

Times Standard

Not My Fault: The 2024 mid-year earthquake report

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Posted July 6, 2024

<https://www.times-standard.com/2024/07/06/lori-dengler-the-2024-mid-year-earthquake-report/>



New York entrepreneurs make the most of the April 5 M4.8 earthquake even though it was centered in New Jersey.

2024 has been notable for a number a natural disasters: heat, earliest category 5 hurricane ever, and catastrophic flooding. It is a relief to report a mild earthquake year, so far. The six-month seismic numbers put the planet well below recent averages in a number of categories including magnitude, death tolls, and damages. But lower than usual numbers don't mean uninteresting and there are always sequences worth highlighting.

Fifty-one earthquakes made it into the magnitude 6 or larger category including four that hit the 7s. That makes the first half of 2024 the fourth lowest 6-month tally of the past 25 years. Since 2000, the half-year average has been about 80 M6s and 8 in the M7 range.

There's a good reason for the relatively moderate numbers, and no, it's not because the earth's tectonic engine is slowing down. We have passed out of the aftershock windows of great earthquakes. 2010 saw the M8.7 Chile earthquake followed a little more than a year later by the M9.1 Japan quake. These huge quakes caused big changes in the regional stress patterns that triggered large aftershocks for years.

The largest earthquake recorded so far this year barely made it into 2024. The M7.5 in the Sea of Japan occurred only seven hours into the new year. The majority of Japan's earthquakes are associated with the subduction zones that run along the northeastern and southwestern part of the island chain.

Most people tend to focus on the compressional part of the subduction zone where one plate dives beneath another. This "leading edge" of the subduction zone is what caused the 2011 Great East Japan earthquake. But subduction zones are complex beasts and set up major changes in the regional stress patterns. One of these is called back-arc spreading where the down going subducting slab stretches the land above, producing extension. The Sea of Japan was formed in this way.

The Noto earthquake was not the direct result of stretching. As the Sea of Japan opens, it meets resistance from the land creating zones of convergence along the western side of Honshu. There are many reverse faults along and near the coast that have produced earthquakes in magnitude 7 to low 8 range. One of my early introductions to tsunami studies was the M7.7 1993 Okushiri earthquake also in the Sea of Japan about 360 miles to the north of the Noto epicenter.

The Noto earthquake ruptured a 100-mile-long fault, causing some areas to uplift by as much as 13 feet and move seaward away from the coast by over 800 feet. This deformation caused some areas of the Noto Peninsula to gain almost two square miles in size. The earthquake, like its predecessor in 1993, produced strong shaking and a local tsunami, causing 281 deaths, over 1300 injuries, and \$17.6 billion (US \$) in losses. It ranks it the deadliest earthquake of 2024 to date.

Japan has the strictest seismic building codes in the world and has spent more of its human and financial resources on earthquake and tsunami preparedness than any other country in the world. Why were there casualties? Because, like California, all Japanese cities have older structures, not built according to current code. A Japanese government assessment reported almost all the damage was to structures built before 1980.

These traditional homes are built of wood with heavy tile roofs. Top heavy, the structures resist typhoons but are not earthquake resilient. They are also vulnerable to fire. Dozens of fires broke out after the earthquake, some caused by damaged electrical wires, others by topple cookstoves. Responders were not able to reach some of the largest blazes due to road damage.

Fire following earthquakes is problematic in both Japan and California where much of the housing stock is built of wood. It was not a problem in the second largest earthquake of 2024 – a M7.4 that struck Taiwan's west coast on April 3. The differences between what happened in Taiwan and Japan are eye-opening,

The Hualien Earthquake, centered near Hualien City, Taiwan's seventh largest metropolis, also caused damage and casualties. The impacts (18 deaths, \$2.5 million damages) were far less than in the similar-sized Noto earthquake. Both earthquakes affected densely

populated areas, but over four times as many people in Taiwan experienced strong to extreme ground shaking than in Japan.

The main difference in impacts is building stock and construction methods. After Taiwan's 1999 earthquake (2,415 deaths), the country embarked on a resiliency campaign enacting strict codes for new construction and requiring many older buildings to be retrofitted. Reliance on concrete, steel, and other non-flammable materials significantly reduced structural damage. No fires were reported after the earthquake.

There is an economic incentive in Taiwan to not only build structures to provide life safety in earthquakes, but also continue normal operations unscathed by minor shaking damage. Taiwan is home to the most advanced semi-conductor industry with manufacturing plants requiring nanometer precision. After the April quake, there were no major work stoppages. It's expensive to rebuild structures and infrastructures. The Taiwan earthquake proved it worth the cost.

Neither Japan nor Taiwan got the nod for the most earthquake media coverage in 2024. That prize was awarded to the mighty magnitude 4.8 Tewksbury earthquake on April 5th. The earthquake was centered in north central New Jersey 33 miles north of Trenton. 183,760 felt reports were posted on the USGS "Did You Feel It?" web site, the most ever reported for an earthquake anywhere in the world. The USGS estimates that over 42 million Americans felt the earthquake from Georgia to Montreal and as far west as Iowa and Georgia.

The Tewksbury quake was not the only oddball of 2024. A 4.0 was detected off the east coast of Florida and a 3.7 in South Dakota. A reminder that earthquakes can and will occur anywhere.

The rest of the U.S. earthquake story for 2024 has no surprises. Alaska as usual had more than twice as many earthquakes than all of the lower 48. California is slightly ahead of Texas for likely felt earthquakes (131 to 108 magnitude 3 or larger) in the coterminous U.S. The largest earthquakes outside of Alaska were a 5.6 on the Blanco fault far offshore of the southern Oregon coast, a 5.2 offshore of Crescent City, and a 5.1 in central Oklahoma.

On the North Coast, it's safe to say the December 2022 M6.4 Ferndale earthquake aftershock sequence is over, and we are back to "normal" background levels. That means expect a few magnitude 3s every month and an occasional 4. Of course, the next significant earthquake sequence is lurking around the corner and could arrive any day. Follow Taiwan's example and build resilience before it happens.

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