Remapping Tsunami Inundation Hazard Using Heterogeneous Sources

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Synopsis

We found that measuring tsunami inundation hazard at three sites — Ocean Shores, WA; Newport, OR; and Crescent City, CA — changes slightly when using heterogeneous slip earthquake sources.

We used 25 sources from the 4 families that fall into L1 and XL1 scenario classification – for a total of 200 scenarios.

- Gauss (Schmalzle et al., 2014)
- Gamma (Schmalzle et al., 2014)
- Li (Li et al. 2018)
- 1 cm/yr (Frankel et al., 2015)

Motivation

Tsunami evacuation maps for the towns and cities off the Cascadia Subduction Zone(CSZ) have based their cutoff for evacuation on the L1 model from Witter et al. (2013). This model is a full rupture of the CSZ with purely homogenous slip.

Realistic megathrust ruptures do not follow that behavior, so it becomes necessary to create scenarios that mimic realistic rupture scenarios. Alas, there is no way to predict what the next CSZ earthquake tsunami source will look like. It becomes necessary to use stochastic methods to gauge the vulnerability of coastal communities.

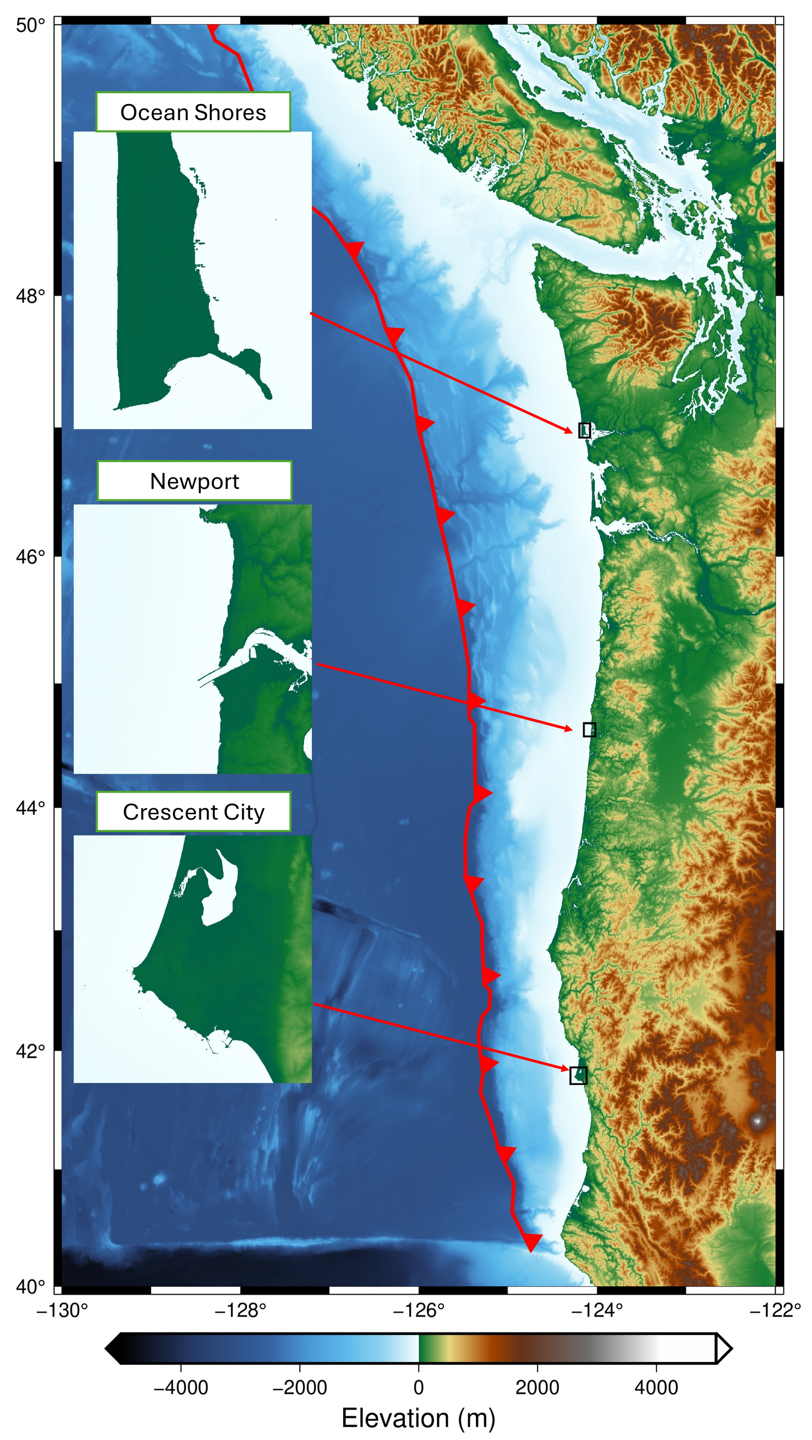

Figure 1. Map of the study area and the 3 sites where inundation was modeled.

