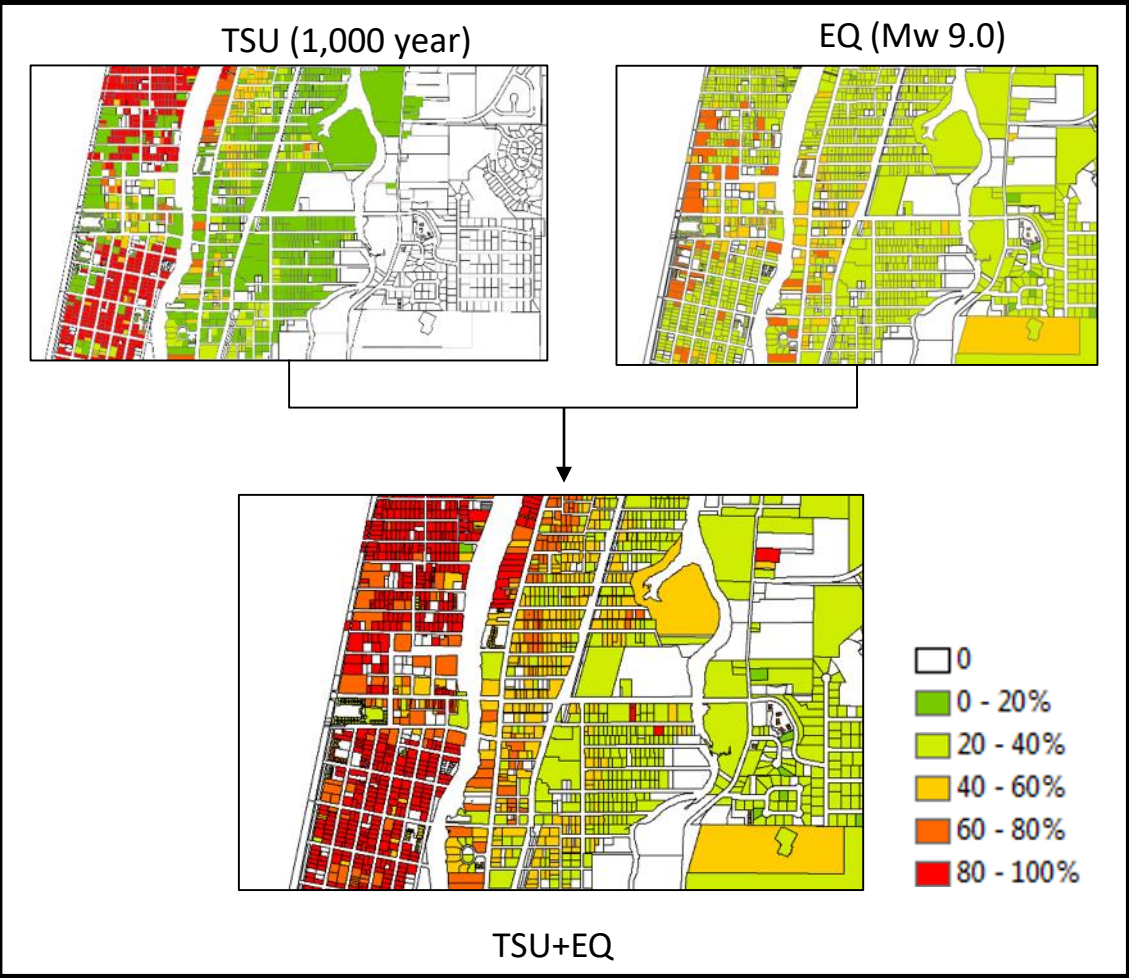


# Envisioning Oregon's Coastal Futures

Probability damage at AEP = 0.001 (~1,000 year event)

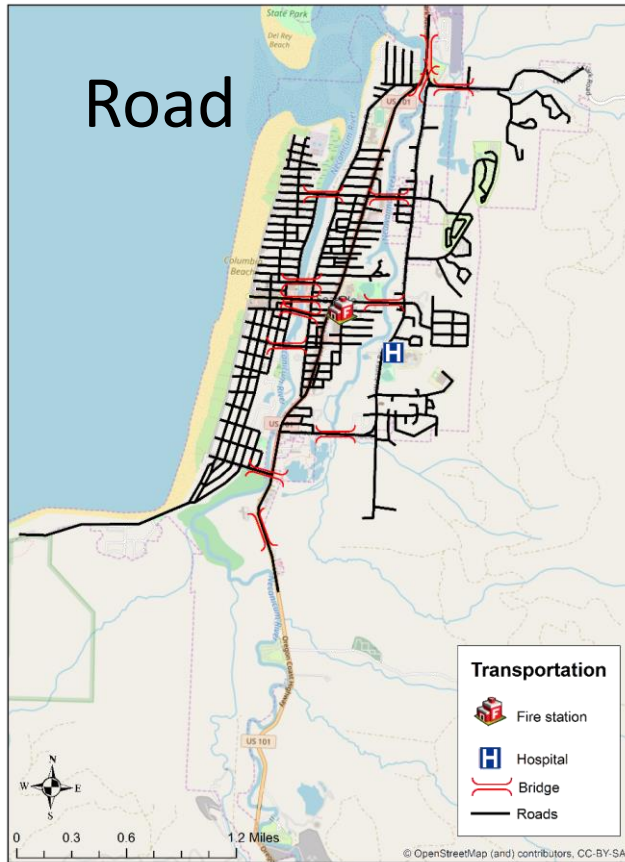
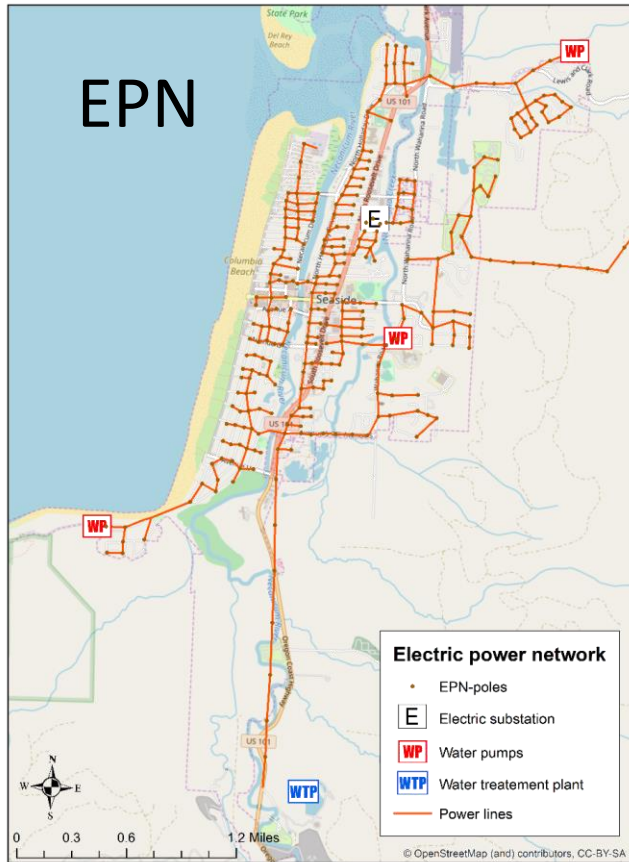
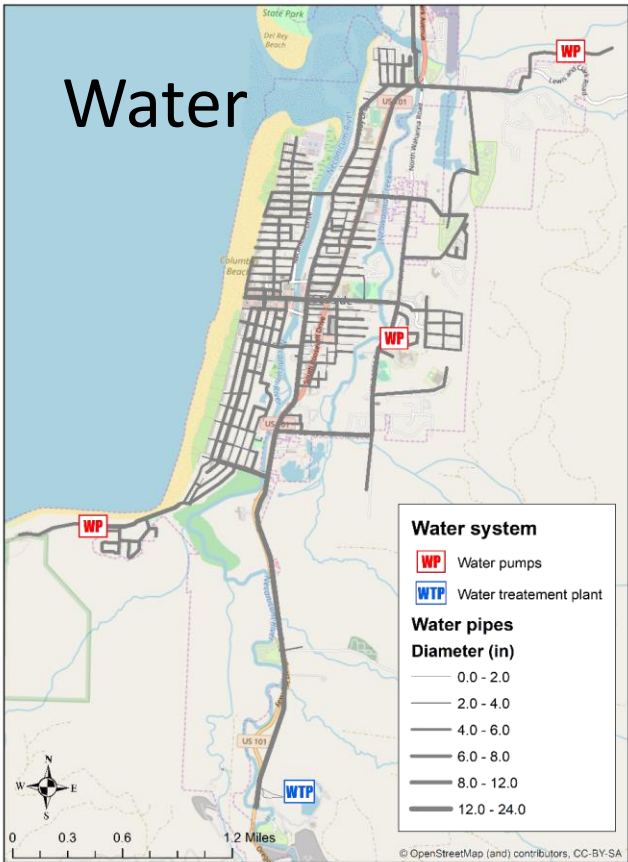
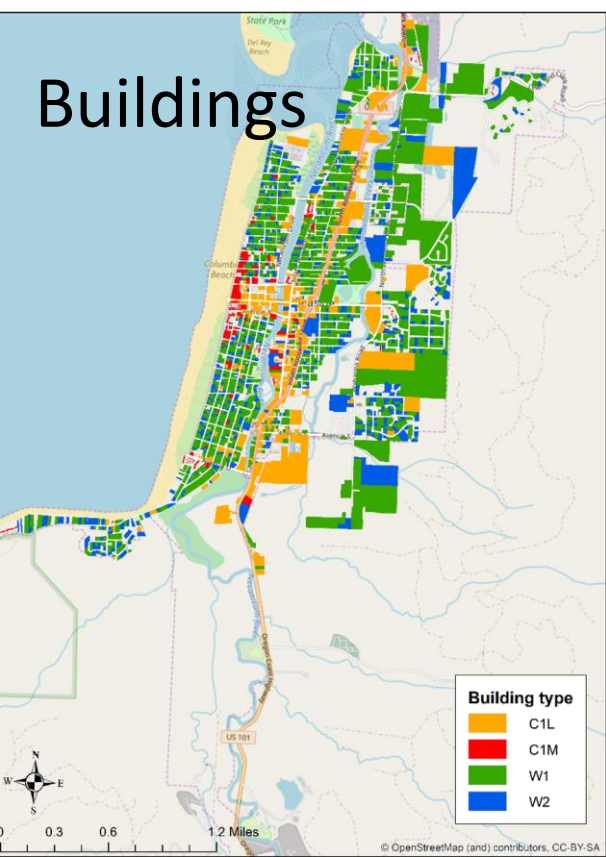




