

Shake It Off: Assessing Seattle's Vulnerability to a Major Earthquake

Matt Allan, December 2015, NUTR 231

Background

In July 2015, the *New Yorker* published a feature, penned by staff writer Kathryn Schulz, on the threat of a major earthquake devastating the Pacific Northwest in the near future. This piece, entitled “The Really Big One,” sparked a renewed public discussion about regional and national preparedness for a cataclysmic seismic event. I began this project interested in assessing what proportion of Seattle’s housing stock is sited on highly vulnerable land and what insights this distribution could offer into the urban development process.

The Cascadia Subduction Zone, a thousand kilometer-long fault line, is approximately 250 kilometers from Seattle at its closest point (PNSN). At the Cascadia Subduction Zone, the Juan de Fuca oceanic plate slips beneath the North American continental plate, forcing the latter upward at the pace of millimeters/year. Over centuries, this movement accumulates until the North American Plate snaps backward, generating the force we experience as an earthquake. This rupture can happen incrementally or at once; in the case of a simultaneous rupture, the Pacific Northwest could experience a magnitude 9.0 earthquake.

The US Geological Survey’s Earthquake Hazards Program maintains a catalog of maps and data sets spanning the entire country, including territories. The dataset uses spectral acceleration, an approximation of the shaking buildings experience during an earthquake (measured in percent of gravity, or %g), to assess risk.

The Seattle City Clerks Office’s Neighborhoods data provides the “unofficial delineation” of city neighborhoods. While this data only represents an approximation of neighborhoods at a single point in time, an understanding of these semi-permeable boundaries could be crucial in identifying the appropriate representatives and civic leaders both before and after a major seismic event.

The Census Bureau’s TIGER data provides census block counts of population and housing totals. This level of granularity allows for the demonstration of how physical boundaries like spectral acceleration can weave in and out of administrative boundaries, bedeviling any attempt to conclusively state that one neighborhood is at greater absolute risk than another.

“An earthquake will destroy a sizable portion of the coastal Northwest. The question is when.”

- Kathryn Schulz, “The Really Big One”

Methods

Before I began constructing a model, I reclassified the Geological Survey’s data into three classes (Low, Medium, and High) based on the relative hazard posed by a major earthquake. Areas with a projected %g of 20-50 were assigned to the low risk class, areas with a projected %g of 51-90 were assigned to the medium risk class, and areas with a projected %g of 91-190 were assigned to the high risk class.

I began building my model by using the Select Layer By Location tool to approximate housing units within each Seattle neighborhood, and converted the data generated by this step into a new feature layer. I then used the Spatial Join tool to merge this layer with a reclassification of the spectral acceleration data to create a census block-level estimate of projected %g. Using the Spatial Join tool one last time, I joined this block-level estimate to the neighborhood boundary data so I could generate neighborhood-based estimates of both housing count and spectral acceleration to produce a “spectral threat” for each census block within a neighborhood.

