INDIAN OCEAN TSUNAMI

In Wake of Disaster, Scientists Seek Out Clues to Prevention

Having claimed more than 150,000 lives and destroyed billions of dollars’ worth of property, nature last week reminded the world of the terrible cost of ignorance. Now the nations devastated by the massive earthquake and tsunami that ravaged the Bay of Bengal the morning after Christmas Day are hoping to marshal the political and scientific will to reduce the toll from the next natural disaster.

A week after the tragedy, the question of how many lives might have been saved had authorities in those countries recognized the danger in time to evacuate their coasts remains unanswered. But it’s a hypothetical question, because the information needed to take such steps doesn’t exist. That’s why researchers are gearing up for an international data-collection effort in the affected countries, aimed at improving models of how tsunamis form and setting up a warning system in the Indian Ocean.

“This was a momentous event both in human and scientific terms,” says Costas Synolakis, a civil engineer and tsunami researcher at the University of Southern California in Los Angeles. “It was a failure of the entire hazards-mitigation community.”

As relief efforts continue, scientists are traveling to the ravaged coasts to survey how far inland the water ran up at different points along the shorelines, how tall the waves were, and how fast they hit. In addition to providing a detailed picture of the event, says Philip Liu, a tsunami expert at Cornell University who is flying to Sri Lanka this week, information from these field surveys will enable researchers to test computer models that simulate the propagation of tsunami waves and the pattern of flooding when they break upon the shore. The geographical span of the disaster presents an opportunity to “run simulations on a scale that has not been possible with data from smaller tsunamis in the Pacific,” says Synolakis, who is joining Liu in Sri Lanka.

Among other surveys being conducted in the region is one led by Hideo Matsutomi, a coastal engineer at Japan’s Akita University, who is studying the disaster’s effects on Thailand’s shoreline.

Testing and refining tsunami models would increase their power to predict future events—not just in the Indian Ocean but elsewhere, too, says Vasily Titov, an applied mathematician and tsunami modeler at the Pacific Marine Environmental Laboratory in Seattle, Washington. Synolakis says the goal is to be able to predict, for any given coast with a given topography, which areas are most vulnerable and thus in greatest need of evacuation.

Such predictions would be easier to make if ocean basins resembled swimming pools and continents were rectangular-shaped slabs with perfect edges. But the uneven contours of sea floors and the jagged geometry of coastlines make tsunami modeling a complex engineering problem in the real world, Titov says. Exactly how a tsunami will travel through the ocean depends on factors including the intensity of the earthquake and the shape of the basin; how the waves will hit depends, among other factors, on the lay of the land at the shore.

What makes tsunami warnings even more complicated, Synolakis says, is that undersea quakes of magnitudes as great as 7.5 can often fail to generate tsunami waves taller than 5 centimeters. “What do you do without knowing precisely where and when the waves will strike and if they will be tall enough to be a threat?” he says. “Do you just scare tourists off the beach, and if nothing comes in, say, ‘Oh, sorry?’”

It wasn’t concerns about issuing a false alarm, however, that prevented scientists in India, Sri Lanka, and the Maldives from alerting authorities to the tsunami threat. Instead, researchers say, the reason was near-total ignorance. At the National Geophysical Research Institute (NGRI) in the south Indian city of Hyderabad, for example, seismologists knew of the earthquake within minutes after it struck but didn’t consider the possibility of a tsunami until it was too late. In fact, at about 8 a.m., an hour after the tsunami had already begun its assault on Indian territory by pummeling the islands of Andaman and Nicobar some 200 km northwest of the epicenter, institute officials were reassuring the media that the Sumatran event posed no threat to the Indian subcontinent.

About the same time, in neighboring Sri Lanka, scientists at the country’s only seismic monitoring station, in Kandy, reached a similar conclusion. “We knew that a quake had occurred—but on the other side of the ocean,” says Sarath Weerawarnakula.
director of Sri Lanka’s Geological Survey and Mines Bureau, who hurried to his office that morning after feeling the tremors himself. “It wasn’t supposed to affect us.”