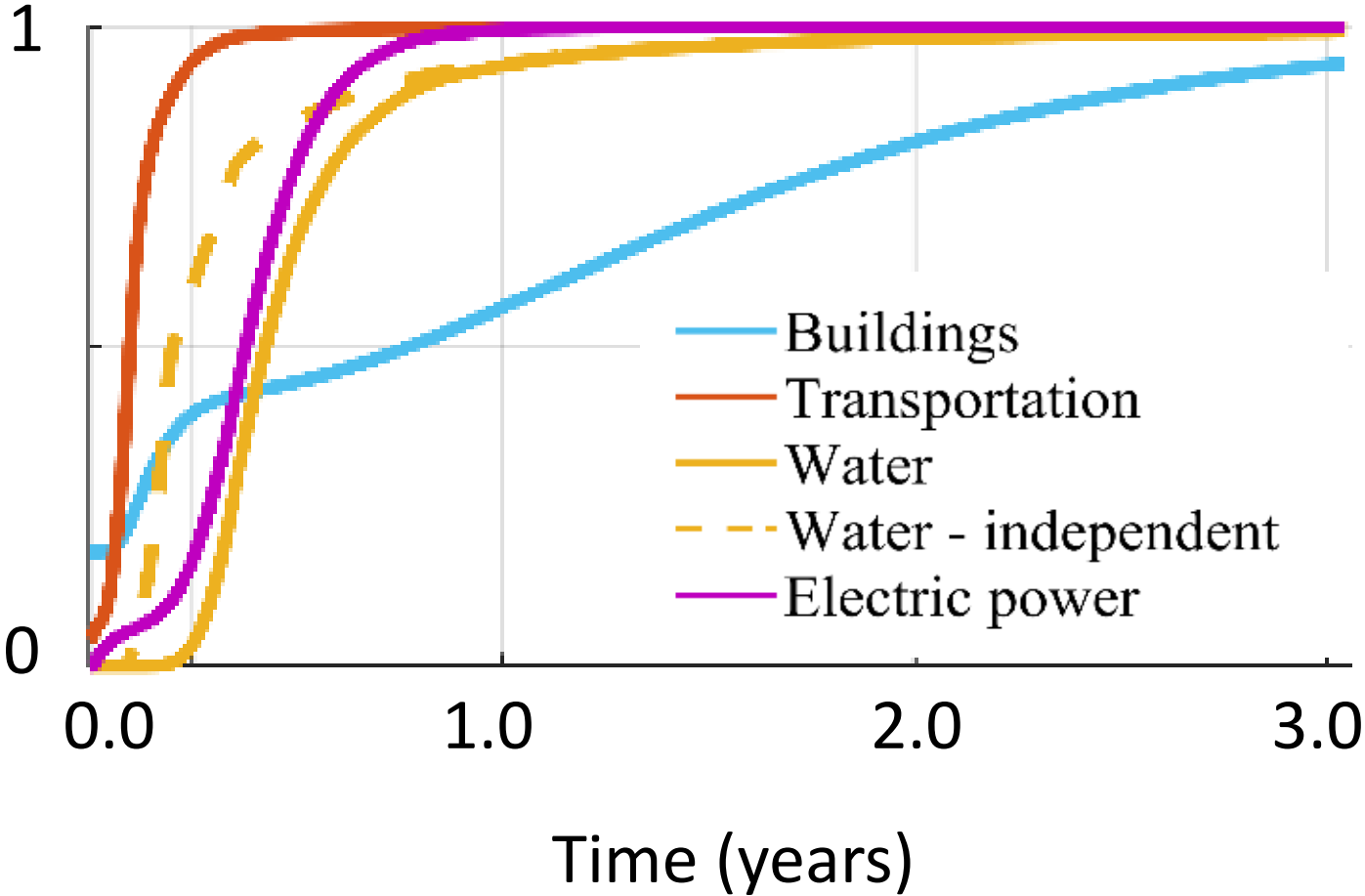


TSU + EQ  
Loss total: 1,230 M

## Buildings plus critical (lifeline) infrastructure networks

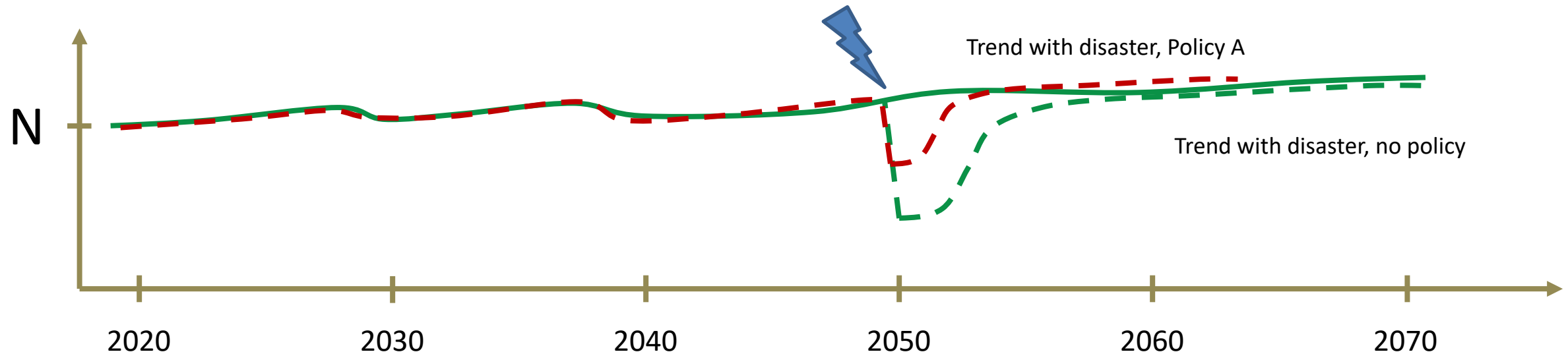


# Estimating the Restoration Rates for Civil Infrastructure





## Framework for Assessing Resilience Strategies



### 1. Acute Hazard

- CSZ: Earthquake + Tsunami
- What scenario? (M7 – M9)
- Timeframe? (2030, 2050)
- ...

### 2. Policy Options

- Status Quo
- Protect (retrofit)
- Realign (moving, zoning)
- ...

### 3. Resilience Metrics

- Direct losses (life safety, capital)
- Indirect losses (recovery)
- Social equity (unequal loss)
- ...





# Oregon Coastal Futures: Equity

Jenna Tilt & Katie Stanton

# Societal Impacts & Equity

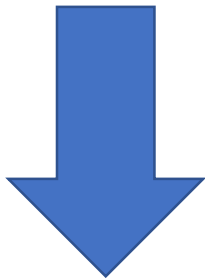
- Investigate societal impacts of coastal hazards and community needs
- Model these impacts & needs through different ENVISION policy scenarios (e.g. baseline, protect, or realign) :



## Methods

### Investigating societal impacts

- Focus groups, and place attachment participatory mapping with Latinx coastal community members (Newport & Astoria) (Katie)
- In-depth interviews with nonprofit organizations and health/human service agencies that serve and/or interact with underrepresented groups (Lincoln, Tillamook, and Clatsop Counties)



### ENVISION

- Secondary data analysis
- Residential
- Business



## Focus Groups, Interviews, and Group Interviews

Preparedness, Awareness, Policy Perception, and Sense of Place

- Found partners to bridge gap – Centro de Ayuda, OSU extension, Lower Columbia Hispanic Council
- Built trust in communities
- Educational Materials Provided
- Participant Compensation – AAGP
- Member Checking





## Example - Critical Facilities Protect or Realign??

- There is a lack of focus regarding sense of place for traditionally disadvantaged communities in building resilience.
- *Sense of place* for disadvantaged communities includes understanding the differences in which “critical facilities” are utilized, accessible, and valued.
- Place Attachment mapping activity for sense of place and policy perception



### Preparación para Desastres—Una Conversación de la Comunidad Latino

Debes ser mayor de 18 años, identificar como Latino/a/x, y vivir en Newport.

Únase a nosotros para una conversación comunidad para compartir en qué desea que se centren los esfuerzos de preparación para desastres.

- ¿En qué lugares de tu comunidad te gustaría estar protegido?
- ¿Qué quieres que haga tu comunidad en preparación para emergencias?

Septiembre 6, 13, 20 y 27, 2019 - 5:30 a 7 p.m.

Niños bienvenidos, tarjetas de regalo por participación y quédate después para cena y una clase de cocina gratis!!



St. Stephens Iglesia  
414 SW 9th St, Newport, Oregon 97365

Si tienes preguntas contacta:

Katie:	stantoka@oregonstate.edu
