



Australian Government
Attorney-General's Department
Emergency Management Australia

EMA Schools Education

TSUNAMI INFORMATION



Tsunami Activity Sheet No. 1

What are Tsunami and how do they behave?

1. What are Tsunami and how do they behave?

A tsunami (pronounced soo-nah-mee) is a series of very long waves that occur over a long period of time. The word 'tsunami' is a Japanese word that means 'harbour wave'. Written in Japanese it looks like this:

津波

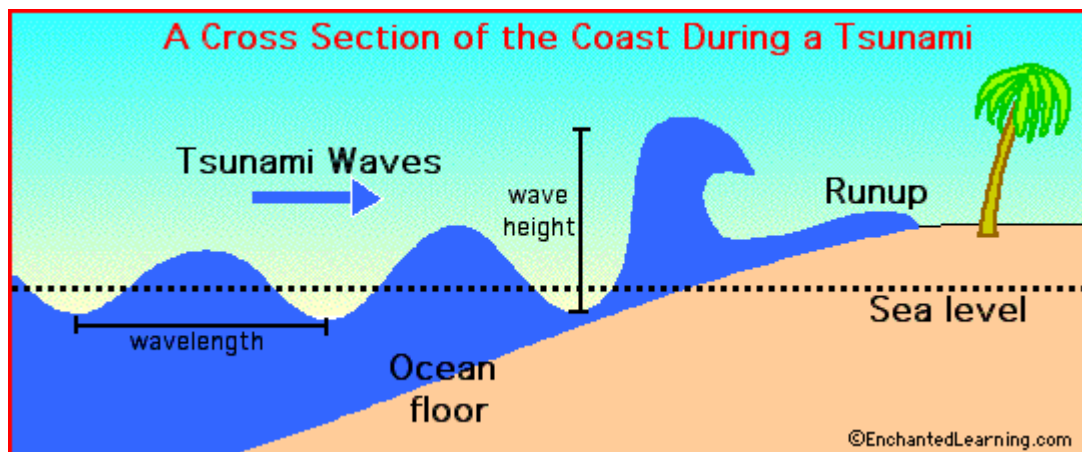
The top is "tsu" meaning harbour

The bottom is "nami", meaning wave.

Defining a tsunami

Read the clear definition and description of a tsunami here.

<http://www.ga.gov.au/urban/factsheets/tsunami.jsp>



[Source: <http://www.enchantedlearning.com/subject/tsunami/>]

1. List three characteristics of tsunami waves.
2. How do tsunami and tidal waves differ? Draw up a table to show these differences. Draw a sketch of the above diagram and use the description that you have read to write additional notes about what is happening.

What causes a tsunami?

Read how tsunamis occur at <http://www.ga.gov.au/urban/factsheets/tsunami2.jsp>

1. Name five events that may cause a tsunami to occur?
2. Do any of these events occur more often than others? Which is the least likely to occur?

How do tsunami waves behave?

Read about the features of tsunami waves here, supported with many diagrams. <http://www.enchantedlearning.com/subject/tsunami/> great introduction in simple terms with diagrams.

1. How much does an earthquake need to measure on the Richter scale before a tsunami can develop?
2. Describe a clue that might warn people on a beach that a tsunami might reach them.
3. Write definitions for the following terms: wavelength; wave crest; wave trough; wave period; run-up. Draw a sketch diagram of a wave to help you define the terms.
4. Use these terms (and a sketch) to describe what happens to a tsunami as it approaches the coast.
5. Collect equipment (bowl, water and rocks) and make a model of a tsunami. You may like to create a coastline with many characteristics such as wetlands and mangroves with a lot of vegetation; built-up areas; agricultural areas. Create your tsunami and describe what happens as the wave approaches and hits the different coastline areas.