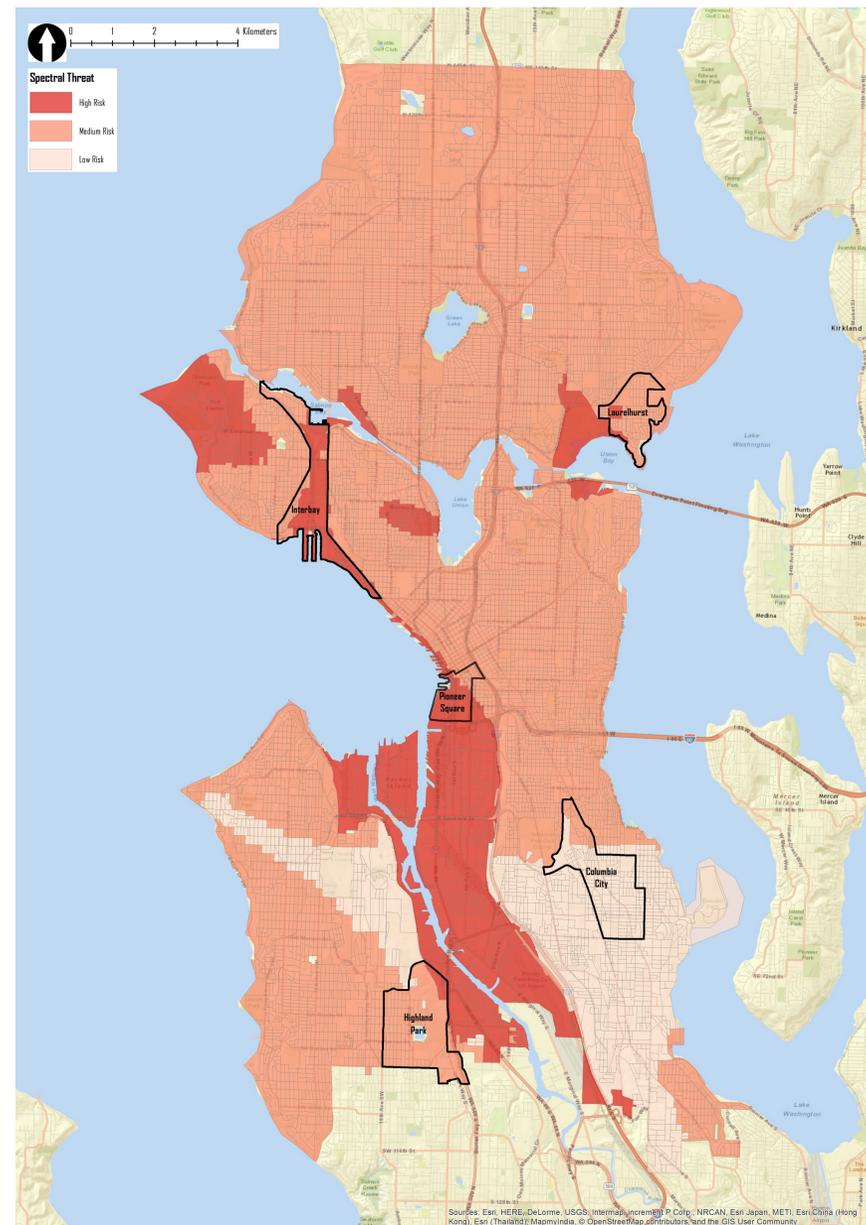


Fig. 1: Citywide Spectral Threat Map. Base Layer by OpenStreetMap.

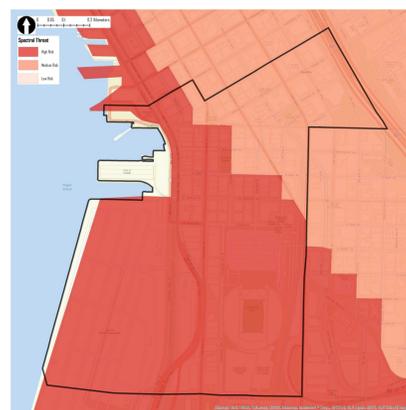


Fig. 2: Pioneer Square Spectral Threat Map. Base Layer by OpenStreetMap.

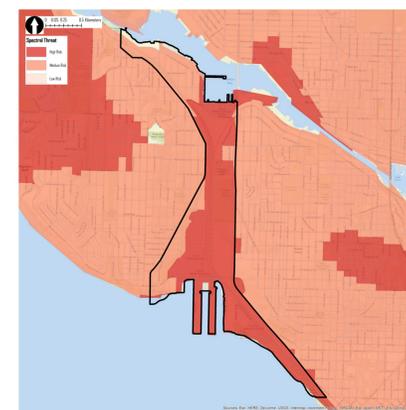


Fig. 3: Interbay Spectral Threat Map. Base Layer by OpenStreetMap.

Results

As Fig. 1 illustrates, waterfront neighborhoods are most vulnerable to a major seismic event, owing to a soil composition of artificial fill and young soils (USGS). Fig. 2-3 and the chart to the right illustrate just how much vulnerability can vary from neighborhood to neighborhood; Columbia City’s housing stock should be much more secure than the housing stock of Pioneer Square. Citywide, 89% of the city’s housing sits in medium-risk zones. While urban development takes a number of factors into consideration beyond natural hazards, the distribution of housing in low- and medium-risk zones relative to high-risk zones suggests that high-risk zones may already be considered marginal lands for development.

I feel that this model is useful as is for generalized planning discussions, but the addition of more data could produce a more accurate prediction of the threat posed by a major earthquake. A more complete model might incorporate data on the distribution of emergency response stations throughout the city to analyze how immediate aid could be most efficiently utilized. More information on venues capable of hosting evacuees could be invaluable for any project examining regional vulnerability.

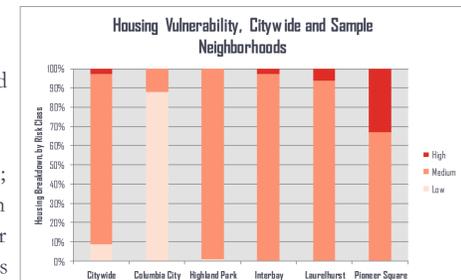


Fig. 4: Risk Class Portfolio for Seattle and Sample Neighborhoods

Tips for Surviving a Major Earthquake:

- 1) Secure your water heater. (In the event of a major earthquake, a toppled water heater could spark a fire or cause a flood.)
- 2) Make a plan with family members. (Appoint one person and select a meeting place.)
- 3) Keep and maintain an “earthquake kit”. (Include emergency contact information, irreplaceable documents, cash, prescription drugs, and first-aid/survival supplies.)
- 4) Know your evacuation route, whether you live in the area or are just visiting for a day.

- Adapted from “How to Stay Safe When the Big One Comes”

Sources

Neighborhoods, November 2014, City of Seattle City Clerks Office; published at data.seattle.gov, accessed December 12, 2015.

Pacific Northwest Seismic Network. (n.d.). Cascadia Subduction Zone. Retrieved from <http://pnsn.org/outreach/earthquakesources/csz>

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Schulz, K. (2015). *The Really Big One*. Retrieved from <http://www.newyorker.com/magazine/2015/07/20/the-really-big-one>.

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All maps use the Washington State Plane Projection.

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