Sounding the Alarm

Nothing can prevent a tsunami from happening—they are enormously powerful events of nature. But in many cases networks of seismic detectors, sea-level monitors and deep ocean buoys can allow authorities to provide adequate warning to those at risk. Mathematical models constructed from partial differential equations use the generated data to determine estimates of the speed and magnitude of a tsunami and its arrival time on coastlines. These models may predict whether a trough or a crest will be the first to arrive on shore. In only about half the cases (not all) does the trough arrive first, making the water level recede dramatically before the onslaught of the crest.

Mathematics also helps in the placement of detectors and monitors. Researchers use geometry and population data to find the best locations for the sensors that will alert the maximum number of people. Once equipment is in place, warning centers collect and process data from many seismic stations to determine if an earthquake is the type that will generate a dangerous tsunami. All that work must wait until an event occurs because it is currently very hard to predict earthquakes. People on coasts far from an earthquake-generated tsunami may have hours to take action, but for those closer it's a matter of minutes. The crest of a tsunami wave can travel at 450 miles per hour in open water, so fast algorithms for solving partial differential equations are essential.

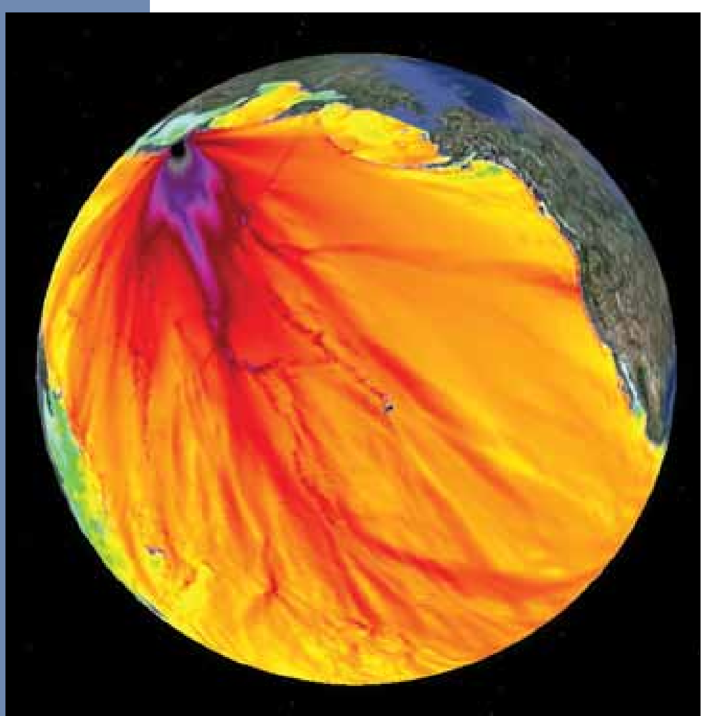

Image: Maximum wave amplitude plot for March 11, 2011 tsunami, © Google. Data: SIO, NOAA, U.S. Navy, NGA, GEBCO; Image: IBCAO.

For More Information: "Surface Water Waves and Tsunamis," Walter Craig, *Journal of Dynamics and Differential Equations*, Vol. 18, no. 3 (2006), pp. 525-549.