Beatriz:	Beatriz.Botello@oregonstate.edu or 541-283-5120
Jenna:	tiltj@oregonstate.edu or 541-737-1232
Debra:	djones@halc.info



Imaginando una Costa de Oregón Resiliente: Co-desarrollo de futuros alternativos para la planificación de la adaptación y la toma de decisiones. El propósito de este estudio de investigación es identificar cómo las acciones o estrategias potenciales de la comunidad para disminuir el impacto de los peligros costeros (por ejemplo, inundaciones, terremotos, tsunamis) pueden afectarlo.

## Preliminary Qualitative Findings: Emergency Awareness & Preparedness


- Need for smaller scaled government outreach
- Lack of resources to prepare in community
- Current outreach strategies are limited in reaching vulnerable groups
- Language proficiency
- Difference in awareness between children and adults and counties
- Role of non-profits and human welfare agencies in wake of a disaster
- Trust





## Preliminary Qualitative Findings: Mitigation Strategies

- Housing affordability and ownership patterns
  - Renters
  - Homeless population
- Ethnicity
  - Lack of trust in local governments
- Transportation Network
  - Dependence on afterschool programs, daycare facilities, etc.
- Dependence on the tourism & fisheries
  - Coastal erosion, beach access, and job security
  - Retrofit & realignment policies: Residents and social service providers worry about livelihoods with disruption to businesses



Oregon State  
University

**Help us spread the word about the Oregon Coastal Futures Study!**


**Who?** Seeking coastal residents of Lincoln, Tillamook, or Clatsop Counties who are at least 18 years old, or those who work for a nonprofit or organization in these coastal communities.

**Why?** To help us learn how public actions that can reduce the impact of coastal hazards (e.g. flooding, earthquake, tsunami) impact community residents and nonprofit organizations.

**How?** By participating in an approximate one hour individual or group interview.

**To learn more or to participate please contact:**  
Jenna Tilt, PhD: tiltj@oregonstate.edu, 541-737-1232  
Katie Stanton, Graduate Student: stantoka@oregonstate.edu

*Envisioning a Resilient Oregon Coast: Co-developing alternative futures for adaptation planning and decision-making*



Oregon State  
University

**¡Ayúdenos a difundir la noticia sobre el Estudio del futuro costero de Oregon!**

**¿Quien?** Buscar residentes en la costa de los condados de Lincoln, Tillamook o Clatsop que tengan al menos 18 años de edad, o aquellos que trabajan para una organización sin fines de lucro en estas comunidades costeras.

**¿Por qué?** Para ayudarnos a conocer cómo las acciones públicas que pueden reducir el impacto de los peligros costeros (por ejemplo, inundaciones, terremotos, tsunamis) afectan a los residentes de la comunidad y las organizaciones sin fines de lucro.

