

# Tsunami Morphodynamics and Their Role in Hazard, Risk and Resilience Modulation and Environmental Impact in Newport

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# What Are We Missing?



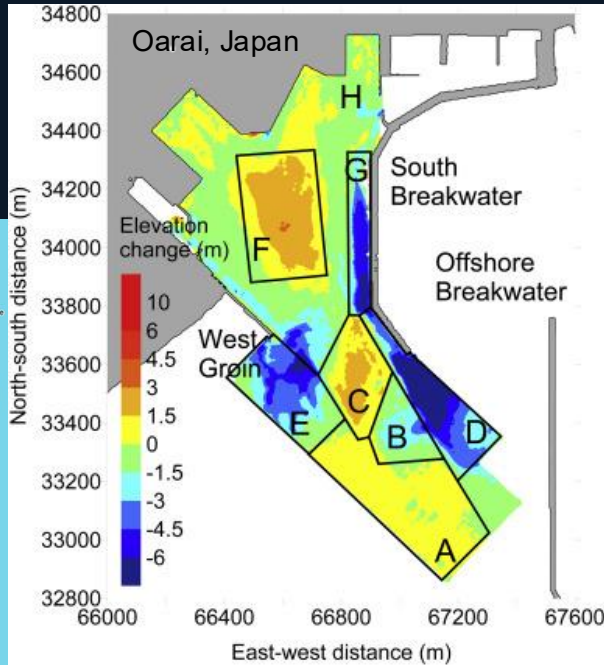
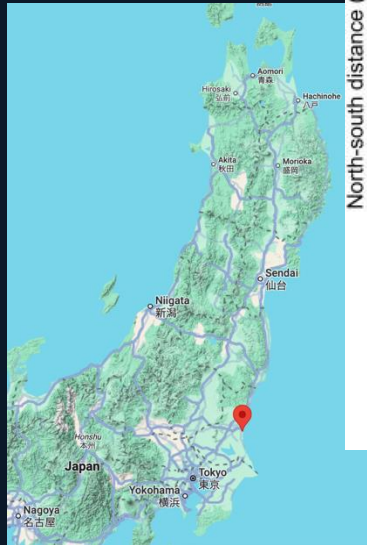
## Hidden Beneath

Tsunamis damage forests, erode foundations, unseat pipelines, and breach protective structures, none of which is captured by fixed-bed models

Sakamoto, 2016



# Tsunami (long-wave) Sediment Transport: A Global Problem



15 m

Maximum scour depth  
Hachinohe, Japan (2011)

