

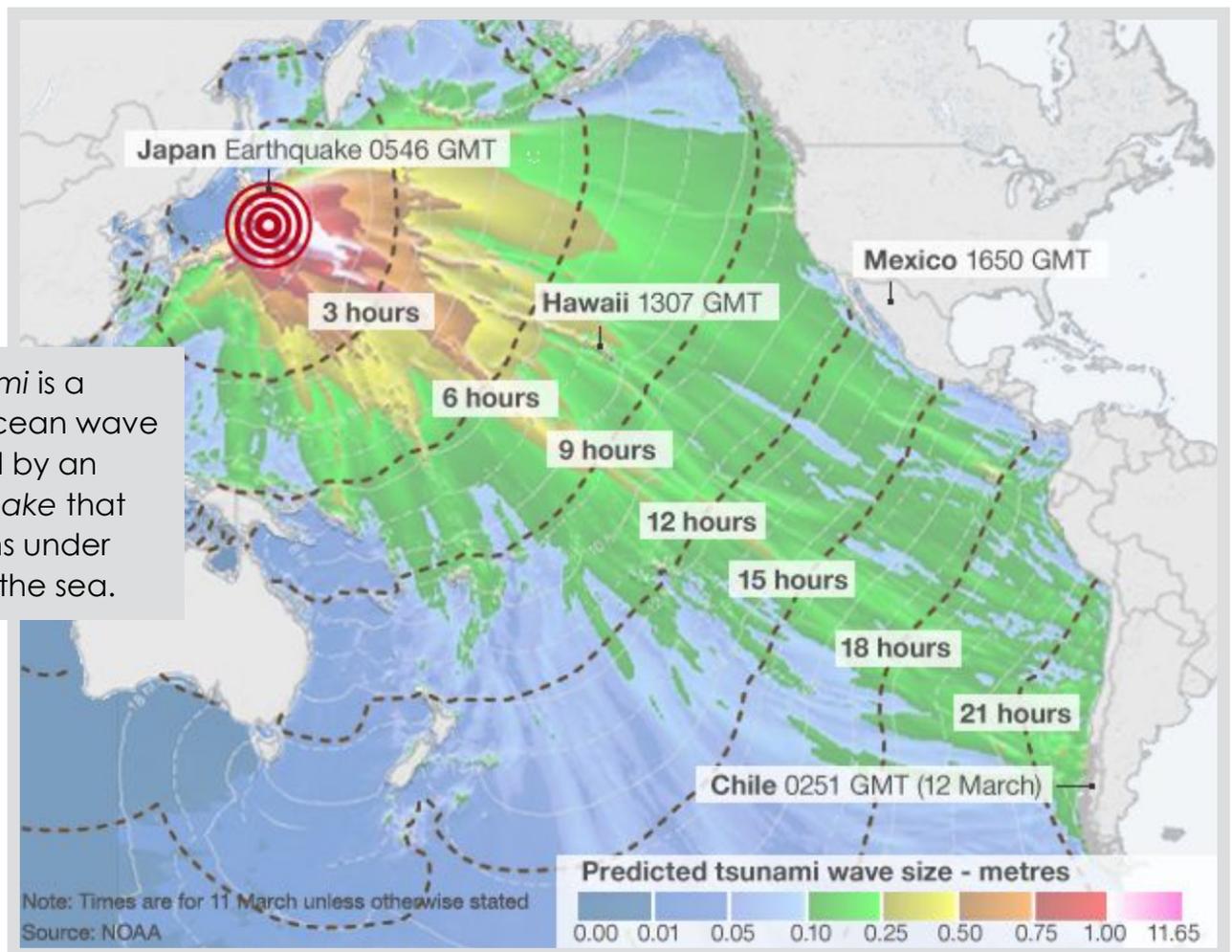
TSUNAMI: Japan Tsunami of 2011

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The 2011 Great Tohoku Earthquake near the coast of Japan created a tsunami that sent destructive waves traveling across the Pacific Ocean.

