Tsunami **Frequently Asked** Questions

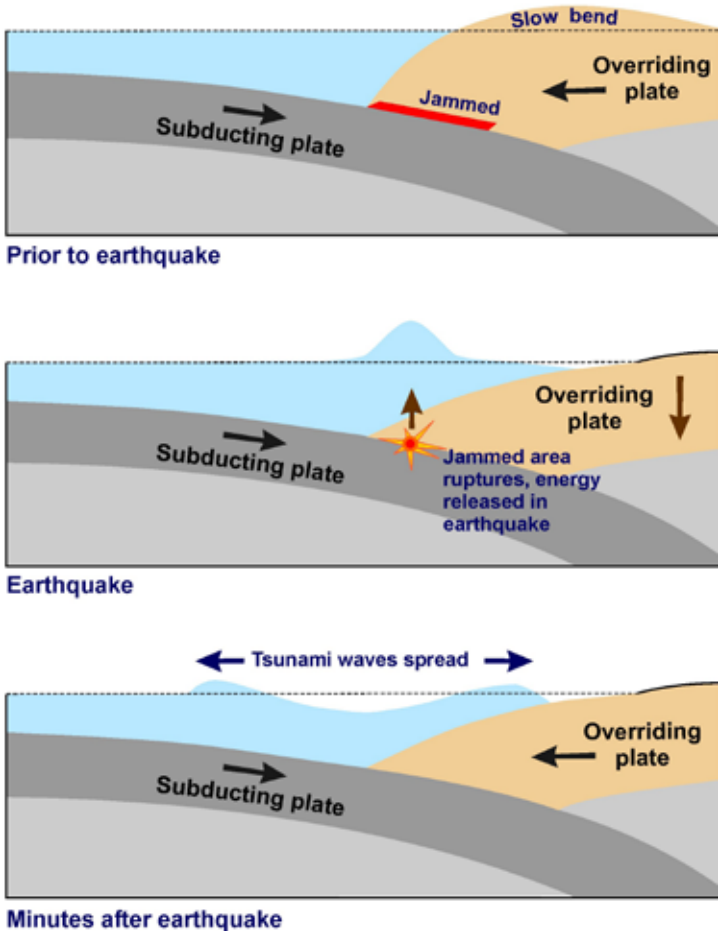
What is a Tsunami?

The name Tsunami, from the Japanese words *tsu* meaning harbour and *nami* meaning wave, is now used internationally to describe a series of waves travelling across the ocean. These waves have extremely long wavelengths, up to hundreds of kilometres between wave crests in the deep ocean.

In the past, tsunami have been referred to as "tidal waves" or "seismic sea waves". The term "tidal wave" is misleading. Even though a tsunami's impact upon a coastline is dependent on the tidal level at the time a tsunami strikes, tsunami are unrelated to the tides. Tides result from the gravitational influences of the moon, sun, and planets. The term "seismic sea wave" is also misleading. "Seismic" implies an earthquake-related generation mechanism. Earthquakes are only one of several ways that a tsunami can be generated. Tsunami can also be caused by events such as underwater landslides, volcanic eruptions, land slumping into the ocean or meteorite impacts.

How are tsunami generated?

The most common cause of tsunami is an undersea earthquake that results in a sudden rise or fall of a section of the earth's crust under or near the ocean. This earthquake creates an explosive vertical motion that can displace the overlying water column, creating a rise or fall in the level of the ocean above. This rise or fall in sea level is the initial impulse that generates a tsunami wave.



View of a vertical slice through a subduction zone showing how a tsunami is generated

What type of earthquake generates a tsunami?

Tsunami are typically generated by earthquakes that occur along subduction zones. A subduction zone is an area on the Earth where two tectonic plates meet and move towards one another, with one sliding underneath the other and moving down into the earth at rates typically measured in centimetres per year.

What are the characteristics of a tsunami?

Tsunami are different from normal waves

A tsunami is different from a normal ocean wave. The effects of wind-driven ocean waves are seen only near the surface of the ocean. Tsunami waves involve the movement of water all the way to the seafloor.

