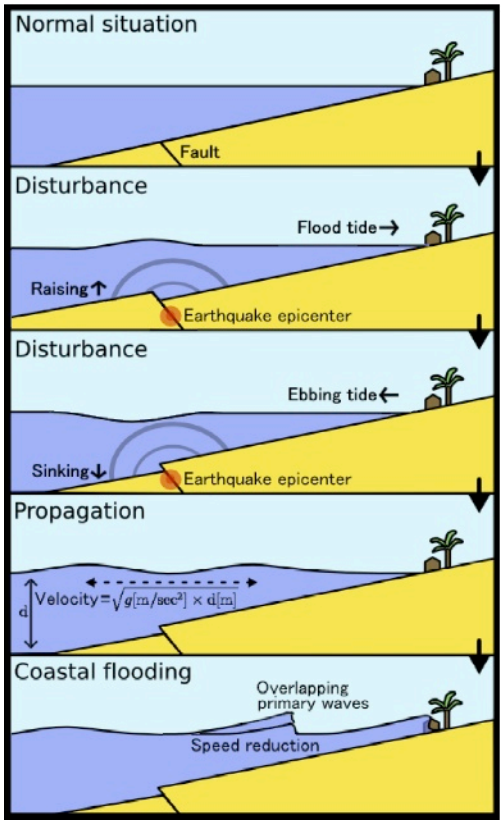
Tsunamis in a Nutshell

A guide for journalists prepared by the Science Media Centre of Canada.

This is part of the Science in a Nutshell series produced by the SMCC. It offers a simple explanation of the science of tsunamis.

What creates the great waves?

Tsunamis are powerful, deadly waves that can devastate coastal areas. Tsunami (pronounced “tsoo-nah-mee”) means “harbour wave” in Japanese.



Tsunamis are generated by earthquakes, landslides, volcanic eruptions, explosions and—in rare instances—incoming space rocks. They are long ocean waves that radiate outwards from the disturbance zone.

Most tsunamis are caused by undersea earthquakes. As tectonic plates collide or grind against each other, the seafloor buckles and heaves, shifting the seawater above it. On December 26, 2004, magnitude 9.0 earthquake off northwestern Sumatra caused the most catastrophic tsunami on record. Waves up to 30 meters high inundated coastal areas around the Indian Ocean killing an estimated 300,000 people.

Submarine landslides, which often accompany earthquakes, can also trigger tsunamis. A magnitude 7.2 tremor in 1929 sent sediment down the Laurentian slope off the south-east coast of the Grand Banks, triggering the "Grand Banks" disaster. The tsunami waves—as high as 7 metres—destroyed homes, docks and boats when they hit coastal communities in southern Newfoundland 2.5 hours after the quake. Twenty-eight lives were lost and 10,000 people were left homeless.

Scientists say the city-sized asteroid impact believed to have killed off the dinosaurs 65 million years ago also kicked up enormous tsunamis.

How fast and how high?

Tsunamis can travel as fast as a commercial jet, racing across oceans at speeds of more than 800 km/h. At sea the waves are usually less than one metre high and their crests can be more than a hundred kilometres apart. From the air, they can be virtually indistinguishable from the normal ocean waves.

The topography of the ocean floor transforms the waves into dangerous tsunamis. As the ocean becomes shallower near the coast, the waves slow down and increase in height, rising to as much as 30 metres. Tsunami waves also grow as they race up inlets. In March 1964, a magnitude 9.2 earthquake in Alaska sent waves racing across the Pacific Northwest towards Japan, Hawaii and Australia at speeds of 830 km/h. When the tsunami hit the west coast of Vancouver Island the waves slowed to about 50 km/h and grew to more than four metres as they funneled up the narrow inlet towards the town of Port Alberni where they washed away cars, houses and boats.

The highest tsunami ever recorded occurred in Lituya Bay, a fjord off the Alaska Panhandle in July 1958. It measured 524 metres. (The CN Tower in Toronto measures 553 metres.) This “mega-tsunami” was generated by several events that followed a magnitude 8.3 earthquake, including a rockslide, movement along the fault, the sudden drainage of a lake beneath a nearby glacier and

collapsing glacial ice that occurred after an earthquake. Two of the three fishing boats anchored at the entrance of the Lituya Bay managed to ride out the great waves.

Forecasting and fortifying

Tsunami warning systems now operate in the Pacific, Indian, and Atlantic Oceans. Computer models can calculate whether an earthquake has the potential to trigger a tsunami. But to add certainty, scientists have deployed a growing network of deep ocean sensors and surface buoys that measure the movement of the sea floor and wave height. The data are relayed via satellite back to tsunami warning centres. As tsunami waves propagate across the ocean and hit the deep ocean sensors, warning centres refine their estimates of when the waves will hit and how big they will be. Warnings are issued using short text messages, e-mail, radio and public announcement systems.

Warning systems can offer plenty of advance notice for locales that are far enough away from the source region. If a large earthquake (magnitude 9.0) hit the west coast of Canada and the United States, people in Japan would have more than 12 hours before a tsunami arrived, giving them time to evacuate areas likely to be affected.

Most research and planning are aimed at improving forecasts and evacuation plans for at-risk communities from Thailand to Chile to Canada's west coast.

Canada's Pacific coast is at risk of tsunamis from both local and distant earthquakes. Megathrust earthquakes (approx. magnitude 9.0) strike the Pacific Northwest coast between Vancouver Island and California on average every 500-600 years.

It is believed that the last giant quake on the Pacific Northwest in January 1700 sent a tsunami racing across the pacific. Waves several meters high hit a long stretch of Japan's coast. Even bigger waves are believed to have slammed into the Pacific Northwest coast less than 30 minutes after the giant tremor occurred. Native oral history recalls a coastal village being destroyed.

For more information:

* International Tsunami Information Centre: http://ioc3.unesco.org/itic/

* Natural Resources Canada's information on tsunamis: http://earthquakescanada.nrcan.gc.ca/info-gen/tsunami-eng

* Department of Fisheries and Oceans' Tsunami research in Canada: http://www.pac.dfo-mpo.gc.ca/science/oceans/tsunamis/index-eng.htm

* NOAA Center for Tsunami Research, Deep Ocean Assessment and Reporting of Tsunamis (DART): http://nctr.pmel.noaa.gov/Dart/

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