

**Geography / Modern Studies**  
**Earthquake and Tsunami in the Indian Ocean**  
Human and physical impact  
(Standard Grade; Intermediate 1 and 2)



Geography / Modern Studies Standard Grade; Intermediate 1 and 2

Earthquake and Tsunami in the Indian Ocean

## **Acknowledgements**

Learning and Teaching Scotland acknowledges the work of Michèle Donohoe in the production of this resource.

First published 2005.

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## Background

On 26 December 2004 as the Indian Ocean tsunami rampaged around the region it brought chaos and almost complete devastation to the towns and villages along the coastlines of the region in southern Asia and as far away as East Africa, including India, Indonesia, Sri Lanka, Thailand and Maldives, as well the Seychelles, Tanzania and Somalia among others.

The impact on the inhabitants, the social-economic infrastructure and the environment was for many catastrophic.



Area affected by the Indian Ocean tsunami

## **Case study: human and socio-economic impact**

### ***Human losses***

In the aftermath of the tsunami, reports estimate that five million people have been directly affected by the tsunami. Over 250,000 were killed and thousands of others declared missing presumed dead.

Thousands of the people affected were tourists. Hundreds of tourists are now dead and many more are missing. UK, Germany and Sweden have been among the hardest hit European nations

#### **BBC news story: Thousands of tourists feared dead**

<http://news.bbc.co.uk/2/hi/asia-pacific/4148479.stm>

Many victims were swept away by the great force of the tsunami. Thousands of bodies have already been recovered from the sea, the beaches and the rubble of hotels, homes and other buildings, but many others may never be recovered. In some areas it took several days before the body recovery exercise started. As time elapses bodies begin to decompose and identification becomes difficult. The use of DNA testing techniques to identify the victims' remains has been an important feature of the recovery exercise.

#### **BBC news story: UK police help identify tsunami dead**

[http://news.bbc.co.uk/1/hi/england/south\\_yorkshire/4228753.stm](http://news.bbc.co.uk/1/hi/england/south_yorkshire/4228753.stm)

### ***Plight of the survivors***



Handing over relief supplies (© Red Cross)

The disaster mostly affected poor communities where people lived on marginal land. In some areas the tsunami completely devastated socio-economic infrastructures, wiping out homes, schools, hospitals, offices, shops, hotels, roads and bridges, electricity supplies, crops, irrigation and fishery infrastructure, food and fuel networks.

Millions of people have seen their families and communities torn apart and are now homeless, destitute and struggling to meet their immediate basic needs such as food, water, health, shelter and protection.

#### **The Indian Ocean tsunami crisis: humanitarian dimensions (Overseas Development Institute)**

<http://www.odi.org.uk/hpg/Tsunami.htm>

Experts warn of the immediate and long-term impact on the physical and mental health of the survivors and others directly affected or involved in the relief effort. There are concerns about the malnutrition of children due to lack of access to adequate food supplies, particularly infant foods in some areas. Water facilities were destroyed or contaminated, increasing the risk of diseases. There is further risk of disease through lack of hygiene products and sanitation facilities. Key concerns are

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dysentery and malaria. Experts have warned that people will find it difficult to rebuild their lives if they are fighting depression and suffering from post-traumatic stress.

### **BBC news story: Fears of tsunami's mental impact**

<http://news.bbc.co.uk/1/hi/uk/4138413.stm>

In many of the affected areas economic life has stopped; businesses have collapsed. Agriculture, fishing and tourism, the mainstays of many of the local economies, have been severely disrupted. Millions of people are facing the prospect of living in poverty as their livelihoods have been destroyed.

### **Economic consequences of the tsunami (ODI website)**

<http://www.odi.org.uk/tsunami.html>

### **BBC news story: At a glance economic impact**

<http://news.bbc.co.uk/1/hi/business/4154277.stm>

### **BBC news story: Asia quake increases poverty risk**

<http://news.bbc.co.uk/1/hi/business/4170353.stm>

In some places the waves washed in more than 2 km inland. In many areas sea salt has entered the water table; the land is covered in salty mud, preventing agriculture. It will take years before this clears, making these areas completely uninhabitable. People have been forced to abandon these areas and it is thought that many are unlikely to return.

## ***Tourist industry***

Tourism is a major source of income in many of the areas hit by the tsunami and is therefore vital to local economies.

The tourist infrastructure such as hotels, shops, restaurants and bars has been badly damaged. A significant number of tourists were killed or are reported missing. Tour and holiday operators have reported that since 26 December 2004 many people have cancelled their holiday bookings and some airlines have cancelled tourist flights for the areas affected.

