

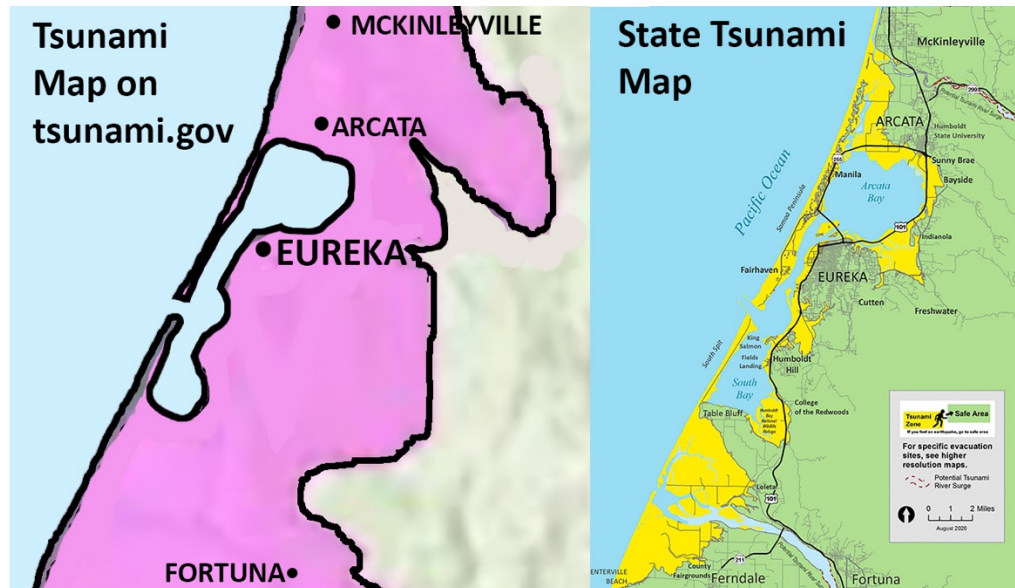
Times Standard

Not My Fault: The Kamchatka tsunami from a U.S. perspective

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The tsunami zone as depicted by NTWC distorts the hazard. The map on the left is an adaptation of the graphic displayed on tsunami.gov. It shows all of the communities in the Humboldt Bay region in the hazard area. The map on the right is the official California tsunami map for the worst-case tsunami event, a great earthquake on the Cascadia subduction zone nearby. Areas in yellow are potentially hazardous and those in green are safe.

Safety in tsunamis is all about one issue – evacuation. The whole point of a tsunami warning system is to get people out of harm's way before tsunami surges reach them. There are two big pieces to the evacuation problem: under-evacuation and over-evacuation. A perfect warning system would make sure that everyone in the area the tsunami will flood gets out of the way. And just as important, everyone NOT a risk will stay put.

The July 29th Kamchatka tsunami tested our tsunami warning system. The good news is that no one in Pacific states or territories were killed or injured in the tsunami. The not-so-good news is that there was considerable confusion, some people who should have evacuated did not and many others who were never at any danger did. Looking at what happened on July 29th offers a review of the vital pieces that makes our system currently work, and what might improve it in the future.

The Pacific Tsunami Warning Center (PTWC) in Pearl Harbor, Hawaii and the National Tsunami Warning Center (NTWC) in Palmer, Alaska, are responsible for issuing alerts to U.S. states and territories. Personnel are always busy but on July 29th, seismicity was somewhat higher than

usual with aftershocks of the July 16th M7.3 south of the Alaska Peninsula and the July 20th M7.4 offshore of Kamchatka adding to the normal global rate. Earlier that day NTWC had sent out tsunami statements for a M4.3 south of the Alaska Peninsula and a M4.5 earthquake offshore of Humboldt County. Statements mean an earthquake large enough to be felt has occurred, but it won't cause a tsunami.

On July 29th only moments after 4:25 PM PDT, an alert sounded at both tsunami centers that a large earthquake had occurred. In less than a minute several instruments had recorded enough of the signal to begin analysis. The shallow depth and initial magnitude of 8.0 was certainly large enough to trigger tsunami concerns and the first bulletins were issued a few minutes later. Thirty-nine hours later, the last bulletin would be issued for the Kamchatka event. Over that period, NTWC would issue 35 messages to Alaska, British Columbia, and the U.S. West Coast. PTWC would issue 42 messages to Hawaii, Guam, and American Samoa, in addition to the 24 messages to foreign countries I wrote about last week.

Why so many messages? The situation changes as further analyses on the earthquake and potential tsunami is completed. It is always a challenge to get an accurate magnitude for a really large earthquake. It took roughly three minutes for the Kamchatka rupture to finish. That whole time it produces seismic waves. Smaller earthquakes are over in seconds to a few tens of seconds, before the signal gets complicated by seismic waves reflecting off of deeper earth structures.

Time is of the essence in issuing alerts, especially for communities close to the epicenter. But the initial information is incomplete. The epicenter location is usually fairly good but the magnitude for earthquakes over M8.5 can be off by a whole unit or more. Modern analysis methods can get a pretty good estimate of the depth and the type of faulting in those first few minutes but there is not data on whether a tsunami was actually produced. The first bulletins issued by both centers was based on the preliminary magnitude of 8.0. The good news for the U.S. was that only the remote western Aleutians were near the epicenter; all states and territories were at least six hours travel time away.

