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Not My Fault: A New Year's Day earthquake and tsunami in Japan

Lori Dengler for the Times-Standard

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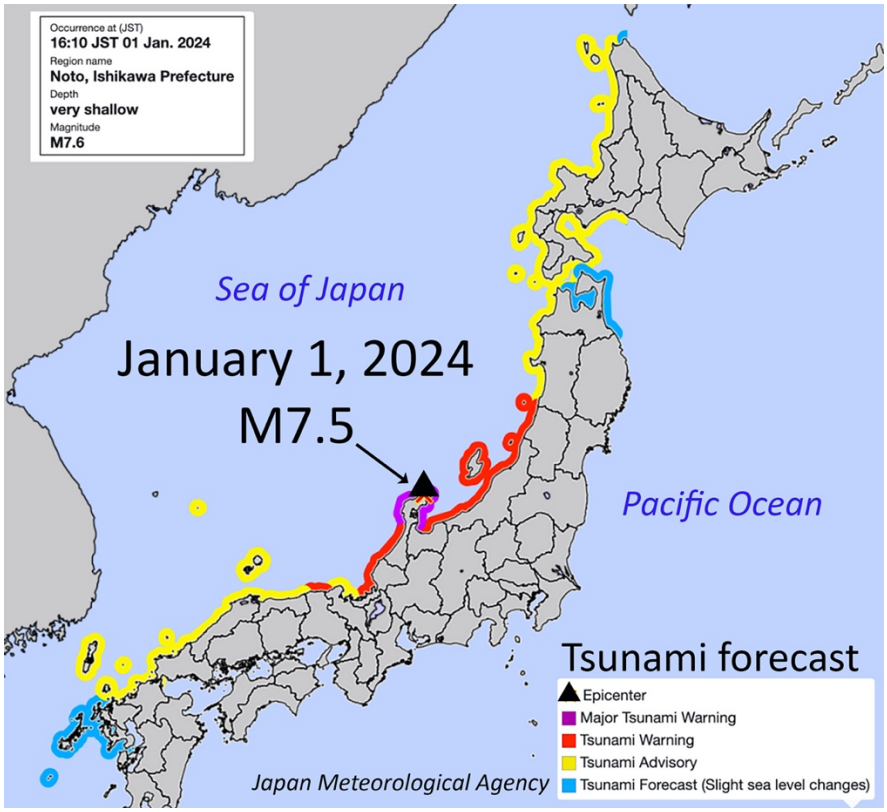

Image: Japanese Meteorological Agency tsunami map following the New Year's Day M7.5 earthquake. No areas of the Pacific were ever at any risk.

2024 got off to a deadly earthquake start. At 4:10 PM (local time in Japan) on New Year's Day, a magnitude 7.5 earthquake struck the Noto Peninsula in Ishikawa Prefecture on the west side of Japan's main island of Honshu. Named the 2024 Noto Peninsula earthquake by the Japanese Meteorological Agency (JMA,) it claimed 126 lives and injured 611. As I write, 211 people are still unaccounted for.

It's human nature to look at natural disasters far away and come up with reasons why it couldn't happen here. We can point to adobe buildings to explain the high death toll in last year's Morocco and Afghanistan earthquakes and blame corrupt construction practices for some of the deaths in Turkey. Quake. Japan's newer buildings meet or exceed construction standards in the U.S. and older buildings are made of wood. The mix of old and new buildings is not unlike what would find throughout California.

It's been less than a week since the earthquake and researchers have not been allowed into the hardest hit areas while rescue operations are still underway. Much more will be learned when scientists and engineers are able to quantify damage and detail the reasons why structures collapsed. I will be careful not to speculate too broadly.

Here's a preliminary look at what is known now. The earthquake was centered on a northeast - southwest trending fault. The epicenter was on the tip of the Noto Peninsula. This 50-mile-long peninsula juts into in the Sea of Japan on the west side of Japan's most populated island of Honshu.

Epicenters mark the point on the ground surface above where the rupture began. On New Year's day, that rupture started at six miles depth and grew along a fault both to the northeast and southwest. It took about 50 seconds for the rupture to propagate and when it stopped, rock along a nearly 100 miles zone had been displaced. It was a thrust earthquake, where the rock to the southeast was shoved up and over the rock to the northwest. The USGS fault analysis shows a peak slip of roughly 15 feet between the two sides.

