Not My Fault in today's Times-Standard (10/26/25)
Dams and earthquakes: water hazards don't only come from tsunamis
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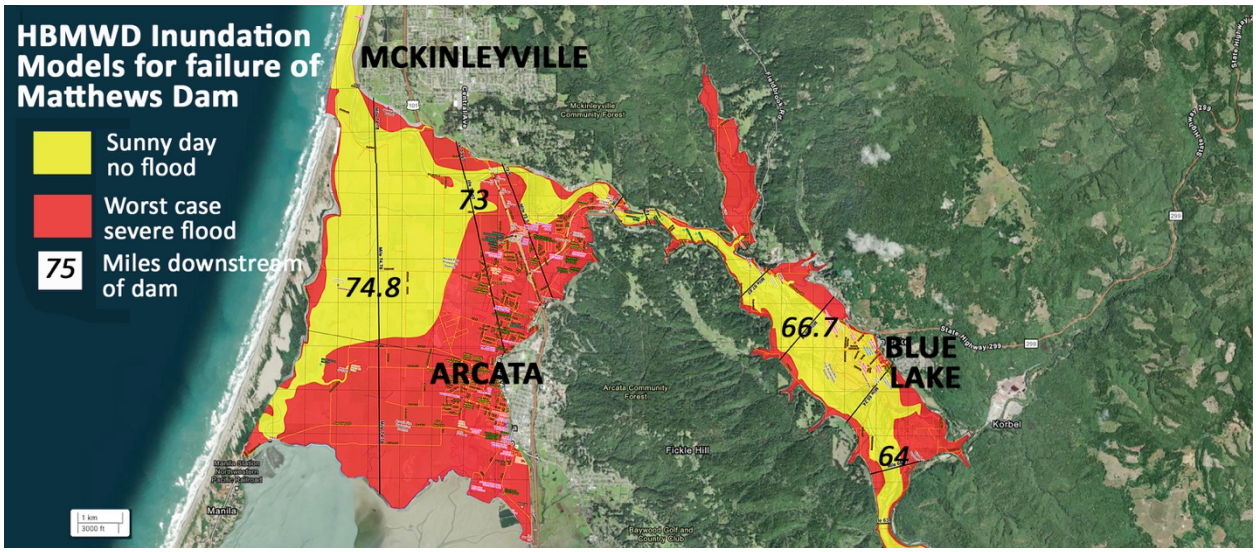

Simulations of the possible downstream inundation for two catastrophic Matthews Dam failure scenarios where all of the stored water is released. Areas in yellow are for "sunny day" conditions with no rainfall in the drainage basin and areas in red show the additional areas flooded for extreme rainfall conditions, such as the 1964 flood. Numbers in italics are the downstream distances in miles from the dam. The map was adapted from the Humboldt Bay Municipal Water District.

During our recent ShakeOut drill, a number of people asked me about dam safety in earthquakes. I am not an earthquake engineer and by no means an expert in dam safety. But I have been poking into the background of what can cause a dam to fail and thought you might be interested in what I have learned.

Dams have been a part of human history for a very long time and date back to the earliest times of agrarian societies. The Jawa Dam in Jordan is the oldest archeologically identified dam, roughly 5000 years old, but there were likely earlier structures that have eroded in time.

Dams are important. In California, they generate 15% of our energy. They provide storage for much of our drinking and agricultural water and a buffer for catastrophic flooding. But all dams are only as good as the science that went into their design, maintenance, and ability to withstand hazards that might not have been inf their original specifications. The oldest recorded dam failure dates back 4,600 years ago when a dam under construction in Egypt collapsed during high flows but there were likely earlier ones that have left no archeological record.

Dams are of strategic importance. During World War II, the British Dambusters program deliberately targeted dams in the Ruhr Valley to disrupt Germany's industrial center. That would be illegal today under international law where dams are considered "installations containing dangerous forces." Deliberately destroying dams is considered a war crime if those dangerous forces result in the loss of civilian life.

Most dam failures can be traced to geologically unstable location, design flaws, poor maintenance, or conditions exceeding the design criteria. When I taught a Natural Disasters class, I talked about the Vajont dam disaster. The dam, located high in the Italian Alps north of Venice, Italy still stands today as a physical monument to human hubris. While it was being filled in 1963, the north slope of the reservoir failed producing a tsunami surge that overtopped the dam and flooded communities downstream. Over 2000 people died in the disaster.

Considered one of the worst engineering disasters of all time, the dam itself was sound, but changes in dam specifications that nearly doubled the reservoir size were never adequately assessed. Many experts raised concerns about the impact of added water load on site stability and others noted the valley walls were geologically unstable. All concerns were ignored even after the slope began to fail as the water began filling the reservoir. Only three years before, a landslide in another Italian reservoir had produced a tsunami that overtopped a dam. Not nearly as devastating, it should have stood as a clear warning. In 2008, UNESCO identified the Vajont dam as a lesson in "the failure of engineers and geologists."

