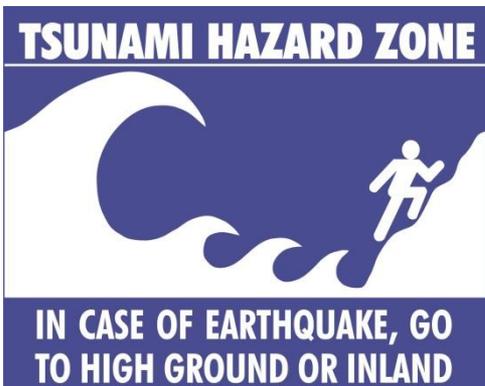




Lesson 1: What is a Tsunami Hazard and how do they Form?



Although all three are sea waves, a **tsunami**, a **tidal wave** and a **storm surge** are all different and unrelated phenomena.

- ✓ A **tidal wave** is a shallow water wave caused by the gravitational interactions between the Sun, Moon, and Earth. ('Tidal wave' was used in earlier times to describe what we now call a tsunami).
- ✓ A **tsunami** is an ocean wave triggered by large earthquakes that occur near or under the ocean, volcanic eruptions, submarine landslides, or by onshore landslides in which large volumes of debris fall into the water.
- ✓ A **storm surge** is a high tide wave which is blown on to the low lying coastline as a hurricane moves towards the coast'.

How a tsunami occurs

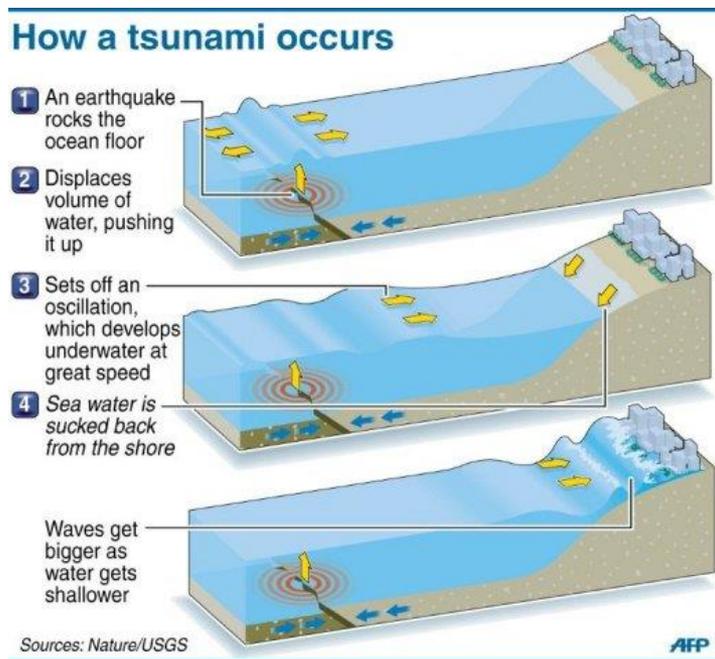




Diagram Number	The Step-by-step Formation of a Tsunami Wave
1	<ol style="list-style-type: none"><li>1. The sea floor is uplifted by a submarine (ocean floor) earthquake.</li><li>2. This displaces a column of water above the sea floor, pushing the water upwards.</li><li>3. A small surface wave is created, which is usually only a metre in wave height.</li></ol>
2	<ol style="list-style-type: none"><li>4. The surface wave splits into two separate waves.</li><li>5. The waves radiate outwards, travelling at high speeds in different directions.</li></ol>
3	<ol style="list-style-type: none"><li>6. The waves build in height as they approach the low-lying coastline.</li><li>7. The base of the wave slows down, due to the friction with the coastline, as the sea becomes shallower.</li><li>8. This makes the wave height build up and can build up to in excess of 25 metres in height. This increase in wave height is called 'stacking'.</li><li>9. The wave washes inland up to a mile, causing much destruction.</li></ol>



Describing and explaining the formation of a hazard or a landform in Geography is a bit like following a recipe to make a cake. Your answer should sequence each step and it is important that the sequence is written in the correct order.

Lesson 2: To What Extent Did the Asian Tsunami have a Social, Environmental and Economic Impact?

