# TSUNAMI ACTIVITY
# (approx 4hrs)

**Overview**

This activity will build on the knowledge students have gained through the Science Unit on earthquakes and disasters with a focus on tsunamis.

After an introduction to tsunamis and gaining an understanding of their destruction, students will experiment with tsunami waves approaching land of varying slopes to determine the affect if any on the inundation distance. Students will collect and record data at set “shoreline” angles/slopes and make predictions for variations in the angles/slopes. They will then suggest how to minimise the effects of a tsunami on a coastal area, such as dredging to change the slope of the ocean floor near the coastline, building sea walls, and planting trees (mangroves) in the ocean to prevent erosion, etc.

# THE AUSTRALIAN CURRICULUM
# CONTENT DESCRIPTORS YEAR 6 2018

Note: This activity addresses parts/all of the following descriptors.

## SCIENCE CURRICULUM

### Science Understanding

**Earth and space sciences**
Sudden geological changes and extreme weather events can affect Earth's surface (ACSSU096)

### Science as a Human Endeavour

**Nature and development of science**
Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE098)

**Use and influence of science**
Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE100)

### Science Inquiry Skills

**Questioning and predicting**
With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS232)

**Planning and conducting**
Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS103)

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS104)

**Processing and analysing data and information**
Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS107)

Compare data with predictions and use as evidence in developing explanations (ACSIS221)

**Communicating**
Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS110)

# MATHEMATICS CURRICULUM

## Measurement and Geometry

### Using units of measurement

Connect decimal representations to the metric system (ACMMG135)

Solve problems involving the comparison of lengths and areas using appropriate units (ACMMG137)

### Geometric reasoning

Investigate, with and without digital technologies, angles on a straight line, angles at a point and vertically opposite angles. Use results to find unknown angles (ACMMG141)

## Statistics and Probability

### Data representation and interpretation

Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables (ACMSP147)

Interpret secondary data presented in digital media and elsewhere (ACMSP148)

**MATERIALS LIST**

- Student Workbooks
- Video clips
    - https://video.nationalgeographic.com/video/101-videos/tsunami-101
    - https://www.youtube.com/watch?v=OQ3oXIjPmaE
    - https://www.youtube.com/watch?v=3yNoy4H2Z-o
- Plastic blanket box tubs 75cm long x 37cm width x 14cm deep (1 per group)
- 3 “slope boards” of varying lengths and 1 “land construction” with 90° edges per group
- 1 “water pusher” per group
- Access to water/1 bucket with 6L measure per group
- Blu Tack
- 1 tape measure per group
- Calculators (1 per student – student supplied
- Rulers (1 per student – student supplied)
- Coloured pencils/textas (per student – student supplied)
- A4 paper

Tsunami stations can be set up prior to first lesson to save time.

# Introduction to Tsunamis (20min)

1. Inform students that this activity will build on the knowledge they have gained through the Science Unit on earthquakes and disasters with a focus on tsunamis. *Tsunami is a Japanese word meaning 'harbour wave'.*

2. Depending on the level of tsunami content discussed in the science unit introduce students to tsunamis as follows:

(a) Access and play "Tsunami 101" videoclip from National Geographic https://video.nationalgeographic.com/video/101-videos/tsunami-101 (2min 42s)

(b) Ask students to recap the information presented in the clip. (Tsunamis are caused by sudden displacement of ocean water as a result of volcanoes, landslides, meteorites or earthquakes. Waves can travel up to 600mph / 965kph; when the wave hits the shallower floor friction slows the wave down and raises its height up to 100 feet/ 30m acting like a solid wall of water; the wave then recedes dragging all the debris back to the ocean; multiple waves occur which can continue to hit land for several hours; effects of a tsunami reaching inhabited land include destruction of buildings and property, erosion of land, death and injuries. Deadliest tsunami in history is the Indian Ocean tsunami of 2004 caused by an earthquake; energy released equalled 23,000 Hiroshima type atomic bombs; wave speed equalled a jetliner; waves affected over 11 countries including Australia; waves travelled over 3000 miles / 4828km; more than 220,000 people were killed. Tsunami warning centres around the world are on constant alert so they can watch for events large enough to cause tsunamis and give people time to move to higher ground.)