Many who have been directly affected are worried about the longer-term impact that the disaster might have on the tourism industry. They fear that the industry will not recover and their key source of income will be lost, leaving them living in poverty or having to leave their communities and go inland looking for new livelihoods to support themselves and their families.

However, there are reports that observers involved in the tourist industry have commented that the drop in tourism is only temporary, as it was after other disasters such as the terrorist attacks in New York on 11 September 2001 or the bombing on the island of Bali in 2002. They believe that travellers will soon want to return to the areas affected and spend time and money there to help local economies recover.

### **BBC news story: Asia tourism 'will bounce back'**

<http://news.bbc.co.uk/1/hi/world/europe/4152213.stm>

## Case study: differences in impact

The full impact of the Indian Ocean tsunami will emerge in the coming months but already it is known that the extent and nature of human and socio-economic impact varies across the affected region stretching from South Asia to East Africa. This is because its impact is dependent on a number of factors such as distance of a country from the epicentre, its physical landscape (topography of the land), design and strength of buildings, the proximity of human settlements (communities) to the coastline and the type of economic activities (jobs) the people depend on for their livelihoods. Some differences in impact are given below.

- **Indonesia**

Indonesia was closest to the epicentre (point where the earthquake happened) and hardest hit in terms of human suffering. It suffered the highest death toll with the estimated number of people killed and reported missing presumed dead reported at 232,732 by early February 2005. The main impact was concentrated in two provinces, Aceh and Northern Sumatra, which are major tourist areas. Much of the socio-economic infrastructure in these areas was destroyed or severely disrupted. The number of people left homeless is estimated at 800,000.

However, as Indonesia as a whole does not rely on the tourist industry for its income it is anticipated that overall the country's economy will barely be affected. Reports are that Aceh region's oil and natural gas production facilities have not been damaged, which is good news for the economy and long-term recovery of the area. The extent of damage to livelihoods in Aceh depends on how much farmland has been flooded by seawater.

- **Maldives**

Experts report that because of the shallow waters along its coastline the Maldives was spared huge loss of life (82 killed and 26 missing) and major physical destruction. The swell water did not have a landmass to build up against as it did in other areas such as Indonesia, India and Sri Lanka. The waves did not reach more than 1.2–1.5m (4–5ft) in height.

However, the land itself was severely damaged and was covered in salty mud. Many of the islands are now completely uninhabitable, and around 12,500 islanders have been displaced. Fishing and tourism have been severely disrupted. Many fishermen lost their boats. The Maldives are far more dependent on tourism than the other affected countries. It is reported that 19 out of 87 resorts were severely damaged, and 14 suffered major partial damage. These will require extensive reconstruction before they can re-open for business.

- **Somalia**

Somalia is the worst hit country in Africa. It is 4100 km (2500 miles) west of the epicentre. Its death toll is estimated to be between 132 and 298. However, because it does not have a functioning government, assessments of Somalia's needs are considered unreliable. Relief workers suspect that in some cases reports of the extent of the death toll and other damage are exaggerated.

- **Seychelles**

The Seychelles lie several thousand miles from the epicentre. One person is reported to have died as a result of the tsunami on the Seychelles. Buildings, transport infrastructure and agriculture were damaged. However, Air Seychelles has reported that several tour operators have been diverting clients to Seychelles resorts from the Maldives and Sri Lanka, which indicates that the island's tourist infrastructure has not been badly affected.

## Case study: impact on the natural environment

The impact of the tsunami on the natural environment is not as immediately visible as the human/socio-economic impact. Scientists and other experts on the environment, conservation and marine science have begun assessing the situation but say that it will take a long time and significant resources (money, manpower and equipment) to assess the full extent and nature of the impact of the tsunami. However, many already fear that the damage caused by the tsunami is extensive and in some cases permanent. Early reports have revealed the following.

### The Earth

NASA's website reports that calculations made by scientists studying the Indonesian Ocean earthquake show that it changed the shape of the globe, reduced the length of a day by almost three microseconds, and shunted the North Pole by centimetres.