Tsunami have long wavelengths

In the deep ocean tsunami waves have extremely long wavelengths. In comparison to wind driven waves, tsunami waves may have wavelengths up to hundreds of kilometres between wave crests. Tsunami are therefore much more destructive than normal waves because the huge flooding body of water can continue to rush onto land for an extended period of time. This may be anything from a few minutes up to an hour, compared to seconds for wind driven waves.

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As a tsunami approaches land, the size increases

The speed and size of a tsunami is controlled by water depth. In the deep ocean tsunami waves may be unnoticed by ships or from the air. As the wave approaches land it reaches shallow water and slows down. Compared to the front of the wave, the rear is still in slightly deeper water (so it is going slightly faster) and catches up. The result is that the wave quickly 'bunches up', the wavelength becomes shorter and the body of water becomes much higher.

Tsunami are fast

In the deep ocean, a tsunami can travel at more than 800 kilometres per hour, close to the speed of a jumbo jet, and in shallow water, it can be described as roughly the speed of a fast cyclist.

Tsunami retain their energy

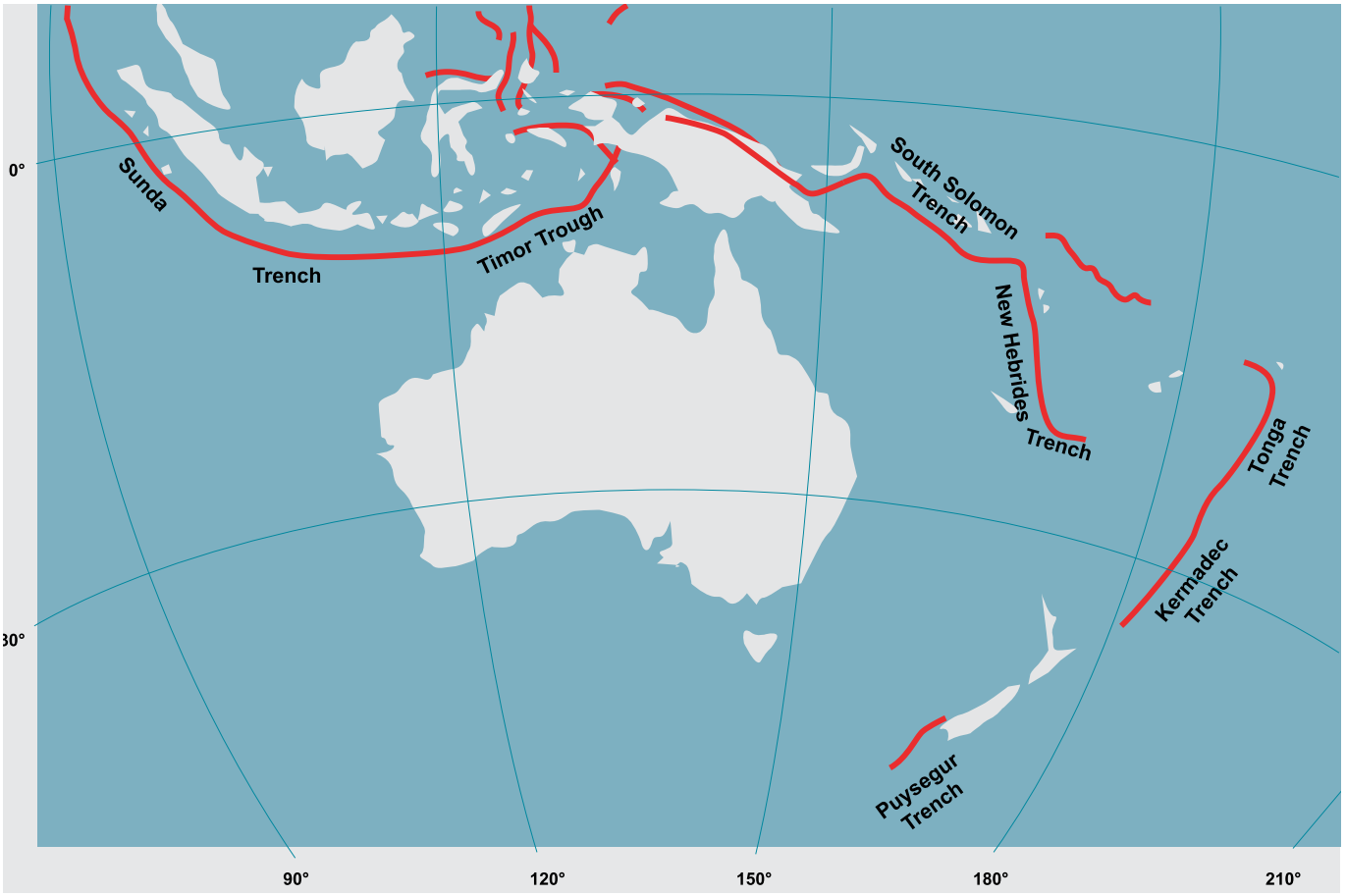
As well as travelling at high speeds, tsunami can also travel large distances with limited energy losses. Tsunami can therefore have sufficient energy to travel across entire oceans.

