

Japan ignores skeptics, keeps goal of earthquake prediction

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In a nondescript government building near the Imperial Palace, a team of Japanese seismologists stands ready to predict an earthquake.

All day, every day, they monitor data from dozens of tiltmeters, strain gauges and other instruments deployed along a stretch of coastline southwest of Tokyo. The region, called Tokai, was last rocked by a major quake in 1854. Scientists fear it's overdue for a repeat.

Since 1979, federal scientists have been watching for ground motion that might herald an impending rupture on the fault zone. If their instruments ever detect an ominous bulge, Japanese law requires the prime minister to issue warnings that would shut down schools, hospitals, factories, roads and trains across one of the country's most populous areas.

The U.S. Pacific Northwest is subject to the same type of seismic disaster that Japan hopes to predict, but neither the U.S. nor any other nation has such an ambitious program to nail down an earthquake before it happens. That's because most experts are convinced it can't be done.

Critics say Japan is wasting money and giving its people the bogus impression that scientists can foretell earthquakes in the same way meteorologists track approaching typhoons. A scientific review panel recently advised the government to pull the plug on the program.

But as one of the most seismologically volatile nations on Earth, Japan has been reluctant to give up on the dream of prediction. While most

American scientists have dismissed the notion for the past several decades, Japan still sponsors research and programs with "prediction" as part of their titles.

"Earthquake prediction is very, very difficult - maybe impossible," said University of Tokyo seismologist Kazushige Obara, a member of Japan's Coordinating Committee for Earthquake Prediction. "But it's the ultimate goal of our research, which is why we keep the name."

Now, at least a few seismologists outside Japan are suggesting it may be time to revive the search for geologic red flags that could raise the risk of a major quake.

In the days before the 2011 Tohoku quake and tsunami, which killed more than 18,000 people, seafloor instruments showed that the offshore fault responsible was chattering and slipping slowly. Similar slip preceded a quake on an offshore fault in Chile.

Those tantalizing hints led two respected earthquake experts to suggest in an opinion piece in the journal *Science* that better monitoring of the seafloor might someday identify reliable precursors to the world's most destructive quakes - including the one that will strike someday off the coast of the Pacific Northwest.

"Whether earthquakes are predictable or not is still an open question, but perhaps there is now some cause for optimism," wrote Emily Brodsky and Thorne Lay of the University of California, Santa Cruz.

Brodsky and Lay agree it would take years of study and monitoring to find the answer.

In the meantime, experts in Japan and the U.S. are considering whether to issue the seismological equivalent of weather forecasts, based on the

simple fact that earthquakes often strike in clusters.

"I think we're close to a working forecast system," said Tom Jordan, director of the Southern California Earthquake Center.

When an earthquake ruptures the Earth's crust, the shifting of rocks and fluid temporarily boosts the odds of more quakes in the vicinity, Jordan said. After the fact, quakes are sorted into foreshocks, mainshocks and aftershocks - but at the time, it's not clear which quakes in a sequence will be the most dangerous.

However, using computer models based on decades of seismological data and what's known about fault structures, scientists can estimate the increased chance of follow-on quakes.

The question is what to do with that information.

Jordan believes the public has a right to know if seismic risk is elevated, even slightly. He envisions regular forecasts that present earthquake odds in the same way weather reports estimate the daily chance of rain.

But seismologists know far less about the machinery of faults than meteorologists do about the atmosphere. And the probability that one earthquake will trigger another is much lower than the probability that a moisture-laden front will deliver precipitation.

The chance of an earthquake can increase a thousandfold and still be minuscule.

For scientists, it's interesting to know what those odds are, said John Vidale, director of the Pacific Northwest Seismic Network at the University of Washington. But it's not clear whether it's useful to the public.

"If the odds of an earthquake that will cause damage rise to 1 or 2 percent, what do you do?" Vidale asked.

Location matters, Jordan pointed out.

"When we have small earthquakes near the San Andreas Fault, we get a lot more nervous than if we have small earthquakes in the middle of nowhere with no big faults around," he said.

In the same way, Vidale and his colleagues pay attention when small quakes strike close to or on the offshore fault called the Cascadia Subduction Zone, which unleashed its latest magnitude 9 megaquake and tsunami in the year 1700.

