Times Standard

Not My Fault: Horrific earthquakes in Turkey

Lori Dengler for the Times-Standard

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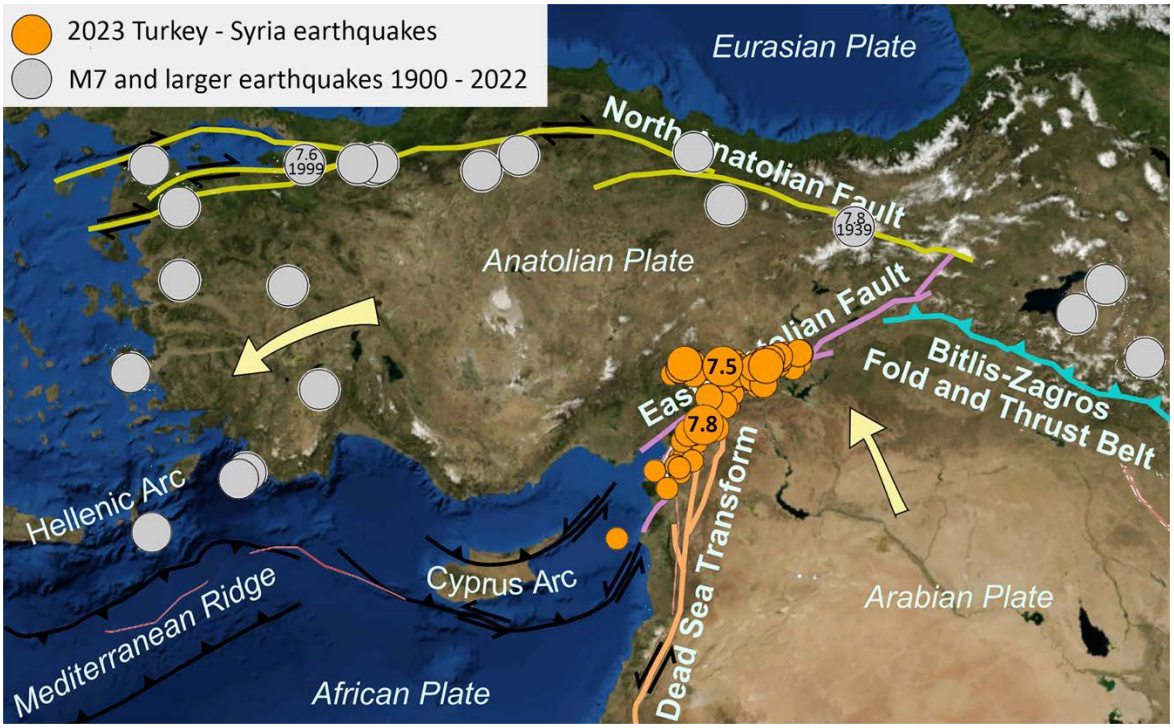

Epicenter location map showing earthquakes (orange) in the Turkey – Syria border area between February 5 – 8, 2023, epicenter of historic earthquakes of M≥7 since 1900 and simplified tectonic features (adapted USGS and Wikipedia Commons).

A little before 5:30 PM last Sunday my phone beeped - a text announcing a magnitude 7.8 earthquake in Southern Turkey. My stomach dropped. Any earthquake in the magnitude 7 range in this area has the potential to be catastrophic. The earthquake, at 4:17 AM Monday morning in Turkey, was likely to have an even greater impact because of the time of day, when most people are sleeping. Not all residences in this part of the world are built to resist earthquake shaking.

Looking through the preliminary USGS postings, I hoped it was not in a heavily populated area. No luck there. My colleague Dave Wald and his USGS group developed PAGER (Prompt Assessment of Global Earthquakes for Response) in 2010 to provide quick post-earthquake impacts. PAGER showed 14 million people in Turkey and Syria likely experienced strong to severe ground shaking. The list included Gazientep, Turkey's sixth largest with over 600,000 residents and Aleppo, Syria with more than 2 million. PAGER put the likely casualties in the 1000 to 100,000 range.

I looked at earthquake depth, hoping it might be deeper than typical for the region. Deeper quakes produce weaker shaking at the surface. No such luck here either. It was only 11 miles deep. I waited to see if the preliminary magnitude was on the high side. Initial postings are automated computer estimates. Sometimes magnitudes to go up or down a few decimal points after a seismologist takes a more detailed look. The M7.8 reading held steady.