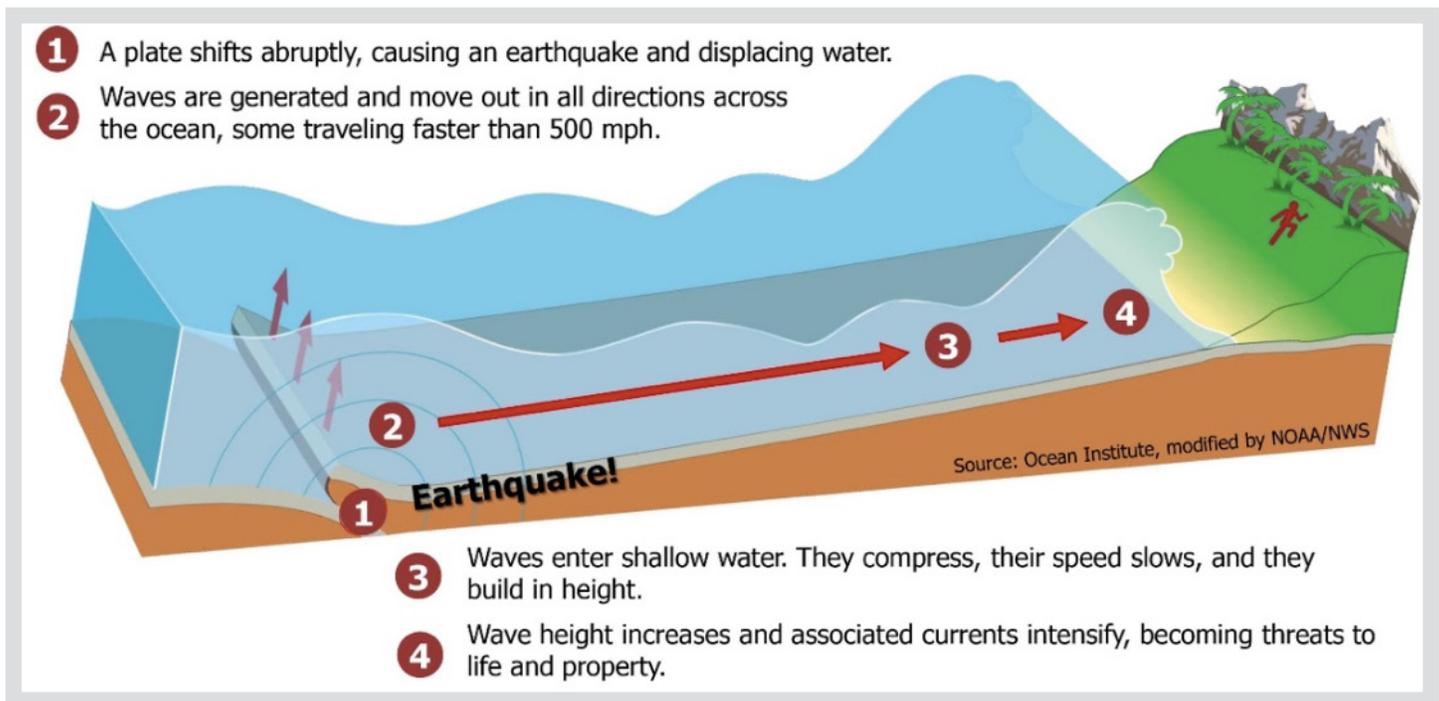
The Tsunami Began in Northern Japan

On March 11, 2011, a 9.1 *earthquake* occurred near Japan, shifting the earth 200 feet along a fault line under the sea. The epicenter was located 45 miles east of the city of Sendai out in the Pacific Ocean. It was almost 3:00 in the afternoon when the *earthquake* started, and the shaking lasted for 6 minutes. Only 22 minutes later, the first Japanese towns were struck by a *tsunami*. As time went on, more towns along the Japanese coastline and countries around the Pacific Ocean were visited by the *tsunami*.



A tsunami is a large ocean wave created by an earthquake that happens under or near the sea.

Japan Earthquake: Wave Forecast Map. <https://www.bbc.com/news/world-asia-pacific-12715415> (accessed March 9, 2020)



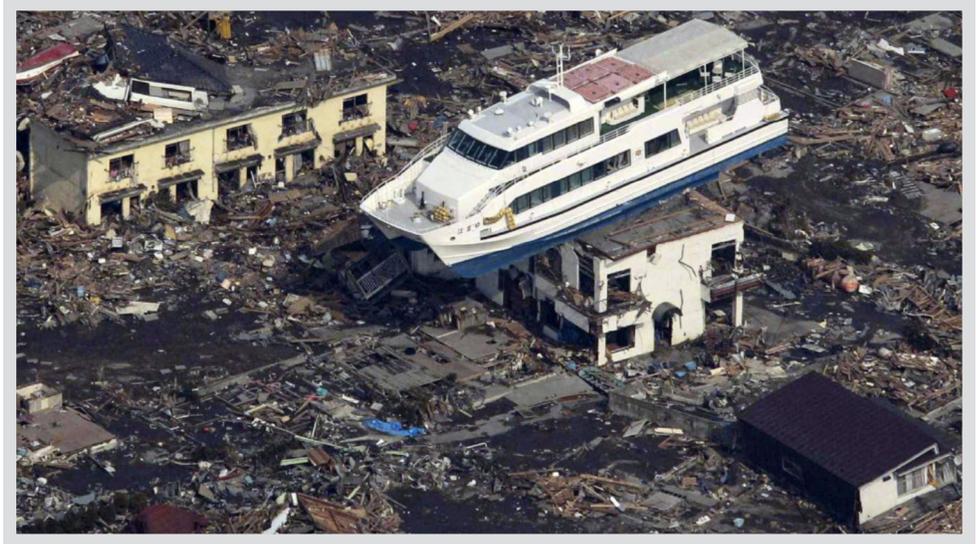
How a *Tsunami* Works. Image from National *Tsunami* Hazard Mitigation Program, 2019; <https://nws.weather.gov/nthmp/guide/> (accessed July 27, 2020)