#### How the Earthquake affected Earth (NASA)

[http://science.nasa.gov/headlines/y2005/10jan\\_earthquake.htm](http://science.nasa.gov/headlines/y2005/10jan_earthquake.htm)

#### Impact on the Natural Environment, (ENN website)

<http://www.enn.com/eco.html?id=441>

### Coastlines

The tsunami was so powerful that its impact permanently changed the shape of coastlines around the Indian Ocean. The National Geographic news website reports:

*Reports continue to surface of vanished islands, restructured coastlines, and uncertain shipping lanes. Geographers are responding with satellites and survey vessels to determine which areas are hardest hit. Their findings are helping and rechart maritime routes essential for the delivery of relief supplies.*

Tsunami Redraws Indian Ocean Maps

[http://news.nationalgeographic.com/news/2005/01/0112\\_050112\\_tv\\_tsunami\\_map.html](http://news.nationalgeographic.com/news/2005/01/0112_050112_tv_tsunami_map.html)



Before



After

Banda Aceh shore before and after impact (Digital Globe [www.digitalglobe.com](http://www.digitalglobe.com))

## **Marine life**

The tsunami's impact on marine life is feared to be extensive. The sheer force of the tsunami waves pounded coral reef and swept away great chunks. It ripped up huge sections of mangrove forests. There is concern about indirect and long-term damage to coastal ecosystems and marine life from the excessive amounts of debris in the shallow waters. Hazardous chemicals, oils or paints might have run off from the land into the sea. Raw sewage, the product of decomposed flora and fauna, unrecovered bodies and timber from mangroves are also hazardous. Other debris such as cars, fridges, buildings, fishing boats, fishing gear, including nets and sharp objects, risk lives of marine animals that get caught up among it.

### **Impact of tsunamis on ecosystems**

<http://www.oceansatlas.org/>

## **Coastal ecosystems**

Experts fear that the tsunami might have caused extensive and permanent damage to coastal ecosystems.

### **Potential ecological impacts of Indian Ocean tsunami on near shore marine ecosystems (NOAA website)**

<http://www.noaanews.noaa.gov/stories2005/s2362.htm>

## **Coral reefs**

### **Image of coral reef (Ocean World)**

<http://oceanworld.tamu.edu/students/coral/index.html>

Coral reefs are living communities of coral polyps and algae. They are often referred to as undersea gardens and are beautiful to look at. However, they also have the very important function of providing a shelter and nursery habitat to communities of marine life including numerous species of fish, sea horses, sea turtles and sponges. Corals are also important for human socio-economic infrastructure. For example, they support fishing communities because the people catch the fish living around the coral reef. They also support the tourist industry. Diving sightseeing trips around the coral reefs are very popular with tourists.

Early investigation reveals that along many of the Indian Ocean coastlines corals were crushed and torn up by the powerful tsunami waves. It is also thought that others have been smothered by mud, sand and debris washed up by the tsunami from land to the sea. This is not good news for the marine species that they once supported as corals grow slowly and their recovery is likely to take years.

Coral reefs are also considered to form a natural defence against hazards in coastal areas as they act as a natural barrier absorbing the energy and minimising the impact of the waves on the shore. Early reports suggest that the ecosystems in areas in which reefs were largely intact may have survived better than areas where coral reef had already been destroyed by urban development, aquaculture and tourism. Keeping the reefs intact around the Maldives is credited with reducing the loss of life.

### **Tsunami impacts on coastal environments (Reefbase)**

<http://www.reefbase.org/Tsunami.asp>

## **Mangrove**

Mangrove is known as the rainforest of the sea. It is vital for healthy coastal ecosystems. Its leaves provide valuable nutrients for the marine environment, supporting diverse varieties of marine life. It also provides a habitat for wildlife including birds, monkeys, lizards and turtles.

There are reports that vast areas of mangrove forests were destroyed and need replanting.

Mangrove forests located close to the epicentre of the tsunami were damaged by the sheer force of the waves. Silt deposited by the waves is also thought to be suffocating mangroves. Mangroves which act as nursery habitats for young fish may have been wiped out. This threatens future fishing crops.

Mangroves are also natural barriers absorbing the wave energy and they protect human coastal settlements. This protective function of mangroves is reported to have reduced the impact of the tsunami in areas located behind mangrove forest in the Maldives, India and Malaysia. Mangroves have been credited with saving lives and property.

Some environmentalists claim that decades of deforestation of mangroves for commercial purposes, including development of housing, agriculture and tourism, has added to the damaging impact of the tsunami, citing the fact that where the mangrove forests remain intact, there was reduced property damage and less impact on the coast compared to areas where mangroves have been harvested for commercial purposes.