Two more sites with animations showing tsunami waves travelling and breaking are found at <http://science.howstuffworks.com/tsunami3.htm> and <http://www.pbs.org/wnet/savageearth/animations/tsunami/index.html>

1. What type of energy is in the tsunami? What happens to that energy when it reaches the coastline?
2. Tsunami waves travel very quickly. How are they able to maintain this speed?

http://www.prh.noaa.gov/itic/tsunami_events/media/graphics/general_maps/tsu_wave_characteristics.pdf has diagram of tsunami wave size from deep water to the coast.

1. Write a statement that summarises the relationship between wave depth, velocity, wavelength and wave height.

It takes different times for a tsunami wave to reach various coastlines.

[At this page](#), you will see a map of travel times of the Chilean earthquake.

1. Use an atlas to study the countries affected by a tsunami after the Chilean earthquake in 1960.
 - a. It took _____ hours to reach New Zealand.
 - b. It took _____ hours to reach Tasmania and _____ hours to reach the Australian mainland.
 - c. It took _____ hours to reach Taiwan.
 - d. It took _____ hours to reach the Aleutian Islands.
 - e. It took _____ hours to reach Papua New Guinea.
 - f. It took _____ hours to reach Hawaii.
 - g. It took _____ hours to reach Western Australia.
 - h. It took _____ hours to reach the Canadian coastline.



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Tsunami Activity Sheet No. 2

Where have Tsunamis occurred in the past

2. Where have tsunamis occurred in the past?

Tsunamis do not occur everywhere and on every coastline – there is a pattern to their distribution. The majority of tsunamis – over 90 per cent – occur in the Pacific Ocean. The reason for this can be seen when looking at a map that shows tectonic plates and the location of active volcanoes.

The **Pacific Ring of Fire** is a region well known for earthquake and volcanic activity.

<http://geography.about.com/cs/earthquakes/a/ringoffire.htm>

1. What is a tectonic plate?
2. Define the following terms: seismic; subduction; dormant volcano; active volcano.
3. What percentage of the world's active and dormant volcanoes is located on the Pacific "Ring of fire"?
4. The plate boundaries also experience a lot of earthquake activity. Go to the **enchanted learning** site and look at the diagram of the Earth's crust. What occurs at the plate boundaries that might give rise to earthquakes?

<http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Continents.shtml>

This site is an excellent site <http://www.guardian.co.uk/flash/0,5860,1121610.html> showing the how earthquakes occur and how they can cause tsunami.

Also read the information and look at the animations at the **geoworld** site.

http://geo-world.org/ks3/year8/plate_tectonics.html

At the **tsunami risks project**, <http://www.nerc-bas.ac.uk/tsunami-risks/> there is a clickable map showing distribution of tsunamis and more information on a few. Click on **past events** to get access to the map. You can also go to a risk atlas and print graphs for various locations

- a) Study this map, which shows the distribution of recorded tsunami events. Look once again at the map showing the Pacific "Ring of fire". Describe the association between the location and distribution of earthquake and volcanic activity and the location and distribution of recorded tsunamis.
- b) An **interactive map** of the world allows you to find out more detail about some tsunami events.

<http://www.geophys.washington.edu/tsunami/general/historic/historic.html>

Where have tsunamis occurred in Australia?

All low-lying coastal areas can be affected by tsunami. A tsunami is recorded on average in Australia every two years but they are usually too small to be noticed by people.

The threat of tsunami in Australia is low for most of our coastline. There is a medium threat along the northern half of the coastline in Western Australia. There are low risks on the eastern coast.

The last tsunami to be noticed in Australia was in 1994 along the northwest coast, following an earthquake in East Java. The biggest ever was recorded at Cape Leveque, Western Australia in 1977. No one was injured by these waves.

<http://www.ga.gov.au/urban/factsheets/tsunami4.jsp>

1. Which parts of the Australian coastline are at risk of tsunamis and why?
2. Look again at the map showing the Pacific "Ring of fire". Are other parts of the Australian coastline potentially at risk from tsunamis occurring in the Pacific Ocean? Explain.