**¿Cómo?** Al participar en una entrevista individual o grupal de aproximadamente una hora.

**Para obtener más información o para participar, por favor contacte a:**  
Jenna Tilt, PhD: tiltj@oregonstate.edu, 541-737-1232  
Katie Stanton, Graduate Student: stantoka@oregonstate.edu

*Imaginando una Costa de Oregon Resiliente: Co-desarrollo de futuros alternativos para la planificación de la adaptación y la toma de decisiones*



## Key Questions for Envision

- How are traditionally under-represented populations affected by policy scenarios (e.g. protect, realign)?
- How might these populations affected by recovery rates and outmigration after an event?
- How do policies aimed at protecting/realigning service sector businesses impact employees and local populations?

### Demographic Variables

- ✓ Income
- ✓ Ethnicity/Race
- ✓ Renter/Owner
- ✓ Dependents
- ✓ Age
- ✓ Tenure

### Business Variables

- ✓ Type & Sector
- ✓ # of employees
- ✓ Profit

## From Preliminary Qualitative Findings to ENVISION

*First “run” focuses on income classes in Tillamook County*

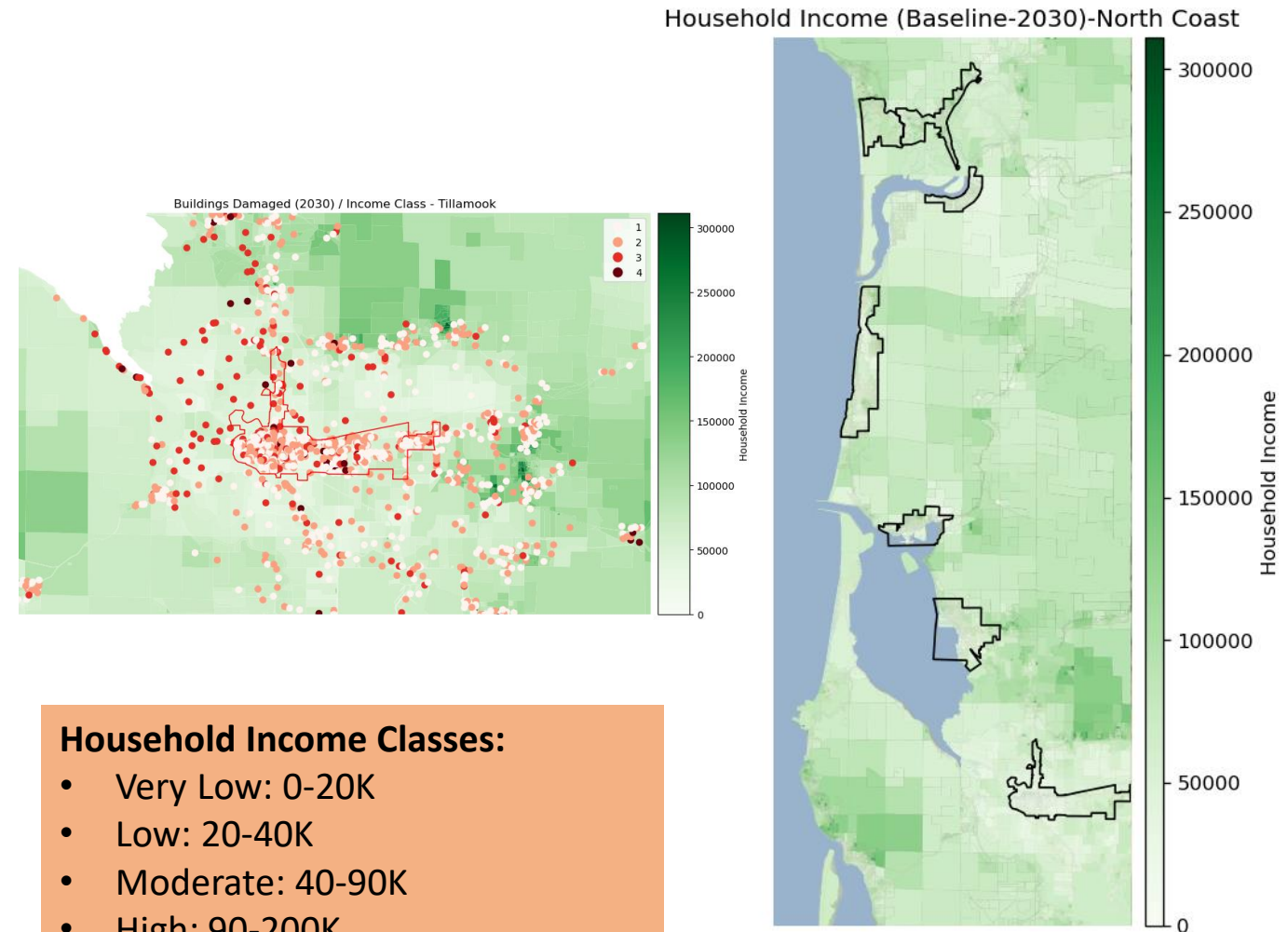
**WHY?:** Limited resources impact one's capacity to be resilient to hazards.

### **Protect Scenario:**

In this scenario, no subsidies for retrofits are provided. It is assumed that higher income households would retrofit their homes at a higher rate than lower income households.

### **Realign Scenario:**

This scenario assumes subsidies have been given to assist lower income households relocate. It is assumed that lower income households would relocate out of the Tsunami Hazard Zone at a higher rate than higher income households.



### **Household Income Classes:**

- Very Low: 0-20K
- Low: 20-40K
- Moderate: 40-90K
- High: 90-200K
- Very high: over 200K

*Tillamook Median HH Income= \$45,000*

## How we might extend this scenario in ENVISION?

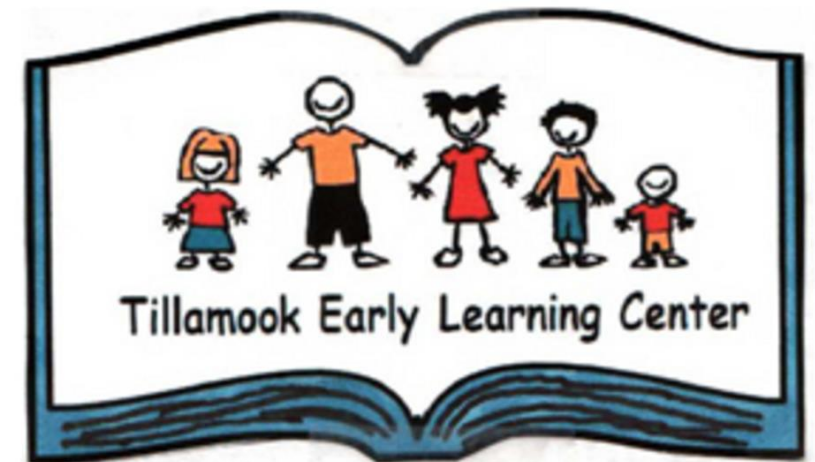
- **Homeowner status:** Rental status with property value will provide an indication of those least likely to have the capacity to protect their home or move without resource assistance
- **Ethnicity:** Lack of trust may limit particular groups' access to resource assistance, even if available
- **Service Sector:** Lack of protection of service sector businesses (e.g. hotels, restaurants) may result in higher outmigration even if homes are protected or relocated. However, relocating/retrofit service sector businesses could temporarily impact vulnerable employees.





## Key Questions for Advisory Council

- What policy “levers” should be modeled to allocate resources to vulnerable populations (e.g. subsidies)? Are there current policies or programs we should use as a model for Envision scenarios?
- What are realistic \$ thresholds for policy “levers”?
- What community facilities (e.g. churches, food banks, day cares, etc.) should be examined beyond critical facilities and why?
- What other items/variables should we consider?