3. Inform students we're going to have a closer look at the science and specifically the waves and energy contained within a tsunami.

(a) Access and play "How are tsunamis formed" videoclip from Brainstuff – How stuff works https://www.youtube.com/watch?v=OQ3oXIjPmaE (3:08min)

(b) Ask students to recap the information provided in the clip. (Waves are actually energy moving through water; normal waves are caused by the wind travelling across the surface of the ocean; tsunami waves are caused by an underwater disturbance; tectonic plates slipping beneath another on a fault line possess a tonne of stored energy called potential energy; when the plates move the energy is released as kinetic energy which is transferred outward; the wave radiates upward and travels outward carrying all that energy; out in the deep ocean the wave seems small and travels really fast; when the wave reaches the sloping shoreline the energy in the wave compresses upward; the wave slows down due to friction with the earth as it reaches land but increases in height. Wave height in the ocean can be as little as 3 feet / 1m when in the deep water but as the wave reaches shallower water/land it increases significantly with some waves reaching over 100 feet / 30m. Tsunamis have several waves; as they reach land they compress which is known as a tsunami wave train. There's no stopping a tsunami wave, the best scientist can do is to try to predict their path and power so they can warn coastal areas to evacuate.)

4. Advise students that as mentioned in the videoclips, some tsunami waves can reach land at over 30m high. In fact there have been larger and smaller tsunamis recorded around the world. The 2004 tsunami in the Indian Ocean was recorded at a maximum wave height of 50.9m.

   Ask students if this means all countries affected by the tsunami experienced 50.9m high waves crashing across their shores? (No, those closest to the earthquake epicentre would have experienced higher waves and low lying countries/areas would have experienced more flooding as the water had no high cliffs/barriers to overcome.)

5. Inform students that the height of the water on the land relative to normal sea level is called the runup. The distance the water travels over normal

land area is called inundation. Provide an example for students such as the following:

If a tsunami wave was 30 metres high as it hit land and flooded as far as 5km inland, the runup would be 30m and the inundation would be 5km.

Tsunami waves can be as small as 2cm high such as the 1906 California tsunami or as high as 524.6m in Alaska in 1958.

https://www.ngdc.noaa.gov/nndc/struts/form?t=101650&s=70&d=7

According to livescience.com tsunamis can travel as far as 16km inland https://www.livescience.com/37497-no-outrunning-tsunami.html

6. Inform students that today we are going to experiment with tsunami waves as they hit land; specifically focussing on the slope of the shoreline and how it affects the inundation distance.

# Tsunami experiment
# (70min)

1. Hand out Student Workbooks and ask students to record their name, partners' names and group number on the cover.

https://www.britannica.com/event/Japan-earthquake-and-tsunami-of-2011

# TSUNAMI!

Your name**:** _____

Your partners' names: _____

_____

Class: _____ Group Number: _____

2. Demonstrate the use of the tsunami station indicating that during the experiment students are required to measure the distance the water inundates the land.

3. Refer students to pg 2 of the Student Workbook. Read the experiment overview along with students.

# Experiment overview

Tsunami stations have been set up for each group. They consist of a plastic tub, a “land construction” and varying “slope boards”. The slope boards are held in place by blu tack on the bottom of the tub. The top edge of the slope board rests on the land. 6L of water is to be gently added to the tub after land and slope 1 are in position. Each student will generate a tsunami wave with a “wave pusher”. The wave pusher will travel approximately 13cm along the base of the tub and will stop when it hits the first row of blu tack. Each student will have 3 practice goes at creating a gentle wave that is not too strong nor too weak. Ideally the waves will travel somewhere between half way and the furthest edge of the “land” for our first slope.