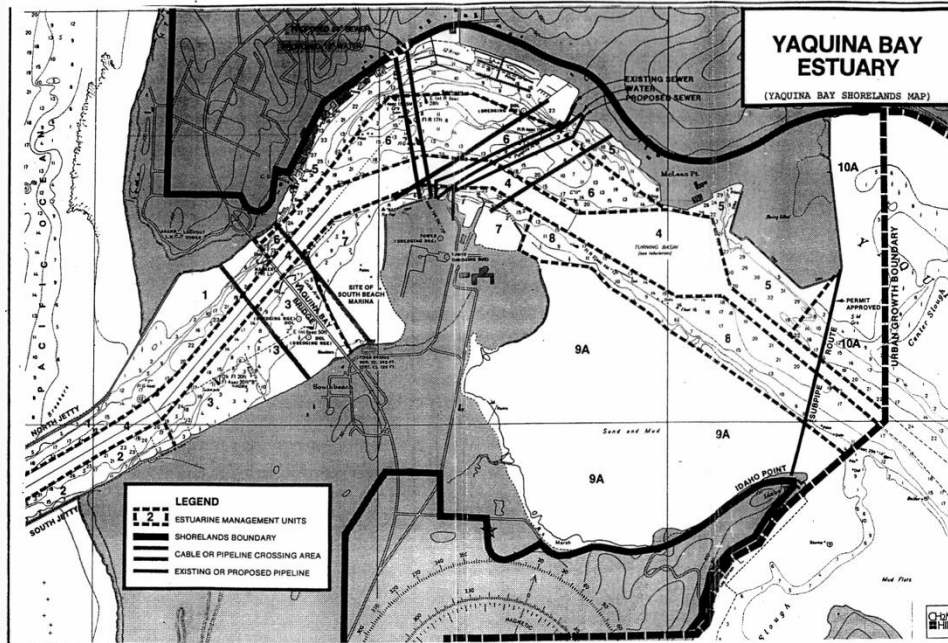
\$5.3B

Debris cleanup cost  
Tōhoku tsunami deposits

18M tons

Total disaster debris  
60% rubble + 40%  
sediment

# Study Area: Newport, Oregon



## Cascadia Subduction Zone

- Mw 9.0 earthquake scenario
- Yaquina Bay Bridge, jetty, port
- Utility lines cross the estuary
- Hybrid coastal environment

# Hydro-Morphodynamic Modeling Framework



## Hydrodynamics

Delft3D-FM  
D-Flow module  
2187 m → 1 m resolution  
3-hour simulation



## Sediment Transport

D-Morphology module  
Sand (267  $\mu\text{m}$ ) + Mud  
Variable thickness  
0.5-20 m layers

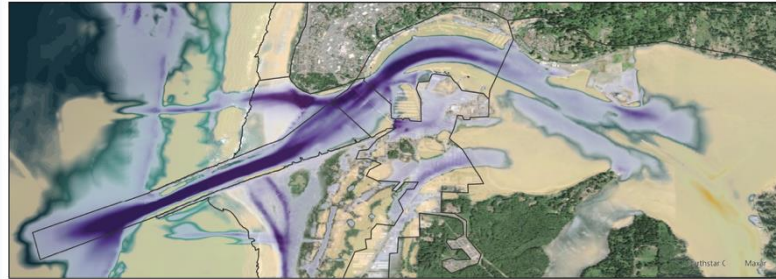


## 9 Scenarios

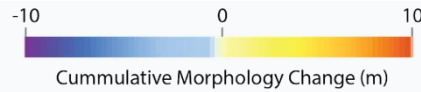
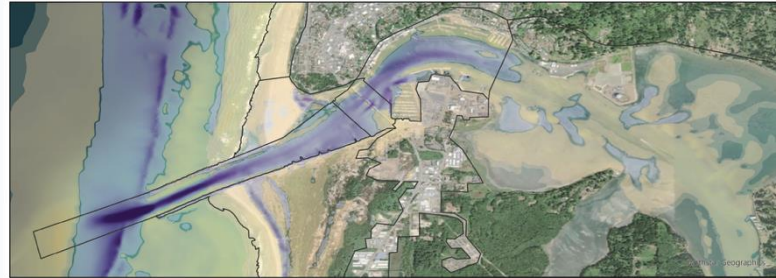
Uniform vs. variable  
Sediment thickness & roughness  
Baseline (no sediment)  
vs. 8 active scenarios

# Morphological Changes: Scour & Sedimentation

Scenario 3



Scenario 8

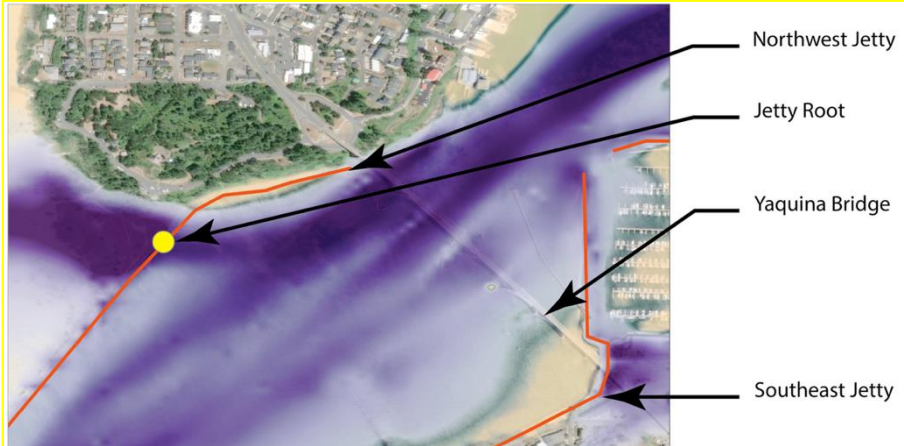


North Jetty root:  $-19.4$  m erosion | Bridge piers:  $-12$  m scour | Marina:  $-5$  to  $-13$  m | Deposition up to  $530,000$  m<sup>3</sup>