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Tsunami Activity Sheet No. 3

**Whats the impact of a tsunami on people
and the environment?**

3. What is the impact of a tsunami on people and the environment?

A tremendous amount of energy is released on impact when a tsunami reaches the coast. Each cubic metre of water weighs about one tonne. Several thousands of cubic metres of water can be washed up on affected coastlines. If a tsunami strikes and people have been warned and evacuated, the number of deaths and injuries are low or even non-existent. In this case, buildings and other structures can be damaged or destroyed and, often, large areas of land become contaminated with sea water. When there is little or no warning, many deaths can occur.

Indian Ocean tsunami, December 26, 2004

This event was one of the most devastating caused by a natural hazard in recent years. The earthquake that triggered the tsunamis occurred west of the Indonesian island of Sumatra and measured 9.0 on the Richter scale, making it the largest quake worldwide in forty years. The death toll in March 2005 was over 275 000 people, with many still missing.

How did the earthquake and tsunami occur? <http://geo-world.org/tsunami/>

Read the general introduction at this site.

1. How does the size of this earthquake compare to others in history?
2. Draw a sketch map of the region affected by the tsunami.
3. Name the countries that felt the quake. Use an atlas to record the distance these countries are from the epicentre.

Click on **causes** and **graphics** and read the information.

1. The movement of which plates were involved in this earthquake? Along what distance and to what depth did the fault move? Draw these plates on your map.
2. Name some of the countries and islands that “sit” on the India Plate.
3. Name some of the countries and islands that “sit” on the Burma Plate.
4. How does the Sunda plate impact on the Burma Plate?
5. Use the graphic of the wave and the height of the figure to estimate the height of the waves in each of the three locations.

Another image showing the plates involved is at the **Earth Observatory** site http://earthobservatory.nasa.gov/NaturalHazards/natural_hazards_v2.php3?img_id=12640

1. Work in groups of three. Look at the photograph of part of Banda Aceh.
2. Print this photograph (using a colour printer, if possible).
3. Now compare it to the same area after the tsunami.
4. How many buildings were in the area shown by the photograph?
5. How many can you see standing after the tsunami?
6. What other features have disappeared?

How long did it take for the tsunami to travel to different areas?

<http://staff.aist.go.jp/kenji.satake/Sumatra-E.html>

1. What do the red dots represent?
2. Name three countries that experienced tsunami waves at each hour.
Use an atlas and the maps to record this information in the following table.

Tsunami travel time (hours)											
1	2	3	4	5	6	7	8	9	10	11	12

3. Where do you expect the greatest impact would occur and why?
4. Use an atlas to locate three places on the Australian coastline that might have felt the greatest impact. Justify your choices.
5. Use the scale on an atlas map to calculate the furthest coastline the tsunami wave travelled (as shown on the map at this site).

This **animation** <http://staff.aist.go.jp/kenji.satake/animation.gif> shows the extent and movement of the tsunami in part of the Indian Ocean.

The Indian Ocean colour map images

http://earthobservatory.nasa.gov/NaturalHazards/natural_hazards_v2.php3?img_id=12645 show the tsunami wave height and wave travel times.

1. Describe the main direction this tsunami wave travelled.
How did this movement relate to the overall impact on various countries?
2. Use an atlas to name four locations that experienced a tsunami wave greater than 4 metres in height. What size were the waves that reached the Australian coastline?

What was the impact of the Indian Ocean tsunami on people and environment?

The **20 sets of satellite photographs** at this site

<http://homepage.mac.com/demark/tsunami/> are very useful to study the change in as the same location over time (before and after the Indian Ocean tsunami). The physical changes caused by this natural event are evident and can be looked at in detail and mapped.

Students should be able to recognise the following features on the satellite images:

- Coastal features
- Relief
- Drainage
- Vegetation
- Land use (urban and rural)
- Transport systems.

