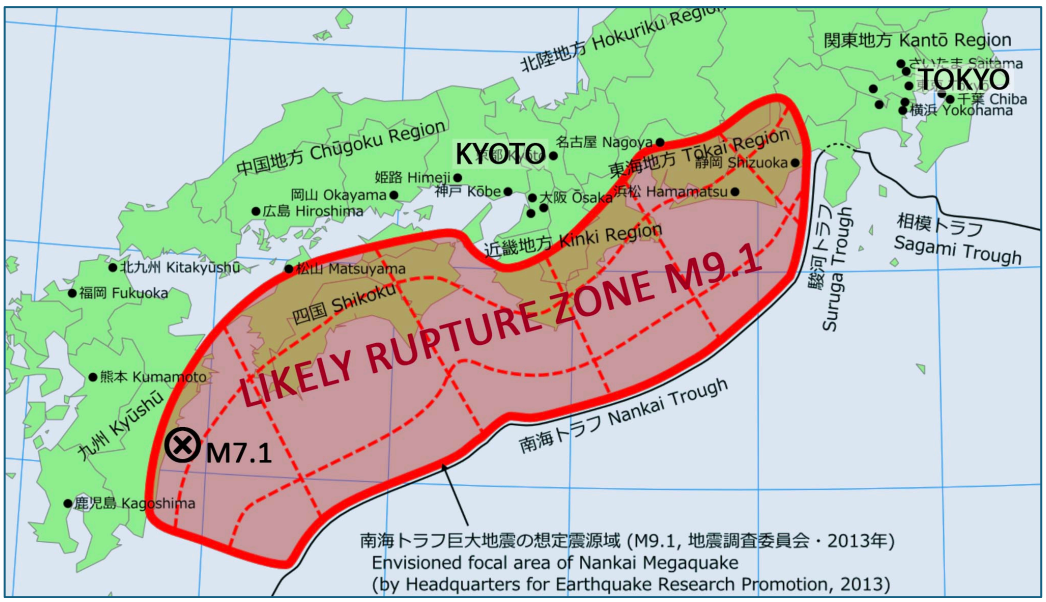
Not My Fault: Japan’s megaquake alert is over – what was learned?

Lori Dengler for the Times-Standard
Posted August 17, 2024
https://www.times-standard.com/2024/08/17/lori-dengler-japans-megaquake-alert-is-over-what-was-learned/



The Aug. 8 M7.1 Japan earthquake (⊗) was centered at the western edge of the estimated rupture area of a M9.1 Nankai Trough earthquake. (Headquarters for Earthquake Research Promotion, 2013)

On Thursday, a week after a magnitude 7.1 earthquake shook the Japanese island of Kyushu, a sense of normalcy is returning to Japan. The Japanese Meteorological Agency (JMA) issued the first ever alert that the 7.1 could be the foreshock of a much larger tremor. That alert expired on August 15th and the “megaquake” has yet to come.

There have been many questions both in Japan and elsewhere about what the alert meant, why it was issued, and what happens now. Japanese researchers are studying the societal impacts and how the public responded, and it will be months before the picture is complete. But some lessons have already emerged.

The purpose of alerts is to save lives and reduce injuries. Most alerts are issued when there is a high likelihood of a hazardous event occurring and the threat is imminent – typically within hours to days. It is easy to recognize weather hazards; you can see them on satellite images and there is no question they are real and approaching.

It gets far murkier with geologic hazards. We don’t have the luxury of being able to monitor areas deep underground and detect the subtle signs that an eruption or fault rupture is about to occur. We've gotten far better with volcanoes, monitoring the small earthquakes, gas emissions, and ground deformation caused by magma moving upward, but there is always more uncertainty than in weather forecasts.

Earthquakes are much harder to forecast than volcanoes. Eruptions involve magma pushing to the surface and always produce some noticeable precursors. Earthquakes are miles below the surface and even though we have more sensitive instrumentation, recognizing precursors remains elusive.

Japan has been hit by great earthquakes and tsunamis far more frequently than the U.S. and has invested heavily in instrumentation, analytical capacity, and seismic/engineering research. The Great East Japan earthquake in 2011 killed more than 19,000 and cost more than $300 billion (US $$), making it the costliest disaster in modern history.

