Times Standard

Not My Fault: A big Cascadia Anniversary: what we've learned and what we haven't

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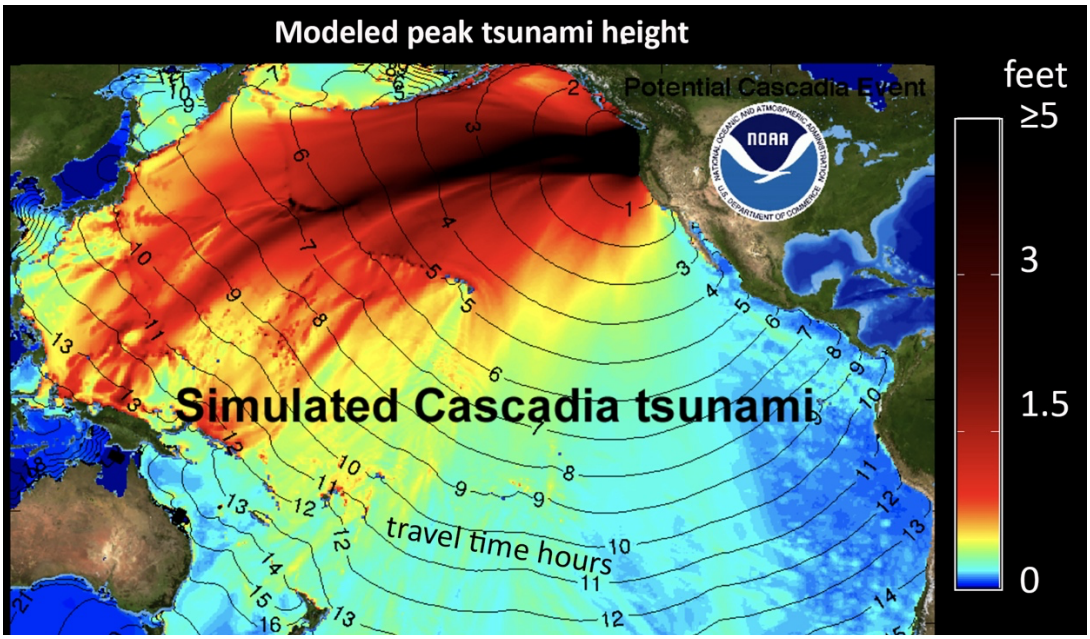

A simulation of peak tsunami wave heights for a magnitude 9 earthquake on the Cascadia subduction zone. Numbered lines are the travel times for the initial tsunami wave to reach that location. Colors show the modeled water heights in feet. Water height depends on the seafloor shape, orientation and slip along the fault and are much larger at coastal locations than shown by the scale of this model.

January 26, 2025, marks 325 years since the last great earthquake on the Cascadia subduction zone. It's a time to reflect on what we've learned about this largest fault system in the lower forty-eight states and important questions that remain unanswered.

Pinpointing the evening of January 26th, 1700 as the date and time of our last great earthquake was a monumental accomplishment. At a magnitude 9, it qualifies as a megathrust event. The 300-year marker didn't make a big media splash but five papers from Los Angeles to British Columbia did run the story.

The 300th anniversary stories focused on how Brian Atwater of the USGS, Kenji Satake of the University of Tokyo's Earthquake Research Instituter and colleagues uncovered the geologic evidence of a great earthquake in the Pacific Northwest and written records of the ensuing tsunami in Japan. It's a gripping detective story that you can read at https://pubs.usgs.gov/publication/pp1707.

A purpose of our Living on Shaky Ground magazines is awareness of the Cascadia subduction zone and our seven editions track the general state of knowledge at the time of publication. Our first version in 1993 included a full page on the subduction zone and introduced the concept that shaking was your warning that a tsunami might be on its way.

To measure the effectiveness of the magazines we conducted telephone surveys of North coast residents. The first was in April of 1993, just before our first edition was released. At that time only 16% of our respondents had hear of the Cascadia subduction zone. By the fifth survey in April 2001, that number had increased to 42%, still less than half but a big step forward.

In 2000, we knew the general outlines of a Cascadia earthquake and tsunami but not the details or likely impacts. Oregon and Washington had completed a few models of the tsunami hazard, but we had little information for northern California. Our 1996 Shaky Ground edition advised "Go to an area 100 feet above sea level or two miles inland."

In 2000 the U.S. had a fledgling tsunami mitigation program. The National Tsunami Hazard Mitigation Program (NTHMP) was launched in 1996 and for the first four years provided a modest 2.3 million dollars annually to improve tsunami center operations, support instrumentation, and help launch mitigation programs in the five Pacific states including tsunami hazard maps.