# Tsunami Risk and Information Shocks

- **Question:** Can new information about the risk of a Cascadia earthquake and tsunami change people's risk perceptions?
- **Relevance:** Oregon's resilience to a magnitude 9.0 Cascadia earthquake is low
- **Goal:** To identify the impacts of tsunami inundation zone designation and risk information shocks on coastal housing values

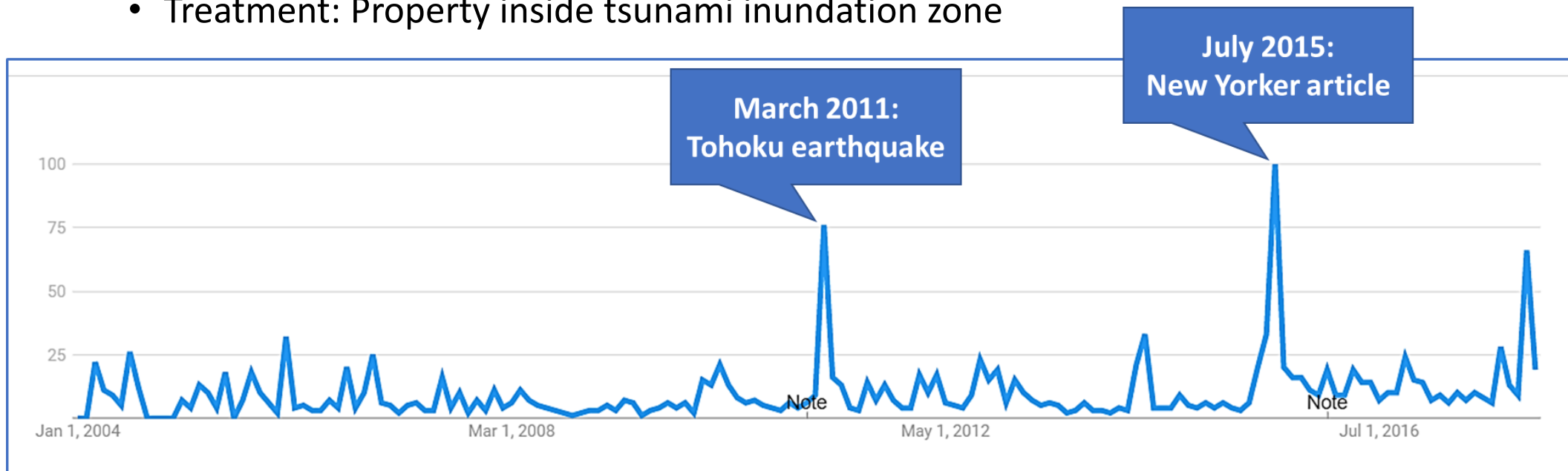




# Tsunami Risk and Information Shocks

## Research design:

- Use information from Oregon housing market to determine effect of two events on property prices
- Quasi-experimental method: Difference-in-differences
  - Event(s): 2011 Tohoku earthquake and tsunami, 2015 New Yorker article
  - Treatment: Property inside tsunami inundation zone



# Tsunami Risk and Information Shocks

**Preliminary result:** No effect.

→ *No evidence that coastal residents are taking tsunami risk into account?*

**Potential next steps:** Test impact of:

- Information shocks – in progress
- Hazard planning lines – 2013 TIM series
- Visual cues – Tsunami Blue Line project

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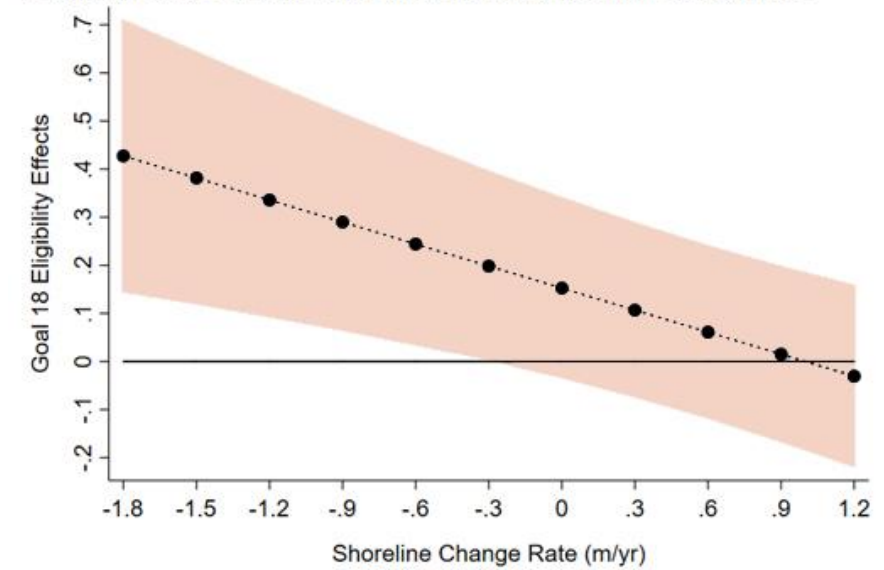


## Economic Factors in Chronic Risk Along the Oregon Coast

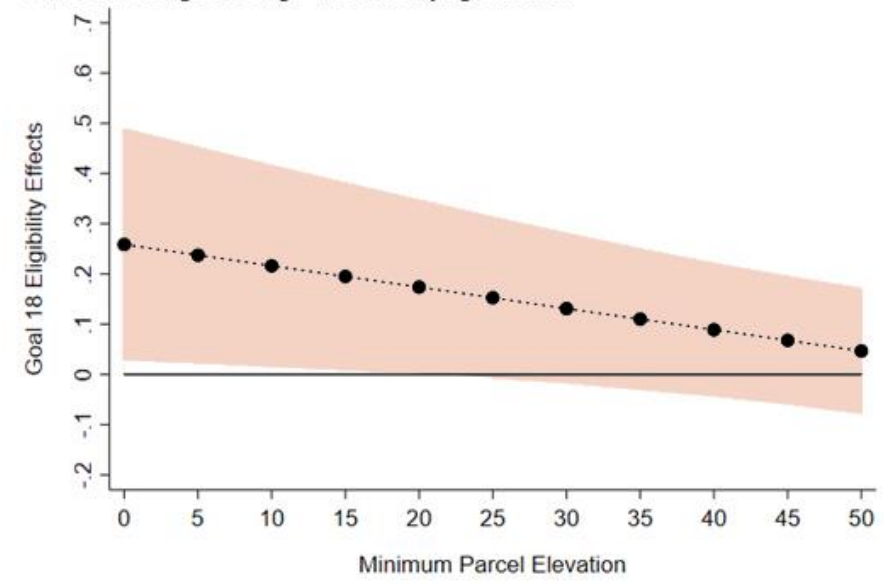
### Capitalization Effect of Goal 18 Eligibility Option

- Varies by parcel vulnerability
- Spillover effects can lower value of neighboring land by 8%
- Apply estimates to each parcel & track changes in value generated by Envision policy scenarios

