

Hazards without disasters

A natural hazard need not become a human disaster if society learns and applies lessons in preparation and resilience. Earthquake history speaks well to this—engineered structures need to stand up to strong shaking. Chile learned this lesson before its 2010 earthquake of magnitude 8.8. Because it had already enforced seismic provisions of building codes, there was little loss of life due to damage to buildings. Engineered structures also performed very well during the giant 2011 Tohoku earthquake in northeast Japan; however, approximately 20,000 lives were lost to the ensuing tsunami. What survival strategies are available for communities at risk for tsunamis?

One community that has recently acted on tsunami risk is the Ocosta School District of southwest coastal Washington state. It is situated in Cascadia, a region that includes the Pacific coast of southern British Columbia, Washington, Oregon, and northern California. This area has a geological history of great earthquakes and associated tsunamis, generated offshore along the Cascadia Subduction Zone. The most recent of these tsunamis, in January 1700, caused massive flooding and subsidence in the coastal lowlands of North America and a tsunami recorded in Japan. Today, the campus of three Ocosta schools is located on a Washington peninsula that the 1700 tsunami invaded. There are only ~15 min between a Cascadia earthquake and the arrival of the first tsunami wave on this sandy strip. The good news is that last month, a safe haven atop a new elementary school was completed there, North America's first engineered tsunami refuge: a flat roof 30 feet above ground, accessible from each of four heavily reinforced corners by extra-wide stairways, supported further by 169 pilings sunk as much as 50 feet deep that would anchor the structure

should a tsunami press against them. The rooftop has space for as many as 2000 tsunami refugees from the school and surrounding residences.

This outcome offers lessons on how to prevent hazards from becoming disasters. Success at Ocosta depended on partnerships: earthquake geologists, tsunami modelers, social scientists, emergency managers, structural engineers, landscape architects, an elected school board, and the district superintendent. The conversation shifted from the sensational risk itself (the tsunami), to how the community could control its own destiny by taking actions that, in the superintendent's words, put students' well-being and safety above all else. The bond measure that included an additional \$2 million for the tsunami refuge was overwhelmingly passed by district voters despite a weak economy and high unemployment. This amounted to 15% of the construction cost of the new school.

The Ocosta example is unusual in its foresight, but it need not be. The safe haven resulted from exceptional local initiative, but the initiative took cues from the 2011 Tohoku disaster and

was founded on scientific discoveries about Cascadia's earthquake and tsunami potential. This combination has triggered action before the next Cascadia tsunami, in what the U.S. Federal Emergency Management Agency calls pre-disaster mitigation. One 2000-person refuge is, of course, just a small step toward reducing losses to the next Cascadia tsunami. But research shows that "the strongest motivator of taking preparedness actions is when average people share what they have done to prepare with other individuals who have not done much."* And plans for additional tsunami safe havens are now proceeding elsewhere in Cascadia.

—Marcia McNutt†



“The conversation shifted from the...risk...to...taking actions...”



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*M. M. Wood *et al.*, *Risk Anal.* **32**, 601 (2012). †M.M. wrote this editorial while editor-in-chief of *Science*.



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Science **353** (6296), 201. [doi: 10.1126/science.aah4247]

Editor's Summary

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