Times Standard

Not My Fault: 1992 highlights co-seismic ups and downs of the land

Lori Dengler for the Times-Standard
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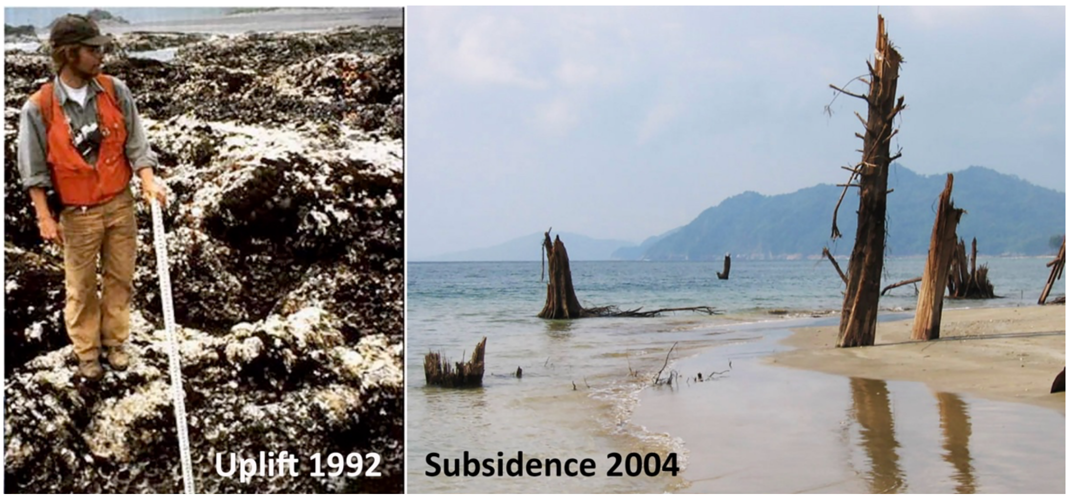

Earthquakes can cause significant changes in ground elevations. Left: Thomas Dunklin measuring the uplifted coast near the mouth of the Mattole River in 1992. Right: Flooded coastal areas and submerged trees on the Aceh coast of Indonesia after the 2004 Andamans - Sumatra earthquake.

Did I miss any important details about the 1992 quakes in my last column? Of course I did, and it was intentional. Space is a limitation, but the main reason was my own limited awareness at the time. I made no mention of tsunami because on April 25th 1992, I wasn't connecting a 7.2 earthquake to a potential tsunami. And I wasn't thinking about land-level changes either.

It took about a week before I heard murmurs drifting about the department that the coastline near the mouth of the Mattole had changed in the earthquake. It looked like low tide all the time and some people were harvesting abalone by wading in knee-deep water. Petrolia old-timers noticed the change immediately, but it took about a week of decaying intertidal marine life for the rest of us to believe accounts that the coastal sea-level had abruptly "dropped".

By the time I visited the area almost three weeks later, a full-scale research project had been launched. Gary Carver in the Geology Department had teamed up with Bob Rassmussen in Biology to map out the uplift, roping a number of students, former students, and colleagues in both disciplines into the effort.

One of those was Thomas Dunklin who lived in Petrolia at the time (and still does). Thomas' geology background and knowledge of the area made him the ideal field assistant for post-earthquake geologic studies, and he was quickly pulled into the coastal uplift project.

Measuring relative sea-level is easy if you have a tide gauge. There are no tide gauges near Petrolia, so how can scientists measure elevation change? There were no established benchmarks in the area of interest. The team came up with a unique method, relying on the marine life itself and measuring the "vertical extent of mortality," the distance between the dead organisms and where they had survived.

More than a dozen species were included in the study, but sea urchins proved particularly useful. They are plentiful on our coast and hollow out small pockets on the rocks to anchor themselves. Thomas and others spent weeks measuring the distance between the highest uplifted "dead" dimple marking where a sea urchin had once lived, and the top of the still living sea urchin zone.