Panel A: Average Low Elevation Parcel at Varying Shoreline Change Rates



Panel B: Average Eroding Parcel at Varying Elevation

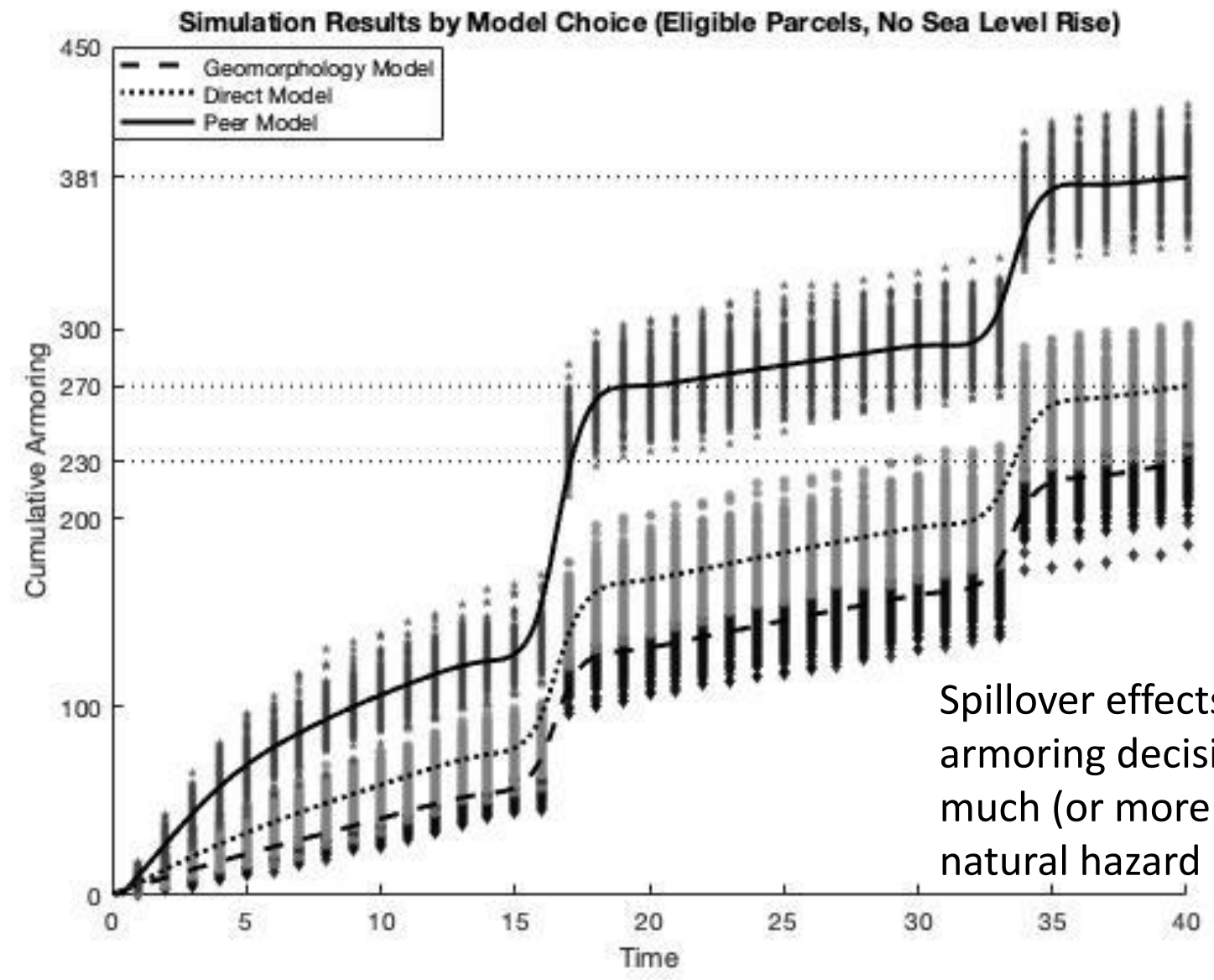
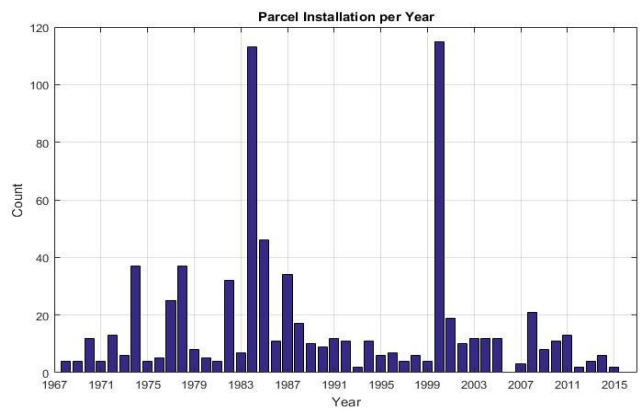




# Envisioning Oregon's Coastal Futures

## Economic Factors in Chronic Risk Along the Oregon Coast

### Behavioral & Risk Drivers of Coastal Land Use Change



Spillover effects influence armoring decisions as much (or more so) than natural hazard risk

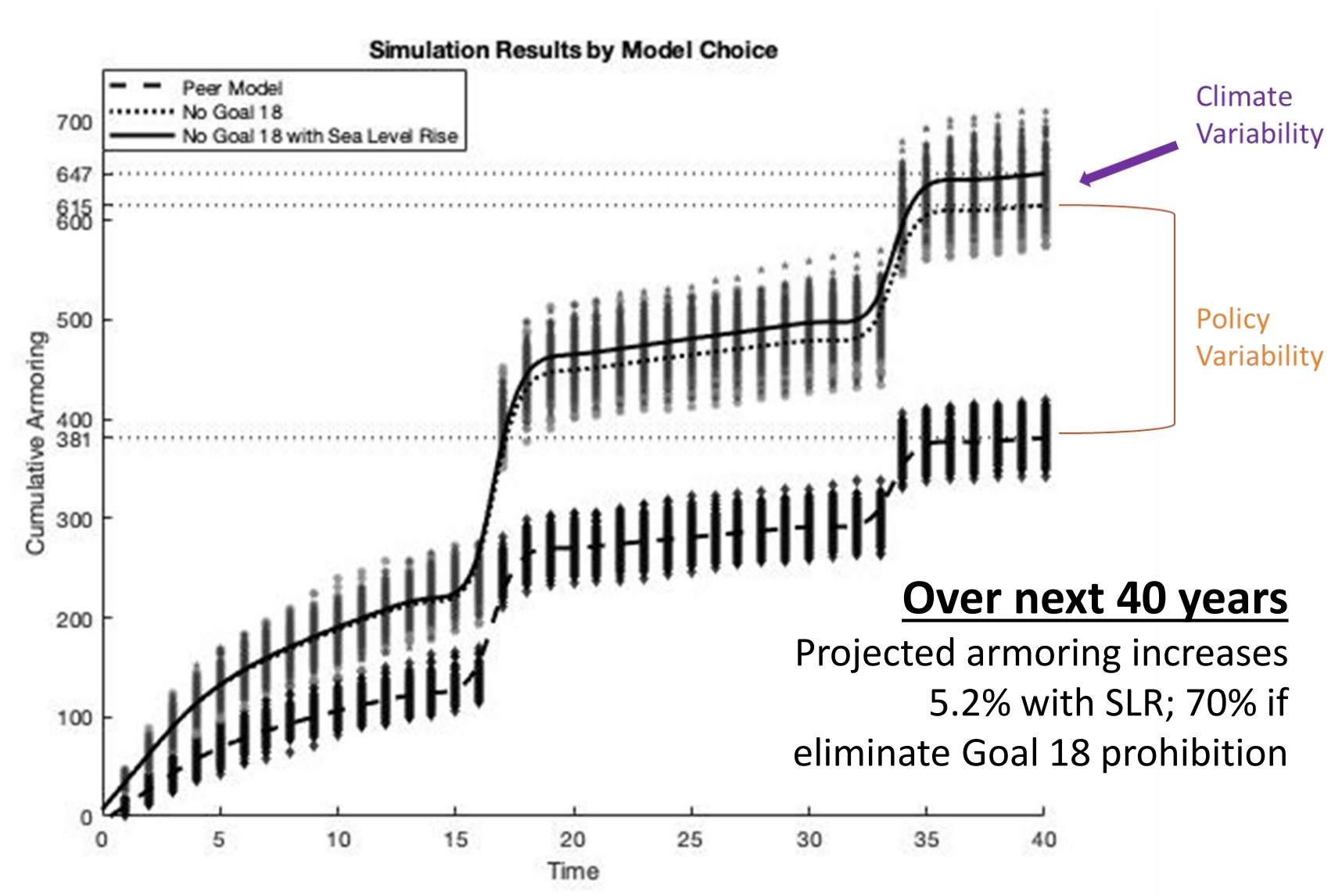
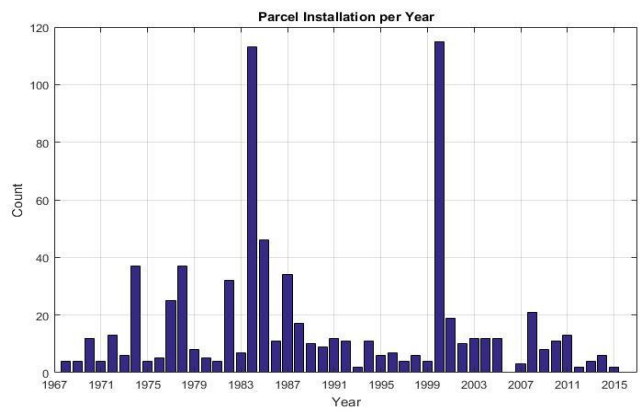