Tsunami waves move outwards, away from their source

The path of a tsunami is never symmetrical and is determined by a number of factors including the bathymetry of the seafloor. Bathymetry is the measurement of the depth of the ocean floor from the water surface and is the oceanic equivalent of topography. A tsunami travels faster through deep water and slower through shallow water. This directs the wave along undersea valleys. The size of the earthquake, the shape of the earthquake and the direction of the subduction zone that ruptures are also influencing factors.

A tsunami is a 'series' of waves

A tsunami generally consists of a series of waves. The amount of time between successive waves is known as the wave period. Waves can be a few minutes or over two hours apart. In most cases, the first tsunami wave is **not** the largest. Subsequent waves, sometimes the fifth or sixth, can be many times larger.



Subduction zones plate boundaries (shown in red) around Australia that have the potential to generate a tsunami that may impact on Australia's coast (source: Geoscience Australia)

Tsunami can vary in size and severity

The impact of a tsunami can vary widely. A small tsunami may result in unusual tides or currents that can be dangerous to swimmers or cause damage to berthed boats. A large tsunami can cause widespread flooding and destruction such as that seen off the west coast of Northern Sumatra on 26 December 2004. The south Java tsunami (17 July 2006) was caused by a relatively small earthquake (magnitude 7.7) that generated a 0.5 metre tsunami. This tsunami inundated the coast by up to four meters in some places, killing over 600 people.

Where and how frequently are tsunami generated?

Most tsunamis occur in the Pacific and Indian Oceans. The boundary of the Pacific Ocean, known as the Ring of Fire, experiences frequent earthquakes. There are two major subduction zones in the Indian Ocean that can also generate tsunami. The frequency of tsunami is variable across the globe and over time. Since the event of 26th December 2004 the Pacific Tsunami Warning Centre has issued 52 tsunami alerts, this has resulted in six tsunami, two of which resulted in significant loss of life.

Australia's vulnerability to tsunami

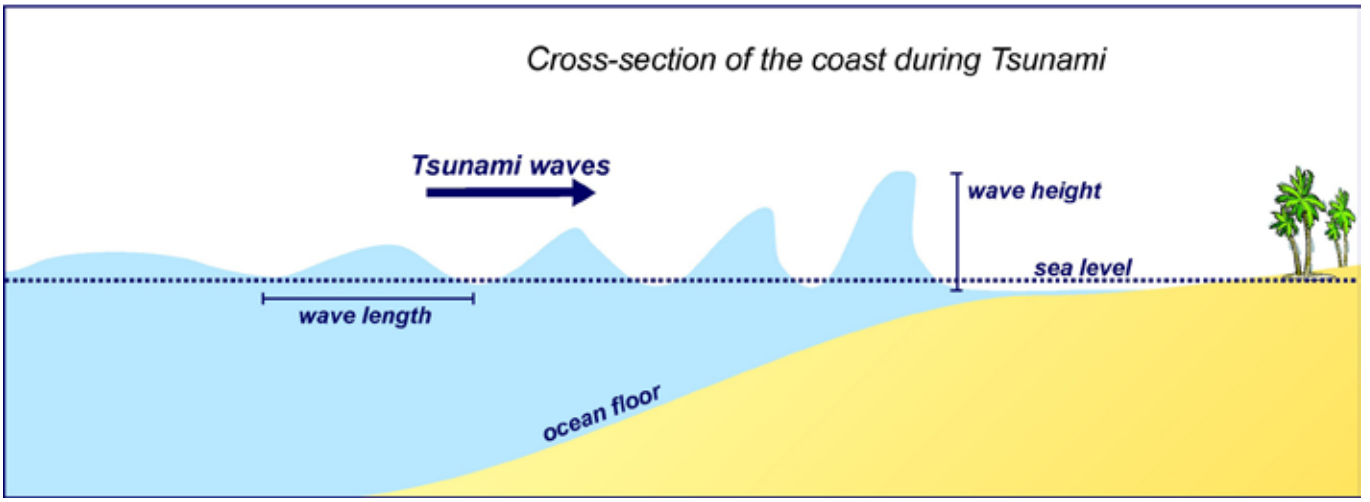
Australia is surrounded to the northwest and east by some 8,000 kilometres of active tectonic plate boundaries capable of generating tsunami, which could reach our coastline within two to four hours. One-third of earthquakes worldwide occur along these boundaries. The impact of a tsunami hitting vulnerable, low lying areas on the Australian coast could be significant.

