TSUNAMIS

2017 YEAR OF RISK

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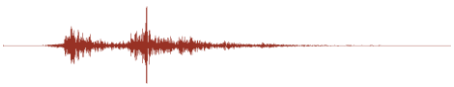
Image above: US navy helicopter flying over Tōhoku in 2011
Image centre: Warning sign for tsunami zone
Image left: Indonesia one week after the 2004 Boxing Day tsunami

A tsunami is a type of tidal wave caused by sudden movements of water (displacement). They can reach speeds of up to 800 km/h, grow to over 30 m in height and travel right across the Pacific. They are one of the world's most dangerous natural disasters, having calamitous effects on coastal communities.

Causes

Water can be displaced in a number of ways but the three most common causes of large tsunamis are:



Earthquakes

An earthquake is caused by the movement of tectonic plates on the Earth's surface. At its epicentre (point on the Earth's surface where the earthquake hits), there is often a great deal of movement in the ground, both side to side and up and down. If the earthquake occurs under water, this up and down movement pushes the water out from the epicentre, which then becomes a tsunami. Some earthquake fault lines do not generate tsunamis as often as others, such as the underwater sections of the San Andreas Fault. This is because their movement is mostly side to side and so not as much water is displaced.

Date	Location	Cause	Height (m)	Deaths
17 June 2017	Greenland	Landslide	90	4
21 July 2014	Iceland	Landslide	20-30	0
11 Mar 2011	Japan	Earthquake	40	18,500
29 Sep 2009	Samoa	Earthquake	14	189
26 Dec 2004	Indian Ocean	Earthquake	33	230,210
17 July 1998	Papua New Guinea	Earthquake	15	2,200
12 July 1993	Japan	Earthquake	30	197
18 May 1980	Washington, US	Volcano	250	0

The largest tsunamis of the last 50 years.

Volcanoes

Volcanic eruptions underwater can also cause tsunamis. In these cases, the force of the explosions (when magma mixes with water, steam explosions occur), volume of rock erupted and associated earthquakes can all cause tsunamis. The blast can also cause parts of the volcano itself to collapse. This collapsed material can fall into lakes, causing tsunamis. This was the case in 1980 when Mount St. Helens erupted in Washington, US.

Landslides

Tsunamis can be caused by both landslides both on land (terrestrial) and under the sea (marine), though tsunamis caused by terrestrial landslides tend to be in lakes and therefore cause less damage. Underwater landslides can be much larger. 8200 years ago, a tsunami triggered by a landslide off the coast of Norway (called the Storegga slide) left a 2 m thick layer of rocks dumped by the tsunami – tsunamiite - along the coastline of east Scotland.
The wave was 21 m high.

DID YOU KNOW?

Another possible cause of tsunamis is meteorite impact. The K-T meteorite, one of the potential reasons for the extinction of the dinosaurs and the cause of the Chicxulub impact crater, generated a 100 m high tsunami when it landed in the shallow sea in south east Mexico. Deposits of this wave are found all around the Caribbean islands. Scientists think that the wave would have been much larger had the meteorite landed in deeper water.

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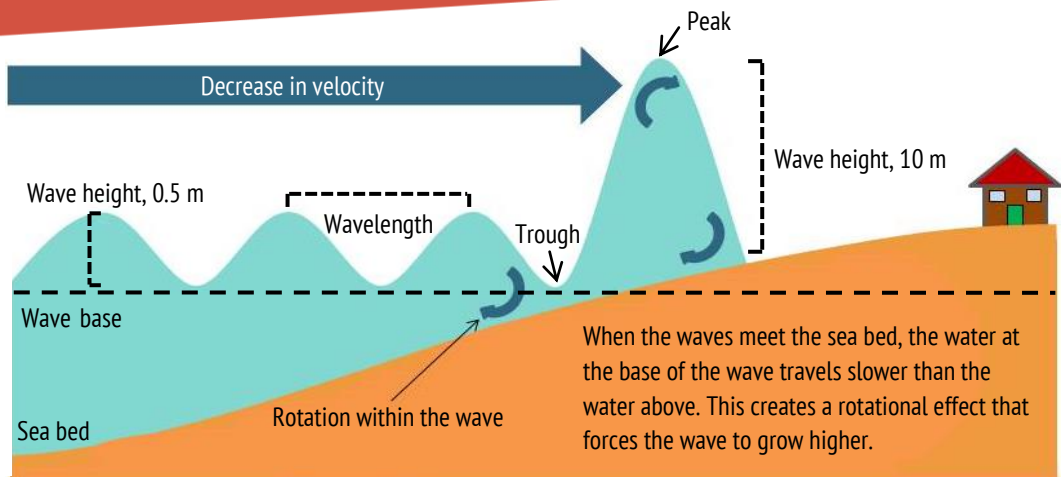

How do tsunamis become so large?

When they first form, tsunamis are not usually very tall. In fact, waves that are over 10 m high on the shore can often be only 0.5 m high out at sea. This makes predicting incoming tsunamis a lot more difficult, as potentially dangerous waves are often too small for satellites to pick up.

So why do they grow? In the ocean, tsunamis can travel up to 800 km/h, slightly slower than a commercial aeroplane. However when they reach shallow water near the coast, the sea bed meets the wave base, forcing the wave to slow down. Along shorelines, tsunamis can slow down to 50 km/h, 6% of its original speed. Since the energy is no longer able to move forwards, it instead pushes the wave upwards, increasing the height. At the same time, the drag created by the shore line causes the front of the wave to rotate inwards so that the front of the wave is slower than the back. This causes the water to pile up through the rotation of the wave – as depicted in the figure at the top of this page.

DID YOU KNOW?

Waves consist of troughs, high points peaks and and low points. When a tsunami occurs, it is always the trough that reaches the shore first. This means that before a tsunami actually hits, there is a period of low tide which exposes the sea floor. This can alert people that a tsunami is coming!

Flooding in Indonesia after the 2004 tsunami

Prevention

Once a tsunami starts, it cannot be stopped. This is why the focus of preventing the damage from tsunamis is still on warning systems: the best method of surviving a tsunami is running to high ground. However there are ways to reduce risks.

- Buildings can be built on reinforced concrete 'stilts' to raise them out of flood waters after a tsunami.
- Tall platforms can be constructed along coastlines for people to reach high ground quickly.
- Planting trees along coastlines help as the trees help to break apart the wave before it reaches homes.
- Education is key. If people know how to react to a tsunami warning, they are much more likely to be safe. This is why the location of the tsunami source is so crucial to survival, if the cause is far out to sea, people can have hours to prepare but if it is just off the coast, there may be only minutes.

Warning Systems

In 1949, the American National Ocean and Atmosphere Administration opened the Pacific Tsunami Warning Centre. It is based on Hawaii and was designed to predict tsunamis around the north Pacific. The site uses a mixture of seismic (earthquake) and oceanographic data to try and predict whether or not a tsunami will strike. Though it is providing good data, earthquakes will not always cause a tsunami - if it is side to side movement, for instance – and so they are often wrong. In fact, 75% of the evacuations they have called have been unnecessary.

More recently, the DART programme (Deep-ocean Assessment and Reporting of Tsunami), set up in 2004, uses a seafloor pressure reader and a surface buoy. The pressure reader measures minute changes in surface water and the buoy sends that data to a satellite. This method has been adopted globally, with arrays of buoys across the Indian and Pacific oceans owned by the US, Australia, India, Chile, Indonesia and Thailand.

'The Great Wave', a famous Japanese woodblock painting which depicts the sea around Mt. Fuji, seen in the background. Katsushika Hokusai, c. 1829 - 1833

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