# Envisioning Oregon's Coastal Futures

## Economic Factors in Chronic Risk Along the Oregon Coast

### Behavioral & Risk Drivers of Coastal Land Use Change

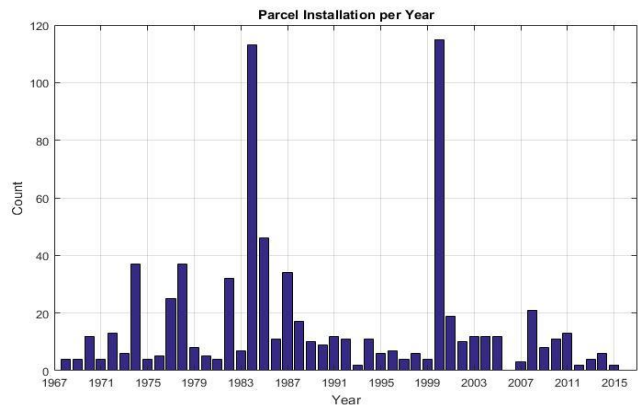




# Envisioning Oregon's Coastal Futures

## Economic Factors in Chronic Risk Along the Oregon Coast

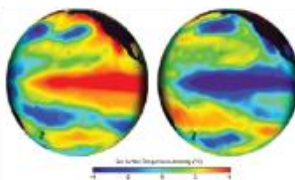
### Behavioral & Risk Drivers of Coastal Land Use Change



Model of Private Landowner  
Adaptation Decisions

TESLA-EX

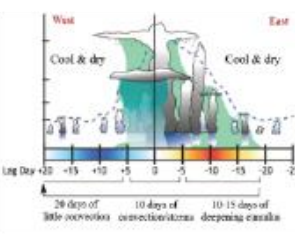
Inter-Annual



Seasonal



Intra-seasonal



Daily Weather Patterns



Coupled model outputs become  
inputs for assessing landscape  
evolution to chronic risks in *Envision*

# Chronic Coastal Hazards

## Flooding and Erosion

Meredith Leung

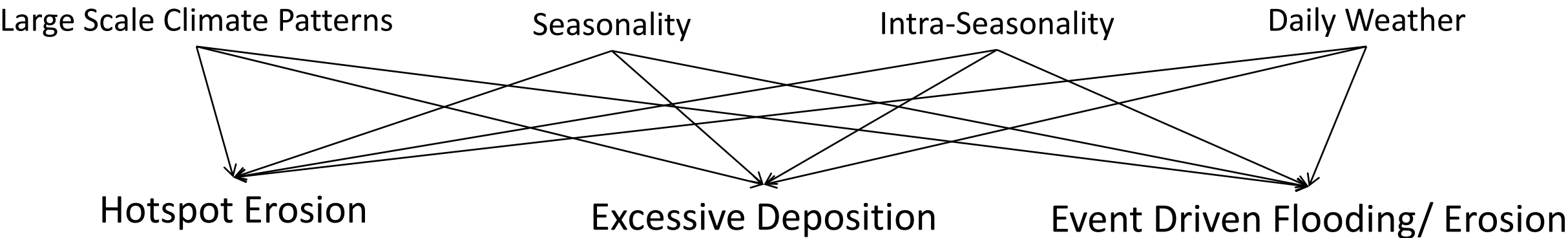


**Oregon State**  
University





# Complex Hazards on the Oregon Coast





## How do we quantify chronic coastal change in a region?

(what do we need to keep track of?)

- › Changes in sediment budget
- › Changes in climate trends
- › Episodic, event driven hazards
- › Hotspot erosion/ deposition



Storm Surge      Monthly Mean Sea Level Anomaly (MMSLA)