Creating and analysing overlay maps

Creating map overlays is a useful method of looking at the extent of change over time. This requires one sheet of unlined paper, one sheet of tracing paper, pencils and clear adhesive tape.

1. Look at the “before” image of Set 1: **Kalutara Beach in Sri Lanka**
[<http://homepage.mac.com/demark/tsunami/>]
2. If you are able, print this image either in colour or black-and-white; otherwise sketch from the image on the screen. Use this print or sketch to draw a map of Kalutara Beach on the unlined paper. You will need to label features such as the coastline and beach, main roads, general areas with housing and vegetation areas. Use colours to distinguish the areas and add this information to your legend.
3. Estimate the scale of this map. Use something known that you can estimate, such as the main road in the top right part of the image. How wide might this road be if there needs to be space for two cars to pass each other, plus some room either side? Can you measure a road near you as a suitable comparison? Once you have done this, use your ruler and some measurements to calculate a scale for the map you have drawn. If you think the road is five metres wide, and you measure the width as two millimeters, then the scale is 2mm = 5 metres. A better way to write this will be 1cm: 25 metres. Check some features on the image (such as some houses) to see if this is reasonable.
4. Use your scale to measure the following: width of the beach in three locations; the size of the sand dunes in the lower half of the image.
Write an appropriate title for your map.
5. Now click on the satellite image to see the same location as the tsunami wave recedes from the coast. Use the tracing paper to draw the changes along the coastline: draw a line to show how far the water has receded; colour and label the sandy areas that have been washed away from the coast.
6. Use adhesive tape to place the tracing paper over the first map, making sure the same areas line up.
7. Use the scale to estimate how far the water has receded. How far has sand been washed out to sea? Compare this image with the second and third set of the same location. Which image do you think shows the area before the wave hit? Outline the evidence you have for this.
8. Look at the images of Kalutara Beach in set 4. Describe the changes that have occurred. Describe the new or altered landforms and features. Have any buildings disappeared in the second image? How many? Where were they located?
9. Write a summary statement about the physical changes at Kalutara Beach caused by the tsunami.

Group work

There are 16 other sets of images showing various locations before and after the tsunami.

Set 5, 6, 7, 8, 9, 10, 11 Banda Aceh (8, 9, 11 difficult)

Sets 12, 13, 14 Gleebruk Village, Indonesia (50km from Banda Aceh)

Sets 15, 16, 17, 18, 19 and 20 Meulaboh, Indonesia

Allocate different sets of images amongst the class. Create another overlay map of the image you have been allocated, showing the changes that have occurred. Ensure you have a clear legend, title, scale and source. Write a summary paragraph describing the changes that have occurred at this location as a result of the tsunami.

It would be beneficial to display the completed overlay maps in the classroom so that all students can gain a picture of the impact in different areas. Display the maps according to their regions.

Further images

The following satellite images represent tsunami impact at other locations. You can see a very high resolution picture by clicking on the image.

- a. The **town of Lhoknga**, on the west coast of Sumatra near the capital of Aceh, Banda Aceh.
http://earthobservatory.nasa.gov/NaturalHazards/natural_hazards_v2.php3?img_id=12647
 1. Describe the impact of this wave on buildings, trees, other vegetation, beaches and agricultural areas.
 2. It is estimated that, in some locations, the tsunami may have reached up to 15 metres in height when it hit the coast. Compare some buildings around you with this height.

- b. The satellite images of **Gleebruk** in Indonesia can be analysed using mapping techniques. Work in pairs and choose one of these to complete the following activity.
 1. The town of **Gleebruk**, located roughly 50 km (31 miles) from Banda Aceh [at
http://earthobservatory.nasa.gov/NaturalHazards/natural_hazards_v2.php3?img_id=12657
]
 2. This image is of **Meulaboh**, Indonesia on Jan 7 at
http://earthobservatory.nasa.gov/NaturalHazards/natural_hazards_v2.php3?img_id=12671 Meulobah is located 95 kilometers from the epicenter of the earthquake. The tsunami completely washed over this peninsula.
 3. Impact at the beaches of **Khao Lak**, Thailand at
http://earthobservatory.nasa.gov/NaturalHazards/natural_hazards_v2.php3?img_id=12648
 4. The high resolution image shows evidence of tourism at this location. This is a popular location with people from Northern Europe. Note the before and after appearance of the beaches.

