Scientists predicted a new temblor in that region of the sea floor

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Less than two weeks ago, a team of earthquake experts published a scientific paper describing how the titanic tsunami-generating earthquake off Sumatra on Dec. 26 greatly raised risks of a fresh offshore earthquake. The earthquake they described was almost exactly like the one that struck yesterday.

The paper's authors and other experts had calculated how the December shock increased stress on the adjacent section of the Sunda Trench, a seam in Earth's crust where one plate dives beneath another. The increased pressure greatly increased the chance that the seam would fail, they said. The new earthquake was generated when the plates suddenly moved, releasing pent-up energy.

Yet for hour after hour yesterday, no scientist could say with certainty whether the new quake – a giant of magnitude 8.7 on a fault known to have triggered killer waves in the past – had spawned destructive tsunamis like those that swept the Indian Ocean the day after Christmas. A tsunami is generated when the ocean floor moves up or down during the quake.

Particularly puzzling to ocean and quake experts was that there were signs that a tsunami radiated southwest from the epicenter, far from the crowded coasts of the Bay of Bengal that were struck so hard in December. For waves to propagate in that direction and not toward the Indonesian coast was highly unlikely, many experts said.

Bruce Jaffe, a U.S. Geological Survey oceanographer in charge of a federal project aimed at clarifying tsunami threats, said he and colleagues had been in touch with Sri Lankan and Maldivian officials who had evacuated some communities as a precaution.

The difficulty of predicting tsunami hazards after earthquakes underscored how much remains to be done to create an effective warning system for tsunamis in the heavily populated but poorly studied region, experts said.

As a result, three months after the December tsunamis exacted a huge death toll, and three weeks after tsunami experts and government officials met in Paris under the auspices of the United Nations to design an Indian Ocean alert system, scientists expressed frustration yesterday with the vast gaps that must be plugged.

Costas Synolakis, a professor of civil engineering at the University of Southern California who attended the Paris meeting, said governments and scientific agencies appeared too focused on expanding networks of seismometers, sensitive gauges that detect ground motion. Knowing how the earth has moved is only the first step to determine whether a wave has been spawned, he said.

Tide gauges, another priority in the new international tsunami-warning plan, also only give a narrow local view, he added, saying the most valuable tools are deep-ocean instruments called tsunameters that sense a passing wave and transmit an alert via buoys at the surface.

"What we really need is direct tsunami detection," he said. In the Pacific, the United States has already deployed half a dozen such devices and plans on expanding the network to 32. They provide a clear, direct signal that a

high-energy wave is passing, he and other experts said.

It would take years before such an array of sensors and buoys could be deployed in the Indian Ocean, where funds and expertise are extremely limited. Until then, countries there will likely have to rely on indirect measures, several tsunami experts said yesterday.

One measure was a tide gauge in the Cocos Islands, 650 miles south of Sumatra. According to Reuters, Australia's Bureau of Meteorology said it had recorded two small waves there, the first four inches and the second 10 inches. The Cocos Islands recorded a 13-inch wave Dec. 26.

Ten inches can be a significant height for a spot in the middle of the ocean, where a wave's energy is spread from the surface to the seabed, making it nearly imperceptible from above.

The prediction of an impending earthquake was made in *Nature* on March 17. John McCloskey and his colleagues at the University of Ulster in Coleraine, Northern Ireland, said the Dec. 26 earthquake increased the pressure on the Sumatra fault near Banda Aceh.

His team predicted that the most immediate threat was probably an earthquake on Sumatra of magnitude 7 to 7.5.

Many tsunami experts could not understand why yesterday's earthquake off Indonesia failed to produce massive waves.

"I'm baffled an earthquake this size didn't trigger a tsunami near the epicenter," said Robert Cessaro, a geophysicist at the Pacific Tsunami Warning Center on Oahu, Hawaii. The center is operated by the National Oceanic and Atmospheric Administration.

Kerry Sieh, a Caltech seismologist who has spent more than a decade deciphering past patterns of quakes and waves etched in Sumatran reefs, said he thought it would be nearly impossible not to have an earthquake on that fault line, of that magnitude, without swamping nearby shores. "I'm biting my fingernails," he said.

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