

# **Geography / Modern Studies**

## **Earthquake and Tsunami in the Indian Ocean**

A natural disaster

(Standard Grade; Intermediate 1 and 2)



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## Natural Disasters

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### ***Background – Indian Ocean disaster***

On 26 December 2004 just before 8 a.m. local time the Earth's crust shifted under the Indian Ocean 200 km west of Sumatra, creating a huge earthquake that recorded magnitude 9 on the Richter scale.

The Earthquake's shock waves then created a fierce tsunami that rampaged around the Indian Ocean, wreaking havoc as it pounded whole towns and villages along the coastlines of the region in southern Asia and as far away as East Africa. In some cases it completely engulfed whole islands isolated in the Indian Ocean. Countries hit include India, Indonesia, Sri Lanka, Thailand and the Maldives, as well the Seychelles, Tanzania and Somalia among others.



## Case Studies

### ***Natural disasters and their causes***

The [Centre for Research on the Epidemiology of Disasters](#) (CRED) defines a disaster as a

*'situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance (definition considered in EM-DAT); an unforeseen and often sudden event that causes great damage, destruction and human suffering'.*

In January 2005, the United Nations reported that at least 2.5 billion people had been affected by natural disasters over the past 10 years, an increase of 60 per cent over the previous decade.

Natural disasters are caused by natural events, physical and biological. Examples are given below:

- **Hydro-meteorological:** floods and wave surges, hurricanes and tornadoes, droughts, forest/scrub fires, landslides/avalanches, and extreme temperatures  
**Hurricanes: how they happen (Guardian website)**  
<http://www.guardian.co.uk/flash/0,5860,773980,00.html>
- **Geophysical:** earthquakes, tsunamis and volcanic eruptions  
**Volcanoes: how they work (Guardian website)**  
<http://www.guardian.co.uk/flash/0,5860,1321109,00.html>
- **Biological:** disease epidemics and insect infestations  
**Locust: Humanitarian early warning system website**  
<http://www.hewsweb.org/locust/>

## ***Some recent natural disasters***

<b>Date</b>	<b>Natural event</b>	<b>Impact</b>
2004	Earthquake and tsunami in the Indian Ocean	Wreaked havoc and devastation in at least 12 countries across several continents. Killed over 250,000 and destroyed whole communities.
2003	Earthquake in Iran measured 6.3 on the Richter scale	Killed more than 50,000 people. Earthquake interactive Guardian website: <a href="http://www.guardian.co.uk/flash/0,5860,1112768,00.html">http://www.guardian.co.uk/flash/0,5860,1112768,00.html</a>
1997	Volcanic eruption on the Caribbean island of Montserrat	Killed 19 people, destroyed towns and villages.
1995	Earthquake in Kobe, Japan, measured 7.3 on the Richter scale	Killed just fewer than 6500 people and left thousands homeless. <a href="http://www.seismo.unr.edu/ftp/pub/louie/class/100/effects-kobe.html">http://www.seismo.unr.edu/ftp/pub/louie/class/100/effects-kobe.html</a>
1991	Tucurui, Brazil	Insect infestation (mosquitoes) killed 2000 people.
1995	El Niño	Brought rain to California and caused severe flooding.
1989	Tornado	The deadliest in history ripped through Bangladesh, killed 1300 people; 50,000 were left homeless.
1988	Hurricane Gilbert	Produced winds to speed as high as 160 mph, killed 318 people and devastated Jamaica.
1980	Mount St Helens volcano in Washington State	Killed 56 people and an estimated 24,000 animals.

Sources: [BBC Natural Disasters website](#)

CRED International Disasters Database <http://www.em-dat.net/>

Natural events are largely beyond human control and are mostly unpredictable. However, scientists and other experts (engineering, technical, medical, and educational) are constantly working to reduce the extent of natural disaster around the world. They aim to do this by developing techniques, technology and equipment, vaccines and educational programmes to allow them to predict natural events and prevent or reduce their impact on our physical and human environment.

## ***Focus on earthquakes and tsunamis***

### **Earthquakes**

The earth's crust is made up of tectonic plates, 12 huge sections like big jigsaw pieces, and beneath this is molten rock that moves very slowly. This is known as the mantle. The tectonic plates float on the mantle and so they move with it. Earthquakes are caused by the tectonic plates moving in different directions and clashing when they meet. Pressure builds along the seam (fault lines) where the plates meet. When one plate suddenly gives way, the force behind it is so powerful that it generates a huge shudder (seismic ground movement). This sends out seismic shockwaves that can cause widespread destruction.

Earthquakes vary in magnitude, which is recorded on the Richter scale. The magnitude indicates the explosive power of the earthquake. It is a measure of the energy released. In our recent history earthquakes recording 9 or above on the Richter scale are rare.