If you can, print a copy of both of these images (preferably in colour) and complete the following (high resolution images can be gained by clicking below the photographs; it is possible to open both images and compare then against your maps):

- Trace a copy of this area before the tsunami.
- Label the following:
 - Beach
 - River
 - Agriculture (orchards, aquaculture)
 - Road and bridges
 - Buildings
- Now complete a second tracing showing the same area after the tsunami. Annotate this sketch with descriptions of the changes to the area.
- Estimate number of buildings destroyed.
- Is there evidence of higher ground? Describe this evidence.
- Write a summary describing the impact on people and the environment.

Read the impact on individual countries at the **BBC impact page** for each country.

http://news.bbc.co.uk/2/hi/in_depth/4126019.stm

Which country/regions suffered the greatest impact? Outline the relationship between their location and degree of impact. Outline the other factors need to be considered and why. (Political, economic, social and environmental).

Other environmental impacts

The enormous energy generated by the earthquake that caused the Indian Ocean tsunami resulted in environmental impacts at different scales.

1. These **NASA images** show how much the Earth's surface moved upwards and sideways as a result of the earthquake.

http://earthobservatory.nasa.gov/NaturalHazards/natural_hazards_v2.php3?img_id=12646

- a. What was the highest uplift that occurred in the area? How does this compare with the area immediately next to the epicenter?
- b. What was the greatest distance of sideways movement of the Earth's surface? Where did this occur in relation to the greatest uplift?
- c. Do you consider these local, regional or global changes? Justify.

Further environmental impacts can be read at

- http://en.wikipedia.org/wiki/2004_Indian_Ocean_earthquake#Environmental_impact
- <http://www.newscientist.com/article.ns?id=dn6840>
- <http://www.newscientist.com/contact.ns;jsessionid=ACGFGLJLJGPD?recipe=nt=dn>

Outline the environmental impacts mentioned.

What action can be taken to remedy each environmental problem? How long might this take to achieve (short/medium/long term)? Justify your answer.

Which do you think will suffer the greatest impact from a tsunami: a small, steeply-sloped island; a coral island surrounded by a barrier reef; or a low-lying island?

Economic impacts

Read the following descriptions to discover the impacts resulting from the tsunami.

General impacts

[http://en.wikipedia.org/wiki/2004_Indian_Ocean_earthquake#Economic_impact

Impact on shipping [<http://abcnews.go.com/Politics/wireStory?id=387928>

Impact on food supply

[http://www.fao.org/tsunami/doc/Note_on_South_Asia_Tsunami_ES.doc

1. Outline the economic impacts on this region.
2. Which of these do you think need to be overcome first? Justify.

How did the Indian Ocean tsunami impact Australia?

Read about the impact the Indian Ocean tsunami had on the **Western Australian coastline**. [<http://www.dpi.wa.gov.au/coastaldata/tidesandwaves/tsunami.html>]

1. Why did the travel speed of 1000kph slow down before reaching the coastline?
2. Many locations around this coastline experienced very different wave effects. List some of the differences in the coastline which resulted in more or less wave impact.
3. Click to see the **tsunami effects around the state** and look at the graphs measuring the wave heights on and after December 26, 2004. Which four locations experienced the greatest wave activity? Describe how these waves might have an impact on the coastline.
4. How might the main direction of the tsunami have resulted in less impact on Australia?
5. Refer to an atlas map showing the Western Australian coastline. Draw a sketch map of this coastline. Now record the time that the tsunami arrived at various coastal locations by going to **tsunami arrival time**.