Earthquakes can trigger dam failure through fault rupture, strong shaking, and liquefaction, although in the historic record, none have produced casualty numbers on the scale of Vajont. Surface fault rupture displaced Taiwan's Shih-Kang dam by as much as 25 feet during the 1999 M7.3 Chi-Chi earthquake. The failure cut the supply of fresh water to the region by nearly half for months. The March 2011 Japan earthquake damaged over 400 dams in northern Honshu and the failure of one killed eight people.

California dams have suffered from earthquake damage. In June 1925, a magnitude 6.8 earthquake occurred just offshore of Santa Barbara. Strong shaking damaged many buildings and also caused the ground in some areas to liquefy. Unfortunately, one of those locations was beneath Sheffield Dam just north of the city. The dam collapsed releasing 30 million gallons of water. The ensuing flood swept away trees, cars, three houses and flooded parts of Santa Barbara to a depth of 2 feet. The 1925 quake claimed 13 lives, but none directly due to dam collapse. It did greatly exacerbate damage, clean up, and recovery.

Some of you may have been in the Los Angeles area in 1971 and remember the M6.5 San Fernando earthquake. Like Sheffield dam in 1925, the 1971 earthquake caused liquefaction, and one of those areas was beneath the Van Norman dams just north of San Fernando. Shaking-induced liquefaction caused settling of the upper Van Norman dam, lowering it by three feet. Damage was worse to the Lower Van Norman dam where the earthen dam partially failed, and a landslide had fallen into the reservoir. Fortunately, the reservoir was only about half full at the time, but more than 80,000 people were evacuated from the downstream areas for fear of a larger failure as the reservoir was quickly drained.

Both 1925 and 1971 were small quakes compared to what we might expect in the Cascadia region of Northern California and the Pacific Northwest. An earthquake in the magnitude 8.5 to 9 range will shake the ground for minutes and produce much longer period vibrations, something our existing dams have never experienced. Landslides are common in the steep, unstable terrain above many reservoirs in the region and we have ample geologic evidence of massive slope failures likely associated with past great earthquakes.

Many of the dams in the region are no spring chickens, built before modern seismic codes were put in place. The National Inventory of Dams lists about 500 dams in the Cascadia region considered high hazard based on their age and the populations downstream. There are no published studies of dam safety under Cascadia loading conditions – in part because the likely ground motions are still being studied. One of the outcomes of the CRESCENT Cascadia region earthquake science center will be to provide realistic ground motion suites to complete a full dam assessment.

What about Humboldt County? Contrary to Wikipedia, Sweasey dam did NOT fail in the 1954 M6.5 earthquake. There was damage to the main water lines and water storage facilities, but the dam itself remained intact. Sweasey is now long gone, replaced in 1962 by Matthews dam and Ruth reservoir in Trinity County. It's the only dam on the Mad River (Baduwa't) and provides most of the industrial and drinking water to communities in the Humboldt Bay area.

Matthews dam is regularly inspected by the State Division of Dam Safety and there is no reason to believe it is unsafe under normal conditions. But the Humboldt Bay Municipal Water District (HBMWD) isn't taking any chances and a decade ago hired consultants to model what could happen if the dam were to catastrophically fail and release the 12 to 15 billion gallons of stored water. The District made two worst-case models. The first considered a "sunny day" with no heavy rainfall and the second was failure during an extremely large flood event like the Christmas floods of 1964,

Neither model is very reassuring. The one positive feature is time – not a lot of it but at least some. The closest population center downstream is Maple Creek where the first flood waters would take about four hours to arrive. Blue Lake would feel the flood surge an hour and a half later and it would reach Valley West in Arcata about seven hours after the failure. Like a tsunami, the first surge won't be the largest. The flood waters would continue to build, cresting three to four hours later before beginning to subside.

A few hours is not a lot of time but should be enough to notify and evacuate people if the public is aware of the risk and knows what to do. The Wireless Emergency Alert System would go into effect and County notifications sent to your phones and email provided you have enrolled in the system. The county and cities have practiced table-top drills on how to respond. But what if the dam failure occurred in non-normal times? A major earthquake could knock out much of our communication infrastructure, and just like tsunami safety, you will need to make decisions on your own. A total dam failure, even in a great earthquake, is extremely unlikely. But it's a good idea to be aware of your zone – whether it's a tsunami coming from the ocean or a surge of water coming from upstream.

See https://www.hbmwd.com/files/5de217fa1/201907+Inundation+Maps.pdf for the HBMWD Mad River flood maps and https://www.madriverunion.com/articles/surviving-ruth-lakes-wrath-in-the-event-that-the-dam-fails/#google_vignette for a more detailed description of the modeled Matthews dam failure flood effects.

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.”