#### **Richter scale:**

[http://en.wikipedia.org/wiki/Richter\\_magnitude\\_scale#Richter\\_magnitudes](http://en.wikipedia.org/wiki/Richter_magnitude_scale#Richter_magnitudes)

### **Tsunamis**

A tsunami results from the shock waves created by an underwater earthquake. It is a series of powerful waves, not just one wave, travelling at great speed across the ocean/sea. Most underwater earthquakes have registered less than 9 on the Richter scale and created tsunamis with a radius that remained within a localised area. Their destructive impact has not been as widespread and devastating as the recent Indian Ocean tsunami.

The Chilean tsunami in the Pacific Ocean was created by the largest earthquake ever measured, a magnitude 9.5 earthquake off the coast of Chile in 1960. The tsunami crashed into Chile first; from there it radiated (spread) outward hitting the Hawaiian Islands, the Philippines and Japan 10,000 miles (16,000 km) away. The tsunami is estimated to have killed over 2000 people and caused destruction in the affected areas.

**Information on the Chilean earthquake and tsunami** can be found at

[http://neic.usgs.gov/neis/eq\\_depot/world/1960\\_05\\_22.html](http://neic.usgs.gov/neis/eq_depot/world/1960_05_22.html)

The Pacific Ocean is prone to natural disasters and many countries whose coastlines are situated in the area have experienced loss of lives and destruction from tsunamis. The Hawaiian Islands, in particular, lie directly in the path of tsunamis created by most of the Pacific Ocean's seduction zones, points where one tectonic plate slips under another. The National Oceanic and Atmosphere Administration (NOAA) Coastal Services Center reports that ten major tsunamis over the past decade have occurred in the Pacific Basin, killing more than 4000 people.

## Indian Ocean tsunami

The Indian Ocean tsunami is reported to be the most devastating tsunami in recent history. The earthquake that created it is reported to be the fourth largest since 1900 and the biggest since the 1964 earthquake off the coast of Alaska, USA, which was magnitude 9.2 on the Richter scale.

The underwater earthquake that created the Indian Ocean tsunami happened because of a pressure build-up between two huge tectonic plates, the Indo-Australian tectonic plate and Burma tectonic plate. The Indo-Australian plate suddenly slipped, sending out shock waves recorded at magnitude 9 on the Richter scale and estimated to have travelled at great speed (400 km in just 200 seconds). The huge tectonic plates then immediately began readjusting, causing a series of aftershocks. Aftershocks will continue for months to come.

The earthquake created a tsunami. Experts have estimated that at the point where the sea floor ruptured, the epicentre, the water surged upward and then outward at up to 900 kph. Initially the waves would not have been high, but wide, about 100 km, and shallow, less than 0.5 m high, but when the water reached land it slowed down, letting the back catch up with the front, narrowing the wave from 100 km to 5 km and creating destructive tsunami waves up to 30 m high in some places.

The speed and spread of the tsunami meant that its devastating impact was not restricted to localised areas, but was extremely widespread, affecting at least 12 countries thousands of miles apart.

### **BBC news story: Images of ocean floor near epicentre**

<http://news.bbc.co.uk/2/hi/science/nature/4247409.stm>

## **Web resource links**

Find out more about the natural disasters from web resources found on the following website. Just click on the links.

### ***What is a natural disaster?***

**CRED International Disasters Database**

<http://www.em-dat.net/>

**Disaster statistics – UNISDR website**

<http://www.unisdr.org/disaster-statistics/introduction.htm>

**Natural Disasters (includes earthquakes, floods and storms, tidal waves and droughts) – BBC website**

<http://www.bbc.co.uk/science/hottopics/naturaldisasters/>

**World Meteorological Organisation website**

<http://www.wmo.ch/index-en.html>

## ***Causes of natural disasters***

### **General**

**Hazard Info – Pacific Disaster Center website**

[http://www.pdc.org/hazard\\_info.php](http://www.pdc.org/hazard_info.php)

**Kay's Geography website**

<http://www.geographer.pwp.blueyonder.co.uk/index.htm>

**Environmental hazards - BBC Scotland website**

<http://www.bbc.co.uk/scotland/education/int/geog/envhaz/>

**National Geophysical Data Center**

<http://www.ngdc.noaa.gov/seg/hazard/hazards.shtml>

**Activity Kids hazards questionnaire**

<http://www.ngdc.noaa.gov/seg/hazard/kqStart.shtml>

**NASA website**

<http://earthobservatory.nasa.gov/NaturalHazards/>

**NASA for KIDS website**

<http://kids.earth.nasa.gov/hazards.htm>

**World Meteorological Organisation website**

<http://www.wmo.int/disasters/naturalHazards.htm>

## ***Specific natural hazards***

### **Flooding – UK Environment Agency website**

<http://www.environment-agency.gov.uk/subjects/flood/?lang=e>

### **El Niño HEW website**

[http://www.hewsweb.org/nino\\_nina/](http://www.hewsweb.org/nino_nina/)