The sea change in megathrust earthquake and tsunami awareness came nearly five years after the 300th Cascadia anniversary when over 900 miles of the Sumatra – Andamans plate boundary ruptured in the first megathrust earthquake anywhere on the planet in 38 years. The ensuing Indian Ocean tsunami is estimated to have killed nearly 230,000 people in 14 countries.

The 2004 tsunami abruptly put tsunami on everyone's radar screen. In the United States, operations at both tsunami warning centers were put on 24 – 7 duty. The network of deep ocean pressure sensors known as DART was expanded from four in 2000 to 39 by 2008. Tsunami hazard modeling efforts were undertaken in all coastal states and territories.

The increased support of California's tsunami program led to the first generation of tsunami maps on the North Coast in 2007 and statewide in 2008. Our revamped 2008 Shaky Ground edition featured the new tsunami maps. Tsunami signs soon followed. The NWS Tsunami Ready program was launched in 2001. Crescent City was one of the first communities to gain recognition in 2002. Nine additional Humboldt and Del Norte communities have joined that list.

Those 2007 hazard maps became the blueprints for tsunami signage and evacuation drills. In June 2007, Samoa became the first California community to hold an evacuation drill, and 14 additional drills have been held in our area since then.

Tsunami interest got additional boosts in 2010 with an 8.7 earthquake in Chile and the 2011 M9.1 in Japan. The video footage of the 2011 tsunami battering Japan's Tohoku coast did more for tsunami awareness than any of our publications. By the time of our last Shaky Ground survey in March of 2013, all respondents knew what a tsunami was and 93% were aware that a tsunami includes many surges lasting for hours. Cascadia subduction zone awareness had climbed to 62%.

In 2023, the Cascadia Region Earthquake Science Center (CRESCENT) was established by a $15 million grant from the National Science Foundation. It is the first research center in the U.S. to focus on subduction zone hazards in general and on the Cascadia region in particular. The purpose of CRESCENT is to understand the earthquake/tsunami hazard, identify the important gaps in our current understanding, to develop and encourage future earthquake scientists, and to work with communities like ours on the North Coast that are at risk.

What are the big Cascadia unknowns in 2025? On the top of my list is when will the next great quake come? Earthquake prediction is still beyond reach, but improvements in ShakeAlert, the earthquake early warning system now gives many of us a few seconds heads up before the strongest shaking reaches us. Denser seismic arrays and offshore instrumentation might stretch that warning a few seconds longer.

A better understanding of possible precursors such as foreshocks and land level changes aided by rapid machine learning analysis shows some promise of providing a slightly longer forecast window. Japan issued its first ever megathrust alert last August after a 7.1 earthquake occurred at the end of a fault zone that will produce a megathrust earthquake in the future. Improving our understanding of stress transfer and foreshocks may provide more clarity when our next M7 occurs.

I reached out to colleagues as to what their biggest unanswered questions were. Several mentioned the complexities of our corner of Cascadia, the southern end near the Mendocino triple junction. We have a pretty clear picture of the subduction zone cycle along the Oregon and Washington coast. In between great quakes while the plates are locked together, subduction pulls the leading edge down and compresses adjacent inland areas causing them to rise. During the earthquake, they do the opposite – the tip pops up and inland area drops. This story doesn't seem to work in the Humboldt Bay area. It dropped in the last great quake, but it is dropping right now during our interseismic "in between time". It is unclear what will happen in the next go round. This has major ramifications for anyone living in the Humboldt Bay region.

The biggest screaming message for me is that many of us still don't know what to do when the ground starts shaking and shaking and shaking. December 5th illustrated that our response to the natural warning that Mother Nature provided is faulty at best. Too many of us over-evacuated and relied on our cars to do so. Now is the time to KNOW YOUR ZONE. Visit https://rctwg.humboldt.edu/tsunami-hazard-maps or pick up a tsunami map from the National Weather Service office. If you are not in the zone – stay where you are. These maps are for our largest tsunami threat – the Cascadia megathrust earthquake. If you are in the zone, practice how to get out of it ON FOOT. Using a car will only get you stuck in traffic, and possibly in a place that is much more dangerous than where you were before.

Lori Dengler is an emeritus professor of geology at Cal Poly Humboldt, and an expert in tsunami and earthquake hazards. The opinions expressed are hers and not the Times--Standard's. All Not My Fault columns are archived online at https://kamome.humboldt.edu/taxonomy/term/5 and may be reused for educational purposes. Leave a message at (707) 826-6019 or email Kamome@humboldt.edu for questions and comments about this column or to request copies of the preparedness magazine "Living on Shaky Ground."