Seismic waves were produced the whole time the fault was rupturing. People in Ishikawa Prefecture would have experienced nearly a minute of very strong shaking. Japan is highly instrumented, and accelerometers recorded peak values of over one g (acceleration of gravity) on the Noto Peninsula. At least two locations hit 1.5 g, similar to the peak in Rio Dell in December 2022. But there was a big difference. The strong accelerations in Japan lasted about three times as long.

These ground motions caused major damage on the Noto Peninsula and in Ishikawa. Damage and injuries were also reported in Toyama and Niigata Prefectures. The earthquake was felt throughout central Japan, by many in Tokyo about 200 miles away and a view in western Honshu and the Island of Shikoku 350 miles distant.

Most of the damage was caused by ground shaking, exacerbated in some areas by liquefaction. Liquefaction occurs in saturated unconsolidated sediments when shaking causes the water to flow upwards and the sand grains are no longer in contact with each other. The ground behaves like a fluid while the shaking persists causing foundations to tilt and founder and riverbanks to spread. Liquefaction can occur in any saturated area, including here on the North Coast where the margins of Humboldt Bay and the Eel River basin are particularly vulnerable.

If Japan has such stringent building codes, why so many collapses? A cursory glance points to older homes built before modern codes as the main problem. Traditional Japanese buildings are made of wood, a material that resists earthquake shaking far better than brick and adobe. But in Japan, the relatively lightweight wooden framework is topped by a heavy tile roof, a construction style that evolved over centuries to resist the high winds from typhoons. Tile roofs make the buildings top heavy, and far more vulnerable to collapse in earthquakes. To compound the problem, on January 1 an additional burden of snow further increased the toppling moment, reducing the amount of force needed to knock a building over.

Thousands of homes are estimated to have been severely damaged, a number that is hard to confirm in these early days because of fire, the often-deadly secondary effect of ground shaking. Fire is a notorious problem in Japan where wood structures, stoves, and sparks can quickly

become conflagrations. The deadliest earthquake in Japan's history was in 1923 where at least a third of the estimated 140,000 deaths are attributed to post earthquake firestorms.

On January 1, a number of fires broke out involving hundreds of buildings. Suzo, a picturesque city of 13,000 was particularly hard hit. Over 5000 structures, 90% of the building stock, were destroyed. It will be difficult to determine how many were damaged in the shaking as fire consumed much of the evidence.

Suzo also received impacts from a tsunami. Within minutes of the earthquake, JMA issued a Major Tsunami Warning. Japan has a 3-tiered tsunami alerting system, Major Tsunami Warning means water heights of 9 feet of higher, a Tsunami Warning for peak water heights in the 3 foot to 9-foot range, and Tsunami Advisories when strong currents are expected to be the only threat and water heights less than 3 feet. The U.S. system only includes Warnings (greater than 3 feet) and Advisories for smaller events.

At least 60,000 people evacuated low-lying areas in the Ishikawa area, most in response to feeling the shaking. Tide gauges recorded the tsunami at 35 sites along the Sea of Japan including South Korea and Russia's Sakhalin Peninsula. The highest recording was 4 feet at Wajima, 20 miles from the epicenter. Eyewitness reports suggest heights of 9 to 14 feet on other parts of the Noto Peninsula and the first surges arriving only minutes after shaking stopped.

It is not clear how much damage was caused by the tsunami. Houses allegedly floated of foundations in Suzo and at least one person may have been swept offshore. We will know more once tsunami survey teams are able to access the area, record water height data, and interview survivors.

It is also unclear how the alerts may have affected response operations. Emergency personnel are not allowed into the expected inundation zone when a Major Tsunami Warning is in effect. There is good reason for this. Hundreds of firefighters died as they entered tsunami zones following the 2011 Great East Japan Earthquake. But this meant anyone in that zone received no assistance in the critical four hours the Warning was in place.

No areas of the Pacific were ever at any tsunami threat on January 1. The two U.S. tsunami warning centers issued 'no tsunami' statements soon after the earthquake. The earthquake source was in the Sea of Japan and tsunami hazards were restricted to coastlines around that basin.

More on the earthquake and regional tectonics at https://temblor.net/temblor/intense-seismic-swarm-magnitude-7-5-japan-earthquake-15891/

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. The new 2023 edition of the preparedness magazine "Living on Shaky Ground" is posted at https://rctwg.humboldt.edu/prepare/shaky-ground.