Student 1 begins Trial 1. Each student will create 5 waves, recording only her own data in the table on pg3 of her Student Workbook. She will record the distance in centimetres that the water travelled across the land.

Groups may like members of their group to help locate the furthest distance and to measure accurately with the tape measure.

When Student 1 has completed her trial, Student 2 creates her 3 practice waves and then begins her trial. The above process is repeated for Students 2 and 3.

Once each member in the group has completed Trial 1, she will be asked to make some predictions about the water inundation distance for the next slope. When all members of the group are ready to proceed, trial 2 can commence and so on.

4. Refer students to pg 3 of the Student Workbook where *they will record their own data only for each of their trials*. Students can ignore the two right hand blank columns for now.

# My trial data

| | Distance (cm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Trial 1 | Trial 2 | Trial 3 | Trial 4 | Trial 5 | | |
| Slope 1 | | | | | | | |
| Slope 2 | | | | | | | |
| Slope 3 | | | | | | | |
| Slope 4 (90°) | | | | | | | |

5. Ask students what elements of the experiment must remain the same to ensure a fair test. (The "land" must be in the same position; the "slope" must be in the same position; the depth of the water must be the same; the way the wave is generated/strength of the wave must be consistent so that runup energy is consistent; the way the inundation distance is measured/recorded must not vary; allow time for the water to settle before creating the next wave)

6. Discuss how to do the following consistently to ensure a fair test:

   - Position the land correctly; as close to the furthest edge of the tub as possible
   - Position the slope correctly on the marked blu tack line; Slope 1 goes on Line 1, Slope 2 goes on Line 2, etc
   - Pour exactly the same volume of water into the tub
   - Generate the wave; the wave pusher is used to create a slow moving wave that is not too strong nor too weak. Ideally the waves will travel somewhere between half way and the furthest edge of the "land" for our first slope. Students may find that using their non-dominate hand only, is best if they are too forceful with their waves.
   - Measure the inundation distance; start from the edge of the shore line to the furthest evidence of water inundation, measuring to the nearest half centimetre. If the water does not reach the "land" the measure will be 0cm. If the water travels past the furthest edge of the land, record the distance as 31.5cm as the land is 31cm across.

7. Refer students to pg 4-6 of their Student Workbook where students will be required to make predictions about the next slope/s after completing each trial. Ensure students understand the whole group must have completed Trial 1 and recorded their individual predictions before the group can move onto Trial 2, etc.

# Prediction

**Let's make a prediction for Trial 2.**

**Q1. Predict what would happen to the inundation distance if the slope were steeper. Explain your answer.**


and wait for all members of your group to have conducted Trial 1, recorded their Trial 1 data, and made their Trial 2 prediction.

8. Now that the experiment has been explained, Trial 1 can now begin with students recording their trial data on pg3 of the Student Workbook.

9. When all members of the group have conducted Trial 1, recorded their Trial 1 data, and made their Trial 2 prediction, Slope 1 can be removed from the water.

   Students can now move onto to Trial 2. Slope 2 is to be placed in position along the blu tack line marked Line 2. The trial process is repeated for all members of the group. Students will again predict for a steeper slope before moving onto Trial 3. The process is repeated for Trial 3 and Trial 4 (90° and therefore no slope board required).

10. Groups can move through the activity at their own pace, following instructions throughout the Student Workbook to the end of pg6.

# Prediction

**Let's make a prediction for Trial 3.**

**Q2. Predict what would happen to the inundation distance if the slope were even steeper. Justify your answer using the data you have collected so far.**


and wait for all members of your group to have conducted Trial 2, recorded their Trial 2 data, and made their Trial 3 prediction.

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# Prediction

**Let's make a prediction for our last trial, Trial 4.**

**Q3. Predict what would happen to the inundation distance if the slope were even steeper still, that is, if the slope were 90°. Justify your answer using the data you have collected so far.**


and wait for instructions from your teacher.

