Times-Standard
Times-Standard / Humboldt Beacon

Not My Fault: Hunting for Earthquake Early Warning sites

Lori Dengler/For the Times-Standard
Posted May 9, 2019

A colleague and friend visited me this week. Dr. Peggy Hellweg is the Operations Manager for the Berkeley Seismology Lab and her job is to oversee the Berkeley network. When she arrived at Berkeley in 2001, Berkeley maintained 25 instrument sites in Northern California. Today it's about 60, and another 73 sites are supposed to become fully operational in next 18 months. Peggy is going to be very busy.

The big increase started in 2015 when California became committed to Earthquake Early Warning (EEW). Don't confuse EEW with earthquake prediction. We can't predict earthquakes hours, days, or weeks before they happen and I'm pessimistic that will happen in my lifetime. But it is possible to send out an alert AFTER an earthquake has already begun and allow protective actions to be taken in the few seconds before the strongest vibrations arrive.

Here's how it works. An earthquake begins at a spot along a fault beneath the surface (hypocenter or focus). The rupture grows and produces seismic waves as it propagates. Two types of waves are of importance to EEW: P-waves and S-waves. Both travel outwards from the hypocenter like ripples when you toss a rock into a pond, but P-waves are faster, zipping along at around 3.5 miles/second near the earth's surface. A P-wave can travel the distance between Eureka and San Francisco in about 70 seconds.

Lucky for us P-waves rarely do damage. It's the secondary or S-wave that is the big problem. Traveling at the relatively leisurely speed of 2 miles per second, it is larger and and produces strong side-to-side motion, the type of vibration that can cause problems for buildings. Sometimes people will tell me they felt two earthquakes – a smaller one followed a few seconds later by a larger one. It was all the same quake; they just noticed both the P and the S waves.

EEW takes advantage of the difference in wave speeds. It requires a network of seismic instruments, about every six to eight miles apart. In the first two seconds of rupture, three to four of these stations will register the initial P-wave. Computer codes rapidly analyze the signals and, in less than a second, estimate the location and magnitude. If the algorithm determines the earthquake is larger than some threshold value, it quickly sends out the estimated time that the stronger S-wave will arrive to locations further away. And as more and more seismic stations pick up the signals, the information is updated and refined.

Suppose you were in Ferndale during the 1992 M7.2 Cape Mendocino earthquake. If an EEW system were fully operational at the time, you would get an alert that strong shaking was expected in five to six seconds, in Fortuna about 7 seconds and in Eureka closer to 14 seconds. Unfortunately, in Petrolia where the shaking was the strongest, you would not a warning because the S-wave would arrive before there was time to process the signal.

Five seconds doesn't sound like very much time, but there are a number of things businesses, organizations and individuals can do even with such short notice. Trains can be slowed and stopped, hospitals can turn on generators and stabilize operations, fire station doors can be opened so that fire engines aren't trapped inside when power fails or shaking jams the opening mechanism. In Mexico and Japan, the two countries with the most evolved EEW systems, information is sent out via radio, television or cell phones, alerting to the public to find a safe place to ride out the shaking.

Three technical pieces need to be in place to have an effective EEW system. First is the seismic network – high quality digital instruments spaced closely enough to quickly catch the seismic signals. Second, automated analytical methods to process the data and rapidly disseminate it and third is the final distribution to users – the alert notification system.

I'll focus on the first today. In California, only Southern California and the San Francisco Bay Area have a dense enough network to detect the signals fast enough for an effective system, but funding is now in place to improve the networks in other areas of the State, like the North Coast.

Berkeley and the USGS have teamed up to identify possible station locations in our area. You can view them at https://seismo.berkeley.edu/research/host-a-station.html . The North Coast has numerous challenges for instrumentation. Access is difficult and the rugged terrain makes signal transmission difficult.

Peggy's visit was an opportunity to check out potential sites off the Bald Hills Road in Redwood National park. Elevation is a plus as the USGS currently has a station on Rogers Peak and a spot with line-of-sight signal transmission capabilities is desirable. It's also good to co-locate a station with other instruments. We found a good candidate so the next step is to start the paperwork – to demonstrate to the Park that the life-safety benefits of locating the small instrument box with its solar panel is in keeping with the Park's mission and to start the permitting process. I'm crossing my fingers that we can replace a question mark on the EEW station location map with a real station and we will be one step closer to having an effective early warning system on the North Coast.

Note: Any business, agency or individual can host a station. Visit the web site above and if you think you have a suitable location, follow the contact information.

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