### **Mangrove forests reduce impact of tsunami and cyclones (ENN)**

<http://www.enn.com/eco.html?id=437>

### **UN urges planting of mangroves as tsunami barrier (Planet Ark)**

<http://www.planetark.com/dailynewsstory.cfm/newsid/29101/story.htm>

## **Marine animals**

Reports on the National Geographic news website highlight the impact of the tsunami on marine animals

*People and uprooted trees were carried out to sea, while stingrays and sharks were left stranded in fields and parking lots... In Thailand, for instance, dolphins were swept 500 yards (500 meters) inland. Many dead and injured sea turtles were left high and dry, and a three-foot (one-meter) shark ended up in a hotel swimming pool. Beaches were littered with dead fish as well as human bodies.*

James Owen, January 17, 2005

### **Tsunami Clouds future of marine animals (National Geographic)**

[http://news.nationalgeographic.com/news/2005/01/0117\\_050119\\_tsunami\\_marine.html](http://news.nationalgeographic.com/news/2005/01/0117_050119_tsunami_marine.html)

Experts are worried about the fate of the region's vulnerable marine animals particularly sea turtles, saltwater crocodiles and dugongs. Dugongs do not cope well in turbulent waters as they are not strong swimmers.

### **Dugongs**

<http://www.deh.gov.au/coasts/species/dugongs/>

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Salt water crocodiles live in creeks, which suffered severe impacts from the powerful tsunami waves.

It is feared that the devastating impact of the tsunami could make some species of sea turtles extinct.

**Marine turtles**

<http://www.nmfs.noaa.gov/pr/species/turtles/>

It is reported that sandy beaches have been seriously damaged and turtle nesting sites have been destroyed. The turtle nesting season runs from November to January but beaches are covered with debris thrown up by the tsunami, creating conditions which are not good for turtles to lay eggs. There are also reports of sea turtles swept up by the waves ending up on the shores, some dead, others with cuts, scrapes and broken shells.

Sea turtles in the affected region (Olive Ridley and Leatherback) are already protected species, but are now thought to have been made even more vulnerable by the tsunami.

## Web resource links

Find out more about the impact of the tsunami in different countries across the region from web resources found on the following websites. Just click on the links.

### **General**

**BBC news story: At-a-glance: countries**

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

**ABC news photo gallery of impact**

<http://www.abc.net.au/news/newsitems/200412/s1272629.htm>

### ***Human and socio-economic impact***

#### **Human losses**

**BBC news story: Death toll**

<http://news.bbc.co.uk/1/hi/world/asia-pacific/4136781.stm#map>

**BBC news story: Fears of tsunami's mental impact**

<http://news.bbc.co.uk/1/hi/uk/4138413.stm>

**Indian Ocean tsunami crisis humanitarian dimensions (ODI)**

<http://www.odi.org.uk/hpg/tsunami.htm>

#### **Plight of survivors**

**Economic consequences (ODI website)**

<http://www.odi.org.uk/tsunami.html>

**BBC news story: Asia quake increases poverty risk**

<http://news.bbc.co.uk/1/hi/business/4170353.stm>

#### **Tourist industry**

**BBC news story: Asia tourism 'will bounce back'**

<http://news.bbc.co.uk/1/hi/world/europe/4152213.stm>

**BBC News story: Special on Asia earthquake disaster**

[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)

Special report on the disaster specifically for young people. Includes step-by-step guide with information and facts, opportunity to comment and share feelings as well as ideas on how young people can help with fundraising.

**BBC news story: Maldives 'set back by 20 years' – BBC**

[http://news.bbc.co.uk/1/hi/world/south\\_asia/4148279.stm](http://news.bbc.co.uk/1/hi/world/south_asia/4148279.stm)

#### **Impact on the natural environment**

**Asia Quake, Tsunami Moved Islands, Shortened Days**

<http://www.enn.com/eco.html?id=441>

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**Science @NASA**

[http://science.nasa.gov/headlines/y2005/10jan\\_earthquake.htm](http://science.nasa.gov/headlines/y2005/10jan_earthquake.htm)

**Coastlines**

**Tsunami Redraws Indian Ocean Maps**

[http://news.nationalgeographic.com/news/2005/01/0112\\_050112\\_tv\\_tsunami\\_map.html](http://news.nationalgeographic.com/news/2005/01/0112_050112_tv_tsunami_map.html)

**Digital Globe website**

<http://www.digitalglobe.com/>

**Ecosystems**

Impact of tsunamis on ecosystems – UN atlas of the oceans

<http://www.oceansatlas.org>

**UN urges planting of mangroves as tsunami barrier (Planet Ark)**

<http://www.planetark.com/dailynewsstory.cfm/newsid/29101/story.htm>

**Marine animals**

**Tsunami clouds future of marine animals – (National Geographic)**

[http://news.nationalgeographic.com/news/2005/01/0117\\_050119\\_tsunami\\_marine.html](http://news.nationalgeographic.com/news/2005/01/0117_050119_tsunami_marine.html)

**Manatees and dugongs**

<http://www.cep.unep.org/kids/kids.html>

## Questions

1. a) Read the background information and case study entitled *Human and Socio-economic Impact*
  - (b) You are a public relations officer with the UK's Department for International Development (DFID). Prepare a short press release describing the human and socio-economic impact of the Indian Ocean tsunami. Give your press release a title. It might be helpful to organise your information using the following headings:
    - i. Introduction
    - ii. Countries hit (map/table)
    - iii. Impact (people, socio-economic infrastructure).