# Identifying variation in the data and calculating the mean (10min)

1. Once all students have completed to the end of pg6 of the Student Workbook, ask students to review their own data looking for variation/similarities across each slope.

2. Ask students if the data are all the same for Slope 1? (Not likely.) Are they all the same for Slope 2, 3 and 4? (Not likely.)

3. Ask students why the variation occurs within slopes when we tried to ensure we conducted a fair test. (Inconsistent wave energy/creation should be the main response.)

4. Ask students what we could do to find the typical distance for each student's slope. (Calculate the mean)

Note: The mean is the sum of all values divided by the number of values.

Average is a colloquial/collective term used to identify the central or typical value in a data set, calculating the mode, mean, median, midpoint, etc., are all ways to describe typical.

Students have calculated the mean in past activities such as the Planes and Flight Activity in 2017.

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5. Ask students why calculating the mean would be useful. (Because there could be a large variation across slopes due to inconsistent wave creation/freak waves; the mean will provide us with a clearer understanding of the typical inundation distance for that slope.)

6. Ask students to turn to pg3 of their Student Workbook and record "my mean" at the top of the first blank column in the table

| | Distance | | | | | | |
|---|---|---|---|---|---|---|---|
| | Trial 1 | Trial 2 | Trial 3 | Trial 4 | Trial 5 | My mean | |
| Slope 1 | 27 | 31.5 | 31.5 | 25 | 31.5 | | |
| Slope 2 | 25 | 31.5 | 17 | 20 | 18 | | |
| Slope 3 | 12 | 16 | 22 | 13 | 15 | | |
| Slope 4 (90°) | 0 | 0 | 5 | 6 | 4 | | |

7. Ask students to use a calculator to calculate and record the mean for each of their slopes.

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# Representing the data
# (45 min)

Once all students have calculated their mean inundation distance, students can represent their own trial data anyway they like.

Each student is to complete their own representation.

The representation must show the 5 inundation distances for each slope and the mean. The representation will be used to answer questions about the variation in the data and to discuss how the slope affects the inundation distance.

Blank A4 paper is to be used.

Note: You may like to suggest students quickly sketch their representation first before proceeding too far with their representation in case they realise it can't be done/does not show the correct/all of the data required.

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# Analysing the data to reach a conclusion (35 min)

Once representations are complete, students are to answer questions 1-8 on pgs 7-10 of Student Workbook. Questions focus on the effect of slope on inundation distance with students asked to discuss their certainty based on the data collected/method of data collection, as well as the position of the mean value in comparison to their raw data.

Time permitting, students can calculate the group mean and add that to their representation, again discussing certainty of their conclusions in light of this additional data.

# Analysing the data to reach a conclusion

**Q1. Using your representation, describe the variation in the inundation distance for each slope.**

**Q2. What do you think caused this variation?**

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**Q3. How does your mean value compare to your other values?**

**Q4. How does including the mean value on your representation help you understand the typical inundation distance for each slope?**

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**Q5. How does the slope affect the inundation distance? Use your data to explain your answer.**

**Q6. How certain are you that your conclusion is correct? Explain your answer.**

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**Q7. What could you do to be more certain of your conclusion?**

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**Q8. Given what you now know about slope and inundation, how could the effects of a tsunami be minimised?**

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# Presentations
# (40min)

Each group presents and explains their representations and conclusions to the class, focusing on pgs 7- 10 in the Student Workbook.  Allow approximately 5 minutes per group.

Constructive questions from the teacher and students are encouraged.

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# Wrap Up
# (15min)

Conclude the entire activity by providing a link to real world of engineering via the following video clip from JBA Trust Organisation. It shows a Coastal Engineer with a wave tank demonstration discussing what coastal defences can be used to minimise flood risk.
https://www.youtube.com/watch?v=3yNoy4H2Z-o (12.22min)

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