This investment has paid off in Japan's earthquake early warning system which now routinely detects earthquakes in the first seconds of rupture, quickly estimating magnitude, location, shaking strength, potential tsunami size and extent, and conveying the information to cell phones, television and radio, transportation systems, and other critical infrastructure. The U.S. Shake Alert system has been built in part on the Japanese experience but does not have the density of instrumentation or the ability to include tsunami information.

ShakeAlert and the Japan early warning system don't predict earthquakes. They kick in only after the rupture has started. Forecasting an earthquake hours, days, or weeks before it happens has yet to be realized in any consistent, scientifically rigorous way. There is only one damaging earthquake in the historic record where a prediction beforehand may have reduced casualties.

In the winter of 1975, a series of moderate earthquakes rocked China's Liaoning province. Changes in electrical properties and snakes coming out of hibernation to freeze on the ground surface added to the concern. Authorities issued several alerts insisting that people stay out of their homes. A magnitude 7.5 earthquake occurred during one of these alerts and the evacuation order is believed to have saved 10,000 lives. The downside was that several hundred froze to death and more than 6500 people suffered frostbite. There is still some controversy over whether the alert was scientifically sound or a fluke. There have been no successful Chinese predictions since then.

The China example illustrates the importance of precursors. The most common is foreshocks, smaller earthquakes that lead to a larger one. Studies suggest roughly 40% of moderate to large earthquakes are preceded by at least one foreshock. The number of foreshocks and amount of time between a foreshock and the mainshock is highly variable – as short as seconds to as long months or even a year or two.

The Nankai trough is a 500 miles long subduction zone that extends along the south coast of central Honshu to Kyushu, the westernmost of Japan's main islands. Earthquakes as large as mid 7 can occur anywhere in Japan, but the Nankai trough is one of two areas in the country where earthquakes in the M9 range have occurred in the past. The other is the

NE coast of Honshu extending north to Hokkaido. We saw the impacts of such a "megaquake" in that region in 2011.

The Nankai trough is complicated. The most recent great quakes were a pair of M8s in 1944 and 1946. A similar pair occurred only a day apart in 1854. In each case, the doublet ruptured one section of the fault followed by a second that ruptured the remaining locked area. But doublets aren't always the rule. In 1707 the entire zone broke in a single quake estimated at close to magnitude 9.

Japan has a wealth of data in the Nankai area where written records go back 400 years and modern instruments now cover the land and sea floor. From the pattern of previous earthquakes and modeling of processes that might precede a magnitude 8 or 9 quake, JMA and university scientists developed protocols for issuing public alerts if they believed the hazard is elevated.

While a significant number of great earthquakes are preceded by foreshocks, not all are, and the overwhelming majority of strong earthquakes are not followed by larger ones. There is nothing in the signature of a particular earthquake to indicate that it is a foreshock. At present, we rely on the statistics of past quakes. On any given day in the Nankai area there is a small (less than 1%) but real chance of a great quake occurring. Statistics suggest that the August 8 M7.1 increased those odds, but they were still small.

There is debate about whether issuing public alerts for low probability events is a good idea. The intent is to make people more aware and take actions to prepare. It also put emergency responders on alert. There are numerous reports of people buying emergency supplies, and in some cases, stripping grocery shelves bare. But how many times can an alert be issued without a larger quake following before the "cry wolf" syndrome sets in?

A second concern is that the Nankai focus has left other parts of Japan that aren't considered as high risk as Nankai bereft of resources. In January the M7.6 Noto earthquake killed 339 and caused major damage to communities along the Sea of Japan. Noto-type quakes could occur almost everywhere in the country.

In 2011 I spent ten days studying the impacts of the 2011 earthquake and tsunami with Megumi Sugimoto, now an associate professor at Osaka University. Our focus was identifying factors that exacerbated or reduced impacts. Meg has continued this work and commends any efforts that promote preparedness, not only for earthquakes but for typhoons, landslides, and floods. But she worries that all of the emphasis on the Nankai region has given the impression that the risk is lower in other areas and the need to prepare is not as important.

It's a tricky business and I am glad I don't have to call the shots. What does ring out loud and clear is the need for better education, both in the Nankai region and throughout the country. Just because the alert has been canceled, the threat has not gone away.

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 or to request copies of the preparedness magazine "Living on Shaky Ground." Digital copies are at https://rctwg.humboldt.edu/prepare/shaky-ground.