Times Standard

Not My Fault: The Turkey – Syria earthquake sequence dominates the first half seismic story of 2023

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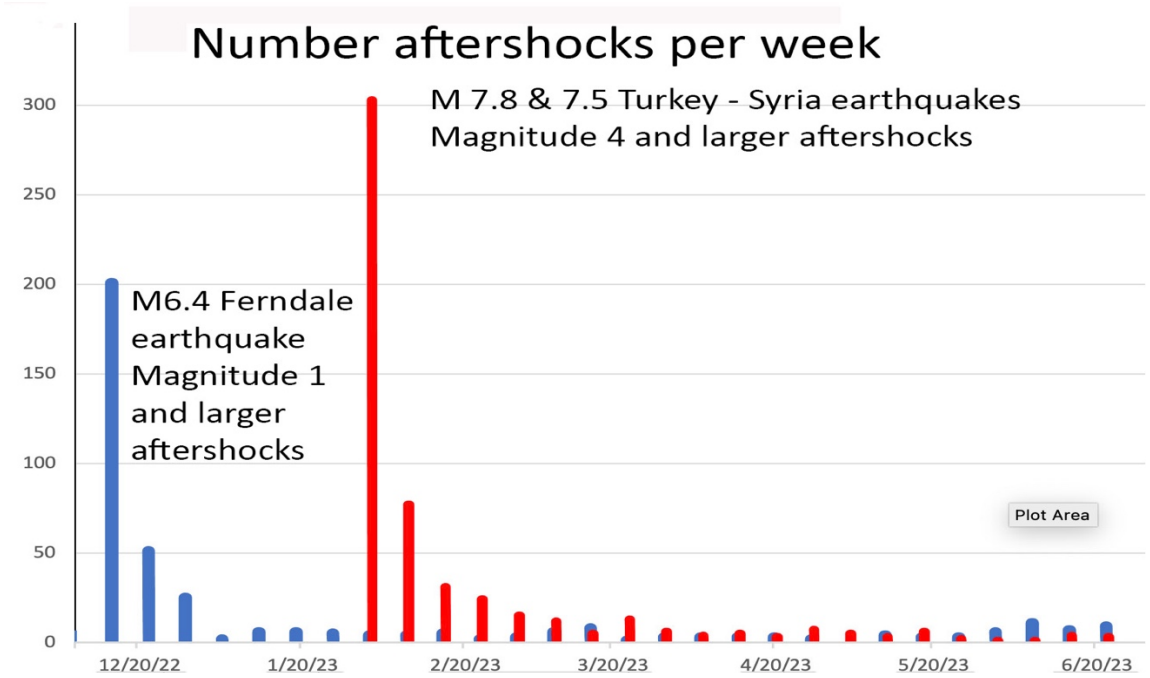
Posted July 1, 1023
https://www.times-standard.com/2023/07/01/lori-dengler-turkey-syria-quake-sequence-dominated-first-half-of-2023-seismic-story/



Rate of aftershocks on California's North Coast and in the Turkey – Syria region. Blue columns show number of earthquakes of magnitude 1 and larger per week following the December 20th, 2022, Ferndale earthquake. Red columns show number of earthquakes of magnitude 4 and larger per week following the February 20th, 2023 magnitude 7.8 and 7.5 earthquakes.

The first half of 2023 is in the books and the main seismic story comes down to one earthquake sequence – Turkey. On February 6th, at 4:17 AM local time in Turkey, a magnitude 7.8 earthquake struck the south-central part of the country. Just over nine hours later, a 7.5 ruptured a different fault, about sixty miles away from the first.

These two earthquakes and the ongoing aftershock sequence head the 2023 earthquake leaderboard for size, loss, and ongoing impacts. The death toll is estimated at 52,783 and more than 107,000 people were injured. The cost of the losses is estimated at nearly $120 billion in U.S. dollars.

The Turkey – Syria earthquakes illustrates how one sequence can turn a relatively quiet earthquake year into a horrific one. There was nothing unusual about the number of large

earthquakes this year. Seventy-four earthquakes of magnitude 6 or larger were reported, slightly below the 78 average over the past twenty-five years. The Turkey M7.8 was the largest magnitude in 2023, close to the average as well.

With earthquakes, it's all about location. We are fortunate that many of the most seismically active area of the planet are far from populated areas. The second largest earthquake of 2023 is a good example. It occurred on May 18th and had a magnitude of 7.7. Earthquakes of this size are capable of doing significant damage, but this one was centered in the southwestern Pacific more than 200 miles from the nearest population center in New Caledonia. The few people who felt it, described the shaking as weak. It is unlikely that you heard about it.