### Boxing Day 2004: Asian Tsunami - Case Study

On Sunday, 26 December 2004, the 9.1-9.3 magnitude Indian Ocean earthquake occurred when the Indian Plate was subducted by the Burma Plate. A series of devastating tsunamis were triggered along the coasts of most landmasses bordering the Indian Ocean, killing over 230,000 people in fourteen countries, and engulfing coastal communities with waves up to 30 meters high.



This tsunami was particularly devastating because:

- The earthquake which caused the tsunami was magnitude 9.
- The epicentre was very close to some densely populated coastal communities, eg Indonesia. They had little or no warning. The only sign came just before the tsunami struck when the waterline suddenly retreated, exposing hundreds of metres of beach and seabed.
- There was no Indian Ocean tsunami warning system in place. This could have saved more people in other countries further away from the epicentre.
- Many of the countries surrounding the Indian Ocean are LICs (Low Income Countries) so they could not afford to spend much on preparation and prevention.

Social	Economic	Environmental
<ul style="list-style-type: none"> <li>• 230 000 deaths.</li> <li>• 1.7 million homeless.</li> <li>• 5-6 million needing emergency aid, eg food and water.</li> </ul>	<ul style="list-style-type: none"> <li>• Ports ruined.</li> <li>• Fishing industry devastated - boats, nets and equipment destroyed. An estimated 60% of Sri Lanka's fishing fleet destroyed.</li> <li>• Reconstruction cost billions of dollars.</li> </ul>	<ul style="list-style-type: none"> <li>• Crops destroyed.</li> <li>• Farm land ruined by salt water.</li> <li>• 8 million litres of oil escaped from oil plants in Indonesia.</li> </ul>



Key

 Countries affected by the Indian Ocean tsunami



To What Extent did the Asian Tsunami have a Social, Environmental and Economic Impact?

Tourism decline	Trees stripped	Debris dumps
Hotels damaged	Soil removed	1.5 bn cars damaged
Floods	Livestock killed	70% of villagers killed (in some villages)
Disease spread	Small islands swept away	Flimsy wooden buildings destroyed
Roads blocked	Sea turtles died	Mud deposition on farmland
Schools closed	People missing	141,000 Houses destroyed
		Subsidence of coast
		Mangrove ecosystems destroyed
		Coral reefs destroyed
		Beaches of Sumatra eroded
		Cost to Indonesia: \$4.40
		600,000 unemployed
		Total cost: \$8.71 bn
		230,000 people died
		Sea fish killed

1. The Rubik's cube on the left contains an assortment of **Social**, **Environmental** and **Economic** ('SEE') impacts of the Asian Tsunami.

Read through all of the impacts.

**Social**

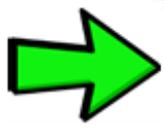
**Environmental**

**\$ Economic \$**

2. Your task is to solve the Rubik's cube and fit the 'SEE impacts' onto the appropriate face of the cube on the right.

Remember: some of the statements could be more than one type of impact! Think carefully!

Start by using a highlighter to identify the impacts on the cube above as **Social**, **Environmental** and **Economic**.



# To What Extent did the Asian Tsunami have a Social, Environmental and Economic Impact?

**Main task:** Using your solved Rubik's cube of 'SEE' impacts, you need to write an answer to the question above. Use the planning framework below to structure your answer.

**Introduction:** State when the tsunami occurred, briefly what triggered it and where it impacted. State that it had a range of social, environmental and economic impacts.

The tsunami was triggered by an underwater earthquake on the Indian Ocean, off the coast of the island of Sumatra on 26<sup>th</sup> December, 2004. It had a range of wide-reaching social, environmental and economic impacts.

**Main - Paragraph 1:**  
Choose two **social impacts** and describe them in detail. Why were people affected? Use your solved Rubik's cube to help you.

230,000 people died due to the wave and 600,000 people were left homeless/unemployed. These were long-lasting impacts which had a direct impact on people's livelihoods, homes and impacted their ability to survive on a day-to-day basis. People could not afford food, water or shelter.

**Main - Paragraph 2:**  
Choose two **environmental impacts** and describe them in detail. How was the environment damaged? Use your solved Rubik's cube to help you.

One of the main environmental impacts included the widespread coastal flooding. This flooding destroyed natural vegetation, residents homes and other buildings. Many coral reefs were destroyed and flooded with sediment, causing a loss of marine biodiversity with fish and sea turtles impacted.



### Main - Paragraph 3:

Choose two **economic impacts** and describe them in detail. How was the economy of the region affected?