How are tsunami detected?

Typically, earthquakes that may generate a tsunami are detected through a network of seismic monitoring stations. Any resulting tsunami are then verified by sea-level monitoring stations or deep ocean tsunami detection buoys. The seismic-monitoring stations can determine the location and depth of earthquakes that have the potential to cause tsunami. The sea-level gauges or deep ocean tsunami detection buoys then measure any abnormal changes in sea level to verify if a tsunami has been generated.

Tsunami warnings

Australia currently relies on advice of a tsunami from the Pacific Tsunami Warning Centre (PTWC, which currently provides tsunami advice for the Pacific and Indian Oceans) in Hawaii and the Japan Meteorological Agency (JMA, which currently provides tsunami advice for the Indian Ocean). This advice is then interpreted for Australia (including islands and territories) and forwarded to the State and Territory Emergency Services and the media by the Bureau of Meteorology. Australia is currently in the process of developing its own, self-reliant tsunami warning system. The Australian Tsunami Warning System (ATWS) Project is a four year project, which will conclude in June 2009, funded by the Federal Government. This is a joint project between the Bureau of Meteorology, Geoscience Australia and Emergency Management Australia.



Cross-section of the coast during a tsunami

What are the warning signs of a tsunami?

The number one warning sign of a tsunami in Australia is the advice you may receive from the media (on radio or television) or from police and other emergency services. Follow their instructions immediately.

The following are natural signs of a tsunami that you may, but not always, experience when you are near the coast in Australia or overseas. If you notice any of these three warning signs take action.

1. Evidence of a large undersea earthquake may be felt prior to a tsunami by a shaking of the ground in coastal regions.
2. As a tsunami approaches shorelines, the sea may, but not always, withdraw from the beach (like a very low and fast tide) before returning as a fast-moving tsunami.
3. A roaring sound may precede the arrival of a tsunami.

What should I do if I notice the warning signs or hear a warning from my local emergency services?

- If you are at the beach, immediately move inland or to higher ground.
- If your boat is in deep water and offshore, maintain your position.
- If your boat is berthed or in shallow water, secure your vessel and move inland or to higher ground.
- If you are on the coast and cannot move inland, seek shelter in the upper levels of a stable building.
- Do not return to the coast until you receive official clearance.
- Continue to follow emergency services instructions.

Glossary of terms

Bathymetry: The measurement of the depth of the ocean floor from the water surface and is the oceanic equivalent of topography.

Inundation: The horizontal extent of flooding from the sea.

Moment Magnitude (Mw): A measure of the energy release by an earthquake. There are a number of different scales for measuring the magnitude. The Moment Magnitude is based on the size and characteristics of the fault rupture, and can be determined from long-period seismic waves.

Run-up: The maximum height of the water onshore observed above a reference sea level. Run-up is usually measured at the horizontal inundation limit.

Seismic: Of or having to do with earthquakes.

Subduction zone: An area on the Earth where two tectonic plates meet and move towards one another, with one sliding underneath the other and moving down into the earth at rates typically measured in centimetres per year.

Wave amplitude: This is quoted as half the wave height. It should be recognised that tsunami waves are typically not symmetrical.

Wave height: The vertical distance between the trough and the crest of a wave.

Wavelength: The mean horizontal distance between successive crests or troughs of a wave pattern.

Wave period: The time taken for a one wavelength to pass a given point.

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