Most people in the towns along the coast of Japan felt safe from a *tsunami*. After a *tsunami* wave hit Japan's coast in 1960 from an *earthquake* that happened in Chile, the town officials created *levees*. A *levee* is a high sea wall built to hold back large sea waves. The *levees* that were built were 10–16 feet tall, which would have been tall enough to protect the towns from waves of the same height as the 1960 *tsunami*. Many towns also had designated *tsunami* survival centers, some located in school buildings. When the people of Japan felt the 2011 Tohoku *earthquake*, many ran to the survival centers. They expected a *tsunami* wave would follow, and it did! However, the 2011 *tsunami* waves reached heights as tall as 128 feet, easily went over the *levees*, and traveled up to 5 miles inland. These waves wiped away the



Tsunami waves hit the coast of Minamisoma on March 11, 2011. Photo by Sadatsugu Tomizawa. <https://www.theatlantic.com/photo/2016/03/5-years-since-the-2011-great-east-japan-earthquake/473211/> (accessed March 10, 2020).

A yacht sits on top of a building following the March 11 tsunami. <https://www.npr.org/2011/03/18/134527591/millions-of-stricken-japanese-lack-water-food-heat> (accessed March 11, 2020)



coastal towns, including many evacuation centers. It quickly became apparent that the places where the townspeople had rebuilt from the 1960 tsunami were not in safe enough locations for larger tsunami waves created by nearby offshore earthquakes. Most people that survived the wave did so by quickly climbing to the highest buildings and hills they could find. The earthquake and tsunami caused more than 18,000 deaths and over 2 billion dollars of damage in Japan (National Tsunami Hazard Mitigation Program, 2019).

The Tsunami Reaches California

Tsunami waves from the 2011 Great Tohoku Earthquake also caused damage in many places around the Pacific Ocean, including California. The tsunami waves reached California in about 10 hours, traveling at over 500 mph in the open ocean, about the speed an airplane flies. The tsunami did not cause a lot of flooding on dry land in California because the waves were much smaller here than the large waves in Japan, but even the smaller waves can still cause a lot of damage. In California, the tsunami damaged boats, docks, and other



Strong currents from the 2011 Japan Tsunami cause damage in the Port of Santa Cruz (Image from CGS Note 55, Photo courtesy of Santa Cruz Port District)

The March 11, 2011, Tohoku *tsunami* causes a lot of damage to many ships and docks in Crescent City Harbor in California. A number of ships sank within the harbor. Photograph by Rick Wilson, California Geological Survey. <https://archive.usgs.gov/archive/sites/sound-waves.usgs.gov/2013/10/research.html> (accessed July 27, 2020)



equipment in harbors statewide. One person in California died during this *tsunami* because he walked too close to the ocean while the strong *tsunami* waves were still moving near the shore.

Nature Warns of an Approaching *Tsunami*

There were a couple of natural warning signs that people observed which let them know that a *tsunami* was going to happen. First, people near the coast in Japan felt the ground shaking when the *earthquake* happened. Second, some people saw that the water along the shore was heading back out to sea, leaving the ocean floor near the beach area exposed. (Sometimes, a *tsunami* wave pulls the water out to sea before it rushes back towards land.) Another natural warning sign that a *tsunami* is coming is hearing an unusually loud sound like the water “roaring” (louder than regular ocean waves sound when you visit the beach). If any or all of these things happen, move away from the ocean and go to high ground (hills or high buildings if possible) as fast as you safely can. Don’t wait for all of the warning signs to occur; any one may indicate *tsunami* danger.

***Tsunami* Hazard Risk in California**

Although *tsunamis* are rare, their consequences can be highly destructive, often leading to years of recovery to coastal communities. The resulting inland floods from a *tsunami* can be as dangerous as storm flooding that typically occurs across the state. The difference is little to no warning from the epicenter of the *tsunami*. In California, *tsunami* waves can vary from 3 to 50 feet high along the coast.