The result was a detailed graph of how the coast had bulged upwards as a result of the 1992 fault slip. Uplift could be detected over 15 miles of coastline between Cape Mendocino and Punta Gorda. The largest uplift was just over 4.5 feet in the center of the profile, gradually diminishing to both the north and south.

This uplift shouldn't have surprised me. Geomorphologists studying the Cape Mendocino coastal area have identified at least eight other uplifted former beach surfaces in the recent geologic past. We call them marine terraces, a flat surface that marks the former surf abrasion platform. If you stand on Mattole Road and look down on Singley Flat, you can see these surfaces etched in the landscape. If you don't want to drive, view Thomas Dunklin's Mendocino triple junction video for a virtual tour (https://www.youtube.com/watch?v=qhDdzHae4Rc).

Each of these uplifted terraces marks a previous earthquake in the past 10,000-year time window. Some of them show a similar amount of uplift as 1992, suggesting earthquakes in the magnitude 7 range. But others are more extensive indicating larger quakes. Of course, it's not just the coast that goes up in these quakes. The King Range is one of the most rapidly uplifting areas on the West Coast and repeating large earthquakes are a major contributing factor.

The 1992 earthquake fault uplift did not stop at the coast. While the rupture began on land beneath Petrolia, it grew upwards and to the west, creating a slanting fault plane roughly 10 miles wide and 15 miles long. The fault possibly broke the sea floor surface near the continental shelf. We will never know because no offshore reconnaissance was done after the earthquake.

We do know that the rock mass above the fault was shoved up and to the west several feet during the earthquake. That means a ten-mile-long patch of the sea floor displaced the ocean above it and the uplift produced a tsunami. I didn't know anything about the tsunami for several weeks. No tsunami warning had been issued, and tide gauges weren't online in those days.

Tsunami protocols were different in 1992, and the local tsunami threat was not well-recognized. The initial magnitude of 6.9 put it below the threshold to issue an alert and local emergency officials were not in favor of making any mention of it. If the earthquake occurred today, a tsunami WARNING would have been issued, and we would see the December 5th scenario play out but amid much more damage.

It took the prodding of then California State Geologist Jim Davis to query NOAA about a possible tsunami. Pulling up the tide gauge records showed not only a tsunami in Humboldt, but it was well-recorded on other instruments from the central California coast to Port Orford and in Hawaii. It was just over 1.5 feet high at Crescent City and had it occurred at a higher tide, could have impacted harbors and low areas.

We also had no robust post-tsunami field survey system in place in 1992. The first Internation Tsunami Survey Team would be deployed about four months later to study a tsunami in Nicaragua. Since then, groups of national and international scientists have quickly mobilized to study the physical characteristics and impacts of moderate to major tsunami events soon after they happen.

By the time we were aware of the 1992 tsunami, wave action had erased any physical traces. We put out a call for people to report any observations of unusual water level activity on April 25th. A group at College Cove near Trinidad reported a sudden water level rise of about three feet and several surfers described unexpected turbulence.

The 1992 earthquake is a story of coseismic (during the earthquake) uplift. A paper was published this week in the Proceedings of the National Academy of Sciences on coseismic subsidence during great Cascadia earthquakes. The paper, headed by Tina Dura of Virginia Tech, examines the potential of sudden lowering of the land surface associated with earthquakes in the upper magnitude 8 to 9 range in the Cascadia region from Cape Mendocino to Vancouver Island Canada.

How can earthquakes uplift one coastline, like the Cape Mendocino area in 1992 and cause other areas to drop? It all depends on the type of earthquake faulting, where you are relative to the earthquake fault slip, and how much strain had been stored before the quake. I've had the opportunity to see both uplift and subsidence in post-earthquake/tsunami field investigations. For earthquakes like Indonesia 2004, Chile 2010, and Japan, the primary signature is the land dropping down.

This week's Cascadia subsidence study estimates that the coastal land elevation could drop between 1.5 and 6 feet at coastal sites from Humboldt County to southern British Columbia in our next great earthquake. We've paid a lot of attention to ground shaking and tsunami hazards associated with great earthquakes and not enough attention to ground level changes. Check out next week's column for a closer look at the implications of the study for the North Coast.

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."