Use your solved Rubik's cube to help you. EXTRA: was this economic impact short or long-term?

Two significant economic impacts included the total rebuild cost at \$8.71 billion and the cost to Indonesia was \$4.40 billion. A loss and decline in tourism in Indonesia was a part of this economic loss as many hotel resorts were destroyed. This was a long-term impact which took years to recover. During the disaster, many tourists were left stranded and homeless in South-East Asia.

**Conclusion:** do you believe that the Asian Tsunami disaster was a truly social, environmental and economic disaster? How strongly do you believe it be? Was it a significant, weak or strong impact?

It is clear that the Boxing Day tsunami was truly social, environmental and economic hazard. The social impacts and loss were by far the greatest impact across the world, with people from a number of countries impacted and caught up in the hazard. Because of this far-reaching impact, the disaster had significant social, environmental and economic impacts. It is the most severe natural disaster of recent times and the most deadly and costly tsunami hazard to date.



### To What Extent was the Asian Tsunami an International Hazard?



+ 15 minutes (after the earthquake) the tsunami hits Sumatra. 119,000 people died & 700,000 left homeless

+ 7 hours, the Seychelles are hit 3 people dead & 40 households homeless

+ 90 minutes, Thailand is hit 8,700 people dead, many homeless

+ over 11 hours, South Africa is hit 2 people died

+ 2 hours, Sri Lanka is hit 37,000 people dead & 1 million people homeless

+ 8 hours, Madagascar is hit No deaths & 1,000 people homeless

+2.5 hours, India is hit 16,000 people dead & 376,000 homeless

+ over 9 hours, the east coast of Africa is hit  
Somalia: 310 people dead, over 40,000 people homeless  
Kenya: 1 dead      Tanzania: at least 10 dead

**Task:** Read the impact statements. Number them in order from the first to the last impact. Shade in each box in a different colour and then locate it on the map neatly. Use an atlas to help.



**Making Links!** Using the map and the impacts above, consider this statement: 'the countries closer to the tsunami wave were impacted more severely, with countries further away being impacted to a less extent'.



The map does support the theory that the countries closest to the wave did receive the most severe impacts, with countries further away not being impacted as severely. This is shown by the factual evidence of how the wave caused damage around the Indian Ocean coastline. For example, the island of Sumatra ended up with a death toll of 119,000 with 700,000 people made homeless. This happened 15 minutes after the wave approached the coast. As the time the wave reached other countries increased, the impacts start to become less severe over distance. For example, the homeless figure is 1,000 people in Madagascar. However, the fact that the tsunami wave impacted 10 countries around the Indian Ocean coastline demonstrates how detrimental the impact of the wave was.

**Making Links!** The 2004 Boxing Day Tsunami is an example of an international hazard which has links to a number of factors which determine the severity and scale of the impact. These factors are:

- ✓ Distance/time from the wave.
- ✓ Population density and distribution around the Indian Ocean coastline.
- ✓ Economic wealth of the countries impacted (the majority of the countries are Low Income Countries).

This proves that when studying the extent of an impact of a hazard, there are a number of human and physical geography factors which must be considered. Governments, charities and agencies work together to mitigate and limit the control these factors have on posing a risk towards their residents.

It is the interaction of these factors which gives the overall risk to those who live in the region/area.





## Risky World: Tsunami Topic Glossary

Keyword	Definition
tsunami	An ocean wave triggered by large earthquakes that occur near or under the ocean, volcanic eruptions, submarine landslides, or by onshore landslides in which large volumes of debris fall into the water.
tidal wave	A shallow water wave caused by the gravitational interactions between the Sun, Moon, and Earth. ('Tidal wave' was used in earlier times to describe what we now call a tsunami).
storm surge	A high tide wave which is blown on to the low lying coastline as a hurricane moves towards the coast.
stacking / shoaling	A sudden increase in the height of the wave due to the sea becoming increasingly shallower. The base of the wave hits the coast and the energy is then transferred into the top of the wave, making the wave height increase.
social impacts	Damage which causes injuries and fatalities to the local population of where the tsunami hits.
economic impacts	Financially costly damage to industry, trade and infrastructure/transport networks.
environmental impacts	Damage to the natural landscape and ecosystems - including an impact on species of animals and plants.
infrastructure	Facilities and installations that help a government or community run, including roads, schools, phone lines, sewage treatment plants and power generation.