Threat of killer waves
Recent scientific studies show the power of tsunamis

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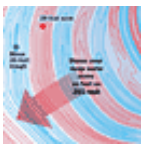

On a warm July evening in Papua New Guinea three years ago, a moderate earthquake jolted the floor of the Bismarck Sea. Within minutes, a train of ocean waves 50 feet high crashed against the island's north coast.

There was no high ground along 19 miles of shoreline, and no time for villagers to flee inland. The waves swept more than 2,200 people to their death -- victims of the worst tsunamis on recent record.

Scientists now believe that a huge undersea landslide triggered by the quake must have added deadly power to the Papua tsunamis -- and that similar landslides could threaten many coastal regions of the world, including California and the entire Pacific Northwest.

OCEANIC GIANTS

These giant sea waves cause major damage to seacoasts around the world. In the past decade alone, tsunamis have killed more than 4,000 people. Yet scientists don't really know how many of the gargantuan waves have been caused by underwater landslides -- as opposed to earthquakes -- or how they get started.

"We understand snow avalanches far better than we understand submarine landslides," says Costas Synolakis of the California Institute of Technology, who is one of the world's leading tsunami experts.

"It was the Papua New Guinea event that made it clear that landslide tsunamis are a far greater hazard than what we had thought," he said. "We are really at the turning point of a new science, and we are trying to make educated guesses."

One of those making educated guesses is Steven N. Ward, a research geophysicist at the University of California at Santa Cruz. He calls the deadly waves caused by such undersea landslides "surprise tsunamis," because they strike with none of the warning signals that mark large earthquakes.

Using an intricate computer program, Ward has estimated the sizes of tsunamis that were

generated thousands to millions of years ago by landslides. Recent sonar surveys reveal the remains of those slides in huge areas of disturbed seafloor.

800-FOOT SCARS

During recent oceanographic voyages, scientists have discovered that one such landslide scar is at least 800 feet thick and covers nearly 9,000 square miles of the ocean bottom off what is now Nuuanu on the north coast of Oahu in Hawaii. It is all that remains of a Hawaiian volcano that erupted some 2.7 million years ago and sent its side crashing into the sea, setting off enormous tsunamis whose waves Ward has modelled in a computer study.

"After 18 minutes, the slide, barely half complete, set the ocean in full turmoil," Ward said. He estimates that waves nearly 200 feet high from trough to peak must have slammed the coasts of Oahu and Molokai within minutes.

In an hour, 130-foot waves reached the islands of Maui, Hawaii and Molokai. And 4 1/2 hours later, the front waves would have reached the Aleutians and the coasts of California and Oregon with waves still 65 feet high, Ward estimated recently in the Journal of Geophysical Research.

Synolakis called Ward's computer-based estimates of tsunamis caused by landslides "excellent, careful, pioneering work treading where nobody has been before."

Ward also worked with geologist Simon Day of University College in London to predict what could happen if the highly unstable Cumbre Viejo volcano in the Canary Islands were to erupt laterally, spewing the entire mass of its rocky side into the sea in one enormous landslide.

It would send as much as 120 cubic miles of rock sliding into the sea and create a wave train that would cross the Atlantic in only eight hours. Although barely perceptible as it sped over the broad ocean's deep waters, the tsunami would build to waves 80 feet high crashing over the Florida coast, Ward and Day calculated in a report published in this month's issue of Geophysical Research Letters.

SCARE TACTICS?

"We're not running these computer numbers to scare people," Ward said in an interview. "But surprise tsunamis need to be a lot better understood, and people on every coast need to be prepared for them."

A tsunami -- the word means "harbor wave" in Japanese -- moves with incredible speed: more than 500 mph over deep water. But in the open ocean, it is barely perceptible at only inches to a few feet high.

When it reaches shallow waters and approaches the shore, the waves' speed slows down to about 25 mph -- "about the speed of a moped," Ward says -- and the wave height grows dramatically. Records of past tsunamis that have crashed on land show wave heights hundreds of feet high.

Ward has just created a new computer model of a hypothetical tsunami that might be triggered if one of the steep walls of the Monterey Canyon that snakes 60 miles out to sea beneath Monterey Bay suddenly were to plunge a mile and a half to the canyon's bottom.

Evidence of old landslides on the canyon's floor -- one of them covering more than 80 square miles -- is well known. Working with geologist Gary Greene of the Monterey Bay Aquarium Research Institute, Ward has used that evidence to create his new computer model.

In the scenario, Ward theorizes a landslide -- perhaps triggered by a large earthquake on the nearby San Gregorio Fault -- that gouges out a chunk of the canyon wall 600 feet thick near its head and tumbles down at a speed of more than 100 mph for 15 miles. "The entire event takes eight minutes to run its course," he said.

The water churned up by the landslide, Ward calculates, would create tsunamis whose leading waves -- reaching the shore at about 30 mph -- would tower as high as 50 to 80 feet on the Monterey side of the bay and 30 to 50 feet high at Santa Cruz.

Ward and Greene caution that their simulation does not mean that any such event is imminent. Indeed, so far there is no evidence along the shores of the Monterey Bay -- nor in the 2,500 acres of Elkhorn Slough that snakes inland from Moss Landing -- that any major tsunamis have ever swept ashore from the canyon.

"But there have indeed been submarine landslides up near the head of the canyon in the past, so we can't be certain," Greene said. "Now we have to marry the geology to the model to get a much clearer picture of what might happen."

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