

Tsunami

What is a Tsunami?

A tsunami is an ocean wave that is generated by a sudden displacement of the sea floor. Tsunami is the Japanese word for "harbor wave." Although they are sometimes mislabeled "tidal waves", they have nothing to do with tides.

The wavelengths (the distance from wave peak to wave peak) of tsunamis typically exceed 200 kilometers. The first wave is not necessarily the biggest wave. The first wave can be mild, with the second or third wave causing severe damage.

What causes Tsunamis?

Tsunamis are usually caused by earthquakes that occur on the sea floor or in the coastal areas. Volcanic eruptions, sub-marine landslides, underwater explosions and human activity may also cause tsunamis.

The energy generated

by the earthquake transmits through the water. In deep oceans, the seismic waves are unnoticeable until the energy of the wave reaches the shallow waters of coastlines. When it approaches the bays, harbors or coastline, the water is forced into a giant wave and may reach as high as 100 feet or more. Wave action is the main source of damage and the loss of life caused by tsunamis. Other sources of damage include strong currents and debris acting as projectiles.

Where do Tsunamis Happen?

Tsunamis and tsunamigenic earthquakes are particular hazards for the Pacific Ocean islands and locations around the Pacific Rim. Hawaii is especially vulnerable to dangerous tsunamis because of its central location in the path of waves generated at many seismically active points around the Pacific Rim. Tsunamis occur less commonly along the Caribbean, Atlantic Ocean, and Mediterranean Sea.

Tsunami Warning Centers

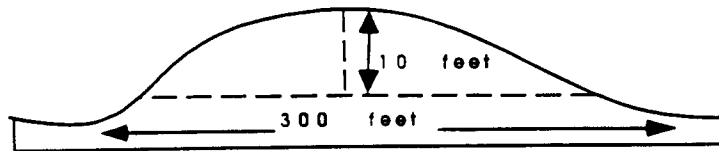
Predicting tsunamis focuses on both identifying earthquakes that are likely to generate tsunamis and on estimating the travel times of tsunamis across the ocean basin. Regional warning systems around the Pacific Rim have been very effective at minimizing the loss of life from tsunamis. The success of local warning systems depends heavily on emergency operations planning, as well as on access to timely information about earthquake occurrences and water levels. Other important factors are the ability of local authorities to assess the danger, the ability to disseminate information very quickly, and the education of the public to respond appropriately in the event of a tsunami emergency.

Early warning systems in the Pacific Ocean basin make use of information relayed from the seismic stations to tsunami warning stations via NOAA (National Oceanographic and Atmospheric Administration) satellites.

Physics of the Wave

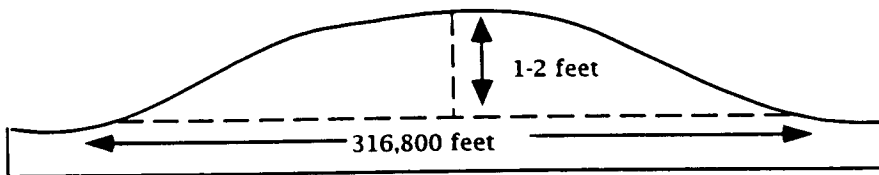
Regular wind generated wave

Speed: 10-20 mph



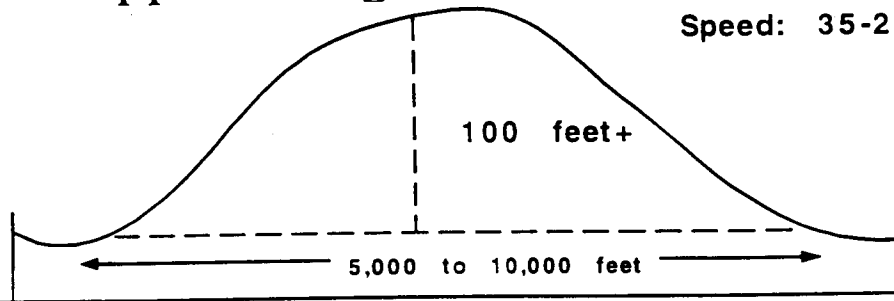
Tsunami in the Deep Ocean

Speed: 450-650 mph



Tsunami approaching shore

Speed: 35-220 mph



Activities

Tsunami Experiment

Materials:

- Plastic cake pan
- 16 oz. water or Rheoscopic fluid
- scissors
- sturdy plastic wrap
- tape

Cut a hole in the bottom of the plastic cake pan approximately 4". Tape plastic wrap on the outside of the pan covering the hole, making sure it is water tight. Fill pan with fluid. Gently tap the plastic wrap on the bottom.

What happens? Why?

What happens when you change the strength of your tap?

Tsunami in Open Ocean

Speed of Propagation
(celery equation)

$$V = \sqrt{gh}$$

where v is velocity (m/s)
g is the accelerated
gravity (10 m/s²)
h is the water depth
(m)

1. If the wave depth is 3000m, what is the velocity?
2. If the water depth is less deep, only 50m, what is the velocity? How does this compare? Is this faster or smaller than a wave in deep water?
3. If the velocity is 15 m/s what is the depth of the water?

Words to Know:

Velocity

Wave Speed

Wavelength

Discussion Questions:

1. *How fast can tsunamis travel?*
2. *What are typical tsunami wavelengths and periods?*
3. *What causes tsunamis?*
4. *As wavelength increases, what happens to wave velocity?*
5. *Which change will cause ocean waves to be more powerful; doubling their wavelength or their height?*
6. *Imagine you live in a coastal community that is susceptible to tsunamis. What should your community do to minimize the potential damages and loss of life?*
7. *Discuss the role of beach sand in providing protection from waves.*

Major Historical Tsunamis

<i><u>Date</u></i>	<i><u>Location</u></i>	<i><u>Death Toll</u></i>
<i>1628 BCE</i>	<i>*Santorini Island, Aegean Sea</i>	<i>Destroyed Minoan Civilization</i>
<i>497 BCE</i>	<i>Potidaea, Greece</i>	<i>?</i>
<i>1293 CE</i>	<i>Sanriku Coast, Japan</i>	<i>30,000</i>
<i>1703 CE</i>	<i>Sanriku Coast, Japan</i>	<i>approx. 100,000</i>
<i>1737 CE</i>	<i>Kamchatka, Russia</i>	<i>?</i>
<i>1755 CE</i>	<i>Lisbon, Portugal</i>	<i>approx. 10,000</i>
<i>1815 CE</i>	<i>*Tamboro, Indonesia</i>	<i>12,000</i>
<i>1868 CE</i>	<i>Chile and Peru</i>	<i>25,000</i>
<i>1883 CE</i>	<i>*Karakatoa, Indonesia</i>	<i>36,000</i>
<i>1896 CE</i>	<i>Sanriku Coast, Japan</i>	<i>27,000</i>
<i>1933 CE</i>	<i>Sanriku Coast, Japan</i>	<i>3,000</i>
<i>1946 CE</i>	<i>Hilo, Hawaii</i>	<i>173</i>
<i>1960 CE</i>	<i>Pacific</i>	<i>200</i>
<i>1964 CE</i>	<i>Pacific</i>	<i>122</i>
<i>1976 CE</i>	<i>Philippines</i>	<i>3,000</i>
<i>1978 CE</i>	<i>Acajutla, Ecuador</i>	<i>100</i>
<i>1992 CE</i>	<i>Nicaragua</i>	<i>116</i>
<i>1992 CE</i>	<i>Indonesia</i>	<i>1000</i>
<i>1993 CE</i>	<i>Sea of Japan</i>	<i>100</i>

All of these tsunamis were caused by earthquakes except for the three with asterisks (*), which were caused by volcanoes.