# Infrastructure at Risk: Beyond Inundation



North Jetty armor:  
loosely interlocked  
boulders  
 $D_{50} \approx 1.2 \text{ m}$



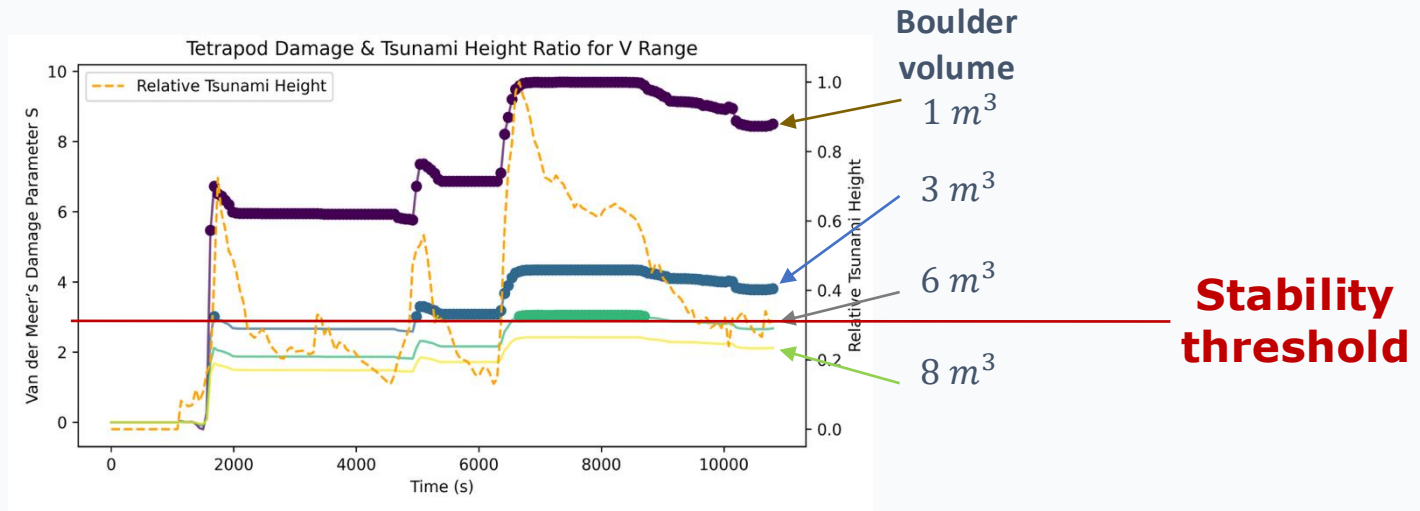
Jetty Armor Failure

Bridge Pier Scour

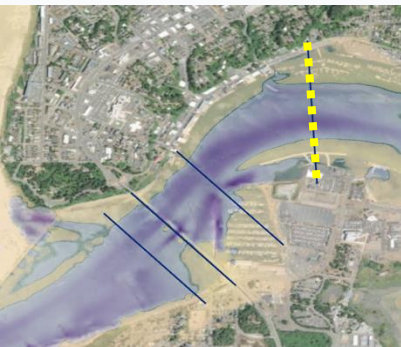
