Briefing Document: Increased flood exposure in the Pacific Northwest following earthquake-driven subsidence and sea-level rise- *Dura et al. (2025)- PNAS*

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Background: Dr. Tina Dura, a coastal geologist specializing in reconstructing past coastal subsidence and sea-level change, led a team of geologists, modelers, sea-level experts, and geophysicists to assess the real-world implications of earthquake-driven subsidence along the Cascadia Subduction Zone (CSZ). By combining geologic records of past earthquakes with numerical models of future subsidence and sea-level rise, the team quantified how flood exposure will evolve under different earthquake and climate scenarios. The work provides a framework for updating flood hazard maps and informing emergency preparedness.

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Key findings:

1. **Increased flood exposure due to earthquake-driven subsidence**

   - If a CSZ earthquake occurred today, coastal land at 24 main estuaries spanning southern Washington to northern California could be permanently lowered 0.23-2.67 m (0.76-8.76 ft).
   - This subsidence could expand the 1% (100-year) floodplains at the 24 estuaries by a total of **90 km^2 or 35 sq mi (low subsidence), 160 km^2 or 60 sq mi (medium), and 300 km^2 or 115 sq mi (high).**
   - The number of residents, structures, and roads exposed to flooding across all estuaries could **more than double** under high-subsidence scenarios.
   - Postseismic recovery times for subsided land could range from decades to centuries.

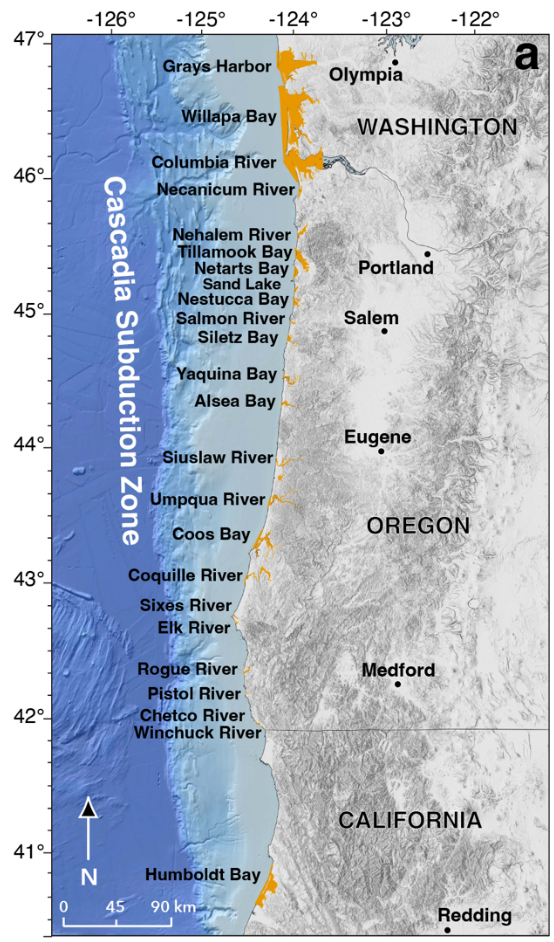

Figure 1. a) Washington, Oregon, and California coastal estuaries analyzed in this study. The orange polygons depict the 1% floodplain after high earthquake-driven subsidence in 2023 (defined baseline year).

2. **Compounding effects of climate-driven sea-level rise (SLR)**

   - If no earthquake occurs by 2100, projected climate-driven SLR (0.4-0.9 m or 1.3-2.9 ft) at the 24 estuaries would independently expand coastal floodplains by **100 km^2 or 40 sq miles**
   - If an earthquake occurs in 2100, **combined earthquake-driven subsidence and SLR could expand the floodplain by up to 370 km^2 or 145 sq mi** (high-subsidence scenario), **tripling flood exposure compared to today.**