Walls of water crashing onto the Indian and Sri Lankan coasts soon proved how wrong the scientists were. The waves flung cars and trucks around like toys in a bathtub and rammed fishing boats into people’s living rooms. “We’d never experienced anything like this before,” says NGRRI seismologist Rajender Chadha. “It took us completely by surprise, and it was a terrible feeling.”

The international scientific community fared somewhat better at reacting to the quake, but not enough to make a difference. An hour after the quake, the Pacific Tsunami Warning Center (PTWC) in Ewa Beach, Hawaii—which serves a network of 26 countries in the Pacific basin, including Indonesia and Thailand—issued a bulletin identifying the possibility of a tsunami near the epicenter. But in the absence of real-time data from the Indian Ocean, which lacks the deep-sea pressure sensors and tide gauges that can spot tsunami waves at sea, PTWC officials “could not confirm that a tsunami had been generated,” says Laura Kong, director of the International Tsunami Information Center in Honolulu, which works with PTWC to help countries in the Pacific deal with tsunami threats.

However, some researchers say that the seismic information alone—including magnitude, location, and estimated length of the fault line—should have set alarm bells ringing. Although not all undersea quakes produce life-threatening tsunamis, the Sumatran quake—later pegged at magnitude 9.0—was “so high on the scale, you had to know that a large tsunami would follow,” says Emile Okal, a seismologist at Northwestern University in Evanston, Illinois. What may have made it difficult for officials to reach that conclusion, says Okal, was the rarity of tsunamis in the Indian Ocean: Fewer than half a dozen big ones have been recorded in the past 250 years.

But even if there had been reasonable certainty that a tsunami was building up stealthily under the waters, scientists say they are not sure what they could have done. As the morning wore on, for example, geophysicists in India realized that “a tsunami would be generated, but how it would travel and when it would strike—we simply had no clue,” says Chadha.

That’s exactly the kind of information that countries in the region hope to have the next time a tsunami comes calling. The Indian government last week announced plans to spend $30 million to set up a tsunami warning system within the next 2 years; Indonesia and Thailand have since announced similar plans of their own. Like those in the Pacific, the proposed warning systems will include up to a dozen deep-sea buoys to detect pressure changes that occur as an earthquake’s energy travels through the ocean and tide gauges to measure rise and fall in sea level.

Kapil Sibal, minister of state for science and technology and ocean development, says India plans to collaborate with Indonesia, Thailand, and Myanmar to eventually build a tsunami warning network in the region. “We’ve been jolted hard, and we’ll take remedial action,” Sibal says.

—Yudhijit Bhattacharjee
With reporting by Pallava Bagla in New Delhi.

VIROLOGY

Chemokine Gene Number Tied to HIV Susceptibility, But With a Twist

Like a long-married couple, a virus and its host shape each other in subtle yet profound ways. AIDS researchers investigating this dynamic have detected several changes in both HIV and humans that likely evolved during the high-stakes wrestling match between the virus, the cells it infects, and the immune system. Now a massive review of DNA from more than 5000 HIV-infected and uninfected people has found that the human genome appears to have responded to the virus by stockpiling extra copies of immune genes that influence a person’s HIV susceptibility as well as the course of disease in infected people. These findings may lead to an important practical advance: better designed AIDS vaccine studies.

Described in the 6 January Science Express (www.sciencemag.org/cgi/content/abstract/1101160), the DNA analysis focuses on a gene with the ungainly name of CCL3L1. Steven Wolinsky, a virologist at Northwestern University Medical School in Chicago, Illinois, whose lab also has studied the relationship between immune genes and HIV, calls the work “an intellectual and technical tour de force.”

Sunil Ahuja, an infectious-disease specialist at the Veterans Administration Research Center for AIDS and HIV-1 Infection in San Antonio, Texas, led an international team that examined the importance of segmental duplications in the human genome. People typically have two copies of each gene (one from each parent), but stretches of DNA sometimes appear repeatedly, causing the overrepresentation of certain genes. Many of the segmental duplications discovered to date include genes related to immunity, inspiring the notion that some duplications protect against invaders such as viruses. Ahuja and co-workers wondered whether HIV might be the target of such an evolutionary response.

The researchers first hunted for segmental duplications that include CCL3L1 in 1000 people from 57 populations. Immune