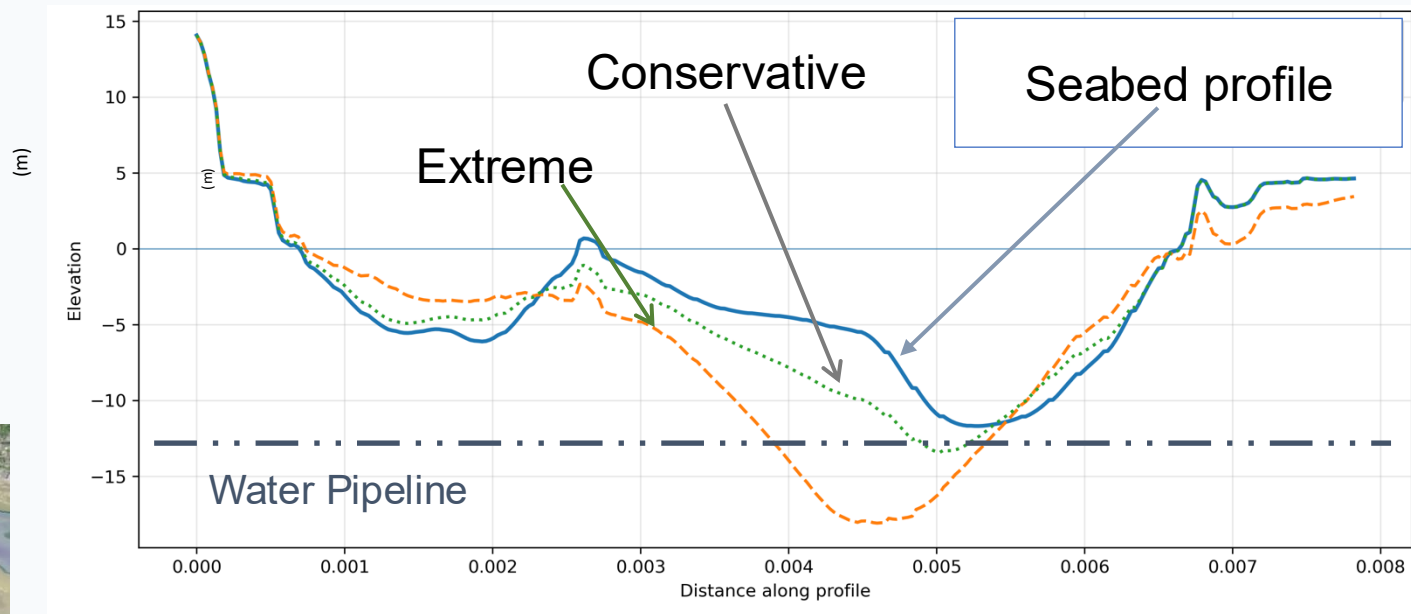
Pipeline Unseating

# Infrastructure at Risk: Jetty Armor Failure

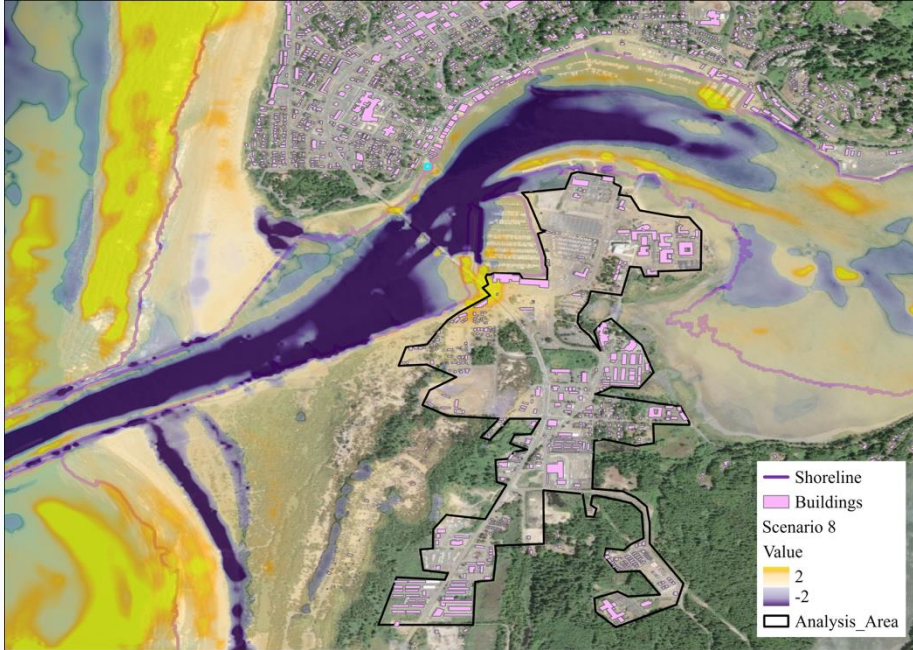
$$S = \frac{\text{Eroded area (m}^2\text{)}}{\text{Diameter of boulder}}$$