### **Biological: disease epidemics and insect infestations**

#### **Locusts – Humanitarian early warning system website**

<http://www.hewsweb.org/locust/>

### **Geophysical: earthquakes and tsunamis and volcanic eruptions**

#### **Volcano**

<http://sio.ucsd.edu/volcano/about/>

#### **Volcanoes**

[http://www.thinkquest.org/library/site\\_sum.html?tname=17457&url=17457/](http://www.thinkquest.org/library/site_sum.html?tname=17457&url=17457/)

#### **Natural disasters: earthquakes – Guardian website**

<http://www.guardian.co.uk/flash/0,5860,1121610,00.htm>

#### **Earthquakes, Tsunamis and Volcanoes – Savage Earth website**

<http://www.thirteen.org/savageearth/index.html>

#### **Earthquakes animated guide – CBBC website**

[http://news.bbc.co.uk/cbbcnews/hi/newsid\\_4130000/newsid\\_4132300/4132319.stm](http://news.bbc.co.uk/cbbcnews/hi/newsid_4130000/newsid_4132300/4132319.stm)

#### **Earthquakes – British Geological Society website**

<http://www.earthquakes.bgs.ac.uk/>

#### **Kobe earthquake – University of Washington website**

<http://www.ce.washington.edu/~liquefaction/html/quakes/kobe/kobe.html>

#### **Earthquakes – Newsround BBC website**

[http://news.bbc.co.uk/cbbcnews/hi/newsid\\_4130000/newsid\\_4132400/4132491.stm](http://news.bbc.co.uk/cbbcnews/hi/newsid_4130000/newsid_4132400/4132491.stm)

#### **Tsunami Q&A FEMA website**

[http://www.fema.gov/hazards/tsunamis/tsunami\\_questions.shtm](http://www.fema.gov/hazards/tsunamis/tsunami_questions.shtm)

#### **Earth Physics, Structural Geology and Plate Tectonics for Geology at Higher (Learning and Teaching Scotland)**

<http://www.LTScotland.org.uk/nq/search2.asp?guidResource=2180&vw=2&id=22802>

These support materials provide student information and worksheets, with staff notes.

## ***Indian Ocean tsunami***

### **US Geological Survey website**

<http://earthquake.usgs.gov/eqinthenews/2004/usslav/>

### **Newsround Asia Earthquake disaster – BBC website**

[http://news.bbc.co.uk/cbbcnews/hi/specials/2004/asia\\_earthquake\\_disaster/default.stm](http://news.bbc.co.uk/cbbcnews/hi/specials/2004/asia_earthquake_disaster/default.stm)

### **New Scientist special report on the Asian tsunami disaster: Instant Expert Geophysics of the Asian tsunami**

<http://www.newscientist.com/channel/earth/tsunami>

The following links give animated graphics of the Indian Ocean tsunami and geographical areas hit.

### **BBC news story: The Tsunami disaster explained**

[http://news.bbc.co.uk/1/hi/in\\_depth/4136289.stm](http://news.bbc.co.uk/1/hi/in_depth/4136289.stm)

### **BBC news story: At-a-glance: Countries hit**

<http://news.bbc.co.uk/1/hi/world/4126019.stm>

### **The Guardian website animated slides**

#### **How it happened**

<http://www.guardian.co.uk/flash/0,5860,1380955,00.html>

#### **How the wave spread**

<http://www.guardian.co.uk/flash/0,5860,1380592,00.html>

#### **Guardian website Country Guide**

<http://www.guardian.co.uk/flash/0,5860,1380654,00.html>

## ***Predicting/preventing natural disasters***

**Science @NASA**

<http://science.nasa.gov/EarthScience.htm>

**The Science Mission Directorate Science @ NASA website**

<http://science.hq.nasa.gov/>

**Tsunami Risks project**

<http://www.nerc-bas.ac.uk/tsunami-risks/index.html>

**Tsunami research – USGS website**

<http://walrus.wr.usgs.gov/tsunami/>

**Disaster Risk Reduction – WMO website**

<http://www.wmo.int/disasters/disasterRiskReduction.htm>

**Disaster reduction terminology**

<http://www.unisdr.org/eng/library/lib-terminology-eng%20home.htm>

**Early warning – ISDR website**

<http://www.unisdr.org/ppew/>

**Natural Disaster Prevention – WMO website**

<http://www.wmo.int/disasters/>

**BBC news story - Early warning technology**

<http://news.bbc.co.uk/1/hi/sci/tech/4149201.stm>

**Tsunami warning – NOAA website**

<http://www.prh.noaa.gov/itic/>

**Earthquakes Hazard Reduction programme – FEMA website**

<http://www.fema.gov/hazards/earthquakes/nehrrp/>

**Hazard risk management – World Bank website**

<http://www.worldbank.org/hazards/>

## Questions

1. Explain what causes natural disasters. Give examples in your answer.
2. *'Natural disasters rarely happen. It is unlikely that another one will happen again any time soon.'*