[<http://www.dpi.wa.gov.au/coastaldata/tidesandwaves/tsunami-arrival.html>]

Summary of the Indian Ocean tsunami

If you would like to read a summary of the Indian Ocean tsunami go to http://en.wikipedia.org/wiki/2004_Indian_Ocean_earthquake Wikipedia site on Indian Ocean tsunami.

Summarise the impact of this tsunami by creating a consequence wheel to show the impact of the tsunami on people and the environment. Write the word *tsunami* in the middle of the wheel. Write the words *environmental, social, economic and political* extending from the centre – these will help you to organise the different consequences. Begin with first order consequences and then build second and subsequent order consequences to follow. Continue adding information as you develop the wheel.

A sample consequence based on gold discovery in Victoria can be found at http://www.qrc.org.au/dbase_upl/explore_section_03.pdf on page 13 of the pdf file.

Tsunami in Papua New Guinea

In July 1998, an earthquake off the north coast of Papua New Guinea caused a tsunami at Aitape Village resulting in the loss of 3000 lives.

- Go to <http://omzg.sccc.ru/tsulab/19980717.html> and click on **location map** and **source area**. Describe the location of the earthquake and tsunami.
- Click on **travel time map** and describe how far the waves from this tsunami travelled?
- Click on **historical tsunamis** and scroll down to the vertical profile. How does the sea bed and coastal profile intensify a tsunami event in this location? Why would tsunami waves be very dangerous along this type of coastline?
- Click on **damage** and visit http://www.ga.gov.au/urban/factsheets/tsunami_png.jsp and <http://www.cnn.com/WORLD/asiapcf/9807/18/tidal.wave.02/> Describe the damage in this area
- To look at a 3D view of how the earthquake caused the tsunami, go to <http://www.drgeorgepc.com/Tsunami1998PNG.html> and scroll down to **plate tectonics**. Also read the conclusion at this site to see what has been recommended to save lives in case of future tsunamis. Discuss the reasoning behind this suggestion and its likelihood of occurring.



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Tsunami Activity Sheet No. 4

What should you do in the event of a tsunami?

4. What should you do in the event of a tsunami?

The emergency management authorities have a plan in place for a range of possible emergencies. If a tsunami were heading for Australia, the emergency management authorities would use all the radio stations and television stations to let people know to move away from the danger zones.

You may have practiced evacuation at school. It would be a bit like this but you would head for higher ground and away from the beach or rivers that lead to the beach.

You can often tell that an earthquake is happening or that a tsunami is coming because the ground shakes under your feet, the furniture may rattle and pictures on the wall move. If this happens or you hear a warning, tell your family and friends and move quickly to higher ground, this could save your life and that of others.

Being prepared for any type of emergency is important. Have a plan in your family about what you would do if a fire or flood or even a tsunami happened. Know how to call for help and talk with your parents about who you should call.

In Australia the emergency number is **000**. You can call this number when there is an emergency, when things are not safe.

Ask your school about its emergency plan and know what you must do if there is something unsafe at school.

Tsunami survival (safety rules)

If you hear that a strong earthquake has occurred, stand by for a possible tsunami emergency, and be prepared to move from low-lying coastal or lakeside areas to high ground at short notice. All tsunamis are potentially dangerous and destructive.

- When an official warning is issued, it means a tsunami actually exists. Some tsunami victims have dismissed such warnings as false alarms and died as a result.
- Approaching tsunamis are sometimes preceded by a rapid rise or fall in sea level. This is nature's warning and should be heeded. Vessels should head for deep water immediately.
- A small tsunami at one point on the shore can be extremely large a few kilometres away so don't let the modest size of one make you lose respect for all.
- As a tsunami is not a single wave, stay out of danger areas until an official 'all-clear'.
- Never go to the shore to watch a tsunami. If you can see it, you are too close to escape.
- Cooperate with your local emergency management authorities if asked to evacuate.