# Infrastructure at Risk: Pipeline Unseating - Breaking?



# Cascading Consequences: From Scour to System Failure



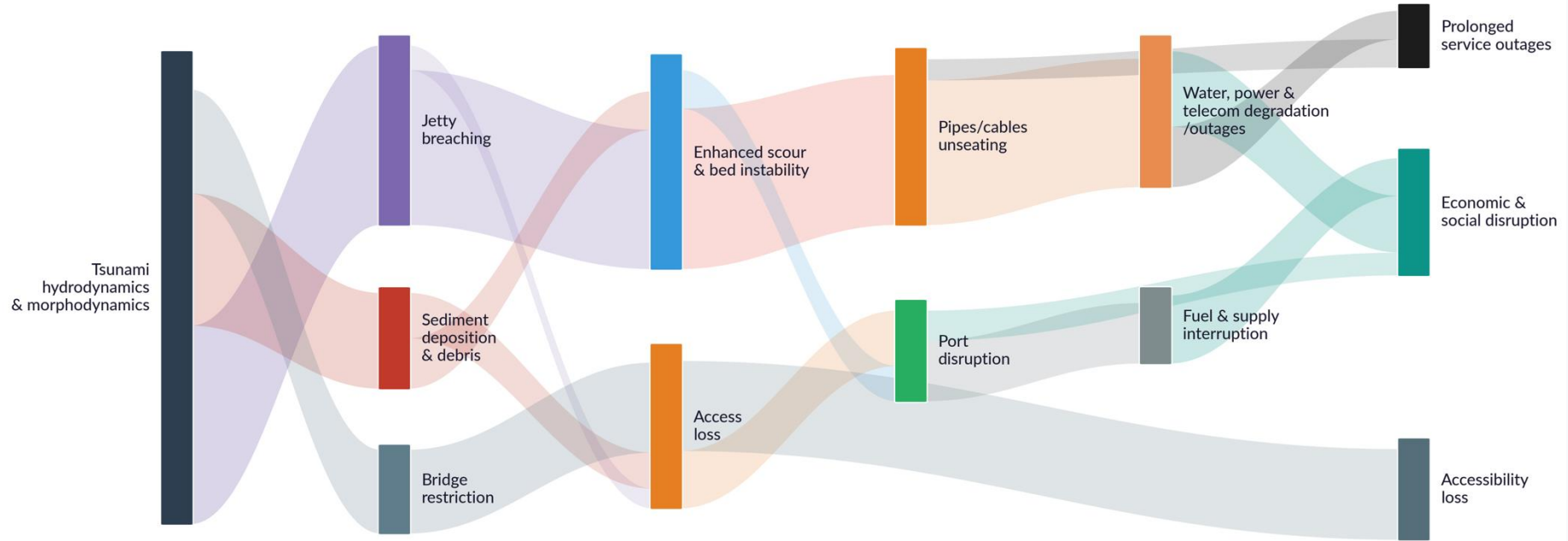
**\$8–38M**

Estimated sediment cleanup cost  
(100,000–530,000 m<sup>3</sup> @ \$50/ton)

**48,000+**

Dump truck loads of  
tsunami sediment deposits

# Cascading Consequences: From Scour to System Failure



## Key Takeaway:

**Fixed-bed models dangerously underestimate infrastructure risk.  
Sediment dynamics control both the spatial distribution and severity of cascading failures.**



Oregon State University  
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Understanding the **dynamic feedback** between **tsunamis**, the **natural/built environment**, and coastal **topography** is essential for **improving hazard assessments** and **strengthening** coastal **resilience**.

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