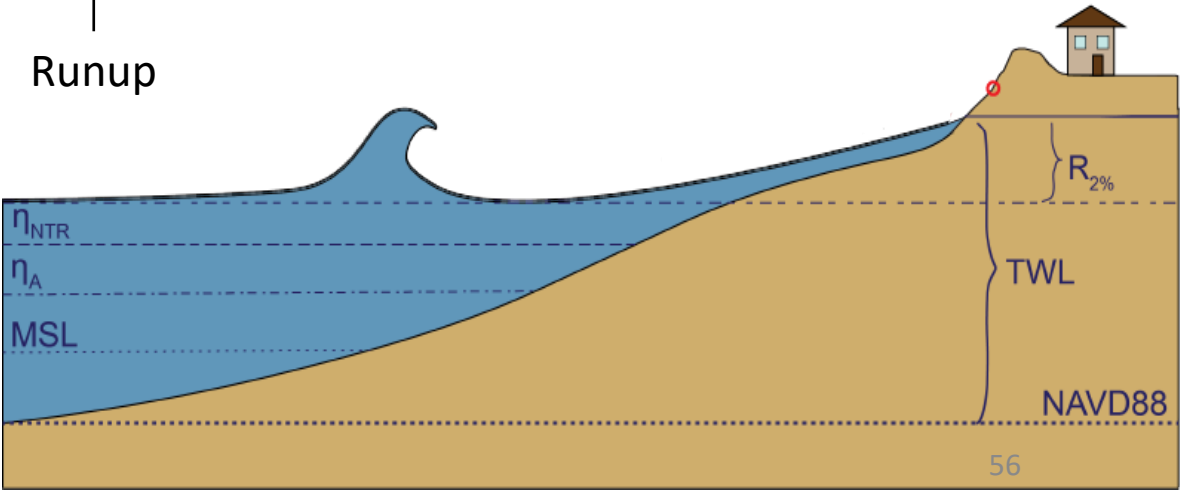
Mean Sea Level

Non-tidal Residuals

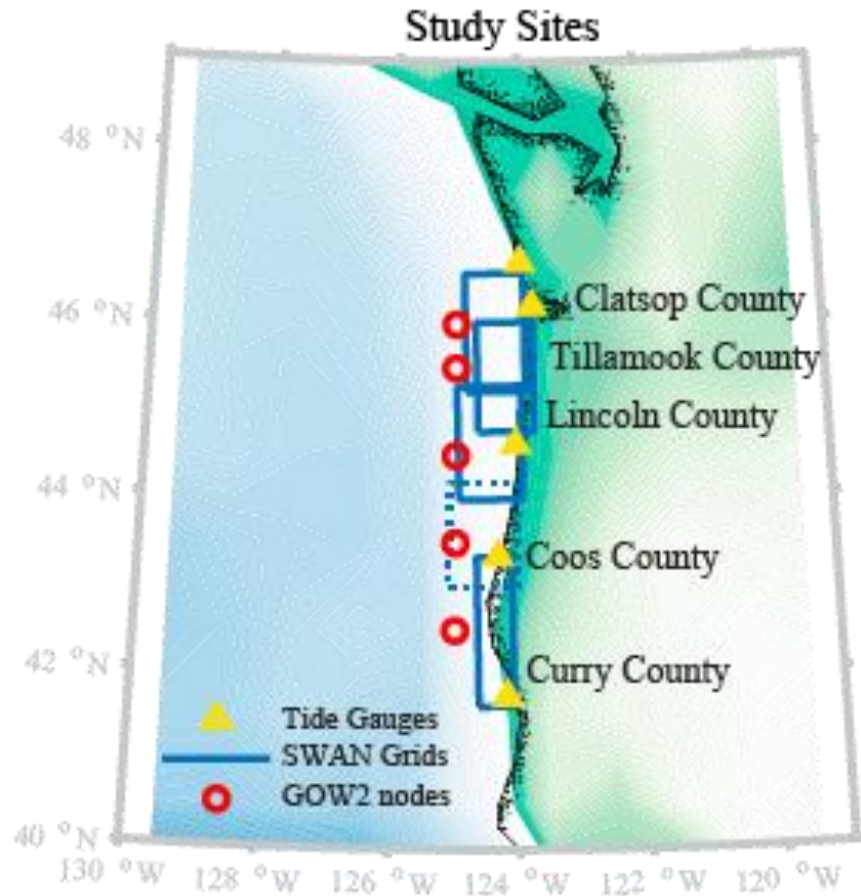
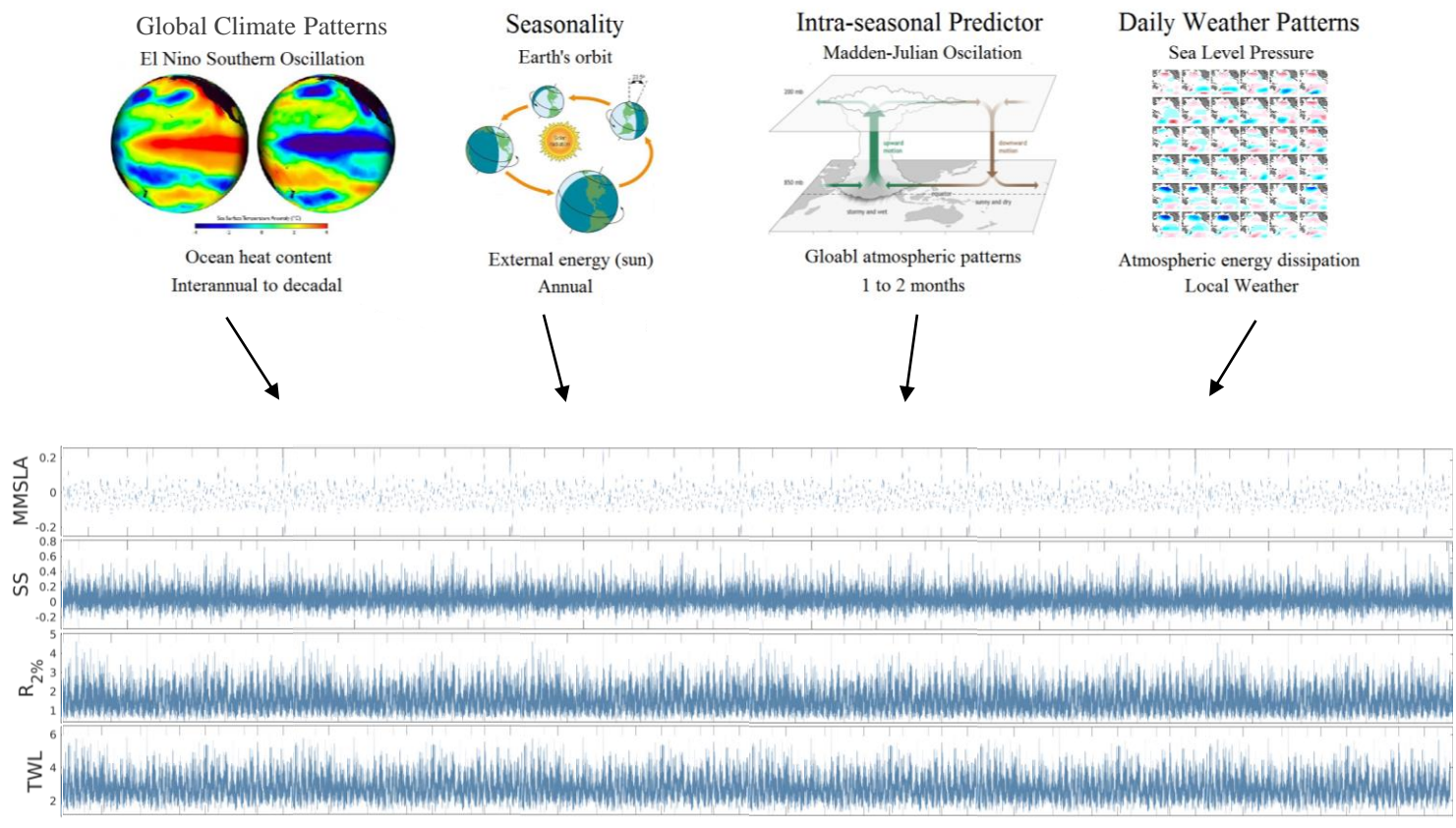
$TWL = MSL + \eta_A + \eta_{NTR} + R_{2\%}$

Astronomical Tide

Runup



## TESLA – statistical framework to forecast TWLs



Anderson, D., Rueda, A., Cagigal, L., J. A. A. Antolinez, F.J. Mendez, and Ruggiero, P. ( 2019), Time-varying Emulator for Short and Long-Term Analysis of Coastal Flooding, *J. Geophys. Res. Oceans*, in review.



## TESLA in Envision:

**Trigger:** Erosion / Flood Frequency

**Policy Response:**

### Protect

Maintain current backshore protection structures (BPS) and allow more BPS to be built on Oregon Goal 18 eligible lots.

### Realign

Prohibit repetitive repairs of buildings severely impacted by erosion or flooding and remove buildings from the shoreline after they reach a predetermined repair limit using buyouts.

Mills, A. K., Bolte, J., Ruggiero, P., Serafin, K. A., Lipiec, E., Corcoran, P., Stevenson, J., Zanolco, C., Lach, D. 2018. Exploring the impacts of climate and policy changes on coastal community resilience: Simulating alternative future scenarios. Environmental Modelling & Software.