But there have been countless small quakes in the intervening 314 years, none of which has triggered a big one, Vidale pointed out.

Japan, the U.S. and dozens of other countries are collaborating to test more than 400 [earthquake-forecasting](#) models against real-world results to see how well they perform, Jordan said. He's also working with state agencies and emergency managers in California to decide whether to issue forecasts, and how to advise the public to respond.

Forecasts could be accompanied by a reminder to get your survival kit in order or update your family's emergency contact list, Jordan said. Operators of nuclear- power plants, hospitals or utilities might step up their alert levels.

In the Pacific Northwest, emergency managers are just beginning to grapple with earthquake forecasting and how to alert the public to any unusual seismic activity off the coast. The Cascadia Region Earthquake Workgroup applied for federal funding to host workshops and develop a plan, said John Schelling, of the Washington Emergency Management

Division.

"This planning may be ahead of the science," he said. "But it's better to be prepared and have these discussions now before something significant takes place."

Those efforts will take on more urgency if the pattern of foreshocks and slow slip that preceded the recent quakes in Japan and Chile shows up again, before other offshore quakes.

Some faults, including the Nankai Trough off Japan and the Cascadia Subduction Zone here, exhibit regular cycles of slow slip accompanied by faint seismic tremors. Computer models suggest that if those cycles accelerate, it could set off a megaquake, Obara said.

"It's very hard to say," he said. "We are going to have to experience more huge earthquakes, and after that we may understand whether this signal is related to the earthquake or not."

Most scientists think it's a long shot. The history of seismology is replete with promising precursors that never panned out - from phases of the moon to radon gas emissions and animal behavior.

University of Tokyo seismologist Robert Geller dismissed any newfound optimism, and chided Brodsky and Lay for being cavalier in their use of the word "prediction."

"Such claims have been made for over 100 years and all have proved false," he said in a written critique.

Geller is also the most vocal critic of Japan's costly effort to predict the next quake in the Tokai region.

The program was established in the late 1970s, at a time when public concern over a possible quake was at a fever pitch. Two segments of the Nankai Trough offshore fault had ruptured in 1944 and 1946, triggering deadly earthquakes and tsunamis. Seismologists pointed out the segment off the Tokai region hadn't ripped in more than 100 years and was cocked and ready.

Japan's prediction program is based on the premise that the quake will be preceded by "pre-slip": precursory fault motion significant enough to cause a swath of coastline to bulge rapidly. But the only evidence that this might happen comes from leveling surveys that hinted at rapid uplift before the 1944 quake.

"It beggars belief ... that the Japanese government operates a legally binding earthquake-prediction system on this basis," Geller wrote in a 2011 commentary in the journal *Nature*.

American seismologists say most of their Japanese colleagues are embarrassed by the program and wish it would be quietly disbanded. But the monitoring is required by law and entrenched in Japan's scientific bureaucracy.

Takeyasu Yamamoto of the Japan Meteorological Agency, which oversees the effort, acknowledges there's no guarantee he and his colleagues will be able to warn the public before the next Tokai quake.

"Even if we observe movement, it may not lead to a quake," he said. And the quake could also strike with no precursory movement.

But if the Tokai program is widely viewed as misguided, seismologists in the U.S. are keen to emulate Japan's billion-dollar earthquake early-warning system. The system uses a dense array of seismometers to detect the initial impulses from a quake and beam warnings that arrive tens of

seconds, or even a few minutes, ahead of the strongest ground shaking.

Most Japanese get the alerts on their cellphones and can use the time to climb down from a ladder or take cover. Bullet trains slow to a halt, school alarms sound, and machinery shuts down.

A prototype system in California is sending out test messages to the Bay Area Rapid Transit System and other organizations. It worked well when a magnitude 6 quake struck Napa on Aug. 24.

Scientists hope Congress will provide the \$120 million it would cost to expand the system throughout California and the Pacific Northwest and operate it for the first five years.

In cities like Seattle and Portland, the network could provide as much as a five-minute warning of a megaquake off the coast, Vidale said.

Considering that [earthquake prediction](#) may never be possible and [earthquake](#) forecasting may never be very useful, a few minutes of solid warning sounds pretty good, he said.

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