1. Create a sign for a beach that warns people about how to act if a tsunami is approaching. Your sign should be understood by all people – young, old, English and non-English speakers. Make your sign to measure 30cm X 30cm. Display this around your classroom.
2. Work in groups of 3 or 4. Design and create a brochure with more detailed information about how to behave in a tsunami. Include the preparation of an emergency kit. Look at the one at the FEMA site <http://www.fema.gov/kids/dizkit.htm> for ideas.
3. What other things do you think should be included in your kit?
4. You may be interested in visiting the US Geological Survey site <http://pubs.usgs.gov/circ/c1187/> to read personal stories of people who survived a tsunami in Chile in 1960.



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Tsunami Activity Sheet No. 5

What happens after a Tsunami?

5. What happens after a tsunami?

Many thousands of people can be affected by a tsunami – the Indian Ocean tsunami in December 2004 killed over 275,000 and displaced over 1 million people. Five million people had basic services affected.

There are a number of levels of response or recovery to an emergency such as this. These include

- an emergency response (usually short term and immediate);
- a medium-term recovery (where people are being helped who are experiencing the after effects such as disease, loss of income and livelihood and loss of shelter);
- and a long-term recovery (which may last from a few months to many years and includes reconstruction of buildings and lives).

Download the free tsunami education kit from <http://www.globaleducation.edna.edu.au/globaled/page1637.html> or <http://www.worldvision.com.au/resources/teachers/>

There is extensive information about the aftermath of the Indian Ocean tsunami, about types of aid and how the poor were more vulnerable. There is also information about how to help children cope with the images they have seen.

1. Draw up a table and list the aid activities that take place during short-, medium-, and long-term responses to a disaster such as the Indian Ocean tsunami.
2. Read the reports from the World Health Organisation about updates of the aid that has occurred in many countries (at http://w3.whosea.org/EN/Section23/Section1108/Section1835_8140.htm)

Imagine you are a journalist visiting one of the devastated countries.

- a. Choose the country from which you are reporting.
 - b. Describe what happened there.
 - c. Now describe what you see, including the work being done by aid workers. How are they helping the local people?
 - d. Describe the challenges involved in such work. What about the rewards?
 - e. Imagine you are interviewing a survivor – what stories might that person have to tell?
 - f. Why are aid workers important in the relief work?
3. Imagine you were involved in a tsunami disaster. Write your own story about what has happened to you and how you are coping.

4. Work in groups of four and **report** on the work being done by two aid organisations. At <http://abc.net.au/news/newsitems/200412/s1273434.htm>
You may like to present this as a television or radio news report; a poster; a play or a PowerPoint format.
5. **Read** about tourism in the affected region <http://news.bbc.co.uk/1/hi/uk/4137633.stm>
 - a. Should affected tourist areas be visited or not? Provide sound reasons for your point of view.
 - b. Divide the class into two groups and conduct a debate: To tour or not to tour?
6. The Australian people donated over \$240 million to various aid organisations for the tsunami victims, which was an unprecedented amount.
Why do you think people have been so generous in helping in this disaster?
7. Conduct a discussion or debate about the appropriateness or otherwise of diverting aid away from global poverty issues or countries suffering enormous health problems to relieve those affected by the tsunami disaster. You will need to conduct some research to prepare your point of view about these issues.



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Tsunami Activity Sheet No. 6

How does a tsunami warning system work?

6. How does a tsunami warning system work?

The Pacific Tsunami Warning System was established in 1949. It is made up of a network of seismic-monitoring stations and sea-level gauges. These detect earthquakes and abnormal changes in sea level and help scientists decide whether a tsunami has been triggered by an earthquake. If so, warnings go out to many countries and regions in the Pacific. A warning centre is located in both Hawaii and Alaska.