Tsunamis from past M8.0 earthquakes coming from the NW Pacific have only had modest impact on the West Coast. NTWC Bulletin #1 put the western part of the Aleutian Islands into an Advisory, a notch below Warning where impacts are expected to only affect beaches and harbors. PTWC issued a tsunami Watch for Guam and Hawaii. A Watch means there is a good chance a Warning or Advisory will be issued but there is time for further evaluation before making a decision. The West Coast and other areas of Alaska were put into an "under evaluation category."

The situation changed a half hour later in the second set of bulletins when the magnitude was upped to 8.7. This jump meant more than a ten-fold increase in the energy released and a much larger fault rupture and tsunami potential. NTWC upped the western Aleutians into a Warning, put the eastern Aleutians into an Advisory, and the rest of Alaska and the West Coast into a Watch. The bulletins included the estimated time of first wave arrival. For northern California, it was expected just before midnight.

As the tsunami traveled outwards, it was recorded on coastal tide gauges and on the deep ocean DART pressure sensors. This data is incorporated into modeling of the tsunami to

estimate peak tsunami amplitudes. As more data points are added, the estimates become more robust. The third bulletins upped Hawaii to Warning status and the West Coast into an Advisory. Southern Alaska coasts were declared unlikely to be of tsunami concern. Advisories can be handled relatively quietly. There are no alerts on cell phones or over media. Ports and harbors are notified, and emergency personnel may restrict access to low-lying areas. Crescent Harbor contacted boat owners, and many took their boats to deep water. It was a warm evening and over the next two hours about 70% of the fishing fleet left the harbor.

Everything changed at 8:27 PM in bulletin #5 when coastlines from Cape Mendocino to the California – Oregon border were placed in a Warning. The Emergency Alert System was activated, radio and TV broadcasts interrupted, and Wireless Emergency Alerts (WEA) sent to all cell phones in Humboldt and Del Norte Counties. I can attest to the jarring quality of the squawk when it arrived on my phone two minutes after the Warning was declared. Unfortunately, the WEA Alert wording still includes the wording “You are in danger,” even when the majority of people getting the message were at no tsunami threat at all.

No surprise that Del Norte County was placed in a Warning. The models consistently showed peak water heights in the 3-to-6-foot range. But I did not expect so much of Humboldt to also be included. The reason is breakpoints, the same issue that led to such a large warning area on December 5th. The tsunami centers have to issue uniform alerts between breakpoints. Modeling suggested that Trinidad could see up to 5-foot surges and because the next breakpoint south of the Del Norte border is Cape Mendocino, we were all put into Warning status even though most of the area was unlikely to see any waves higher than a foot.

Confusion was amplified by the maps showing the tsunami hazard displayed on tsunami.gov, the official site for tsunami information. Unfortunately, the tsunami centers are not allowed to use the highly vetted state tsunami maps and must use NWS products. There are no NWS tsunami hazard maps, so they use a weather hazard map instead. All coastal areas of the U.S. are divided into weather zones that act like breakpoints, requiring a uniform alert level for wind and other weather warnings. In Humboldt County, the zone generally extends to coastal ridges, in some cases at more than a 1000-ft elevation and more than ten miles to Kneeland.

From an emergency manager’s perspective, all hell breaks loose when a warning is declared. The Eureka NWS Office tried to tamp down concerns by including the expected water heights. I spent time on local radio stations explaining that only areas closest to the high tide line were at any risk. Unfortunately, there was still considerable confusion about whether we were in a Warning or not and what to do. There was a mass exodus of tourists staying in the Valley West area of Arcata that led to traffic congestion and hampered responders’ ability to reach a traffic accident that had occurred before the warning had been declared. Traffic jams were far worse in Hawaii where the warning was in place for all of the islands and the tourist population far greater.

We were fortunate that the tsunami was expected at midnight, and few were inclined to go to the beach to view the tsunami – always a bad idea because there is little to see, you put yourself in danger and obstruct emergency response. The tsunami warning system generally worked as designed. But the WEA messaging, breakpoint issue, and tsunami.gov map problem were all identified after last December’s M7.0 tsunami warning and have yet to be changed.

Revised WEA wording has nearly been approved but is now tabled due to the government shutdown.

Ah the shutdown. How will it affect the tsunami alerting systems? Tsunami center employees are considered essential and will continue to monitor potential tsunami-producing earthquakes and issue alerts. They won't be paid during the shutdown and maintenance of equipment like the DARTs will be deferred. Scientists at NOAA's Tsunami Research Center are not considered essential and won't be working or able to provide insights if unusual tsunami events occur. At best, it puts the system at a standstill at a time we should be moving forward to address some of the issues learned from the Kamchatka tsunami.

Note: Tune into my recent webinar for a deeper dive into the Kamchatka earthquake and tsunami at <https://cascadia.engineering.oregonstate.edu/webinars/the-july-29-2025-m8-8-kamchatka-earthquake-tsunami-and-the-tsunami-warning-system-lessons-for-the-cascadia-region/>

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