Tourist

Do you agree or disagree with this statement? Give evidence to support your answer.
3. *'We could not have stopped the earthquake and ensuing tsunami in the Indian Ocean.'*

International Scientist

Do you agree or disagree with this statement? Give reasons for your answer.
4. Design and produce a poster, slide show or PowerPoint presentation to show how the Indian Ocean natural disaster happened. Include the main events leading up to the natural disaster. Provide text and graphics/pictures.
5. Prepare a map showing the countries hit by the Indian Ocean tsunami.

## WebQuest: natural disasters



Meluaboh Overview  
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### Introduction

On 26 December 2004 disaster struck in the Indian Ocean region. A terrifying tsunami rampaged around the Indian Ocean for hours, wreaking havoc as it went. The tsunami brought catastrophe to the human, physical and natural environments and killed over 250,000 people. This was not a man-made disaster but a natural disaster.

Some say that the disaster could have been prevented, but others say that would be impossible, that natural disasters are beyond human control and that we just have to live with the consequences. Are natural disasters beyond our control? Can they be prevented? Your WebQuest is to find out.

### Task

You are an expert on Natural Disasters. You have been appointed by the United Nations to work with the team at the UN's International Strategy for Disaster Reduction (ISDR).

Your task is to conduct research into recent natural disasters and their causes, and our current capacity (technology, resources and expertise) to predict and control these causes. This will include a special focus on the Indian Ocean disaster.

You will report your findings and draw conclusions on the hypothesis that we can stop natural disasters from happening. Based on your conclusion, you will make recommendations to the Head of ISDR for future action.

## **Process**

You can work on your own or in partnership with others. Your teacher will tell you how this will be organised.

Before you begin, decide on your own, or if you are working with others agree with your partners, the following:

- a fair allocation of research and presentation tasks among the partners (e.g. research by area or web resource)
- the arrangements for progress updates and feedback sessions with your partners, including the communication medium (e.g. this could be through regular team meetings (face to face/VC), discussion forum, e-mail communication or blog)
- deadlines for completion of individual elements of the task and final deadline (if not already set by your teacher)
- how you will present your findings and recommendations (e.g. written report, video or PowerPoint presentation).

## **Background preparation**

- Read UNISDR's mission and objectives.
- Read background paper and case studies for natural disasters.
- Complete natural disaster activity questions. (This is optional and your teacher will let you know if you are to carry out this task.)

## **Research**

- Research into each area listed below using the web resources provided:
  - Research areas
  - Natural disasters
  - Causes of natural disasters
  - Predicting natural disasters
  - Preventing natural disasters.
- Record your findings using the research log.
- Participate in update/feedback sessions.

## **Analysis of findings**

On completion of the research, conduct an analysis of your findings, define the main issues and draw your main conclusions. Make recommendations for future action based on your conclusions. If you are working with others get together with your partners to share and discuss findings and conclusions and recommendations.

## **Presentation**

Prepare your report/presentation. Include the following:

- Introduction (include a note of your remit, aims and objectives)
- Overview of natural disasters and their causes
- Summary of findings on:
  - recent natural disasters and their causes (include special feature on Indian Ocean tsunami)
  - capacity to predict natural disasters
  - capacity to prevent natural disasters
- Conclusion
- Recommendations for future action
- Credits (e.g. note of sources used, partners you worked with and other people who helped).

Deliver your presentation.

## **Resources**

- Background paper and case studies for natural disasters
- ISDR mission and objectives  
[http://www.unisdr.org/eng/about\\_isdr/isdr-mission-objectives-eng.htm](http://www.unisdr.org/eng/about_isdr/isdr-mission-objectives-eng.htm)
- Use the web resources links given in this document.

## **Conclusion**

### **Summary record of achievements**

Through investigating the hypothesis that we can stop natural disasters from happening, you will have learned about natural disasters and their physical causes including the natural events that brought about the Indian Ocean disaster. You will also have developed your skills of enquiry.

## **Evaluation**

Your teacher will tell you how your work will be evaluated and how your achievements will be recorded.

## **Reflection**

Reflect on the following. Use the template provided to record your thoughts.

- What was achieved
- Own contribution
- Contribution of partners

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- Own level of interest and motivation
- Level of interest and motivation of others
- What you would do differently and why
- WebQuest activity