Tsunami Model Setup

We run the GeoClaw tsunami modeling software for the sites of Ocean Shores, WA; Newport, OR; and Crescent City, CA. Inundation was run for 4 hours for ruptures within the constraints of L1 to allow for tsunami arrivals from the far north or far south of the CSZ to reach all 3 sites. Owing to the nature of the stochastic models, not all scenarios in this branch are full ruptures. Geoclaw models for XL1-like scenarios were run for 2 hours as all were full ruptures of the CSZ.

The nested grids of the tsunami model go from 5 arcmins (~ 10 km) to 1 arcsec (~30 m). We used the finest grid for inundation of the 3 sites. Maximum inundation for the 3 sites were stored for further processing.

Tsunami Evacuation Map Comparison

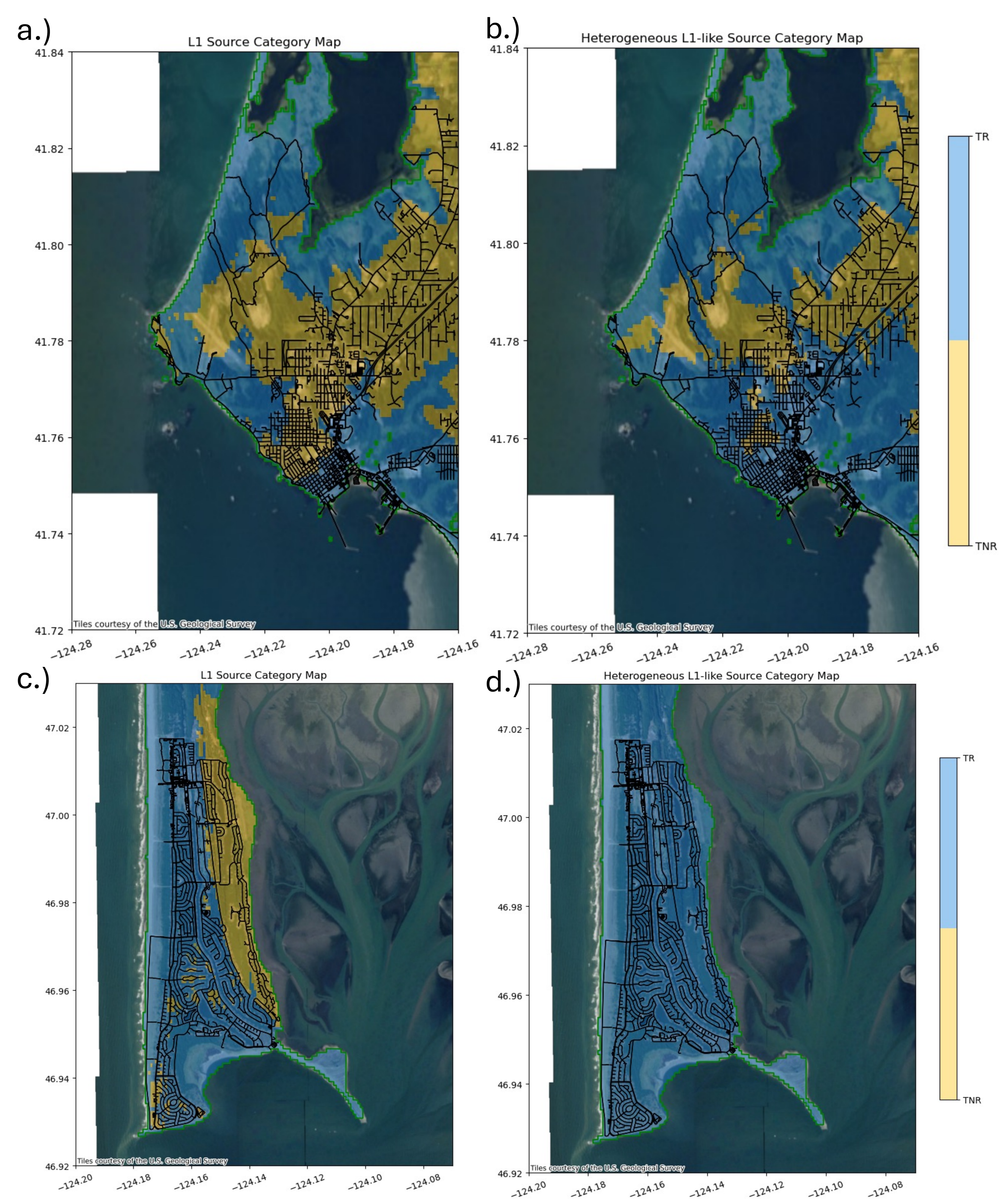

Figure 2. Threshold category maps where the threshold for being "wet" is 30 cm of maximum inundation. Green shaded areas fall under the "TNR"(Threshold not reached) category while yellow areas fall under the "TR" (threshold reached) category. Streets/roads of the sites are plotted in black for geographic reference. a.) The category map for the L1 model given these constraints. b.) The category map for the mean inundation of 100 L1-like heterogeneous earthquake sources. .c) Same as .a) except for Ocean Shores. d.) Same as .b) except for Ocean Shores.