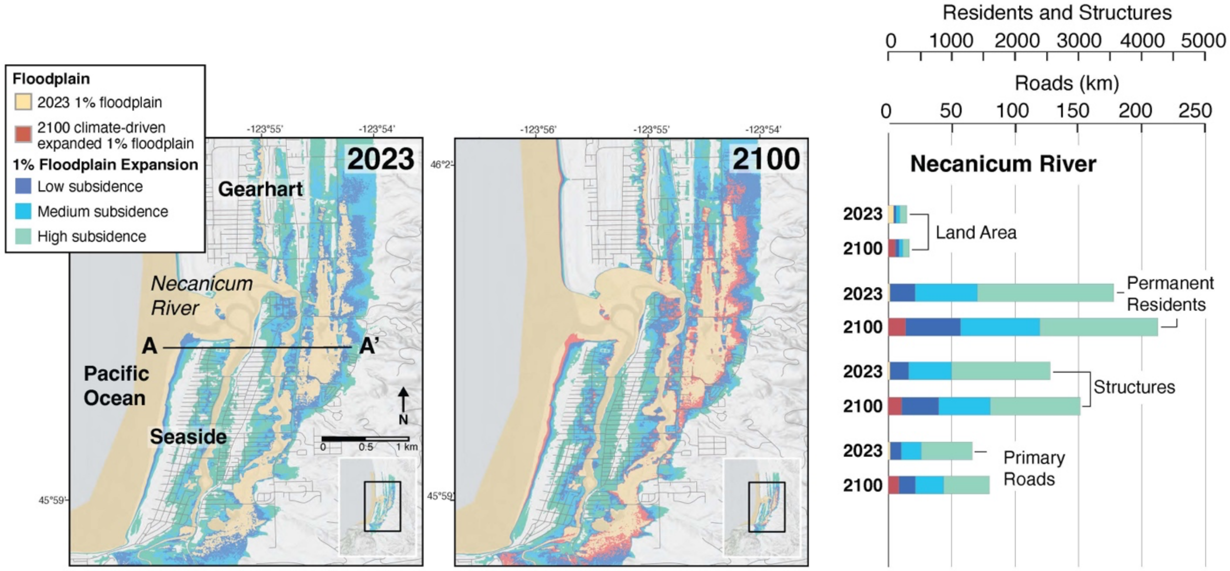

Figure 2. Floodplain maps depicting the expansion of the 1% floodplain after earthquake-driven subsidence today (2023) and in 2100 when earthquake-driven subsidence is amplified by climate-driven sea-level rise for the Necanicum River estuary (communities of Seaside and Gearhart, OR). Bar graphs to the right of the maps show increases in the amount of land area, residents, structures, and roads in the 1% floodplain following earthquake-driven subsidence.

<u>Impacts of earthquake-driven subsidence:</u>

1. **Key infrastructure exposed to increased flooding**
   - **Airports, emergency response facilities, hospitals, coastal roadways, bridges, and seaports** in the new post-earthquake floodplain could cause delays in emergency response and disaster recovery.
   - **Wastewater treatment plants and electric substations** in the new post-earthquake floodplain could cause interruptions to service.
   - **Agricultural lands** in the new post-earthquake floodplain could lead to soil salinization and long-term economic losses.
2. **Coastal ecosystems exposed to increased flooding**
   - **Intertidal wetlands**, which provide natural flood protection, could be drowned or eroded, diminishing their ability to buffer storm surges and store carbon.
   - **Estuarine tidal ranges may increase**, exacerbating high-tide flooding and storm surge effects.
   - **Sandy coastlines could experience accelerated erosion**, increasing vulnerability to extreme weather events.
3. **Tsunami considerations**
   - Existing tsunami hazard maps account for earthquake-driven subsidence but **do not incorporate climate-driven SLR,** potentially underestimating future tsunami inundation zones.

<u>**Future considerations:**</u>

1. **Update flood hazard and tsunami inundation maps**
   - Integrate earthquake-driven subsidence and climate-driven SLR into hazard assessments.
   - Identify at-risk communities for adaptation measures.
2. **Strengthen infrastructure resilience**
   - Identify **critical infrastructure** (e.g., emergency response centers, hospitals, transportation corridors) in high-risk flood zones.
   - Plan for **relocation or adaptation** of essential services in high-risk flood zones.
3. **Enhance disaster response and evacuation planning**
   - Develop **contingency plans for subsidence-induced permanent flooding** and its effects on response operations.
   - Increase **public awareness and preparedness** for long-term land-level changes post-earthquake.
4. **Coordinate with land-use and environmental planning**
   - Promote nature-based solutions, such as **wetland restoration**, to maintain natural flood buffers.
   - Identify areas where future development might occur in areas of subsidence and SLR-driven flooding.
5. **Engage in multi-hazard planning**
   - Ensure that recovery strategies consider the potential for **delayed land uplift** and long-term sea-level rise impacts.
   - Work with federal, state, and local agencies to **integrate findings into emergency preparedness policies.**

<u>**Conclusions:**</u> Earthquake-driven subsidence combined with climate-driven sea-level rise will significantly increase coastal flood exposure following the next great CSZ earthquake in the region. For communities to be prepared, this hazard should be taken into account in earthquake response and infrastructure planning and community resilience strategies to mitigate long-term impacts.

<u>**Data availability:**</u> All shapefiles generated in this study are available at (https://github.com/DuraGEOSVT/Cascadia). All data integral to the stated conclusions are presented within the manuscript Results, Materials and Methods, or Supporting Information sections.