Put a similar sized earthquake in a densely populated area and the story is very different. Roughly twenty-five million people in Turkey and Syria were exposed to strong ground shaking in the two main earthquakes. Numbers that large are hard to contemplate. About 125,000 people were exposed to similar levels of shaking in last December's Ferndale earthquake. Peak ground accelerations in Turkey were close to or exceeded 1g (gravitational acceleration) in much of the epicentral region, similar to those recorded in Rio Del and Fortuna in December but with an important difference. Our strong accelerations lasted about ten seconds and in Turkey the duration was more than 30 seconds.

The result was a disaster. In Turkey, 1.25 million buildings were exposed to very strong shaking. About a quarter of them suffered damage and over ten percent were destroyed or uninhabitable. The distribution of damage was not uniform. In some communities, more than half of the building stock was destroyed.

Much has been made in the media and earthquake engineering circles of the failure of buildings constructed after 1999 when stricter building requirements were implemented. The government pronounced that almost all damaged structures were built before 1998 and legislation was successful. Analyses of satellite data and some onsite field investigations dispute those claims.

The epicentral area had experienced a building boom in the past twenty years. Many of the structures were multistory complexes with commercial space on the ground floors and apartments or offices on the upper floors, not unlike many newer buildings in California's urban regions. Large open retail spaces need special design consideration and reinforcement to resist earthquake ground motion, part of the International Building Code used both in Turkey and California.

But such reinforcement requires additional time and money, and it appears that some builders cut corners in turkey and some inspectors turned a blind eye. The result is what earthquake engineers call a 'soft story,' one that is weaker than the floors above, or in some cases below. Soft stories on ground floors are particularly vulnerable. Tall buildings can act like an inverted pendulum; the taller they are the greater the force on the base.

One Turkey success story appears to be base-isolated structures. Called seismic isolation, a large building sits atop large dampers. When the ground moves, the inertial mass of the structure above allows it to sit still, with almost all of the relative movement occurring at the dampers. It's a construction technique that has been around for decades, but never tested in

such a strong earthquake as Turkey. It's an expensive design solution, but several newer hospitals in the area of strong shaking had been built with seismic isolation and not only suffered little damage but were able to continue operation after the earthquake.

Many factors contributed to the impacts in Turkey and Syria. Collapse of structures both old and newer was the major cause of damage but the winter conditions, civil war in Syria, large numbers already displaced persons exacerbated response. The most important lesson for emergency planners and responders is to plan for the worst, then multiply it by a factor of ten.

Despite the vast difference in scale and impact, there are similarities between the December M6.4 Ferndale earthquake and the Turkey – Syria quakes. Both occurred in complex tectonic regions with several faults involved. And both are still experiencing aftershocks.

Aftershock discussions involve several areas of confusion. What is an aftershock? How can you tell whether an earthquake is an aftershock or not? Is there a difference between a "normal" earthquake and an aftershock? Can aftershocks be bigger than the main earthquake? Does it matter?

Aftershocks are earthquakes and physically no different than any other earthquake. They involve fault rupture, produce the same types of seismic waves, and if large enough and close to populated areas, are capable of causing damage. Two things distinguish an aftershock from any other earthquake: it occurs after a bigger earthquake and is centered in the same general area as the bigger earthquake.

Large quakes cause complex changes in regional stresses. Aftershocks are nature's method of restoring equilibrium. The larger the magnitude of the main earthquake, the longer it generally takes to get back to a new normal. An aftershock sequence is over when the regional earthquake activity returns to the pre-mainshock level.

North Coast earthquake activity has almost returned to background levels. Before the December 20th quake, we would typically record zero to one small earthquakes (magnitude 1 or larger) every week. That number jumped to 200 for the week after December 20th and after a month, was averaging two to three earthquakes per week. The Turkey-Syria area is experiencing something similar but on a larger scale. More than 300 moderate (M 4 and larger) in the first week and after two months, the rate has settled down to five to ten a week.

I can't predict when the Ferndale aftershocks will end but I expect they won't last as long as Turkey. And we could have another strong quake on a different fault before it is over.

Lori Dengler is an emeritus professor of geology at Humboldt State University, 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. Downloadable copies of the North Coast preparedness magazine "Living on Shaky Ground" are posted at https://rctwg.humboldt.edu/prepare/shaky-ground.