The epicenter was in the area where the East Anatolian fault meets the Dead Sea transform fault. I studied Turkey tectonics back in 1999 when a M7.6 earthquake struck the northwestern part of the country. The Izmit earthquake was on the North Anatolian fault and killed over 18,000 people. Turkey is caught in a seismic vise, responding to the relentless pressure of the African plate as it moves north and the ongoing collision of the Indian subcontinent plowing into Asia to the east.

Continental collisions are complex messy things, splintering plates into smaller chunks that rotate and fracture to accommodate the stresses. Most of Turkey sits on the Anatolian subplate which is rotating counterclockwise relative to the Arabian plate. This rotation occurs by means of slip along several great fault systems, Dead Sea transform and the North and East Anatolian faults, strike-slip systems where the two sides move horizontally relative to each other. Along with the San Andreas in California and the Alpine fault of New Zealand, these are among the best studied strike-slip faults in the world.

Monday's quake was no surprise to seismologists. The Seismological Society of America compiled a list of nine recent papers pertinent to the area. Prior to this week, thirty-four earthquakes of magnitude 5.5 or larger had occurred in the East Anatolian fault system since 1970, the largest a 6.8 in 2020 that caused some damage. Five earthquakes exceeded M7 since the late 18th century.

The last century has been relatively quiet in the area that ruptured on Monday. There have been a number of smaller quakes and a M4.2 earthquake occurred two days before the mainshock. It would turn out to be a foreshock although there was nothing unusual about the size and location of the earthquake at the time.

Everything changed at 4:17 AM last Monday. USGS fault analysis suggests the earthquake ruptured about 100 miles of the East Anatolian fault and another 20 miles of the Dead Sea fault, producing ground motions that reached three-quarters of a g, the acceleration of gravity. Very strong shaking lasted about 40 seconds and total duration of shaking was more than a minute. The Ferndale earthquake last December produced stronger accelerations but they lasted less than 10 seconds.

Aftershocks immediately followed. In the first hour, ten strongly felt aftershocks were recorded, the largest a 6.7. Over the next eight hours, 31 more aftershocks were felt, a rate of about one every ten to fifteen minutes. At 1:24 PM local time, nine hours after the first earthquake, another major quake struck. Estimated as a 7.5 by the USGS, this quake was not on the same fault as the 7.8. Centered 60 miles north of the mainshock epicenter, it was only six miles beneath the surface and ruptured 30 miles along an east-west oriented fault.

Was the 7.5 an aftershock? This is splitting hairs. The Turkish government proclaimed it a separate earthquake, but most seismologists consider it an aftershock or triggered earthquake.

It was directly related to stress changes caused by the initial earthquake. Looking at earthquakes worldwide, the USGS data shows a one in twenty chance that an earthquake of roughly equal size to the first earthquake likely to occur close by in the first week afterwards.

The 7.5 exacerbated impacts from the initial quake. It would have caused damage all by itself. PAGER loss estimates suggest over a thousand casualties. Striking an area of structures already weakened by the 7.8, it caused many more collapses, endangering responders and hampering rescue efforts.

Five days later, the full picture is still emerging. As I write, the death toll stands has exceeded 27,000 and injuries have topped 87,000. It is the third worst earthquake of the 21st century for shaking damage alone, behind the 2010 Haiti and 2008 Sichuan, China earthquakes. And the numbers continue to rise as debris is removed. We may never know the true toll as parts of Syria remain inaccessible to outside response organizations.

Lessons? It is early days and over the next weeks numerous international teams will be joining with Turkish scientists and engineers to examine the impacts. They need to wait until the emergency responders have completed search and rescue efforts and the impacted areas secured for life and safety considerations. Then the hard work of tabulating structures damaged and determining their causes will begin. They won't only look at the collapsed structures; it is just as important to analyze all the buildings that didn't fail and determine the factors that made them resilient.

What is clear is that Turkey and Syria got the quadruple whammy: two major earthquakes, dense populations, weak buildings, and nighttime. If that's not enough, add in a civil war and millions of people already without homes. There is still so much we don't know. Was there surface rupture? How did buildings built to code perform compared to ones that weren't? How well were codes enforced? What prognostications will pop up and can they be verified? Stay tuned.

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/resources and may be reused for educational purposes. Leave a message at (707) 826-6019 or email rctwg@humboldt.edu for questions and comments about this column, or to request a free copy of the North Coast preparedness magazine "Living on Shaky Ground."