Average Inundation with Heterogeneous Sources

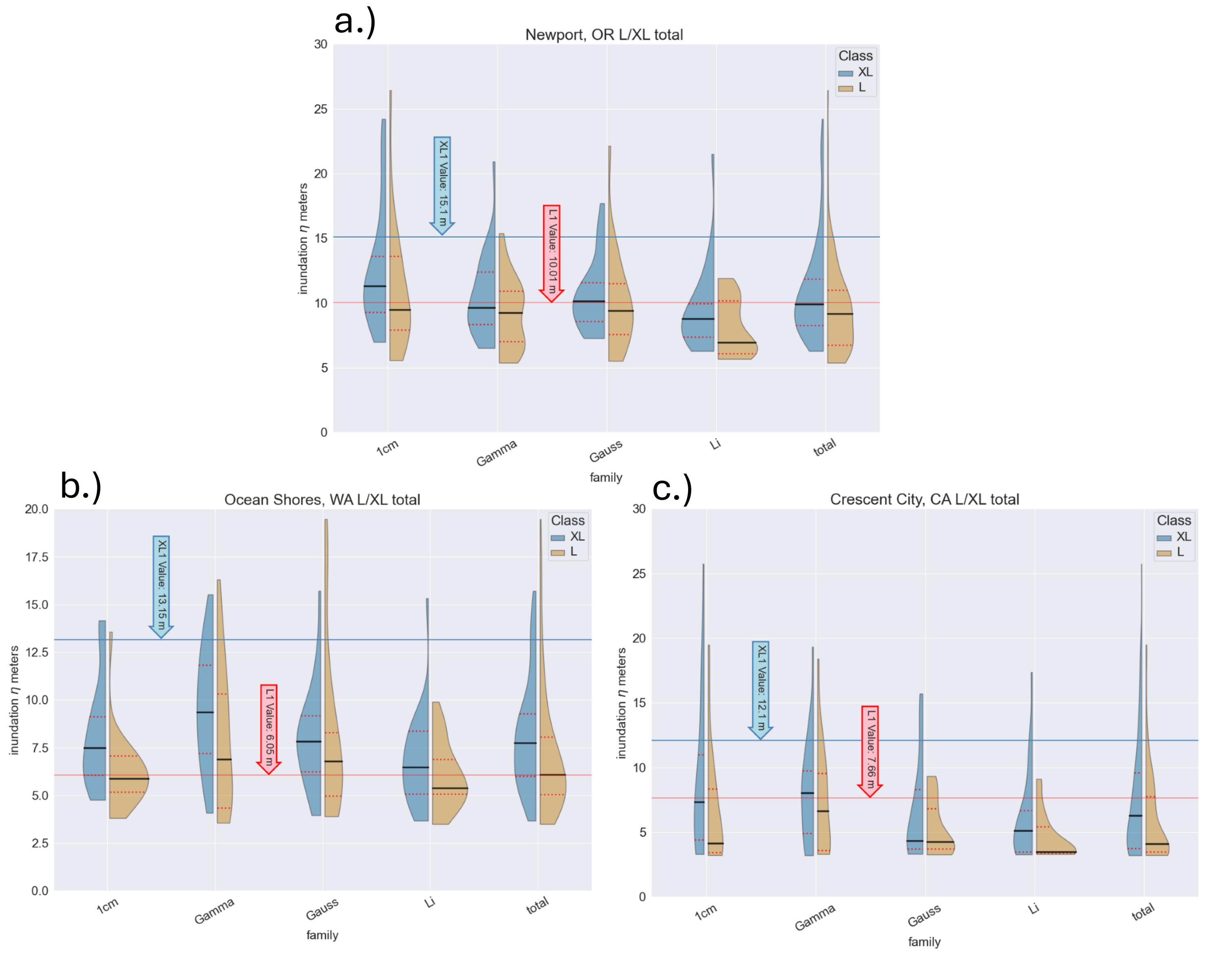

Figure 3. Violin plots showing the probability density functions of mean inundation for each of the rupture families utilized along with the total probability density function. Blue line and light blue arrow shows the mean inundation for the XL1 scenario. Red line and light red arrow shows the mean inundation for the L1 scenario. The results for a.) Newport, OR; .b) Ocean Shores, WA; and c.) Crescent City , CA.

Conclusion

Site	Jaccard Similarity Index [0,1] (L1/XL1)	Hamming Distance [pixels] (L1/XL1)
Newport, OR	0.94/0.90	30096/53217
Ocean Shores, WA	0.90/0.90	146610/146610
Crescent City, CA	0.86/0.71	176058/444709

Differences are small. However, most changes occur in populated areas of site inundation domains!

Scan for copy of poster!

References

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