Tsunami alert! Run for the hills or stay by the sea?
Why does one type of earthquake produce a tsunami, whilst another does not?

Use textbook examples or news items to remind pupils of the devastation which may be caused by a tsunami. (e.g. the Indian Ocean tsunami of 26th December 2004). Point out that tsunamis are mostly caused by earthquakes under the sea. These in turn are produced by sudden movement of one massive 'block' of rocks against another, at plate margins. However, not all such earthquakes result in tsunamis. Why not?

Set up a demonstration, with a sloping plane in a shallow tank of water, as shown in Photograph 1. Model houses help to make the activity more realistic.

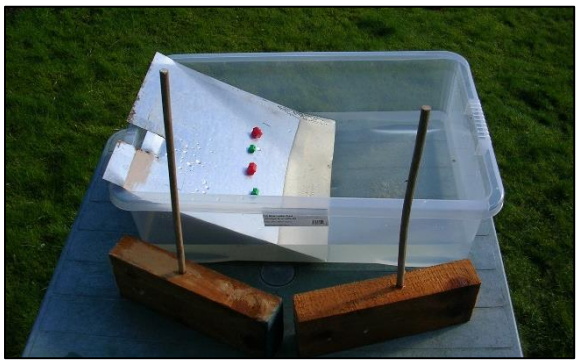


Photo 1: The apparatus, showing a sloping metal sheet with model houses in a tank of water, with two wood blocks to represent 'lithospheric plates'.

- Model the effects of movement along a strike-slip fault, by sharply sliding one block sideways against the other (Photo 2). Ask pupils to note what happens to the water surface. Is a 'tsunami wave' created, which swamps the 'houses', or not?

Photo 2: Modelling a strike-slip fault, by sharply sliding one block sideways against the other.

- Now model the effects of movement along a subduction zone, where one plate descends below another. Raise one block above the other, and then sharply push it down lower into the water (Photos 3 and 4). Ask pupils to describe the wave which this produces, and to comment on its effect on the 'land' and the 'houses'.

Photo 3: One block raised ready for a 'subduction event'

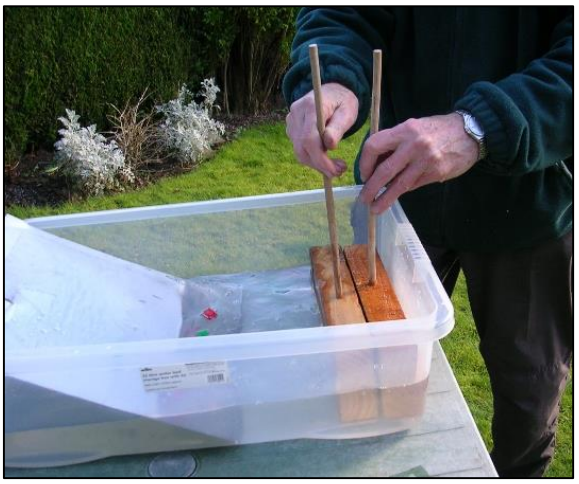


Photo 4: The aftermath of a 'subduction event', where the 'tsunami wave' swept up the slope and washed away the 'houses'.
(*Photo sequence by Peter Kennett*)

The back up

Title: Tsunami alert! Run for the hills or stay by the sea?

Subtitle: Why does one type of earthquake produce a tsunami, whilst another does not?

Topic: A demonstration of the effects of displacing water in a tank in different ways, to simulate why one type of movement can produce a tsunami wave and another may not.

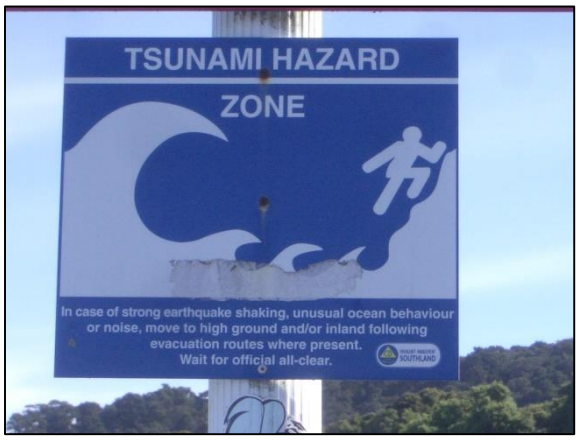
Age range of pupils: 12 – 18 years

Time needed to complete activity: 5 minutes

Pupil learning outcomes: Pupils can:
- describe how waves are generated by movement of wood blocks in water;
- explain why an up-and-down movement of wood blocks produces a wave which rises up a nearby slope;
- explain that a sideways movement of wood blocks does not produce a wave;
- explain the dangers of living on a sloping coast when a tsunami strikes.

Context: The activity may be used in the context of a science or a geography lesson, where wave motion is being considered, together with its impact on the nearby community.

Following up the activity: See the website below for some interesting information about tsunamis in general: http://facts.randomhistory.com/tsunami-facts.html and the following site for up-to-the-minute information about earthquakes from http://earthquake.usgs.gov/earthquakes/map/ or from the app. 'Earthquake Alert'.
Show pupils the photograph below, to emphasise how seriously the risk of a tsunami is taken in some communities:



A coastal road sign in South Island, New Zealand (*Photo: Chris King*)

Underlying principles:
- Tsunamis (from the Japanese 'harbour waves') are triggered by major events such as earthquakes, submarine landslides or volcanic explosions.
- When one plate is suddenly thrust down beneath another, at a subduction zone, millions of tonnes of rock can be displaced up or down on the ocean floor, in a matter of minutes, violently displacing the water mass above.
- It is estimated that, in the Indonesian earthquake of 2004, the over-riding plate was thrust up by as much as 10m, displacing the floor of the Indian Ocean upwards and creating the devastating tsunami.
- When one plate slides along against another, there is no major vertical change in the position of the rock of the sea bed. The volume of water displaced is small and little energy is transmitted into the water. A major earthquake may be produced, but a significant tsunami does not generally follow.
- A tsunami wave has kinetic energy because of its forward motion and potential energy because of its depth. As the wave enters water which is too shallow to accommodate its full depth, the wave rises above the general sea level and some potential energy is converted to kinetic energy, i.e. the wave accelerates. At the same time, the base of the wave is slowed down by friction. The wave crest overtakes the base and may then pile up to form a 'wall of water', which crashes down on the beach.

Thinking skill development:
- understanding an emerging pattern of water motion, dependent on the movement of the blocks (construction);
- reasoning behind the answers (metacognition);
- when one plate slides against another an earthquake is produced but no resulting tsunami (cognitive conflict);
- applying the findings to real situations (bridging).

Resource list:
- a large tank, preferably transparent. The one in the photographs measures 55 x 35 x 17 cm.
- a sheet of metal, or a board which can be weighted down to prevent it from floating
- two large wood blocks, with some sort of handle, so that they can be manipulated. The ones in the photograph measure 10 x 25 x 5 cm.
- model houses
- water

Useful links: Try the Earthlearningidea activities 'A tsunami through the window – what would you see, what would you feel?' and 'Tsunami – what controls the speed of a tsunami wave?'
http://www.earthlearningidea.com

Source: Written by Peter Kennett of the Earthlearningidea team, based on a demonstration by Mike Parker, at the Conference of the Earth Science Teachers' Association, September 2015.

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