Investigating the damage potential of seismic seiches: a case study of the Puget Lowland, Washington State

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Abstract

Investigating the damage potential of seismic seiches: a case study of the Puget Lowland, Washington state

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Large seismic waves in the Puget Lowland can be a result of earthquakes on local crustal faults, the Cascadia subduction zone or distant fault zones. The M_w 7.9 Denali, Alaska, earthquake of 3 November, 2002, generated large seismic surface waves directed along the west coast of North America by the source mechanism. These seismic waves initiated large water waves which damaged at least 20 houseboats along the shores of Lake Union and Portage Bay in Seattle, Washington State, at an epicentral distance of 2400 km. To investigate and characterize wave motion in lakes during strong ground shaking, a 2-D finite difference code developed for tsunami propagation and runup is used for predicting the response of water bodies during local and regional earthquakes.

A numerical model, the Method of Splitting Tsunami (MOST), has been modified and is implemented to simulate the response of lakes during strong ground motions. MOST is tested with other numerical results. The focus of this study is Lake Union subjected to a variety of ground motions. Both the relatively simple harmonic excitation and the more complex earthquake excitation (synthetic and real seismic data) are used for this purpose. To isolate any effects resulting from a

predominantly east-west or north-south motion or the contribution from parts of the shoreline, ground motions are first separated into their horizontal components (motions along latitude or longitude) before they are combined together. This approach shows that long linear shorelines are the most effective wave generators. The numerical results also show that large sedimentary structures known for amplifying ground motions affect the distribution and the magnitude of seiches. Depending on the shape of the lake enhanced wave heights can also be a result of focusing. The study of Lake Union shows that structures near water bodies far from tsunamigenic sources can still be vulnerable due to resonant conditions initiated from subduction zone earthquakes.