Look at how **buoys send a message** via satellite to the warning centres. Many buoys are distributed in the Pacific Ocean.

http://www.prh.noaa.gov/itic/tsunami_events/media/graphics/general_maps/tsu_detect_ion_buoy_sys.pdf

There are also many **sea level gauges** distributed in the region

http://www.prh.noaa.gov/itic/tsunami_events/media/graphics/general_maps/tsu_detect_ion_buoy_locations_pac.pdf

http://www.prh.noaa.gov/itic/tsunami_events/media/graphics/general_maps/sea_level_networks_pac.gif

1. Describe how the system of buoys and sea level gauges help scientists to detect and monitor a potential tsunami.

Other warning systems and education needs to be in place along side the buoys and gauges. Read the **storybook** at to learn about how this system works.

<http://wcatwc.arh.noaa.gov/book01.htm>

2. Use this story to write a step-by-step procedure of how the warning system works.
3. Should people in tsunami-prone areas rely on the tsunami warning system? When might there not be enough time to rely on this system?
4. Look at a map of the Pacific Ocean and the extent of habitable coastline. Is it feasible that all habitable areas can be educated about and ready for a tsunami?
5. The Pacific Tsunami warning system has hundreds of seismic stations worldwide, coastal tide gauges and sophisticated buoys in the Pacific Basin capable of detecting a centimetre's difference in ocean height. But, without similar gauges and buoys in the Indian Ocean, scientists were not able to detect a tsunami there. Describe how a tsunami warning system might have changed the outcome of the Indian Ocean tsunami in 2004?
6. Papua New Guinea is located in the Pacific. Why did the system not work to save lives there in 1997? Work with another person to outline what could be done in the future.

Tsunami modelling

In September 2004, **Geoscience Australia** published an article that used computer modelling to predict the impact of a large earthquake and resultant tsunami in the Indian Ocean. It is chilling to read how close the modelling was to the actual event.

[\[http://www.ga.gov.au/image_cache/GA5059.pdf\]](http://www.ga.gov.au/image_cache/GA5059.pdf)



Australian Government
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TSUNAMI INFORMATION



Tsunami Activity Sheet No. 7

Future Tsunamis?

7. Future tsunamis

Given the Earth's geology and activity, there is no doubt that tsunamis will occur again in the future. Records show that they occur quite frequently. The most frequent, and easiest to predict, are those located in areas that follow regular cycles. It is more difficult to predict tsunamis that occur irregularly and where they are not usually expected.

Tsunami prediction is very difficult and computer modelling is often used to try and determine where the tsunami might occur and how large it might be. Predicting when the event may occur is extremely difficult. By monitoring active earthquake and volcanic areas, scientists can make these predictions.

Some scientists believe that an asteroid might impact with the Earth in about 800 years, creating a giant tsunami.

Read about the asteroid prediction.

<http://www.abc.net.au/catalyst/stories/s708821.htm>

1. When is it believed that an asteroid last hit the Wollongong area? Describe the evidence for this occurrence.
2. How powerful was the resultant tsunami? Describe the evidence for this.
3. How likely is another event such as this occurring?

Scientists have made another tsunami prediction regarding an active volcano in the **Canary Islands**.

<http://www.earthfiles.com/news/news.cfm?ID=851&category=Science>

1. Describe the location of the Canary Islands. Describe the size and shape of the Cumbre Vieja volcano.
2. Outline the activity of this volcano in the past. Why do scientists think that part of this volcano is unstable?
3. Draw a timeline and sketch maps to show what the computer modelling predicts might happen if the western side of the volcano erupts.
4. On your map, label the countries that would be affected by the predicted tsunami.
5. How long will it take for the tsunami to reach various coastlines? Record this on your map.
6. Study a population map of the areas that might be affected. Are they densely populated? Explain the importance of this factor?
7. When do scientists predict this event will take place?
8. One scientist has stated that "it is not a matter of if it will happen, but when". Describe how people might become aware of, and prepared for, this event.