Your press release can be written or recorded on video

2. In the aftermath of the Indian Ocean tsunami millions of people have seen their families and communities torn apart and are now homeless, destitute and struggling to meet their basic needs.
  - (a) Explain what is meant by basic needs.
  - (b) List the basic needs of those involved in the disaster.
3. *The tsunami has ruined tourism in the area. No one will ever want to come back to a place that is so dangerous*

(local hotelier)

Give at least one argument for and one against this statement.

4. *People and the socio-economic infrastructure have been devastated by the Indian Ocean tsunami but there has been little impact on the natural environment.*

(UK tourist)

Give arguments for and against this statement. Use examples to support your arguments.

5. Design and produce a 'before and after' poster to show the likely impact of the tsunami on the natural environment (the earth, coastlines, coastal ecosystems and marine animals).

## WebQuest

### Introduction

The impact of the tsunami on the natural environment is not as immediately visible as the human/socio-economic impact. Scientists and other experts on the environment, conservation and marine science have begun assessing the situation from South Asia to East Africa but say that it will take a long time and significant resources (money, manpower and equipment) to assess the full extent and nature of the impact of the tsunami. However, many already fear that the damage caused by the tsunami is extensive and in some cases permanent.

However, those currently involved in the initial assessment process fear that the tsunami might have caused extensive and permanent environmental damage to affected coastlines, the eco-system and marine animals.

### Task

You are a marine scientist, an expert in your field. You have been asked by United Nations Environment Programme (UNEP) to assist in the assessment of the nature and extent of the impact of the tsunami on the earth and its natural environment.

You will investigate, report your findings and draw conclusions on the hypothesis that although people and the socio-economic infrastructure have been devastated by the Indian Ocean tsunami, there has been little impact on the natural environment.

### 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 team (e.g. research by area or web resource)
- the arrangements for progress update and feedback sessions with your partners, including communication medium (e.g. regular team meetings (face to face/VC), discussion forum, e-mail communication or weblog)
- 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, conclusions and recommendations (e.g. written report, AV, PowerPoint presentation).

### Background preparation

- Read background paper and case studies for *Earthquake and Tsunami in the Indian Ocean – Human and physical impact*.

### Earthquake and Tsunami in the Indian Ocean

- Complete *Earthquake and Tsunami in the Indian Ocean* 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:
  - The Earth
  - Coastlines
  - Ecosystems
  - Marine animals.
- Record your findings using the research template.
- 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 agree conclusions and recommendations.

### Optional activities

(Your teacher will tell you if you are to complete these activities.)

Based on findings, compare the extent and nature of impact on the environment in areas where coral reefs/mangrove forests were intact compared to impact where they were not.

Use your findings and conclusions to make recommendations for future action to aid recovery and minimise the environmental impact of future tsunamis.

### Presentation

Prepare your report/presentation. Include the following:

- Introduction (include a note of your remit, aims and objectives)
- Overview of the Indian Ocean disaster and areas hit
- Summary findings on the impact on:
  - The Earth
  - Coastlines
  - Ecosystems
  - Marine animals.
- Comparison of impact (optional)
- Conclusions
- Recommendations for action (optional)

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- Credits (e.g. note of sources used, partners you worked with and other people who helped)

Deliver your presentation.

## **Resources**

Web resource links – Impact on the Natural Environment

## **Conclusion**

### **Summary record of achievements**

By taking part in this investigation, you will have developed skills of enquiry. You will also have learned the extent and nature of the human, physical and environmental impact of the Indian Ocean earthquake and tsunami, in the areas directly hit and on a global scale.

In drawing comparisons on the extent and nature of the impact on the environment in different areas affected you will have understood that the tsunami has not had a uniform effect on areas hit.

### **Evaluation**

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

### **Reflection**

Reflect on the following using the template provided.

- What has been achieved
- Own contribution
- Contribution of partners
- Own level of interest and motivation
- Level of interest and motivation of others
- What you would do differently and why
- WebQuest activity